

Fall 2009



Transportation & Outdoor Air Quality

Educator Guide



**An Educator Resource for
the Washington Green Schools
Transportation & Outdoor Air Quality
Assessment**

About This Educator Guide

Goal of This Guide

The purpose of this guide is to provide an overview on transportation choices so teachers can help educate students about how their decisions impact environmental and human health. Teachers will be able to help their students:

- Recognize the important role that transportation plays in their everyday lives.
- Discuss the environmental impact that daily transportation habits have on energy consumption, outdoor air quality, and other environmental problems associated with transportation.
- Identify behaviors and habits that individuals can modify to reduce their use of fossil fuels through different modes of transportation, thereby decreasing air pollution.

How to Use This Guide

This guide includes basic introductory information on transportation, outdoor air quality, alternative modes of transportation, and alternative fuels. Included are:

- [Key Ideas on transportation and outdoor air quality](#)
- [Key Vocabulary words](#)
- [Starter Discussion Questions for overview or enhancing curriculum](#)
- [Connections to Other Topics](#)
- [Resources and Links](#)

This Guide will support your Green Team's efforts to be educated and effective as catalysts for reducing energy consumption from transportation.

For in-depth information and classroom activities, take a look at the Ontario EcoSchools Guides available at: http://ontarioecoschools.org/curriculum_resources/index.htm.

For additional program information, visit:
www.wagreenschools.org

Acknowledgements for the Washington Green Schools Educator Guides:

- Washington Green Schools Steering Team and Cascadia Consulting for Educator Guide development.
- O'Brien & Company for design donation.
- Washington State Department of Ecology for grant funding for program development.
- With special thanks to Ontario EcoSchools for providing ideas & inspiration.



Introduction

Why Care about Transportation and Outdoor Air Quality?

Americans have come to depend on motorized transportation for getting to school, work, the grocery store, the library, and everywhere in between. Transportation is responsible for bringing food to our grocery stores and products to our shopping aisles – whether it's bananas on morning cereal, spaghetti for dinner, or notebooks for class today.

Commercial transportation is vital for producing and shipping these items through its complete life cycle: from vehicles that cut lumber and deliver it to the mill to make paper; to trucks that collect the notebooks and transport them to the stores for eventual purchase; to the garbage trucks that dispose of discarded items.

Personal vehicles—cars—became popular in the 1920s when more and more families could afford to buy one. Most personal vehicles in the U.S. today run on gasoline. Having a car allows people to live farther from work, school, stores, and entertainment than they did previously. As a result, since the age of the automobile, 86% of the growth in population in the United States has happened in outlying suburban areas as opposed to urban centers creating urban sprawl and some subsequent land use issues.

One negative consequence of more people travelling more miles is an increase in *air pollution*. Pollutants such as *carbon monoxide, particulate matter, nitrogen oxides, and hydrocarbons* are emitted into the air while we drive to school or fly to our next destination. These pollutants can adversely affect human health and lead to habitat degradation. Driving automobiles also has negative consequences on local water quality, as car fluids that drain onto the streets

can end up polluting nearby waterways. With more people driving more miles, it is essential to examine our transportation choices and find ways to decrease our impact on the environment.

Different modes of transportation are powered by *gasoline, diesel, hybrid-electric, propane, ethanol, biodiesel, electric, natural gas, methanol*, and other sources.

In 1902, large-scale production of the automobile by Ransom Olds at his Oldsmobile factory and later by Henry Ford in 1914, provided the opportunity for people to have their own cars.

In 2007, there were about 806 million cars and light trucks on the road worldwide. These numbers are rapidly increasing.

Fossil fuels, including gasoline and diesel, are the fuels we rely on, almost exclusively to power cars, buses, planes, automobiles, and trains.

While numerous options are being explored, there is not one perfect solution to solving the fuel and energy crisis that lies ahead, except for *conservation*. By driving less and by walking more, by biking and taking public transportation, by buying locally grown and produced items, and by further developing alternative fuels, the many collective actions of all of us can help solve the energy challenges we face.

Key Ideas

Americans consume about one quarter of all of the oil extracted from the Earth each year.

- *Over 60% of the oil* consumed in the US is imported from other countries, mostly from the Middle East.
- Across the globe, *demands for oil are on the rise*, and international conflicts and wars between countries that export oil and countries that import it have become a large problem.
- As more oil is extracted from the earth, it will become more difficult and more costly to extract remaining reserves. *Oil is a non-renewable resource.*
- *Gasoline* makes up 44% of the crude oil Americans use and is becoming more expensive.
- Of all the vehicles driven in the United States, around 98% are fueled by petroleum or diesel.
- Gasoline cost a mere \$0.25 per gallon during World War I, and surpassed \$4.00 per gallon in 2008. If costs increase in the next 100 years at the same rate as they have over the last century, a gallon of gas could cost \$64.
- On average, Americans consume *over a gallon of gas* per day

Using the automobile as our main choice of transportation affects outdoor air and water quality and leads to changes in global climate.

- *Vehicles* emit many types of pollutants into the air—carbon monoxide, particulate matter, nitrogen oxides, and hydrocarbons.
- *Carbon monoxide* causes respiratory problems, headaches, visual impairment, and other health problems.
- *Particulate matter*, commonly associated with diesel engines, also causes respiratory problems.

- Nitrogen oxides are harmful to human and environmental health, and cause smog and ozone in the lower part of the atmosphere where it is damaging to human health.
- Hydrocarbons also contribute to ozone development in the lower atmosphere and are associated with medical problems.
- Cars, buses, and trucks account for more than half of the air pollution experienced in urban areas. They not only pollute the air, they can also leak oils and grease in parking lots. When it rains, these wash into storm drains that lead directly to our waterways without being treated or filtered.
- Using fossil fuels (e.g. gasoline) in vehicles emits *carbon dioxide*, a greenhouse gas. Carbon dioxide and other greenhouse gases form a blanket around the atmosphere preventing sun energy (heat) from leaving the earth. As emission rates continue to rise, along with other contributing factors, the earth's temperature warms. Scientists have predicted numerous consequences to rising temperatures such as rising sea levels, changes in insect populations, forest fires, loss of glaciers, changes in water runoff, and more intense storms.
- The transportation sector is responsible for *nearly one-third of all the carbon dioxide emitted* in the United States. Of that amount, passenger cars are the



Key Ideas

biggest source of transportation-related greenhouse gas emissions.

- *Respiratory problems* and other health issues are increasingly reported, especially among children and the elderly, and connections have been made to automobile emissions.

Urban sprawl plays a major role in excessive driving habits which leads to increased air pollution.

- With the advent of cars, people began moving away from city centers to suburban and rural areas.
- *Sprawl* is typically characterized as areas with strip malls, mostly single-family houses, and many miles between residential and commercial areas.
- Studies have shown that urban sprawl is linked to problems with obesity.
- People living far from work and school have to *commute*. Commuting by car is a major contributor to outdoor air pollution.
- When possible, choose to live in *walkable communities* and areas close to where you work or go to school to lessen your car use. Less driving helps to decrease air pollution caused from burning fossil fuels.

Expanding roads to accommodate heavier traffic is destructive to the environment.

- Collectively, *Americans travel roughly four trillion miles each year* in their vehicles. This is the equivalent of taking approximately eight million trips to the moon and back.
- *Commercial vehicles travel 183 billion miles*, and buses drive an additional 6.5 billion miles per year.
- The number of miles Americans drive is increasing.
- To accommodate more traffic and more time spent on the road, transportation departments have to widen existing roadways and build new ones, turning

land that was once habitat for plants and wildlife or a residential community into a flattened landscape paved with cement (an impermeable surface).

- Transportation competes with other sectors for land use, such as agriculture for food crops and open space.

Traveling by plane is a fuel-intensive mode of transportation and leads to greater air and atmospheric pollution.

- Fuel use and carbon dioxide emissions from air travel are almost equivalent per mile to driving a car alone, even though we ride in planes with many people.
- *Jet travel* emits other greenhouse gases higher in the atmosphere where they are more harmful. Other pollutants released by jet planes destroy ozone in the upper atmosphere where ozone is beneficial, and creates ozone in the lower atmosphere where it is harmful to human health.
- *Washington is ranked third in the nation*, after Alaska and Hawaii, in the number of miles travelled by air per person.

Diesel fuel is more efficient than gasoline, but poses more threat to air quality.

- *Diesel fuel* is 20-40% more efficient than gasoline and is considered safer because it is not as flammable, but the using of diesel fuel emits pollutants including sulfur dioxide, nitrogen oxides, and particulate matter.
- Diesel fuel is used in over 60% of farm equipment, school buses and public transit, construction machinery, and freight transport.
- School buses that idle in front of schools while waiting for students cause air pollution around the school. Fumes from the bus can travel through any open classroom or office windows.

Key Ideas

- In Europe, diesel-powered personal vehicles are much more popular than in the U.S.
- New diesel fuels contain less sulfur which results in less pollution emission.

Alternative fuels and engines provide more efficient and cost-effective ways to travel.

- There are more than 60 different types of alternative fuels—each with its own

advantages and disadvantages. The table below outlines information about the most common types.

- Considering the options in the table is helpful, but ultimately conservation through increased use of public transportation (bus, train), walking, and biking are the most effective actions.

Fuel	How it Works	Advantages	Disadvantages
<i>Ethanol</i>	<ul style="list-style-type: none"> • Liquid alcohol that is colorless and odorless. • Made from the fermentation of the biomass in carbohydrates. • Commonly produced from sugar cane, corn, or wheat. 	<ul style="list-style-type: none"> • Can be and is blended with gasoline at many fuel stations in urban areas. • Emits less carbon monoxide than petroleum. • Crops to produce ethanol also serve as a carbon sink for carbon dioxide, a greenhouse gas. • Comes from renewable supplies. • Can be grown and processed locally. • Quickly biodegrades, so it's virtually harmless if spilled. • Reduces emissions of gasoline powered cars when blended with gasoline. 	<ul style="list-style-type: none"> • Susceptible to price fluctuations depending on crop years. • Can be corrosive to some metals and rubber, so engine parts must be resistant to corrosion and damage. • Has 15% less energy content than gasoline and therefore decreases miles per gallon.
<i>Hybrid electric vehicles</i>	<ul style="list-style-type: none"> • Utilizes a combination of fuel and energy storage, such as internal combustion engine and battery. 	<ul style="list-style-type: none"> • Can be 1.5 to 3 times more efficient than conventional vehicles. • The battery recharges automatically through the braking system, so it doesn't require plugging in to recharge. • Emits 30 to 50% fewer pollutants than regular cars. 	<ul style="list-style-type: none"> • Initial purchase price is higher than for traditional vehicle. • Maintenance, parts, and service costs are higher because there are two systems working together. • Special precautions have to be taken during repairs or when an accident has occurred because of the risk of electric shock.
<i>Propane</i>	<ul style="list-style-type: none"> • A by-product of petroleum • Used as a fuel source by taxis, school districts, and government agencies 	<ul style="list-style-type: none"> • Burns cleaner than gasoline • Requires less maintenance on the engine and lengthens the life of the engine 	<ul style="list-style-type: none"> • There is less infrastructure for the distribution of propane than for gasoline. • Costly to convert a conventional engine to one that
<i>Electric vehicles</i>	<ul style="list-style-type: none"> • Runs on electricity. 	<ul style="list-style-type: none"> • Electric vehicles produce no emissions. • Most of Washington's electricity comes from hydroelectric dams, so it is much cleaner than in other areas of the U.S. 	<ul style="list-style-type: none"> • The process of converting energy to electricity to charge the electric vehicle can create pollution (i.e. from coal power plants). • There are limitations on the battery—can't travel as far between charges as a conventional vehicle can between gasoline fill-ups.

Key Ideas

Fuel	How it Works	Advantages	Disadvantages
Biodiesel	<ul style="list-style-type: none"> Fuel processed from fats, oils, or grease from vegetative sources with lye to make it less acidic and usable in engines. 	<ul style="list-style-type: none"> Contains much less sulfur than petroleum-based diesel. Emits 93% less hydrocarbons and 30% percent less particulate matter than diesel. Can be used in diesel engines without modifications. Waste oil from the food industry can be used if not too contaminated. As petroleum prices increase, biodiesel will become a more cost-effective option. Crops for biodiesel can be grown locally and the fuel can be processed domestically. Though fossil fuels are generally used to produce biodiesel, using 100% biodiesel reduces fossil fuel consumption by 95%. 	<ul style="list-style-type: none"> Biodiesel is a solvent. Older vehicles may need to have rubber hoses and other rubber parts replaced. Has a cleansing effect on engines so filters can clog. Biodiesel can be added in increasing proportions with regular diesel over time to prevent clogs. Fueling stations offering biodiesel are few and far between but they are becoming more common. There is concern that biodiesel crops compete with food crops for land. Some studies show that biodiesel emits slightly more nitrous oxide, a chemical in smog, while others say it emits slightly less.
Natural gas	<ul style="list-style-type: none"> A fossil fuel found on its own or near crude oil reserves, but not a petroleum product. A mixture of gaseous hydrocarbon compounds. The natural gas Americans use is extracted domestically, and current reserves are anticipated to last 120 years at current consumption levels. 	<ul style="list-style-type: none"> Fuel is very clean-burning. Emits about 90% less carbon monoxide and around 15% less carbon dioxide than gasoline-run automobiles. Liquefied natural gas takes less space so tanks can be smaller. 	<ul style="list-style-type: none"> Has 1/3 the energy of gasoline. Has a shorter driving range than gasoline-powered vehicles. Gasoline-powered vehicles can be converted to run on natural gas, but the cost is high. There are less than 800 fueling stations in the U.S. There are even fewer stations that offer liquefied natural gas. Liquefied natural gas must be kept colder than natural gas, which takes energy and is less efficient.
Hydrogen fuel cells	<ul style="list-style-type: none"> Hydrogen and water are used in fuel cells to create energy without harmful emissions. Hydrogen exists on earth in liquid form, so processes are utilized to harness hydrogen in the form of gas. 	<ul style="list-style-type: none"> Produces no emissions; its main byproduct is water. Hydrogen is an abundant element on Earth—it just needs to be converted to gas for use in fuel cells. 	<ul style="list-style-type: none"> It is expensive to produce hydrogen gas. Hydrogen has lower energy content than other fuels, so tanks must be larger to travel the same distance—6 times larger than a gasoline tank!
Methanol	<ul style="list-style-type: none"> Odorless, colorless liquid that can be made from coal, natural gas, residual oil, or biomass. Used in auto races because of the higher acceleration power methane has versus gasoline. 	<ul style="list-style-type: none"> Vehicles can run on 100% methanol, but an 85:15 blend of methanol and gasoline is more common. Doesn't require significant changes to vehicle engines, but no manufacturers make compatible vehicles. Emits fewer hydrocarbons than gasoline. 	<ul style="list-style-type: none"> Less efficient than gasoline. Requires the use of costly, special engine lubricant. There are no public fueling stations at this time. Creates more formaldehyde, an air pollutant, than gasoline automobiles.

Key Ideas

Washington State has a Commute Trip Reduction law.

- In 1991, Washington State legislature passed the *Commute Trip Reduction law* as part of the Washington Clean Air Act. Governments in areas with high traffic congestion offer incentives to commuters to take the bus, carpool, vanpool, bike, walk, work from home, or shift their schedules to work fewer days. In 2007, commuters from employers participating in the program made 26,000 fewer trips each day of the work week.
- In Washington State, *transportation accounts for nearly 50% of the overall energy use* and is responsible for 40% of the state's greenhouse gas emissions.
- One study has shown that Puget Sound residents save approximately \$552 million a year by using public transportation.
- Shifting habits to drive less is more important than ever, as concerns about costs, higher occurrence of health problems, air and water pollution, and climate change are increasing.

Roughly 40% of all car trips in the U.S. are less than 2 miles.

- Europeans walk or ride bikes for 40 to 50% of their trips, and take public transportation for an additional 10%. Americans use the car for 87% of their trips and take public transit for only 3%. *Americans could save \$820 per person* by using transit for 10% of their trips. This would also decrease air pollution, water pollution, and traffic congestion.
- On average, *Americans spend 13 to 16% of their budgets on transportation*. Only housing is higher.
- Using *public transportation*, whether to school or work, frees up time to do other things. Students can get a jump start on their homework, read a book, or catch up with friends.

- Walking or biking, rather than driving, helps prevent air and water pollution, and provides physical exercise.
- Using technologies such as *telecommuting, web conferencing*, and other forms of electronic communication help to decrease the amount of travel.

There are simple things to do while driving to make cars as fuel efficient as possible when driving is necessary.

- *Remove excessive weight* from the vehicle or trunk to increase fuel efficiency.
- *Keep car properly maintained* - be sure to keep tire pressure at the proper level.
- *Refrain from heavy acceleration* along with quick braking which can decrease gas mileage by over 30% while driving on the highway.
- *Slow down* - speeding can also be less efficient. For most cars, gas mileage significantly decreases above speeds of 60 miles per hour.
- *Turn off engine when stopped* at a bridge, railroad crossing, or in traffic for more than 30 seconds.
- *Start your motor only once you are ready to drive*. Old cars used to require a "warm up." With fuel-injection technology -- turn the key and go!
- *Carpool*—you can double fuel efficiency and cut emissions in half by sharing a ride.



Vocabulary

Air Pollution

The introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the natural environment, into the atmosphere.

Alternative Fuel

A popular term for “non-conventional” transportation fuels made from natural gas (propane, compressed natural gas, methanol, etc.) or biomass materials (ethanol, methanol).

Carbon Dioxide

A colorless, odorless noncombustible gas with the formula CO₂ that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass) and by respiration, which is a slow combustion in animals and plants, and by the gradual oxidation of organic matter in the soil.

Climate Change

A term used to refer to all forms of climatic inconsistency, but especially to significant change from one prevailing climatic condition to another. In some cases, “climate change” has been used synonymously with the term “global warming”; scientists, however, tend to use the term in a wider sense inclusive of natural changes in climate, including climatic cooling.

Crude oil

Unrefined liquid petroleum.

Emission

- (1) A discharge or something that is given off; generally used in regard to discharges into the air.
- (2) Releases of gases to the atmosphere from some type of human activity (cooking, driving a car, etc). In the context of global climate change, these consist of greenhouse gases (e.g., the release of carbon dioxide during fuel combustion).



Fossil Fuels

Fuels (coal, oil, natural gas, etc.) that result from the compression of ancient plant and animal life formed over millions of years.

Gas

- (1) A non-solid, non-liquid (as hydrogen or air) substance that has no fixed shape and tends to expand without limit.
- (2) A state of matter in which the matter concerned occupies the whole of its container irrespective of its quantity. Includes natural gas, coke-oven gas, blast furnace gas, and refinery gas.

Gasoline

A complex mixture of relatively volatile hydrocarbons with or without small quantities of additives, blended to form a fuel suitable for use in spark-ignition engines.

Greenhouse Gases (GHG)

Gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect. The two major greenhouse gases are water vapor and carbon dioxide. Lesser greenhouse gases include methane, ozone, chlorofluorocarbons, and nitrogen oxides.

Vocabulary

Greenhouse Emissions

Waste gases given off by industrial and power plants, automobiles and other processes.

Hydrocarbons

Chemical compounds that contain hydrogen and carbon. Most motor vehicles and engines are powered by hydrocarbon-based fuels such as gasoline and diesel. Hydrocarbon pollution results when unburned or partially burned fuel is emitted from the engine as exhaust, and also when fuel evaporates directly into the atmosphere. Hydrocarbons include many toxic compounds that cause cancer and other adverse health effects. Hydrocarbons also react with nitrogen oxides in the presence of sunlight to form ozone. Hydrocarbons, which may take the form of gases, tiny particles, or droplets, come from a great variety of industrial and natural processes. In typical urban areas, a very significant fraction comes from cars, buses, trucks, and non-road mobile sources such as construction vehicles and boats.

Miles Per Gallon (MPG)

A measure of vehicle fuel efficiency. MPG is computed as the ratio of the total number of miles traveled by a vehicle to the total number of gallons consumed.

Nonrenewable Fuel

Fuels that cannot be easily made or “renewed.” We can use up nonrenewable fuels. *Oil, natural gas, and coal* are nonrenewable fuels.

Oil

The raw material that petroleum products are made from. A black liquid fossil fuel found deep in the Earth. *Gasoline and most plastics are made from oil.*

Particulate Matter

Tiny particles or liquid droplets suspended in the air that can contain a variety of chemical components. Larger particles are visible as smoke or dust and settle out relatively rapidly. The tiniest particles can be suspended in the air for long periods of time and are the most

harmful to human health because they can penetrate deep into the lungs. Some particles are directly emitted into the air. They come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and wood burning. Other particles are formed in the atmosphere by chemical reactions.

Peak Oil

The point in time when *the maximum rate of global petroleum extraction* is reached, after which the rate of production enters terminal decline. This concept is based on observed production rates of individual oil wells, and the combined production rate of a field of related oil wells.

Petroleum

Generally refers to *crude oil or the refined products* obtained from the processing of crude oil (gasoline, diesel fuel, heating oil, etc.) Petroleum also includes lease condensate, unfinished oils, and natural gas plant liquids.

Renewable Energy Sources

Fuels that can be easily made or “renewed.” We can never use up renewable fuels. Types of renewable fuels are hydropower (water), solar, wind, geothermal, and biomass.

Smog

A commonly used term for *pollution caused by complex chemical reactions involving nitrogen oxides and hydrocarbons* in the presence of sunlight. Ozone is a key component of smog. Smog-forming chemicals come from a wide variety of combustion sources and are also found in products such as paints and solvents. Smog can harm human health, damage the environment, and cause poor visibility. Major smog occurrences are often linked to heavy motor vehicle traffic.

Vocabulary source: <http://www.eia.doe.gov/kids/glossary/index.htmlglossary.html>

Discussion Questions

Below are five sample discussion prompts to use in your classroom. For more ideas on classroom activities, please refer to the Resources.

1. Brainstorm some possible economic and environmental results of continued and/or increased consumption of oil by Americans?

- It will become more expensive to drill and obtain the oil—it won't be as easily accessible.
- Because oil is a fossil fuel that takes thousands of years to replenish, it will eventually be gone.
- The US transportation system could reach a crisis in the future - discuss ways to change habits, lessen car and plane trips, and develop or improve fuel options.
- Climate change will become a larger problem and even more difficult to solve.

2. List what you had for lunch today. How far did the food you ate travel before making it onto your lunch tray? Are there choices you can make to decrease the miles your food is transported?

- Students list what food items they had for lunch and identify items came from a local source or were transported long distances.
- Choosing to eat a locally grown apple instead of an orange from Florida can result in lower transportation costs and fewer GHG emissions.
- Students can encourage their families to purchase locally raised meats, locally grown produce, and other items that require fewer miles to transport.
- Students, teachers, and parents can work with the school and cafeteria staff to find ways to incorporate locally grown food into the school's lunch menu.
- Students could grow their own food.

3. How can Americans reduce dependence on oil from foreign countries?

- Drive less and walk or bike to more places to avoid using oil in the first place.

- Use public transportation and support the expansion of public transit systems to get more cars off the roads.
- Invest in finding new or modified technologies and alternative, renewable fuels.
- Recycle plastics which are derived from oil - and find ways to create new materials from recycled plastic. Use fewer plastic items.

4. What is the most important step in decreasing the miles traveled?

- While it's important to explore new technologies and increase fuel efficiency, the first step is to avoid the distance traveled in the first place. By residing where we work, play, and go to school Americans can lessen the distance it takes to get to those locations.
- While moving into a different home may not be an option, making choices to share rides, take public transit, and use the energy from our own bodies to get from one point to another (through walking or biking) can cut travel distances and lessen transportation impacts dramatically.

5. What is one habit you can change to decrease the time you spend traveling by car? How will this affect your life?

- Older students can walk or bike to school. Younger students can work with parents and neighbors to organize a walking school bus to school as a neighborhood group, with a parent as the bus driver. This could be done on bicycles too.
- If students' home are too far away from school to walk or ride a bike, they can talk to their parents and their friends' parents to set up a carpooling system—each parent could drive students one day of each week.
- Take the bus! The school and/or public buses will run whether or not they are full, so students can take advantage and hop on to save car miles.

Connections to Other Topics

Transportation and Water Quality & Conservation

- *Oil spills* from tankers transporting petroleum resources and material goods between countries can be devastating to coastal and marine habitat, wildlife, and communities.
- Water is used in a car's engine's cooling system to make sure it doesn't overheat.
- Cars that aren't properly maintained can negatively impact our waterways. *Engine leaks can contaminate nearby water sources*—antifreeze, oil, and wiper fluid are just a sampling of the toxic chemicals that are washed "away" by rain. The rain, with all of the pollutants, washes into storm drains that lead directly (often without treatment or filtering) to streams, rivers, lakes, and oceans. Washing your car on the street has the same consequences, adding dirt, soap, and other residues to the list of pollutants that are dumped into the nearby waterways.

Transportation and Toxics Reduction & Indoor Air Quality

- Vehicles emit different types of air pollutants—*carbon monoxide, particulate matter, nitrogen oxides, and hydrocarbons*. *Carbon monoxide* can cause respiratory problems, headaches, visual impairment, and other health concerns. *Particulate matter* from diesel engines also causes respiratory problems. *Nitrogen oxides* are harmful to human and environmental health and cause smog as well as ozone in the lower part of the atmosphere. *Hydrocarbons* contribute to ozone development in the lower atmosphere and are associated with medical problems.
- Cars, buses, and trucks account for more than half of the air pollution experienced in urban areas.

Transportation and Recycling & Waste Reduction

- The less waste we generate, the less we need to transport for disposal.
- *Thoughtful purchasing* can also reduce the quantity of goods produced and transported.
- Some people "on the go," litter roads and highways with waste from their cars. More than *18 million pounds of materials are discarded illegally* on Washington roadways, in parks, and in other places of recreation.
- The Washington State Department of Ecology spends over four million dollars per year to clean up litter.
- *Litter can pose a threat to drivers*. It also can harm fish and wildlife and contaminate their habitat.

Transportation and Energy Efficiency

- Transportation requires large amounts of energy. Most of this comes from fossil fuels.
- *It takes energy* to create, maintain, and operate the vehicles we travel in
- The largest energy source for personal vehicles is gasoline.

Transportation Action Tips:

International Walk to School Day is held each year in October – students can work together with teachers and parents to coordinate an event at school. Take it a step further and schedule weekly or monthly "Walking Wednesdays."

Organize a neighborhood walking (or cycling) school bus led by an alternating parent as the "bus driver." This helps to build community and reduces the need for short car trips and idling, thereby decreasing pollution, and traffic congestion. It is also a great way for parents and students to exercise.

Connections to Other Topics

Transportation and Climate Change

- *Carbon dioxide* is the most prevalent greenhouse gas. The burning of fossil fuel emits carbon dioxide. Carbon dioxide naturally exists in the atmosphere—humans exhale it and plants need it to survive, but too much of it can have a blanket-like effect on the earth by trapping in heat that would normally exit the earth's atmosphere. Burning fossil fuels in engines emits large amounts of carbon dioxide, contributing greatly to climate change.
- The transportation sector is responsible for nearly *one-third of all the carbon dioxide emitted in the United States*. Of that amount, passenger cars are the biggest source of transportation-related greenhouse gas emissions.
- There is a *direct correlation between fuel efficiency and emissions*—the more miles per gallon a vehicle gets, the less greenhouse gases produced.
- *Vehicle emissions have decreased* by over 95% since 1960, but the number of vehicle miles travelled has increased by 424%.

Transportation and Food

- Some studies show that *food travels an average of 1,500 miles* during distribution.
- Foods *grown and purchased locally* are more nutritious—nutritional content is lost over time during transport.
- Often *less packaging (or no packaging)* is used for locally grown produce resulting in less waste generated. Less fuel is required for transport since produce is brought in from nearby farms.
- Buying things locally supports the local economy, including *local farmers and businesses*.

Transportation and Sense of Place

- Transportation accounts for about half of our total energy consumption in Washington state.

- *Urban sprawl* is a key factor in the amount we drive.
- Consider *how you relate to your community or nature* if you are walking or bicycling compared to driving a car. What do you see, hear, smell, taste or feel? How do you relate to other people or animals?



Resources and Links

Educator Resources

Powerful Choices for the Environment program (for middle school) and other educational programs: <http://www.pse.com/community/educationalprograms/Pages/Default.aspx>

Cool School Challenge website:
<http://www.coolschoolchallenge.org>

Office of the Superintendent of Public Instruction, Education for Environment and Sustainability:
<http://www.k12.wa.us/curriculumInstruct/EnvironmentSustainability/default.aspx>

Ontario Ecoschools Ecological Literacy Guides are downloadable free of charge at:
http://ontarioecoschools.org/curriculum_resources/index.html

Resources And Links

Educator Resources (Cont'd)

Green Teacher's Teaching About Climate Change - Cool Schools Tackle Global Warming: www.greenteacher.com. Classroom activities created by teachers for K-12. This resource also includes good background information for teachers.

Going Places, Making Choices: Transportation & the Environment by the National 4-H Council contains five units that address the history of transportation, natural resources and energy use, land use, and decision-making. Purchase by visiting http://www.fourhcouncil.edu/enviro_gpmmc.aspx or call (301) 961-2934.

<http://www.walkingschoolbus.org> has information and resources on starting a Walking School Bus.

Go for Green's includes great tools and resources for walking/biking to school programs. http://www.goforgreen.ca/asrts/home_e.html

<http://www.cdc.gov/nccdphp/dnpa/kidswalk/resources.htm> has resources on walking and biking to school, community presentations, lessons, and more.

Environmental Protection Agency's website includes many resources for K-12 teachers and students: <http://www.epa.gov/epahome/students.htm>. Find the EPA Idle Reduction Campaign Toolkit here: <http://www.epa.gov/cleanschoolbus/antiidling.htm>

The End of Suburbia: Oil Depletion and the Collapse of the American Dream. Documentary. <http://www.endofsuburbia.com>

Kid's Air Site has animated lesson that helps students understand how air quality is measured. http://airnow.gov/index.cfm?action=aqikids_new.main

Feet First has a website with great information on walking! <http://www.feetfirst.info/>

Washington Department of Transportation's Safe Routes to School program offers grants, lesson plans and more. <http://www.saferoutes-wa.org/schools/curriculum/lesson-plans-for-educators>

Union of Concerned Scientists has information and resources on transportation and air quality and much more. <http://go.ucsusa.org/game/> - Check out The Great Green Web Game or click on the link to their homepage.

For sources/contacts for information about air pollution in WA, this Department of Ecology webpage includes a map of the state and each of the clean air agency regions. http://www.ecy.wa.gov/programs/air/pdfs/local_map.pdf

-<http://www.pscleanair.org/>. Puget Sound Clean Air Agency (King, Snohomish, Pierce, & Kitsap counties)

-<http://www.swapca.org>. Southwest Clean Air Agency (Lewis, Skamania, Clark, Cowlitz, & Wahkiakum counties)

-<http://www.nwair.org/>. Northwest Air Pollution Authority

-<http://www.nwcleanair.org/> Northwest Clean Air Agency (Whatcom, Skagit, Island counties)

-<http://www.orcaa.org/>. Olympic Region Clean Air Agency (Thurston, Mason, Pacific, Grays Harbor, Jefferson, & Clallam counties)

-<http://www.spokanecleanair.org/> Spokane Regional Clean Air Agency (Spokane County)

-<http://www.bcaa.net/>. Benton Clean Air Authority (Benton County)

-<http://www.co.yakima.wa.us/cleanair/>. Yakima Regional Clean Air Authority (Yakima County)

National Science Teacher Association has resources for teachers: www.nsta.org.



Sources used to Develop this Guide

Gershan, David and Andrea Barrist Stern. "Ecoteam: A Program Empowering Americans to Create Earth-friendly Lifestyles."

<http://www.need.org/needpdf/FutureIsToday.pdf>

<http://www.need.org/needpdf/altfuelsdebate.pdf>

<http://www.fueleconomy.gov/feg/driveHabits.shtml>

<http://www.ofm.wa.gov/databook/energy/yt01.asp>

http://www.drivecleanacrosstexas.org/for_teachers/grades_9-12/unit4/resources/fuel_fact_sheets.pdf

http://www.nesea.org/uploads/textWidget/890.00010/documents/Cars_of_Tomorrow_and_the_American_Community.pdf

<http://www.transportationchoices.org/facts-quality-of-life.asp>

<http://www.wec.ufl.edu/extension/gc/harmony/food/local.htm>

http://www.transportationchoices.org/facts-econ_negative.asp

<http://www.eia.doe.gov/kids/energyfacts/sources/non-renewable/oil.html>

http://www.cityofbremerton.com/content/sw_waterpollutionfacts.html

<http://www.epa.gov/OMS/inventory/overview/definitions.htm>

<http://www.epa.gov/oms/cfa-air.htm>

<http://www.epa.gov/otaq/inventory/overview/pollutants/index.htm>

<http://www.epa.gov/otaq/inventory/overview/pollutants/carbonmon.htm>

<http://www.epa.gov/otaq/inventory/overview/pollutants/nox.htm>

<http://www.epa.gov/otaq/inventory/overview/pollutants/hydrocarbons.htm>

<http://www.ecy.wa.gov/climatechange/whatis.htm>

<http://climate.dot.gov/about/transportations-role/overview.html>

<http://washington.chenw.org/RIgroup/documents/sprawl-health-obesity.pdf>

http://www.sightline.org/research/energy/res_pubs/reI_air_travel_aug04

<http://www.greenamericatoday.org/pubs/realgreen/articles/ElectricBikes.cfm>

<http://www.wsdot.wa.gov/TDM/CTR/overview.htm>

<http://www.wsdot.wa.gov/TDM/CTR/>

<http://www.fhwa.dot.gov/policyinformation/statistics/2007/vmt421.cfm>

<http://www.fueleconomy.gov/Feg/ethanol.shtml>

