Chapter 6 Air Quality and Climate Change

1 What affects air quality in the central Puget Sound region?

Air pollution comes from many different sources, including industry, transportation, and agriculture. It affects both human health and the environment, including plants, animals, and visibility, as well as the built environment.

Air quality in the central Puget Sound region is affected by several factors, including geography, climate, and the urban environment. The region is located between the Cascade and Olympic mountain ranges and is bisected by Puget Sound. Largely surrounded by mountains and water, the region's land is further restricted by steep hills and environmentally sensitive areas. Most of the urban development in the region has occurred near sea level, adjacent to Puget Sound. Most of the air pollution in the region comes from the urban areas and transportation corridors that follow the north/south trending geography of the Puget Sound.

The central Puget Sound region has a modified marine climate. Temperatures are generally moderate with few extremely cold or hot days throughout the year. On most days, clean ocean air combined with wind disperses air pollutants in the region. When the onshore airflow is interrupted, the combined effects of urban development, geography, and weather can result in stagnating air and an increase in air pollution. In particular, the mountains on both the east and the west side of the region create a bowl, trapping pollution in the urban basin.

Which elements of Washington Administrative Code (WAC) 197-11-444 are addressed in this chapter?

This chapter addresses:

- Section (1)(b)(i) Air quality
- Section (1)(b)(iii) Climate
- Section (1)(b)(ii) Odor is not discussed separately because odor impacts from vehicle emissions would be similar to those discussed in the response to question 6 in this section.

Air Quality Information Sources

Air quality monitoring and other relevant information in this chapter was obtained from the Puget Sound Clean Air Agency (PSCAA), the U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and the University of Washington.

2 What are the pollutants of concern in the central Puget Sound region?

The pollutants of concern in the central Puget Sound region include the following:

- Particulate matter
- Carbon monoxide
- Ozone
- Hazardous air pollutants/air toxics
- Greenhouse gases

Particulate Matter

Particulate matter is the term for small particles of dust, soot, and organic matter suspended in the atmosphere. In this document, coarse particulate matter is referred to as PM_{10} and fine particulate matter is referred to as $PM_{2.5}$. Sources of particulate matter include motor vehicles, industrial boilers, wood stoves, open burning, and dust from roads, quarries, and construction activities. Relating to transportation sources, road and construction dust is often in the larger PM_{10} range, while vehicle exhaust emissions are generally in the smaller $PM_{2.5}$ range. In particular, diesel exhaust is a significant source of fine particles.

What is PM_{10} and $PM_{2.5}$?

PM_{10} is particulate matter that has a diameter of 10 micrometers or less.

$PM_{2.5}$ is fine particulate matter that has a diameter of 2.5 micrometers or less.

Health effects of particulate matter include respiratory illnesses, such as aggravated asthma, chronic bronchitis, and decreased lung function. Fine particulates can pose more serious health risks because they are easily inhaled and have the ability to penetrate deeper into lung tissue. As with many pollutants, sensitive populations such as children and the elderly are more susceptible to these health risks. Particulate emissions from diesel exhaust are of particular concern due to their toxicity. The U.S. Environmental Protection Agency (EPA) has concluded that diesel exhaust is a probable human carcinogen, and diesel particulate matter is the most likely portion of the exhaust to pose a risk (EPA, 2002).

Particulate matter can also cause environmental damage. Particles can be carried by the wind for long distances before being deposited on the ground or in the water. Water bodies may become acidic, changes may occur to the nutrient balance in both water and in the soil, forests and crops may be damaged, and the diversity of ecosystems may be affected. Particulate matter is also the primary cause of reduced visibility, or haze, affecting specific national park and wilderness areas. In addition, particulates can cause aesthetic damage to buildings and stone, such as staining and accelerated decay.

Carbon Monoxide

Motor vehicles are the primary source of carbon monoxide (CO), but other sources include industry, outdoor burning, and non-road mobile sources such as off-road vehicles and lawnmowers. Areas of high CO concentrations are usually localized, occurring near congested roadways and intersections. These localized areas of elevated CO levels are referred to as CO hot spots. High levels generally occur in autumn and winter months during conditions of light winds and stable weather, which prevent dispersion of the emissions.

What is carbon monoxide?

Carbon monoxide (CO) is a colorless, odorless, poisonous gas produced when carbon-containing fuel is not burned completely.

CO reduces the blood's oxygen-carrying capability. Acute health effects include headaches, slowed reflexes, weakened judgment, and impaired perception. Chronic effects include aggravation of pre-existing cardiovascular disease and increased heart disease risk in healthy individuals. At very high levels, CO is poisonous and can be fatal.

Ozone

Ozone in the upper atmosphere provides protection from harmful ultraviolet radiation from the sun; ozone in the lower atmosphere, referred to as ground-level ozone (also known as smog), poses numerous health and environmental risks. The term ozone in this chapter refers to ground-level ozone.

How is ozone formed?

Ozone is formed when emissions of nitrogen oxides (NO_X) and volatile organic compounds (VOCs) chemically react in the presence of sunlight.

Ozone is formed when its precursors, nitrogen oxides (NO_x) and volatile organic compounds (VOCs), chemically react in the presence of sunlight. Peak ozone levels occur during the warmer summer months. Ozone is a regional concern because it, along with its precursors, can be carried hundreds of miles from its origins. Maximum ozone levels generally occur at locations several miles downwind from the sources. Sources of the precursor pollutants to ozone—NO_x and VOCs—include mobile sources, industry, commercial solvents, wood burning, and natural (biogenic) sources such as forests.

Ozone is an eye and respiratory tract irritant and increases the risk of respiratory and heart diseases. Ozone can cause breathing difficulty for susceptible populations (e.g., asthmatics and the elderly), and may lead to impaired lung function and premature death. Ozone can also affect the environment, causing damage to crops and other plant life, waterways, and ecosystems.

Hazardous Air Pollutants or Air Toxics

Hazardous air pollutants, also referred to as air toxics, are chemicals emitted into the atmosphere that cause or are suspected to cause cancer or other severe health effects, such as birth defects or reproductive problems. At the state and regional level, Washington State Department of Ecology (Ecology) and Puget Sound Clean Air Agency (PSCAA) list 400 pollutants as air toxics. This list includes the 188 national hazardous air pollutants set by EPA as well as additional pollutants believed to be harmful. Hazardous air pollutants are a subset of air toxics, but the terms are often used interchangeably. Examples of air toxics include benzene, perchlorethylene, methylene chloride, formaldehyde, and asbestos, as well as diesel particulate matter and wood smoke.

What are hazardous air pollutants or air toxics?

Hazardous air pollutants, also referred to as air toxics, are chemicals emitted into the atmosphere that cause or are suspected to cause cancer or other severe health effects, such as birth defects or reproductive problems. Asbestos and wood smoke are two examples of hazardous air pollutants.

Air toxics are emitted by a variety of sources, including industry, small facilities such as dry cleaners, motor vehicles, non-road mobile sources (such as trains, boats, lawnmowers, etc.), and outdoor and indoor wood and debris burning. In the Puget Sound region, particulate matter from diesel exhaust represents more than 70 percent of the potential cancer risk from air toxics (PSCAA).

Air toxics are pollutants known or suspected to cause cancer and other serious health effects. These health effects include respiratory illnesses such as asthma and reduced lung function, damage to the immune system, neurological problems, and reproductive problems such as reduced fertility. Once deposited into the soil and waterways, air toxics can build up in the food chain, resulting in human consumption of contaminated plants, fish, and other animals.

Greenhouse Gases and Climate Change

Some greenhouse gases occur naturally in the atmosphere, trapping solar energy and warming the earth's surface. These gases include carbon dioxide (CO_2), nitrous oxide, and methane. If not for this greenhouse effect, the earth would be about 60 degrees cooler. However, more greenhouse gases are being added into the atmosphere, causing more heat to be trapped and the earth's surface to warm even further. The earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated warming during the past two decades; the decade between 1998 and 2007 has been the warmest on record for the last 100 years (National Academy of Sciences, 2006; IPCC, 2007).

Levels of CO_2 are higher now than at any time in the past 650,000 years, and according to EPA and the Intergovernmental Panel on Climate Change (IPCC), most of the warming in recent decades is very likely the result of human activities. There is 90 percent certainty that the burning of fossil fuels and other human activities are driving climate change (IPCC, 2007). Climate change refers to a significant change in long-term weather patterns around the world, as measured by temperature, rainfall, wind patterns, etc. Global warming refers to an average global increase in the earth's temperature.

The primary source of greenhouse gases is the burning of fossil fuels to generate electricity and power engines. Other sources include industry, agriculture, and landfills. In the Puget Sound region, 50 percent of the emissions are attributable to transportation sources, including motor vehicles, aircraft, construction equipment, and boats (PSCAA, 2005).

Expected consequences from climate change include an increase in global temperatures, resulting in a rising of the sea level. Other effects include a change in precipitation and impacts to local climates, which could alter forests, crop yields, and water supplies. Climate change may also affect human

What are greenhouse gases?

Greenhouse gases come in several forms. These gases include carbon dioxide (CO_2), nitrous oxide, and methane. CO_2 makes up the bulk of the greenhouse gas emissions from the transportation sector. Any process that burns fossil fuel releases CO_2 into the air. Vehicles are a significant source of greenhouse gas emissions and contribute to global warming primarily through the burning of gasoline and diesel fuels.

health, animals, and many types of ecosystems. For example, deserts may expand into existing rangelands, and features of some national parks may be permanently altered. The Puget Sound region may experience warmer summers and longer, wetter winters. Such effects could reduce forests in the Cascade Mountains and decrease snow packs. Reduced snow packs are likely to drastically change water availability in the region, which in turn will require a change in the way current water demands for agriculture, salmon populations, and energy uses are managed. Climate change is also likely to result in more winter floods and higher water temperatures that would further stress salmon populations, and potentially increase heat-related pollution such as ozone (UW Climate Impacts Group, 2007). Policy considerations related to the impacts of climate change specific to transportation infrastructure are included in the Transportation 2040 plan.

3 What regulations apply to air quality?

Numerous federal, state, and local regulations relate to air quality in the central Puget Sound region, including those under the federal Clean Air Act and the Washington Clean Air Act. For example, there are controls on industrial emissions, indoor and outdoor burning, and vehicle engines and fuels. This section focuses on those regulations pertinent to the scope of Transportation 2040 and the alternatives being considered, relative to the pollutants discussed in the previous section.

National Ambient Air Quality Standards

Under the federal Clean Air Act, EPA established National Ambient Air Quality Standards (NAAQS) for six principal, or criteria, pollutants considered harmful to public health and the environment. Primary standards set limits to protect public health; secondary standards set limits to protect the environment, including protection against decreased visibility and damage to wildlife, plants, and buildings. The six criteria pollutants are CO, lead, nitrogen dioxide, particulate matter (PM_{10} and $PM_{2.5}$), ozone (NOx and VOCs), and sulfur oxides. Air quality is monitored and areas are designated according to whether or not they meet the NAAQS for each pollutant. Geographic regions that meet the NAAQS are referred to as attainment areas; areas that do not meet the NAAQS are

What is the Clean Air Act?

The United States Clean Air Act describes legislation enacted by Congress to control air pollution on a national level. The first Clean Air Act was the Air Pollution Control Act of 1955, followed by the Clean Air Act of 1963, the Air Quality Act of 1967, the Clean Air Act Extension of 1970, and Clean Air Act Amendments in 1977 and 1990. Numerous state and local governments have enacted similar legislation, either implementing federal programs or filling in locally important gaps in federal programs.

designated nonattainment to that standard. Once designated nonattainment, the Clean Air Act requires the preparation of an attainment plan to demonstrate how an area will thereafter meet and maintain the NAAQS. Once a nonattainment area has subsequently met the NAAQS for a period of time, the area may be redesignated as a maintenance area. A maintenance plan is required for these areas to demonstrate that the NAAQS will continue to be met in the future. Maintenance and attainment plans for individual regions comprise the State Implementation Plan (SIP) for Air Quality for a given state. The terms maintenance plan, attainment plan, and SIP are often used interchangeably.

Maintenance plans will often contain control strategies to ensure attainment of the standards related to the pollutant sources. Depending on the pollutant, these sources can include transportation, industry, and wood smoke. An emissions inventory will be prepared, estimating the emissions from each of these sources. This inventory will be used to identify the appropriate level of emissions from each source that will ensure the region will maintain the standards. As an example, a motor vehicle emissions "budget" may be prepared for certain pollutants, which is a ceiling of total emissions from on-road mobile sources in the region that cannot be exceeded.

In 1978, the central Puget Sound region was classified as a nonattainment area for CO and ozone. In 1987, the industrial areas of the Seattle Duwamish River, Kent Valley, and Tacoma Tideflats were classified as nonattainment areas for PM_{10}. The Seattle and Tacoma industrial areas include the ports of both those cities. In 1996, having met the federal standards for several years, the region was redesignated by EPA as a maintenance area for CO and ozone; the three PM_{10} nonattainment areas were redesignated as maintenance areas in 2001. As required, each of these areas has approved maintenance plans in place. Approval of both the CO and ozone maintenance plans occurred in 1996, with subsequent updates to both plans approved in 2004; approval of the PM_{10}

maintenance plan occurred in 2000, with the plan becoming effective in 2001.

In June 2004 EPA officially designated areas to a new ozone standard, and in April 2005, to a new particulate matter standard. The original ozone standard for which the Puget Sound region was in maintenance was based on a 1-hour concentration. The new standard is based on an 8-hour average concentration and replaced the 1-hour standard as of June 15, 2005. The new particulate matter standard is for $PM_{2.5}$, and is in addition to the existing PM_{10} standard, which remains in place. EPA further strengthened the standard for $PM_{2.5}$ in 2006, and strengthened the ozone standard in 2008.

Both the new $PM_{2.5}$ and ozone standards have recently been violated in the Puget Sound region. The South Tacoma (Wapato Hills/Puyallup River Valley) area was designated by EPA as nonattainment to the new $PM_{2.5}$ standard in December 2008. This designation became effective with the October 2009 Federal Register notice published by EPA. [1]

Ecology, in coordination with PSCAA, must develop an attainment plan within 3 years of this designation to demonstrate how the area will come back into compliance with the standard. The primary source of $PM_{2.5}$ emissions in this newly designated area is wood-burning activities, but mobile sources represent approximately 27 percent of the emissions[2].

The region has also experienced exceedances of the new ozone standard, with a final exceedance in summer 2008 leading to a violation of the standard. In January 2010, EPA proposed a revision to the 2008 ozone standard, and put all area

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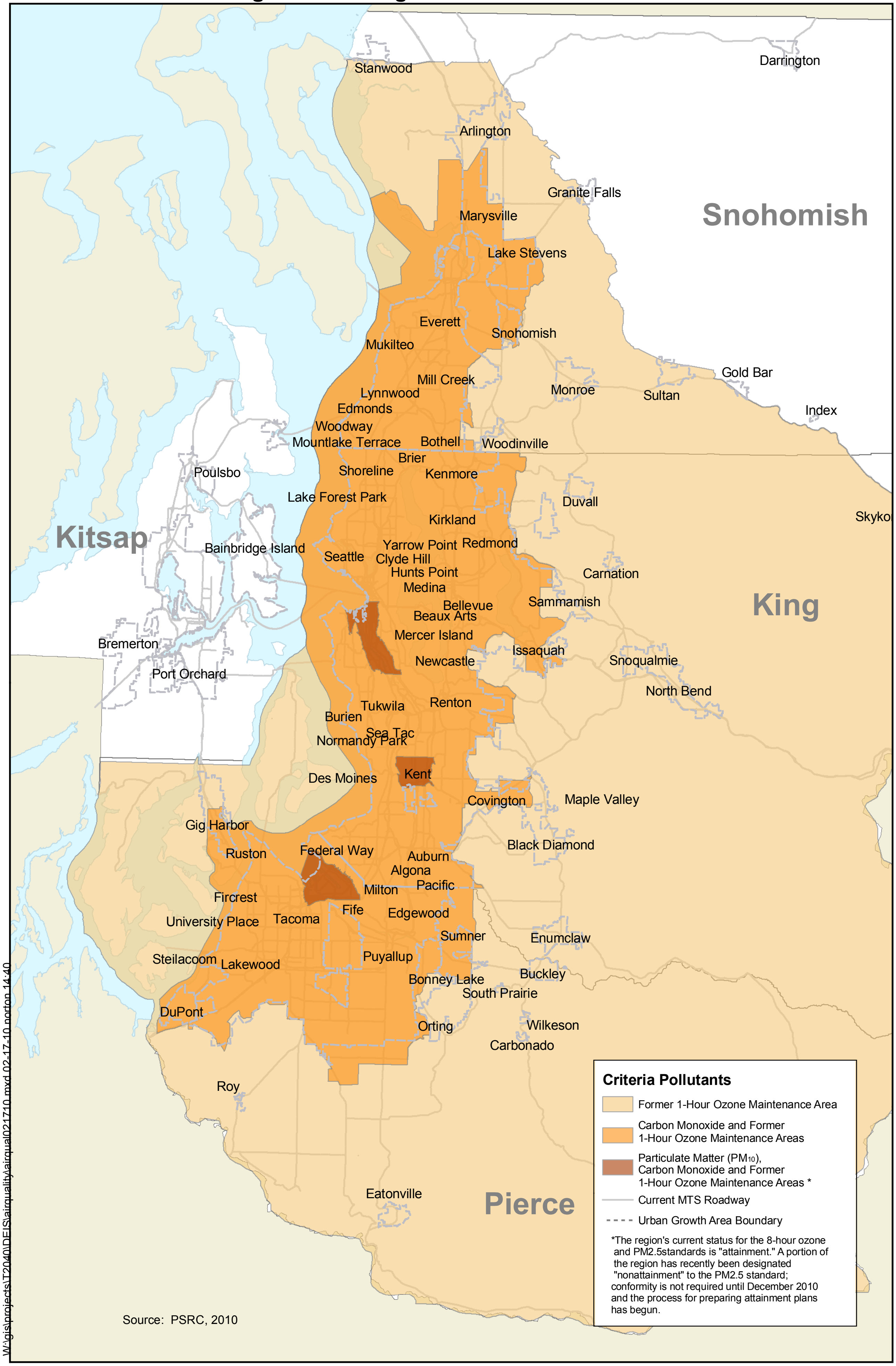
[1] The December 2008 notice did not become effective until the October 2009 Federal Register notice.

[2] The final source apportionments will be completed as part of the attainment plan process.

designations to the 2008 standard on hold. The revised standard is expected to be finalized by August 2010.

Exhibit 6-1 illustrates the region's current maintenance area boundaries. The $PM_{2.5}$ and ozone redesignations are not reflected on this map, because they are still ongoing processes. Exhibit 6-2 identifies the current NAAQS for each of the criteria pollutants.

Exhibit 6-1. Central Puget Sound Region Maintenance Areas



Source: PSRC, 2010

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Exhibit 6-2

National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon monoxide	9 ppm (10 mg/m^3)	8-hour [1]	none	
	35 ppm (40 mg/m^3)	1-hour [1]		
Lead	0.15 $\mu g/m^3$ [2]	rolling 3-month average	same as primary	
	1.5 $\mu g/m^3$	quarterly average	same as primary	
Nitrogen dioxide	0.053 ppm (100 $\mu g/m^3$)	annual (arithmetic mean)	same as primary	
Particulate matter (PM_{10})	150 $\mu g/m^3$	24-hour [3]	same as primary	
Particulate matter ($PM_{2.5}$)	15.0 $\mu g/m^3$	annual [4] (arithmetic mean)	same as primary	
	35 $\mu g/m^3$	24-hour [5]	same as primary	
Ozone	0.075 ppm (2008 standard)	8-hour [6]	same as primary	
	0.08 ppm (1997 standard)	8-hour [7]	same as primary	
	0.12 ppm	1-hour [8] (applies only in limited areas)	same as primary	
Sulfur dioxide	0.03 ppm	annual (arithmetic mean)	0.5 ppm (1,300 $\mu g/m^3$)	3-hour [1]
	0.14 ppm	24-hour [1]		

Notes: ppm = parts per million mg/m^3 = milligrams per cubic meter µg/m^3 = micrograms per cubic meter

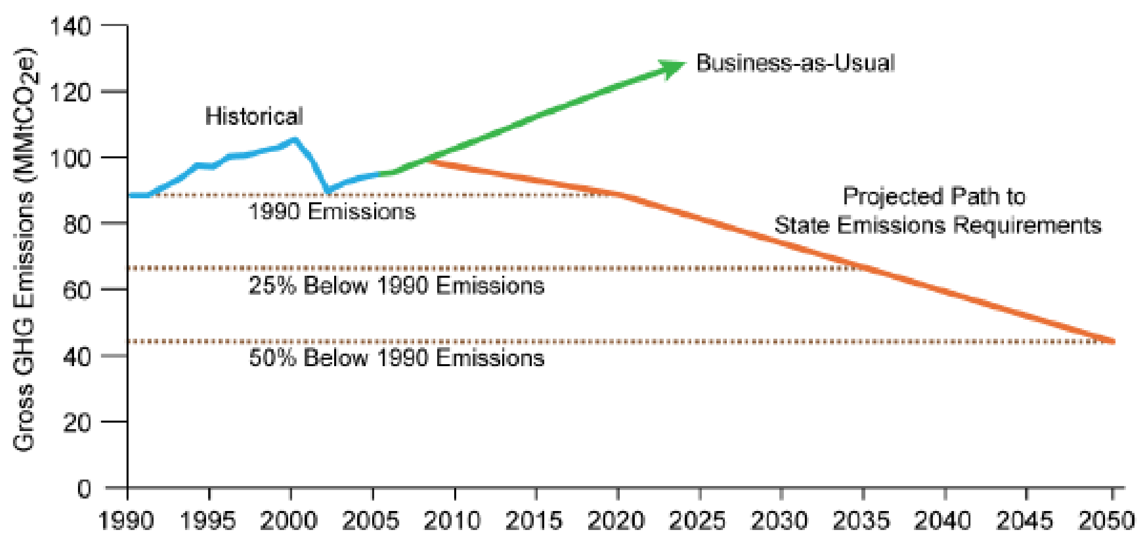
1. *Not to be exceeded more than once per year.*
2. *Final rule signed October 15, 2008.*
3. *Not to be exceeded more than once per year on average over 3 years.*
4. *To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.*
5. *To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).*
6. *To attain this standard, the3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).*
7. *(a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.*
   (b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
8. *(a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.*
   (b) As of June 15, 2005, EPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas.

Source: EPA, 2009.

Greenhouse Gases

At this time, there are no federal standards related to greenhouse gases. The state of Washington has passed several pieces of legislation related to the reduction of greenhouse gases, including setting statewide goals to reduce emissions to 1990 levels by 2020, 25 percent below 1990 levels by 2035, and 50 percent below 1990 levels by 2050 (Exhibit 6-3). In addition, the state has set benchmarks for reducing annual statewide per capita vehicle miles traveled (VMT). These benchmarks are to decrease annual statewide VMT per capita by 18 percent by 2020, 30 percent by 2035, and 50 percent by 2050. These reductions are from a forecasted statewide VMT baseline of 75 billion in 2020; trucks over 10,000 pounds gross vehicle weight are exempted. Currently, no emission reduction goals have been established for individual sectors (e.g., transportation, industry) or specific emission goals or VMT benchmarks established for specific regions.

Exhibit 6-3
Greenhouse Gas Reduction Goals



Source: CTED, 2008

There may be future federal and state legislation that sets requirements for reducing greenhouse gas emissions and/or VMT, pertinent to the transportation and growth management planning activities conducted by PSRC. In the absence of such requirements, PSRC has taken an active stance to address the state's climate change goals in the VISION 2040 policies and in the development of Transportation 2040. Each alternative has been evaluated for greenhouse gas emissions as well as total and per capita VMT (refer to Question 5 later in this chapter). The data produced from this analysis will help to inform the region and state on the potential benefits from alternative combinations of transportation and land use strategies in reducing emissions and VMT. In addition to the information contained in the Potential Mitigation Measures section of this chapter, the Transportation 2040 plan discusses the potential benefits from improvements in technology (vehicles and fuels), as well as policy considerations such as market penetration and cost issues.

Transportation Conformity

Transportation conformity is a mechanism to ensure that transportation-related activities—plans, programs, and projects—are reviewed and evaluated for their impacts on air quality prior to funding or approval. The intent of transportation conformity is to ensure that new projects, programs, and plans do not impede an area from meeting and maintaining air quality standards. Specifically, regional transportation plans, improvement programs, and projects may not cause or contribute to new violations, worsen existing violations, or interfere with the timely attainment of air quality standards or the required interim emission reductions towards attainment. Positive findings of conformity are required by the federal Clean Air Act, the Clean Air Washington Act, and the federal transportation act (the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users—SAFETEA-LU) to allow regions to proceed with transportation project implementation in a timely manner.

A regional transportation conformity analysis must show that the total regional emissions produced by projects in the long-range transportation plan and the short-range transportation improvement program, plus activity on the existing transportation system, do not exceed the motor vehicle emissions budget identified in the maintenance plan for each criteria pollutant (refer to the previous section). In the Puget

What is SAFETEA-LU?

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) is a bill that governs United States federal surface transportation spending. It was signed into law by President George W. Bush on August 10, 2005 and expired on September 30, 2009. Congress is working on a replacement bill for the next six-year period.

Sound region, based on the pollutants for which the region is in maintenance to the standard, conformity is demonstrated for CO and PM_{10}. Because the 1-hour ozone standard has been revoked and the region is currently in attainment of the 8-hour ozone standard, demonstrations of conformity are no longer required for this pollutant. Conformity to $PM_{2.5}$, based on the newly designated nonattainment area in Pierce County, is required to be demonstrated by December 14, 2010. PSRC is working with the region's air quality consultation partners on the procedures and parameters for conducting this analysis, which will be concluded after Transportation 2040 is adopted.

4 What are the current conditions and trends for air quality?

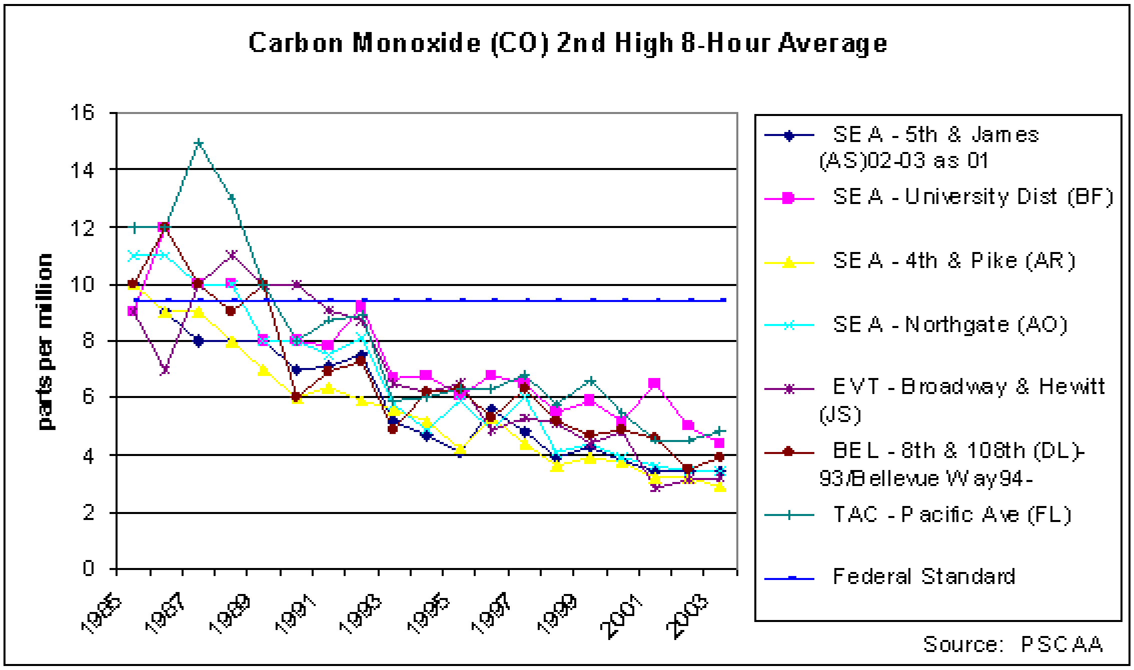
National Pollutant Trends

Nationally, emissions of the six criteria pollutants have declined by 41 percent since 1990, even while population, VMT, and energy use have increased. This decline is a result of regulatory and voluntary control programs in a variety of sectors, including mobile sources and industry. However, many parts of the country are in violation of one or more of the NAAQS, and ozone and fine particulates present particular challenges. Emissions of air toxics are also on the decline, with a decrease in emissions of certain pollutants such as benzene of 5 percent or more per year between 2000 and 2005. Alternatively, total emissions of greenhouse gases have increased 15 percent since 1990. This is primarily due to CO_2 emissions from the combustion of fossil fuels (EPA, 2007).

Regional Pollutant Trends

Regional air pollution trends have generally followed national patterns over the last 20 years, with the level of criteria air pollutants decreasing over the last decade to levels below the federal standards. Levels of CO in particular have decreased substantially in the region (Exhibit 6-4). On-road gasoline vehicles represent over 70 percent of CO emissions in the region (PSCAA, 2006b). Decreases in CO concentrations have resulted in large part from federal emission standards for new vehicles and the gradual replacement of older, more polluting vehicles. Local oxygenated fuels programs, inspection and maintenance programs, and traffic control measures have also played a role in the declining CO emission trend.

Exhibit 6-4
Carbon Monoxide Trends in the Central Puget Sound Region



Source: PSCAA, 2006b

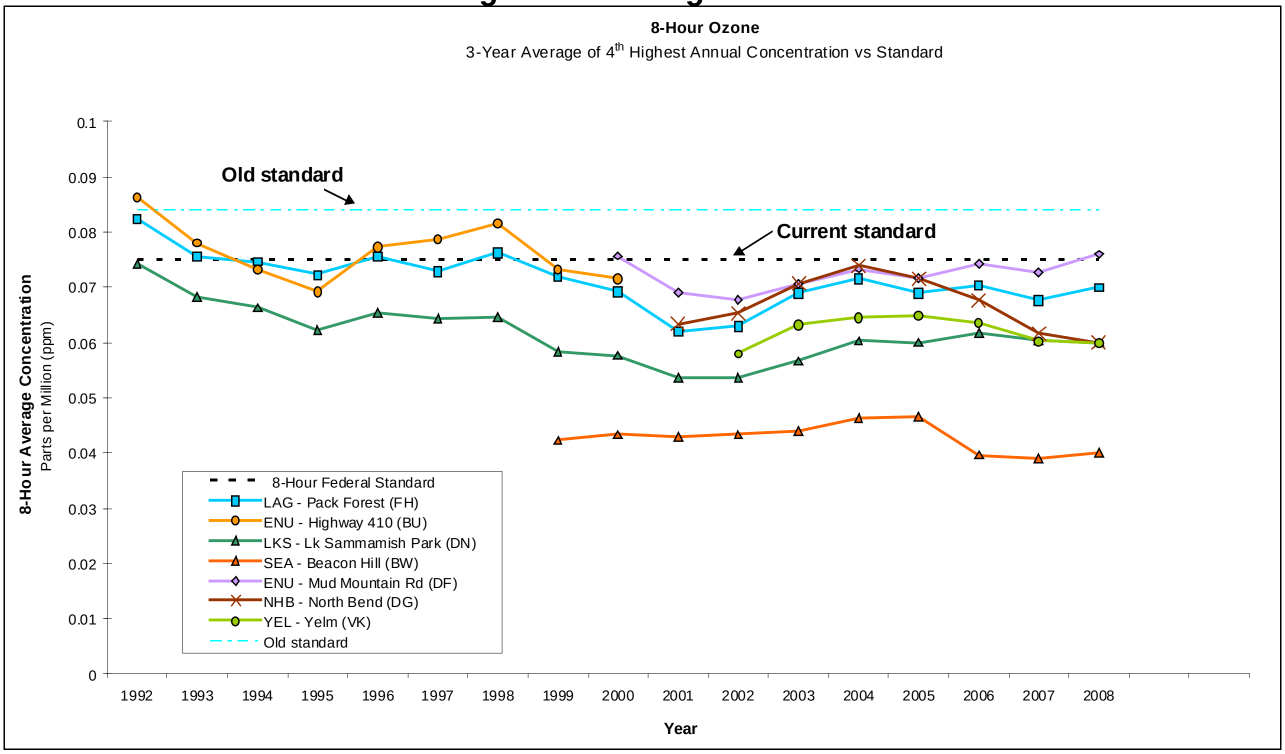
Emissions of sulfur oxides, NO_x, and lead are below levels of concern in the Puget Sound region and have been for many years. Levels of sulfur oxides in the region have shown significant decreases in the last 20 years, and PSCAA ceased monitoring for this pollutant in 1999. Lead in the ambient air is no longer considered a public health concern, and it has not been monitored in the region since 1999. Although NO_x is a concern in the region due to its role in the formation of ozone (along with VOCs in the presence of sunlight), emissions of this pollutant have been dramatically reduced in the region.

Emissions of ozone and fine particulates, however, have been of concern in recent years. In fact, as stated in the previous section, the region has recently violated the more stringent standards set by EPA and is soon to be designated as nonattainment of both standards.

Exhibit 6-5 illustrates the ozone trend in the region since 1992. The dashed black line represents the current federal standard; the high ozone concentrations that occurred last summer, plus several previous years' exceedances, have resulted in a violation of the standard. While the emissions are originating primarily in urban areas, the highest concentrations of ozone are measured in communities 10 to 30 miles downwind from the source, in areas such as North Bend and Enumclaw. Because of the complex chemical reactions occurring in the formation of ozone, the reduction of the precursor pollutants (VOCs and NO_x) does not produce proportional reductions in ozone. In the Puget Sound region, it has been determined that at a certain level, reducing emissions of NO_x may actually increase ozone concentrations. Therefore, reducing VOCs will be the most effective way to reduce ozone.

Exhibit 6-5

Ozone Trends in the Central Puget Sound Region

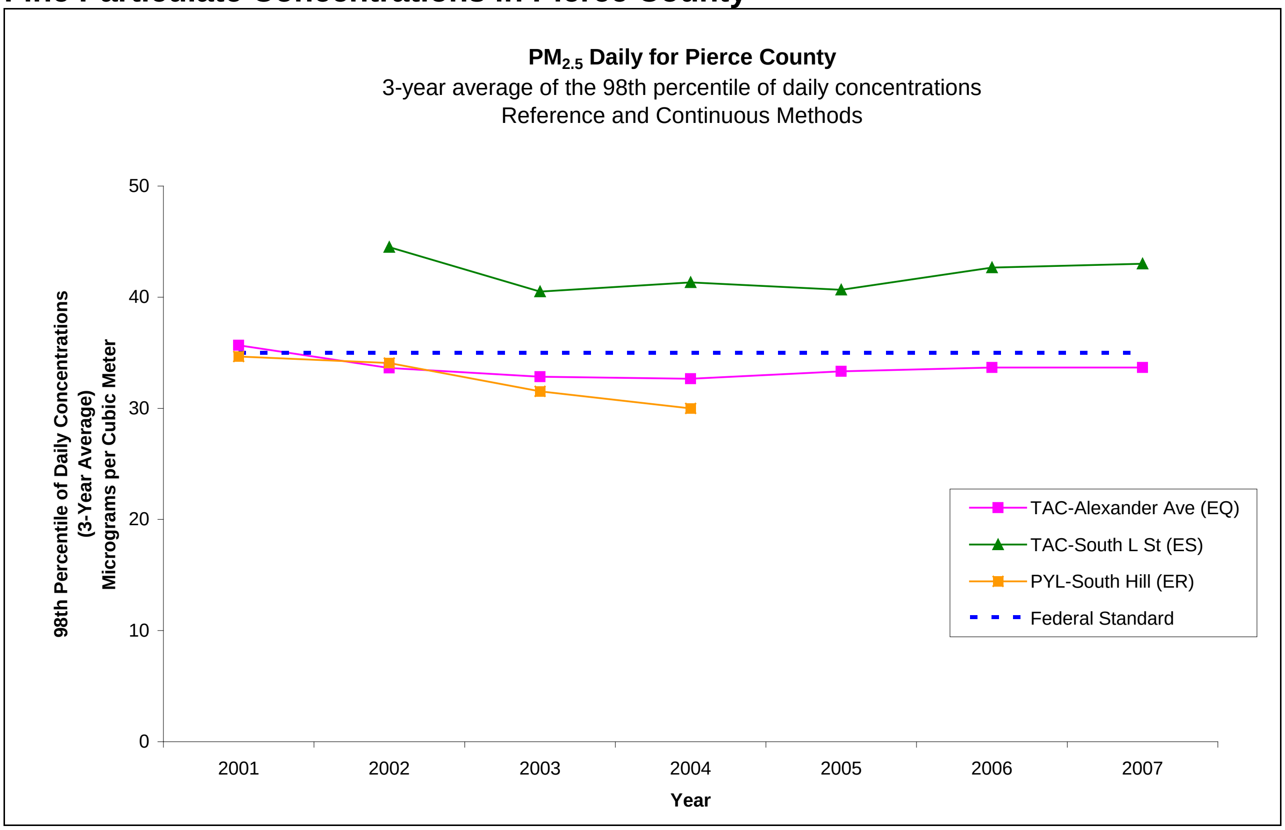


Source: PSCAA, 2009

Exhibit 6-6 shows the $PM_{2.5}$ concentrations in Pierce County since 2001; the graph illustrates that the Tacoma area has now violated the new standard. Other monitors throughout the region are close but have not yet violated the fine particulate standard. As stated previously, the primary source of $PM_{2.5}$ emissions in the Tacoma area is wood burning activities, with mobile sources representing approximately 27 percent of the emissions. A similar composition of sources can be found in other parts of the region for this pollutant, although the percentage share between mobile sources and wood burning has seasonal differences. Emissions of coarse particulates, or PM_{10}, in the region have remained below the federal standard since the early 1990s.

Exhibit 6-6

Fine Particulate Concentrations in Pierce County

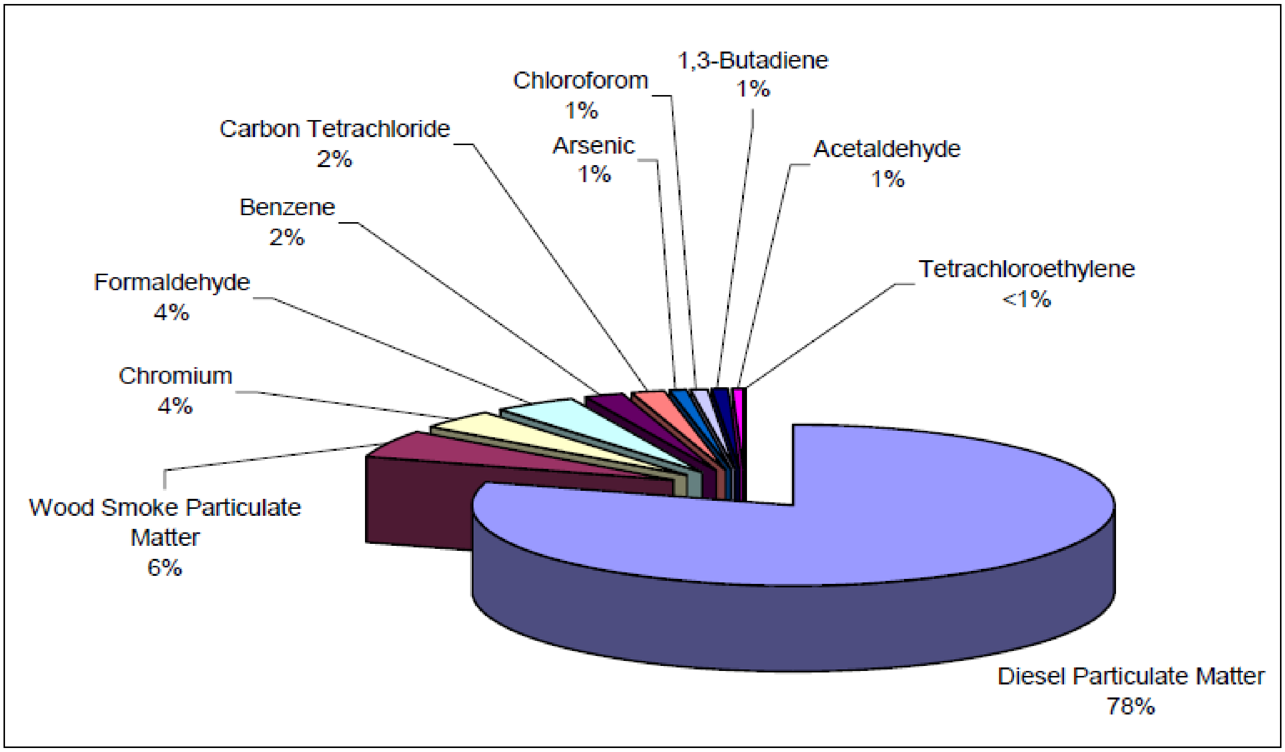


Note: All South Hill data are Federal Reference Method (FRM) from 2000 to 2007. Alexander Avenue data are FRM from 1999 to 2002 and nephelometer data from 2003 to 2007. South Hill data are FRM from 1999 to 2002 and nephelometer data from 2003-2004; incomplete nephelometer data were collected from South Hill in 2005.

Air toxics are present in the region at levels posing a health risk, and EPA has placed the region in the top 5 percent of the country for potential cancer risk from air toxics (PSCAA, 2006a). As shown in Exhibit 6-7, diesel particulate matter from diesel-fueled vehicles and equipment accounts for approximately 78 percent of the potential cancer risk from all air toxics in the central Puget Sound region. At 6 percent, particulate matter from wood smoke represents the second-highest potential cancer risk in the region (PSCAA, 2003). Monitoring in the region for 17 air toxics has occurred since 2000. While 2000 to 2005 is a relatively short span of time on which to draw conclusions for regional trends, concentrations decreased in that time for all but one air toxic (PSCAA, 2006a).

Exhibit 6-7

Greatest Air Toxics Contributors to Potential Cancer Risk



Source: PSCAA, 2006a

Finally, while transportation sources account for 50 percent of the greenhouse gas emissions in the Puget Sound region, emissions are expected to grow fastest in the buildings and facilities sector and electricity supply (PSCAA, 2004). This is due in large part to the region's increasing reliance on natural gas and coal-based electricity sources, because the region's hydropower resources have largely met their maximum potential. The 2 years for which there are regional inventories—2000 and 2005—indicate an overall increase of approximately 0.8 million metric tons of CO_2 equivalent during this 5-year time period, or 1.7 percent; the percentage by source has stayed roughly the same.

5 How were the alternatives analyzed?

NO_x, VOCs, ozone, CO, PM_{10}, and $PM_{2.5}$ emissions for on-road mobile sources for the alternatives were estimated using PSRC's travel demand model and EPA's MOBILE6.2 vehicle emissions modeling software. EPA's draft Motor Vehicle Emission Simulator (MOVES) software was used to estimate greenhouse gas emissions represented as CO_2 equivalents (and hereafter referred to as CO_2). Emissions were calculated on an individual link basis, based on the VMT and speed of each link. This calculation was performed separately for five time periods (a.m. peak, midday, p.m. peak, evening, and night). The calculated emissions of individual links were then summed for each of the five time periods, which in turn were summed for the total daily emissions. No modeling was performed for air toxics, but emissions are expected to vary among the alternatives similarly to the other pollutants. Refer to Appendix E for further details on the air quality modeling parameters.

Where can I learn more about EPA MOBILE6.2 and MOVES?

For more information about the vehicle emissions modeling software used by the EPA, refer to http://www.epa.gov/otaq/models.htm.

CO and PM_{10} emissions were modeled within their respective maintenance areas as well as for the entire region. This approach allows modeled emissions under each alternative to be compared to the motor vehicle emission budget for each maintenance area. Emissions of all other pollutants were modeled for the entire region, because there are no currently designated maintenance or nonattainment areas in the Puget Sound region for these pollutants. The method for performing conformity analyses is slightly different than that used to analyze the entire region and reported in Exhibit 6-8; refer to Appendix E for further details.

6 What effects on air quality are common to all alternatives?

Exhibit 6-8 presents the results of each alternative for all pollutants analyzed (for the entire region). Exhibit 6-9 shows the percent change of emissions from each of the action alternatives (Alternatives 1 through 5 and the Preferred Alternative) compared to the Baseline Alternative. Exhibit 6-10 compares the CO and PM_{10} emissions for each alternative against the motor vehicle emission budget for those two pollutants within their respective maintenance areas (as illustrated in Exhibit 6-1).

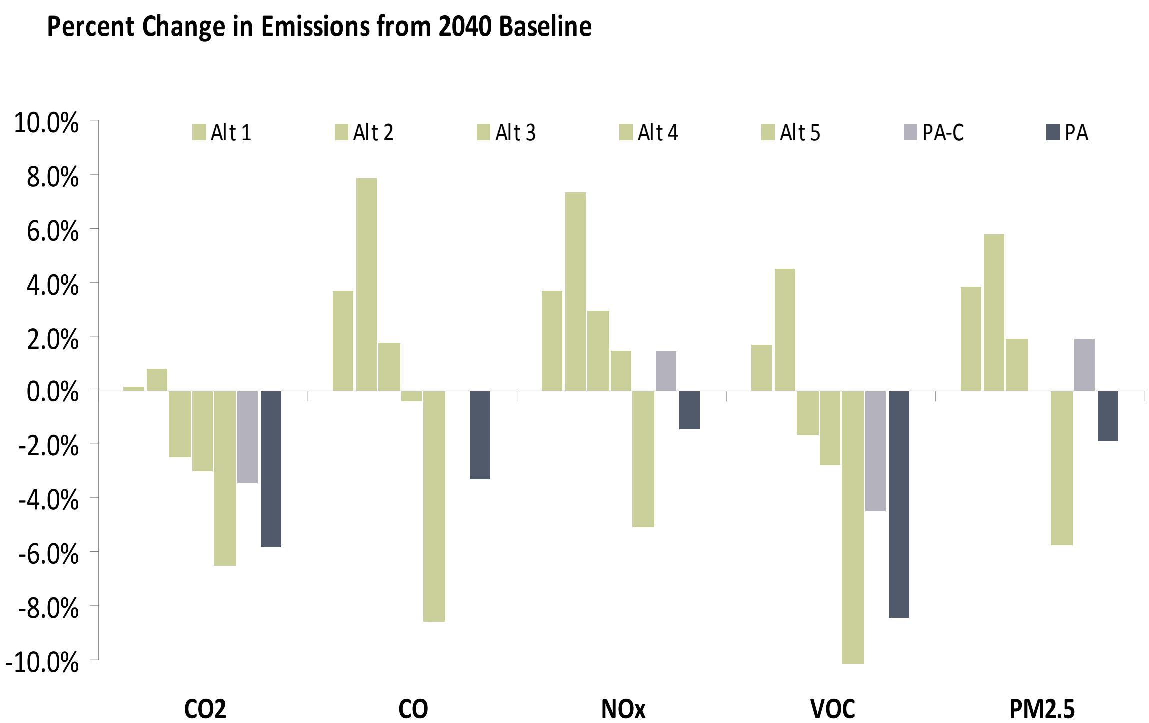
In addition to on-road mobile sources, emissions from the energy consumption of buildings were estimated for each of the alternatives. The energy consumption from these facilities is described in Chapter 11: Energy; the corresponding CO_2 emissions related to this energy consumption are included in Exhibit 6-8 and 6-9 (refer to Appendix E for additional information on the methods used).

As demonstrated in Exhibit 6-10, all of the Transportation 2040 alternatives remain below the motor vehicle emission budgets for the two pollutants for which the region is in maintenance status. As shown in Exhibits 6-8 and 6-9, emission trends compared to the base year show a decrease for the criteria pollutants but an increase for CO_2. As described in the previous section, regulatory and technological improvements such as the Tier II emission standards, which will reach full implementation by 2009, have played a significant role in the declining trend in these emissions. Because CO_2 emissions from mobile sources are more directly related to the amount of carbon in the fuel and the amount of fuel burned, the trend for these emissions is different than that of the other pollutants. The criteria pollutants are more affected by vehicle emission control technologies and improvements in fuel combustion because carbon is the main component of petroleum fuels. CO_2 emissions are less affected by these technologies and more by improvements to the fuel economy of vehicles and lowering the carbon content of fuels.

Exhibit 6-8[3]
Emissions (annual tons))

	2006	2040 Baseline Alternative	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	PA-C	PA
CO2 Mobile	17,158,000	23,648,000	23,708,000	24,020,000	22,789,000	22,568,000	21,257,000	22,308,000	21,526,000
CO2 buildings	8,893,000	13,176,000	13,154,000	13,086,000	13,105,000	13,136,000	13,169,000	13,245,000	13,141,000
Total CO2	26,051,000	36,824,000	36,862,000	37,106,000	35,894,000	35,704,000	34,426,000	35,553,000	34,667,000
CO	497,400	387,000	402,200	418,200	394,600	386,300	354,600	387,600	374,900
NOx	57,900	13,700	14,200	14,700	14,100	13,900	13,000	13,900	13,500
VOC	34,500	17,800	18,100	18,600	17,500	17,300	15,900	17,000	16,300
PM2.5	1,770	520	540	550	530	520	490	530	510

Exhibit 6-9[4]
Percent Change from 2040 Baseline Alternative



[3] This exhibit has changed since the DEIS.

[4] This exhibit has changed since the DEIS.

Exhibit 6-10[5]

Transportation Conformity Analysis

	Motor Vehicle Emission Budget*	2040 Baseline Alt	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Preferred Alternative (Constrained)
CO (daily tons)	2,512	1,164	1224	1278	1208	1187	1084	1188
PM_{10} (daily pounds)								
Kent	232	83	88	91	87	88	85	84
Duwamish	844	299	296	291	299	296	275	288
Tacoma	461	236	247	252	250	254	231	240

Source: From the Central Puget Sound Region Maintenance Plan for each pollutant. Note: Conformity is applied only to the financially constrained portion of the Transportation 2040 plan; for the full conformity determination, including analysis of interim years, refer to Appendix E of the Transportation 2040 plan.

7 What effects on air quality are specific to individual alternatives?

As illustrated in Exhibits 6-8 and 6-9, Alternative 2 has the largest increase in emissions compared to the Baseline Alternative for all pollutants. Alternative 1 has an emissions increase for all pollutants compared to the Baseline Alternative, and Alternatives 3 and 4 show a mix of increases and decreases, depending on the pollutant. Alternative 5 shows the largest decrease in emissions for all pollutants. The full Preferred Alternative reduces emissions of all pollutants compared to the Baseline Alternative. The full Preferred Alternative has lower emissions of all pollutants than Alternatives 1 through 4, while emissions are higher than in Alternative 5. The results from the full Preferred Alternative are closest to the results of Alternative 5 than any of the other alternatives. The financially constrained portion of the Preferred Alternative has higher emissions than the full Preferred Alternative, and demonstrates a mix of increases and decreases compared to the other alternatives, depending on the pollutant.

As shown in Exhibits 6-11 and 6-12, Alternative 5 has the lowest percentage of single-occupant vehicle (SOV) trips, and the highest percentage of transit and bike/walk trips. Alternative 2, on the other hand, has the highest percentage of SOV trips and the lowest percentage of bike/walk trips; the share of transit trips in Alternative 2 is lower than in Alternative 1 and Alternatives 3 through 5, but is equivalent to

[5] This exhibit has changed since the DEIS.

the transit share of trips in the Baseline Alternative. These mode share differences correlate with the emission results in Exhibits 6-8 and 6-9. The Preferred Alternative has a lower percentage of SOV trips, and a higher percentage of transit and bike/walk trips than the Baseline Alternative. The mode shares in the Preferred Alternative are similar to those in Alternatives 4 and 5.

Exhibit 6-11[6]

2040 Mode Shares (percent)

	Baseline	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Preferred Alternative (Constrained)	Preferred Alternative
SOV	44	43	45	43	43	42	43	42
Shared Ride	40	40	42	40	40	40	40	40
Transit	4	5	2	4	5	5	5	5
Bike/Walk	12	12	1	12	12	13	12	12
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Note: Numbers may not add to 100% due to rounding.

Exhibit 6-12[7]

Total Vehicle Miles Traveled (VMT)

	Baseline	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Preferred Alternative (Constrained)	Preferred Alternative
Total VMT	102,519,000	106,647,000	110,481,000	104,059,000	101,643,000	94,063,000	102,539,000	99,511,000

In terms of total VMT, Alternative 5 has the lowest VMT and Alternative 2 the highest among the alternatives. Chapter 4: Transportation discusses more fully the differences among the alternatives in terms of average daily speed and other indicators, including differences among facility types. Because individual pollutants react differently to changes in speed, these nuances may help to explain why Alternatives 3 and 4 display decreases in emissions of certain pollutants but increases in others. The full Preferred Alternative has lower VMT than the Baseline Alternative and all other alternatives except Alternative 5. The financially constrained portion of the Preferred Alternative is very similar in total VMT to the

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[6] This exhibit has changed since the DEIS.

[7] This exhibit has changed since the DEIS.

Baseline Alternative; total VMT is less than shown in Alternatives 1 through 3, but higher than Alternatives 4 and 5.

Daily VMT per Capita Reductions

HB 2815 sets benchmarks for reducing statewide annual per capita VMT. The benchmark is based on a statewide forecast of 75 billion VMT by 2020; trucks over 10,000 pounds gross vehicle weight are exempted. The methodology for estimating the daily VMT per capita resulting from each Transportation 2040 alternative is different than the annual statewide benchmarks as described in the legislation. To make a reasonable and valid comparison, assumptions were made regarding the forecasted statewide 2020 annual VMT, the percentage of VMT attributed to trucks over 10,000 pounds, the forecasted 2020 statewide population, and the appropriate conversion factor from annual VMT per capita to daily VMT per capita. These assumptions are further discussed in Appendix E.

Based on these assumptions, average statewide daily VMT per capita in 2020 for passenger vehicles and light trucks is estimated to be approximately 27 miles. The statewide benchmarks would then be 22.1 miles by 2020, 18.9 miles by 2035, and 13.5 miles by 2050. In contrast, the PSRC regional forecast of 2020 daily VMT per capita is approximately 20.1 miles per day for passenger vehicles and light trucks, which is 26 percent lower than the state's forecast of VMT per capita in 2020. Exhibit 6-13 shows the daily VMT per capita results for each of the Transportation 2040 alternatives, for passenger vehicles and light trucks.

Exhibit 6-13[8]

Daily VMT per Capita for Passenger Vehicles and Light Trucks

	2020 Regional Baseline	Baseline Alternative	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Preferred Alternative (Constrained)	Preferred Alternative
Daily per Capita VMT	20.1	18.6	19.4	20.1	18.8	18.3	16.8	18.5	17.9
Percent Reduction from 2020		-8%	-4%	0%	-6%	-9%	-16%	-8%	-11%

[8] This exhibit has changed since the DEIS.

The mobile source emission analyses do not include emissions from transit vehicles. At this time, PSRC's travel demand models do not represent all transit vehicle miles on the transportation network. As such, the impact from transit vehicles on emissions is not represented in the quantified analyses, although the subsequent transit ridership and distribution of trips among modes is captured. Each of the Transportation 2040 alternatives contains different levels of transit investment for light rail, commuter rail, and bus service. Each vehicle type has different emission characteristics; therefore, total ridership and the number of miles traveled by the vehicles will affect the total resulting emissions.

Greater electric vehicle use would reduce greenhouse gas emissions.

Source: Wikimedia Commons, 2008

Greenhouse Gas Emissions and Technology

In addition to the pricing, transit, efficiency, and other strategies included in each of the Transportation 2040 alternatives (refer to Chapter 3: Plan Alternatives for more complete alternative descriptions), the PSRC Transportation Policy Board also directed staff to consider the potential effects from improved vehicle and fuel technologies on each alternative with respect to reducing greenhouse gas emissions. These technologies are discussed in greater detail in Question 9 and in the Transportation 2040 plan. However, as an example of the ultimate potential such technologies might provide, a scenario to replace the current fleet of passenger vehicles and light trucks with all electric vehicles was evaluated. With the caveat that achieving a full fleet replacement by 2040 would most likely require a shift from current policy and market mechanisms, the potential CO_2 emission reductions for such a scenario within the Transportation 2040 alternatives is in the range of 60 percent. This represents the approximate share of CO_2 emissions from passenger vehicles and light trucks for each alternative; replacing the existing fleet with electric vehicles that produce zero CO_2 emissions from the tailpipe (these calculations do not take into account upstream emissions that may result from the generation of electricity) would therefore remove the same proportionate share of total emissions for each alternative. For each of the alternatives, this scenario would reduce emissions in the range of approximately 50 percent from base year 2006 levels. Based on the analysis results, the Transportation 2040 plan includes a Four-Part Greenhouse Gas Strategy to address the reduction of greenhouse gas emissions. This strategy includes land use, transportation choices, user fees, and technology. The Transportation 2040 plan also contains more information on the potential benefits of these strategies.

8 What cumulative effects on air quality could occur if the Transportation 2040 actions coincide with other planned actions?

Beyond the transportation-related impacts described previously, all of the alternatives would result in development and construction activity in various areas throughout the region. Construction would likely generate localized dust and exhaust emissions from vehicles and other equipment. In addition, these construction activities would likely contribute to localized traffic congestion, which may temporarily worsen localized emissions. The potential quantities of generated dust and exhaust emissions would depend on the amount of construction activity associated with each alternative. Specific impacts would be analyzed and addressed during project-level analysis of individual projects.

What are cumulative effects?

Cumulative effects address the impact on the environment that results from the incremental impact of the action being considered when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The surface transportation-based forecasts used for the air quality analysis do not attempt to predict other changes in regional and external pollution that could affect regional air quality. Growth outside of the region could also increase vehicle emissions in nearby metropolitan areas.

9 How can the effects to air quality be mitigated?

Individual projects may require mitigation, which would be identified during future project-level planning and environmental review. Each of the alternatives is estimated to result in emissions well below the motor vehicle emission budget for the pollutants for which the region is in maintenance (CO and PM_{10}); therefore, mitigation to reduce these emissions would not be required. However, given that certain pollutants are still a concern in the region (e.g., ozone and $PM_{2.5}$), existing programs and measures to ensure the region's continued attainment and maintenance status should continue.

There have been many improvements in vehicle and fuel technologies over the past several decades, resulting in dramatic reductions in mobile source emissions. However, with population and VMT continuing to grow, emissions from mobile sources are still a concern, particularly with issues related to climate change taking prominence in our world today. Some of the current innovations occurring in our region include a conversion of transit buses to diesel/electric hybrid engines and the use of ultra-low-sulfur diesel or biodiesel fuel.

Washington State Ferries (WSF) is developing strategies that would lower ferry emissions.

Source: WSDOT, 2009

Washington State Ferries is currently researching the use of biodiesel fuel for use on the ferry system. The ferry system has already converted their entire fleet to run on ultra-low-sulfur diesel fuel. Much work has also been done to reduce emissions from port-related activities, such as using cleaner fuels, electric shore power, and other activities. The Diesel Solutions program run by PSCAA, in partnership with Ecology and EPA, has been working since 2001 to retrofit diesel engines in public and private fleets. The goal of Diesel Solutions is to retrofit or replace 100 percent of these fleets by 2040, resulting in a 90 percent reduction in particulate matter emissions.

The use of ultra-low-sulfur diesel fuel in highway engines has the potential to reduce emissions of particulate matter and NO_x by more than 90 percent when the current heavy-duty vehicle fleet has been completely replaced by 2030 (AFDC, 2009). The use of biodiesel, depending on the percentage blended with conventional diesel, can reduce emissions of CO, particulate matter, sulfates, hydrocarbons, and air toxics. Biodiesel also has the potential to reduce greenhouse gas emissions by 10 to 50 percent, depending on the blend. There are larger issues with the use of biodiesel, however, related to the upstream energy impacts from production (dependent on the agricultural source, for example).

Using low-carbon fuels in transit reduces greenhouse gas emissions.

Source: King County Metro Transit, 2003

Another fuel improvement currently being researched is to reduce the carbon content of fuel. The state of California established a Low-Carbon Fuel Standard in 2007, with a goal of reducing the carbon intensity of fuels 10 percent by 2020. The 2008 Climate Action Team in the state of Washington has also recommended a low-carbon fuel standard as one of several “most promising” strategies to reduce greenhouse gas emissions in the transportation sector.

There are also many innovations in vehicle technologies that are either currently in the market or are being researched for future implementation. These include hybrid electric vehicles, plug-in hybrid or full electric vehicles, and hydrogen fuel cells. The potential tailpipe emission reduction from each of these technologies depends, in part, on the market penetration of the vehicles. The length of time it takes for these vehicles to enter the market, including at what percentage, is significant when discussing the impacts on climate change. “Traditional” hybrid electric vehicles have the potential to reduce greenhouse gas emissions in the range of 30 percent, and plug-in hybrid electric vehicles have the potential of reducing greenhouse gas emissions in the range of 30 to 60 percent (EPA, 2007). Many other factors, such as the source of electricity, play a role in the potential for upstream emission reductions from these technologies. Fuel cell vehicles may present the most promising technology in terms of tailpipe emission reduction, but they also present the most challenges (including costs, transport and storage of hydrogen, safety, and distribution systems).

Greenhouse Gas Strategy

For more information about PSRC’s Greenhouse Gas Strategy, refer to Appendix L: Greenhouse Gas 4-part Strategy.

An expanded analysis of the potential benefits from improvements in vehicle and fuel technology, as well as policy considerations such as market penetration and cost issues, are included as part of the Transportation 2040 plan. As with travel-related strategies, it will take a mix of strategies to result in the most effective emission reductions possible from vehicle and fuel technologies. However, the literature and research to date suggests that to achieve the maximum emission reduction from the transportation sector, a mix of all strategies must be undertaken—travel reduction, efficiency improvements, and vehicle and fuel technology improvements. It is also important to note that these quantified analyses do not capture all of the possible benefits from the investments assumed for each of the

Transportation 2040 alternatives, due to the limitations of the analytical models. Additional emission reductions may be possible from components such as additional sidewalk infrastructure, travel demand management programs, and Intelligent Transportation System (ITS) investments.

10 Are there any significant unavoidable adverse impacts to air quality?

Future project-level environmental review would determine if applicable air quality standards would be exceeded at specific locations. Where this occurs, potential mitigation for such impacts would be evaluated and implemented as appropriate to address the impact. If all mitigation measures required as part of subsequent project-level actions are implemented, no significant unavoidable adverse air quality impacts are expected under any of the alternatives.