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Puget Sound Clean Air Agency

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2007
Air Quality Data Summary

October 2008

Working Together for Clean Air

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The 2007 Air Quality Data Summary is available
for viewing or download on the internet at:

www.pscleanair.org/

Links to additional documents for download are also available at the web site.

This material is available in alternate formats for people with disabilities. Please call Carol Pogers at (206) 689-4080 (1-800-552-3565, ext. 4080).

INTRODUCTION

BACKGROUND

The Puget Sound Clean Air Agency (the agency) has issued an air quality data summary report almost every year for over 30 years. The purpose of this report has been to summarize regional air quality by presenting air monitoring results for six criteria air pollutants. The U.S. Environmental Protection Agency (EPA) sets national ambient air quality standards (NAAQS) for these pollutants. These criteria air pollutants are:

- Particulate Matter (10 micrometers and 2.5 micrometers in diameter)
- Ozone
- Nitrogen Dioxide
- Carbon Monoxide
- Sulfur Dioxide
- Lead

Beginning in 2004, the agency added additional information on air toxics to the Air Quality Data Summary. Air toxics are pollutants broadly defined by the agency to include over 400 chemicals and compounds. Most air toxics are a component of either particulate matter or volatile organic compounds (a precursor to ozone), so there are overlaps between the criteria pollutants and toxics. Toxic pollutants are associated with a broad range of adverse health effects, including cancer. In recent years, the agency added additional fine particulate matter monitoring information and more graphics (maps displaying concentrations), in an effort to continually improve this report.

The agency and Washington State Department of Ecology work together to monitor air quality within the Puget Sound region.[1] Real-time air monitoring data are available for some pollutants on the Internet at http://www.pscleanair.org/airq/aqi.aspx and https://fortress.wa.gov/ecy/aqp/Public/aqn.shtml. Visit the agency's website to find more extensive air quality data, educational materials, monthly air quality summaries, and discussions of current topics. To receive the agency's monthly electronic newsletter, Clean Air Newsline, and stay current on air quality issues in King, Kitsap, Pierce, and Snohomish counties, visit www.pscleanair.org/news/agencynews.aspx and select Clean Air Newsline. Subscribers receive the latest on air quality news, trends, and projects that affect local communities in the Puget Sound region. It is also used to send timely and important messages about burn bans, smog watches, and early calls to action when air quality deteriorates.

The agency is expanding and refining our internet site to better serve the residents of the Puget Sound region. We encourage feedback on our air quality data and program via e-mail to Mary Hoffman at maryh@pscleanair.org or at 206-689-4006.

[1]The Agency's jurisdiction covers King, Kitsap, Pierce, and Snohomish Counties in Washington State.

REPORT ORGANIZATION

A brief overview of the report is provided in the executive summary. A description and summary of the Air Quality Index (AQI) and the agency's monitoring program and network are provided immediately following the executive summary. Information on the agency-issued burn bans and smog watches and a local emissions inventory are then presented.

The primary focus of this report is to present information on criteria air pollutants. Graphs, statistical summaries, and health effects information are provided for each pollutant as well as comparisons to ambient air quality standards and health goals. Information about visibility based on fine particulates is included as part of our particulate matter presentation.

In addition to the information on criteria air pollutants, a summary of air toxics data based on monitoring by the Washington State Department of Ecology is also presented, along with links to more comprehensive reports describing air toxics concentrations and health effects information.

EXECUTIVE SUMMARY FOR 2007

The agency, along with partners, continued to monitor the region's air quality in 2007. Over the last decade, criteria air pollutant concentrations for some pollutants have fallen well below levels of concern in our jurisdiction. For example, levels of carbon monoxide, a pollutant that the region was formerly in nonattainment for, have fallen to levels so low that the Washington State Department of Ecology discontinued many of the monitors in 2006 in order to focus its monitoring resources on higher priority pollutants. The same is true for the criteria pollutants sulfur dioxide, lead, and nitrogen dioxide.

While the area enjoys improving air quality, we are facing new challenges. After more than a decade of attaining all federal standards, the agency faces nonattainment, potentially in multiple areas, for $PM_{2.5}$ and ozone. This is due to recent revisions to the national fine particulate and ozone standards to better protect public health.

For fine particulate matter, concentrations at the South L Tacoma monitoring site, located in the south end of Tacoma, violate the more protective, daily fine particulate matter federal standard. The U.S. Environmental Protection Agency (EPA) is expected to designate a contributing area (Wapato Hills, Puyallup River Valley) surrounding the South L Tacoma monitor as nonattainment by December 18, 2008. For more information on this monitor and designation area, please see http://www.pscleanair.org/news/library/reports/Tacoma_PM2_5_rec.pdf.

Other sites in Snohomish and King Counties are close to the daily fine particle federal standard. The agency has begun work with the Department of Ecology, other local governments, businesses, and citizens to develop a plan to attain the standard in the Wapato Hills, Puyallup River Valley nonattainment area and to maintain $PM_{2.5}$ attainment status in the rest of our region. While efforts to reduce fine particulate emissions will be tailored to different areas, they generally target wood smoke emissions reductions, as the highest $PM_{2.5}$ levels occur in heating months when wood stoves and fireplaces contribute the majority of $PM_{2.5}$. $PM_{2.5}$ levels at monitors in Snohomish, King, Kitsap, and Pierce County continue to exceed the agency's local health goal, which has been set at 25 $\mu g/m^3$ to more adequately protect health.

Ozone levels remain a concern in our region. Ozone concentrations have not decreased as significantly as precursor pollutants. Furthermore, EPA revised its standard from 0.08 parts per million to 0.075 parts per million in March 2008. Preliminary ozone data from the summer of 2008 indicate that the Puget Sound Region has violated this standard. Although 2007 had a relatively "clean" ozone summer, the high 2006 concentrations will continue to affect a potential nonattainment status because of the three year form of the standard. Meeting a stricter ozone standard presents a challenge for the Puget Sound region, and will require the agency and its partners to develop a plan to reduce ozone precursor emissions.

Air toxics are also present in our airshed at levels that pose adverse health effects.[2] These health effects include, but are not limited to, increased cancer risk and respiratory effects.

[2]Puget Sound Final Air Toxics Evaluation, 2003; http://www.pscleanair.org/airq/basics/psate_final.pdf.

Many of the same sources that produce criteria and toxic air pollutants also generate greenhouse gases. The agency collaborates with public and private partners to reduce greenhouse gases.[3] Unlike the criteria pollutants and air toxics included in this summary, we do not monitor their levels in the atmosphere or present historic trends. The agency focuses on local emission inventories and reduction strategies. For more information, refer to http://www.pscleanair.org/programs/climate/default.aspx.

The agency is taking action with many partners to face these air quality challenges. These actions include exploring new methods to better characterize fine particulate and air toxics, estimating greenhouse gas emissions, developing reduction strategies, working with planning agencies, and implementing voluntary incentive programs that achieve reductions. Visit our website at www.pscleanair.org for more information about emission reduction programs.

AIR QUALITY INDEX (AQI)

The AQI is a nationwide reporting standard developed by the EPA for the criteria pollutants. The AQI is used to report daily air quality. "Good" AQI days continued to dominate our air quality in 2007. However, air quality degraded into "moderate" approximately one fifth of the time and to "unhealthy for sensitive groups" and "unhealthy" for brief periods.

Table 1 shows the AQI breakdown by percentage in each category for 2007. Snohomish County registered the highest AQI value of 155 on January 15. Fine particulate matter ($PM_{2.5}$) determined the AQI on January 15. $PM_{2.5}$ typically determines the AQI in the Puget Sound area on days considered unhealthy for sensitive groups. EPA has not yet updated the AQI breakpoints to reflect the new $PM_{2.5}$ standard. When the AQI is updated, it is likely that monitors will register more frequently in the "unhealthy for sensitive groups" and "unhealthy" range.

Table 1: AQI Ratings for 2007

	AQI Rating (% of year)				
County	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Highest AQI
Snohomish	79%	19%	2%	0%	155
King	78%	21%	1%	0%	115
Pierce	82%	16%	3%	0%	137
Kitsap	88%	12%	0%	0%	92

[3] Roadmap for Climate Change: Reducing Greenhouse Gas Emissions in Puget Sound; http://www.pscleanair.org/programs/climate/rptfin.pdf.

EMISSION INVENTORY

An emission inventory is an estimation of the pollutants discharged into the air during a specified 12-month period. It is a critical tool in assessing air quality in our region. The 2005 inventory is the most recent inventory released by the Puget Sound Clean Air Agency and can be accessed at http://www.pscleanair.org/news/library/reports/2005AQDSFinal.pdf. The 2005 inventory shows that on-road vehicles continue to be the greatest contributors to both criteria pollutant and green house gas emissions in the Puget Sound airshed. Area sources such as outdoor and indoor burning are major contributors to $PM_{2.5}$ emissions.

IMPAIRED AIR QUALITY -- BURN BANS AND SMOG WATCHES

The Puget Sound Clean Air Agency issues temporary bans on indoor and outdoor burning when air inversions trap fine particle pollution emitted from our chimneys, cars, trucks, and other activities close to ground level. These burn bans are mandatory. There are two stages of the burn bans. Stage 1 prohibits burning from fireplaces and uncertified wood stoves unless it is the only adequate source of heat. Stage 2 prohibits burning in fireplaces, uncertified wood stoves, EPA certified wood stoves, and pellet stoves unless it is the only adequate source of heat.

The agency issued three burn bans in 2007. These burn bans occurred January 13-16, January 28-31, and December 9-11.

The agency also may issue a smog watch when predicted ozone levels are expected to persist for several days. During a smog watch, the agency encourages people to voluntarily take steps that will keep smog levels from rising even higher including driving less, using the most fuel efficient vehicle, and avoiding the use of gasoline-powered yard equipment and gasoline-fueled recreation vehicles. The agency did not issue a smog watch in 2007.

CRITERIA AIR POLLUTANTS AND VISIBILITY

The Puget Sound airshed is currently in attainment for carbon monoxide, ozone, and PM_{10}, and has maintenance plans in place for these pollutants. As noted above, the Region's ozone status may change when 2008 data for ozone are quality assured.

The Tacoma South L monitor and surrounding area are expected to be designated nonattainment for fine particles in December 2008. Marysville and Darrington monitors are close to the standard and may have violations in the near future. Concentrations at monitors in all four counties continue to exceed our more stringent, local health goal.

A more protective 8-hour ozone federal standard may result in nonattainment at the Enumclaw Mud Mountain monitor. This monitor typically has the highest regional ozone concentrations during high-ozone episodes.

EPA plans to propose a new lead standard in September 2008. Lead concentrations measured in the Puget Sound area are well below the levels that are being proposed.[4]

Monitoring shows that visibility associated with fine particulate matter in the Puget Sound area has continued to improve over the last decade.

AIR TOXICS

The Department of Ecology began monitoring air toxics at the Seattle Beacon Hill site in 2000, as part of EPA's national air toxics trend network.

Carbon tetrachloride, a chemically persistent air toxic banned in 1996, presented the highest potential cancer risk from air toxics monitored in 2007 at the Seattle Beacon Hill site. Benzene, an air toxic from gasoline and other combustion, ranked second. It is important to note that this ranking does not include diesel and wood smoke particulate matter. A comprehensive 2003 evaluation showed that diesel particulate matter presents the majority of potential air toxics cancer health risk in our area.[5] Unfortunately, there is no direct monitoring method to measure diesel particulate matter.

[4] It is not yet clear what method and size fraction will be required with the new lead standard that will be proposed in September 2008. Comparisons with PM_{10} lead from Beacon Hill and $PM_{2.5}$ lead from speciation sites show low concentrations.
[5] Puget Sound Final Air Toxics Evaluation, 2003; http://www.pscleanair.org/airq/basics/psate_final.pdf.

AIR QUALITY INDEX

The air quality index (AQI) is reported according to a 500-point scale for five of the six major criteria air pollutants: ozone, particulate matter (both $PM_{2.5}$ and PM_{10}), carbon monoxide, nitrogen dioxide, and sulfur dioxide. The highest pollutant determines the daily ranking. For example, if an area has a carbon monoxide value of 132 on a given day and all other pollutants are below 50, the AQI for that day would be 132. The scale breaks down into six categories, listed below. Each category has a corresponding color, shown with pollution concentration breakpoints for each category, shown in Tables 9 and 10 in the Definitions section of this document.

- **0 - 50: Good.** Satisfactory air quality; little or no risk from pollution.
- **51 - 100: Moderate.** Acceptable air quality; potential moderate health concerns for a very small number of people.
- **101 - 150: Unhealthy for Sensitive Groups.** Air quality is acceptable for the general public, but people with health conditions that make them sensitive to a particular pollutant are at greater risk of health problems.
- **151 - 200: Unhealthy.** Everyone may experience some health effects, more serious for members of sensitive groups.
- **201 - 300: Very Unhealthy.** Everyone may experience more serious health effects.
- **301 - 500: Hazardous.** Health risk is at emergency levels. Everyone is likely to be affected.

The AQI is a national index, so the reported values and colors used to show local air quality and the associated level of health concern will be the same throughout the United States. Current and archived AQI values for Puget Sound can be found on our website at www.pscleanair.org.

The number of "good" air quality days continues to dominate our air quality in the Puget Sound area. However, air quality degraded into "moderate", "unhealthy for sensitive groups", and "unhealthy" for brief periods. Table 1, presented in the executive summary, shows the AQI breakdown by percentage in each category for the year.

In 2008 EPA revised the AQI breakpoints for ozone in order to be consistent with the new ozone standard; however, the graphs in this report will be based on the 2007 breakpoints. EPA has not yet revised the AQI breakpoints to reflect the revised $PM_{2.5}$ daily standard. When EPA updates the AQI to reflect the new standard, it is possible that the Puget Sound Clean Air Agency could see more days in "moderate", "unhealthy for sensitive groups", and "unhealthy" categories.

Figure 1 presents the annual number of "good" AQI days for each of the four counties. The number of "good" days has been relatively constant over the last few years for each county. Lower numbers of "good" days now can not be directly compared with the numbers before 1999, when $PM_{2.5}$ was added to the index and the "unhealthy" category was divided into "unhealthy" and "unhealthy for sensitive groups."

Figures 2 through 5 present AQI days for King, Kitsap, Pierce, and Snohomish Counties. Graphs include numbers adjacent to the “unhealthy for sensitive groups” and “unhealthy” lines for clarification of the number of days with these designations. Pages A-1 through A-4 of the Appendix present summaries for each county. Summaries include “good”, “moderate”, “unhealthy for sensitive groups”, and “unhealthy” days from 1980 to 2007 (from 1990 to 2007 for Kitsap County).

Figure 1: Number of Days Air Quality Rated As "Good" Per AQI

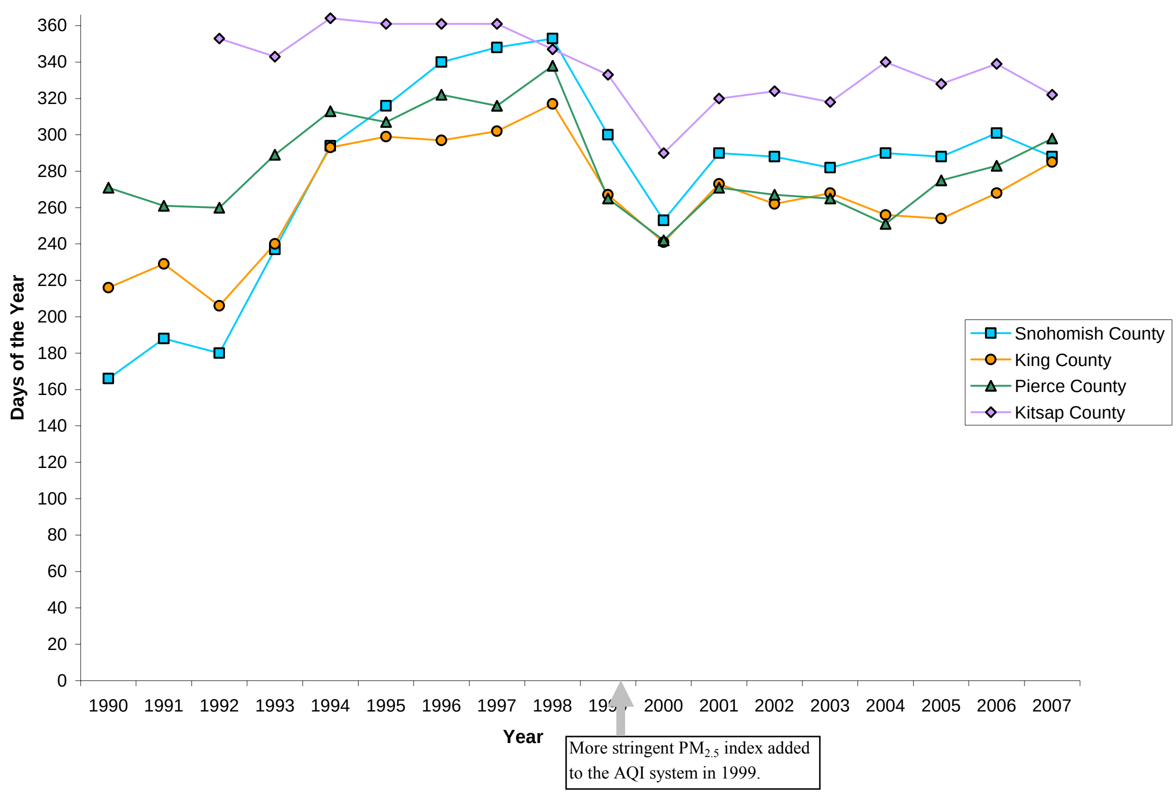


Figure 2: Air Quality for King County

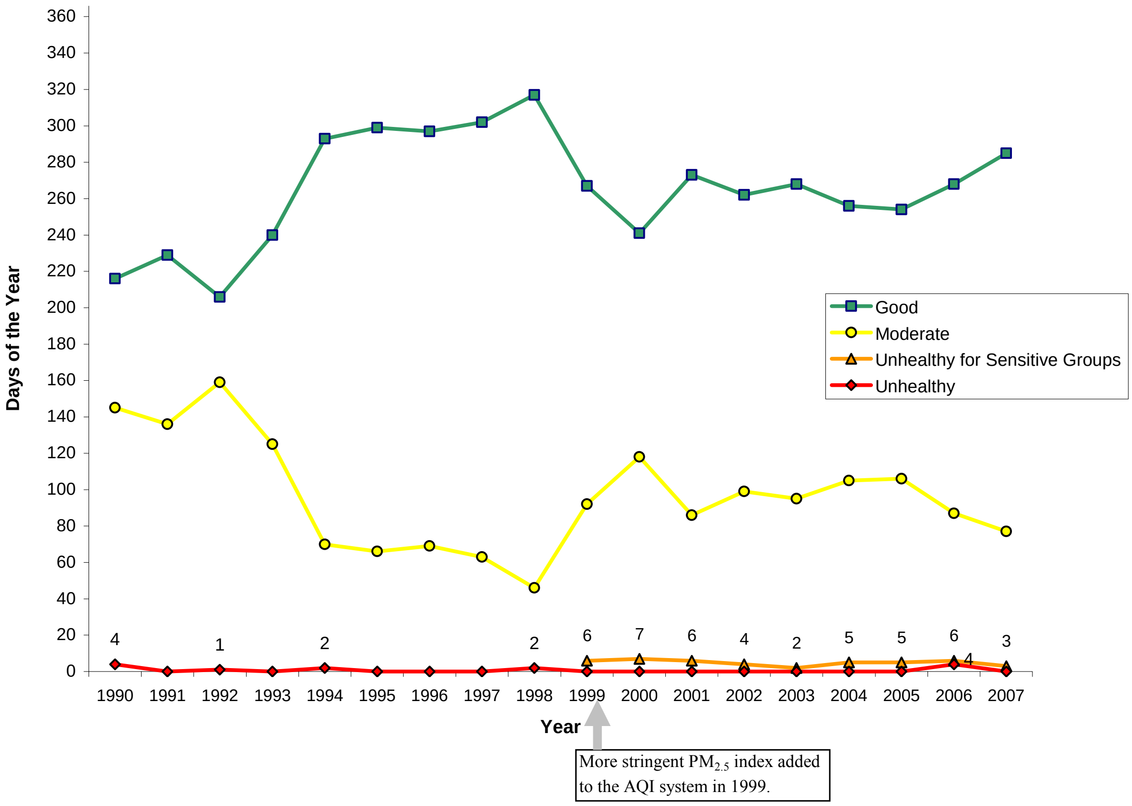


Figure 3: Air Quality for Kitsap County

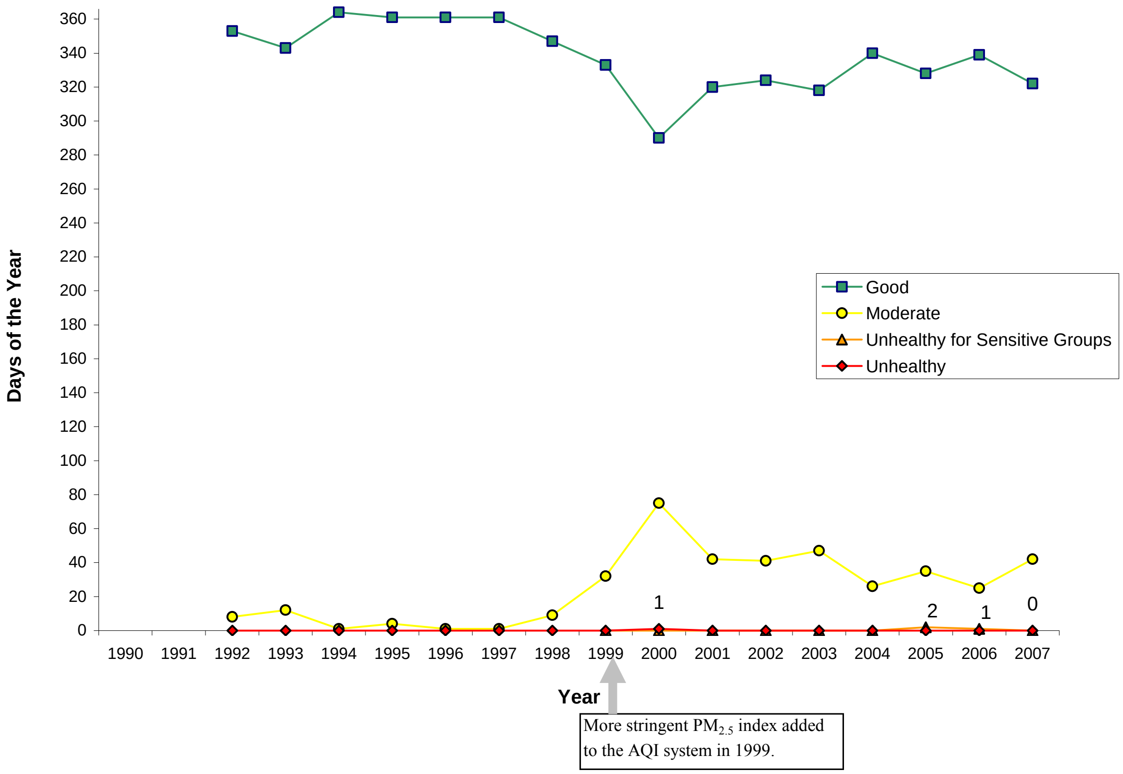


Figure 4: Air Quality for Pierce County

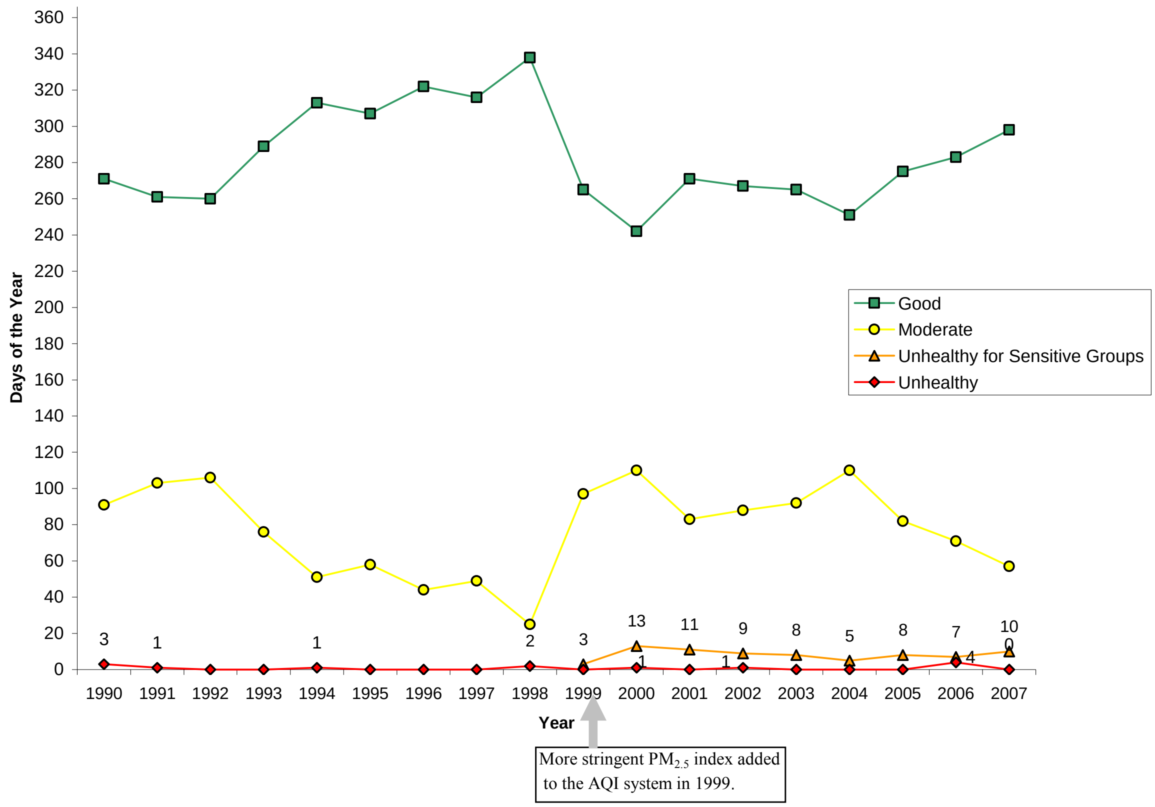
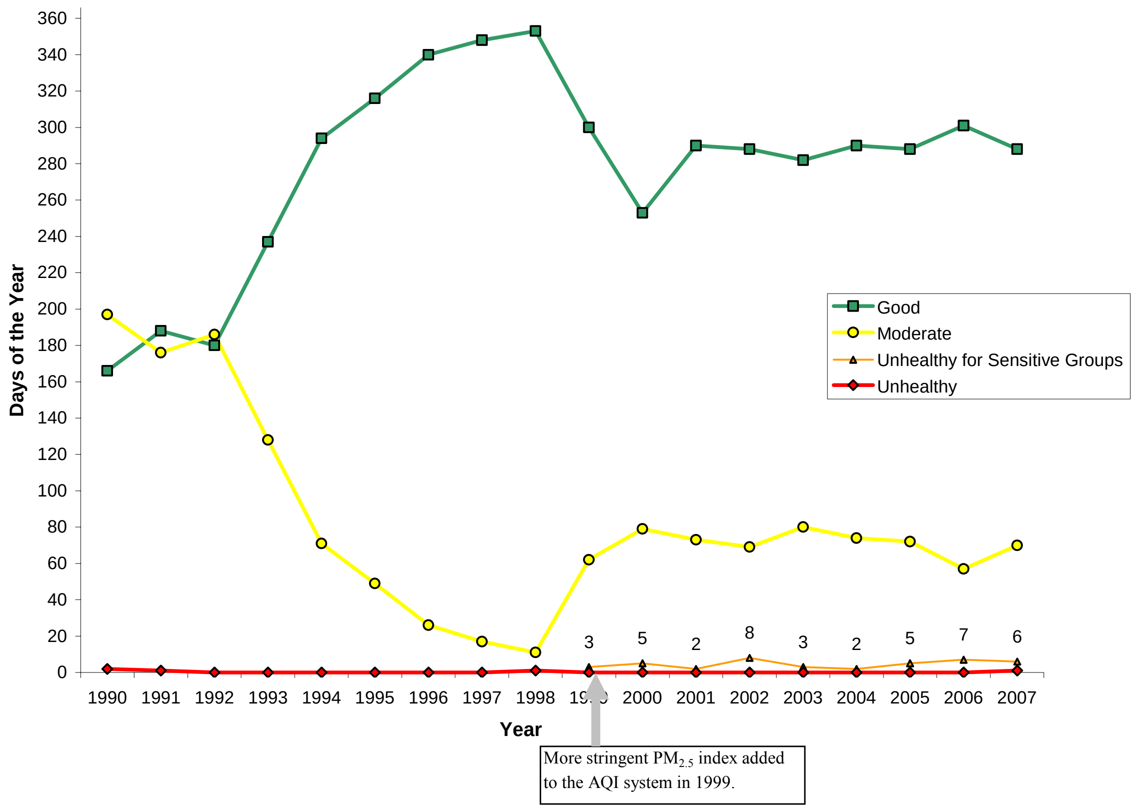


Figure 5: Air Quality for Snohomish County



MONITORING NETWORK

The agency and the Washington State Department of Ecology operate the Puget Sound region's monitoring network, comprised of both meteorological and pollutant-specific equipment. Data from the network are either collected manually by field staff or sent directly to engineers and scientists through a telemetry network. The agency is working with the Washington State Department of Ecology and other local air agencies to improve the efficiency of the telemetry network.

The agency conducted monitoring as early as 1965; however, this report will focus on post-1999 monitoring. Table 2 presents a summary of the monitoring stations and parameters monitored from 1999 through 2007. Some parameters were monitored for only part of this time frame. Shaded stations in the table are currently operating. Similarly, a filled circle denotes a pollutant that is currently monitored (in 2007). An “x” denotes a pollutant that was no longer monitored in 2007. The network changes because the agency and the Department of Ecology regularly re-evaluate monitoring resources to measure and report on the pollutants that are most relevant to public health. Additionally, sometimes logistical issues (such as loss or gain of real estate) cause changes in the network.

Monitoring stations are located in a variety of geographic locations in the Puget Sound region. Most are located in highly populated areas. Monitors are sited according to EPA criteria to ensure a consistent and representative picture of air quality. Map 1 on page 19 shows monitoring stations that were active in 2007.

The station IDs shown on the map correspond with table identification letters. These same identification letters are used throughout this data summary. General location descriptors are also provided for each station in the last column of the monitoring network table. These descriptors make broad distinctions between urban center, suburban, and rural, and also provide information as to whether areas are more commercial, industrial, or residential. Sites that have more than two descriptors have varied land use; for example, both residential and commercial. In addition, some sites are selected to focus on the emissions of a specific pollutant or source (for example, near a busy roadway or residential areas where wood is used for home heating). Pollutant-specific sections of this report highlight these monitoring locations and objectives.

The agency and the Washington State Department of Ecology measure criteria air pollutants using federal reference methods (FRM) that are approved by the Environmental Protection Agency (EPA). In addition to the federal reference method, the agency measures particulate matter using alternate methods. These methods help engineers and scientists better understand the presence and behavior of these pollutants. For example, as shown in the monitoring network table, fine particulate ($PM_{2.5}$) is monitored according to the EPA reference method (“ref” in the table), as well as several other methods that provide real-time values.

Table 3, on page 20, lists the methods used for the criteria pollutants. Additional information on these methods is available at EPA’s website at http://www.epa.gov/ttn/amtic/. Information on air toxics monitoring methods is available at http://www.epa.gov/ttn/amtic/airtox.html.

SPECIAL MONITORING PROJECTS

In addition to the network described in this section and presented on Map 1, the agency conducted a short-term special monitoring project in 2007 to improve our understanding of the spatial distribution of wintertime $PM_{2.5}$ concentrations in Marysville, where the monitor is close to violating the new $PM_{2.5}$ standard. Three temporary monitors were set up in or near Marysville in order to assess $PM_{2.5}$ conditions across Marysville. In addition, two temporary monitors – one in Lake Stevens and one in North Everett were installed to evaluate these locations. The monitors were operated from mid-September 2007 through January 2008. Details on the special monitoring projects are provided in the "Particulate Matter - $PM_{2.5}$ Special Monitoring Project" section of this report.

FINE PARTICULATE MONITORING – FEDERAL REFERENCE METHOD AND CONTINUOUS METHODS

Fine particulate matter ($PM_{2.5}$) is measured using a variety of methods because it is the main pollutant of concern in our area. The EPA considers the federal reference method (FRM) to be the most accurate way to determine $PM_{2.5}$ concentrations.[6] This method involves pulling in air (at a given flow rate) for a 24-hour period and collecting particles of a certain size (in this case $PM_{2.5}$) on a filter. The filter is weighed and the mass is divided by air volume (determined from flow rate and amount of time) to provide concentration. Particles on the filter can be later analyzed and modeled for more information about the types of particulate matter. Unfortunately, the FRM does not provide continuous or rapid turnaround information.

The agency uses the FRM as well as two continuous methods to provide more time-relevant data. Our agency has been a national leader in this type of continuous monitoring.

These methods determine fine particulate matter concentration differently:

- the nephelometer uses scattering of light
- the tapered element oscillating microbalance (TEOM) measures mass

The agency also uses instruments to measure organic components of fine particulate matter, called aethalometers. These instruments measure light absorption.

In this report, continuous method data are compared, where possible, to the reference method values and calculations are made to determine the degree of difference from the reference method. The differences are then applied to the current continuous values in an attempt to make them “FRM-like.” Continuous concentrations from Kitsap County are not adjusted to make them “FRM-like”, as there is no site-specific FRM data at the Meadowdale and Silverdale monitoring sites.

[6] EPA also accepts continuous methods that have been adjusted to make them “FRM-like.”

Table 2: Air Quality Monitoring Network

Station ID	Location	PM_{10} Ref	PM_{10} bam	PM_{10} Teom	$PM_{2.5}$ ref	$PM_{2.5}$ bam	$PM_{2.5}$ teom	$PM_{2.5}$ ls	$PM_{2.5}$ bc	O_3	SO_2	NO_Y	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
AO⦿	Northgate, 310 NE Northgate Way, Seattle (ended 3/31/03)												X						b, d, f
AQ	Queen Anne Hill, 400 W Garfield St, Seattle (photo/visibility included)							●						●	●	●		●	a, d, f
AR⦿	4th Ave & Pike St, 1424 4th Ave, Seattle (ended Jun 30, 2006)												X						a, d
AS⦿	5th Ave & James St, Seattle (ended Feb 28, 2001)												X						a, d
AU⦿	622 Bellevue Way NE, Bellevue (ended Jul 30, 1999)												X						a, d
AZ	Olive Way & Boren Ave, 1624 Boren Ave, Seattle SPECIATION SITE							●	●					●	●	●		●	a, d
BF⦿	University District, 1307 NE 45th St, Seattle (ended Jun 30, 2006)												X						b, d
BU⦿	Highway 410, 2 miles E of Enumclaw (ended Sep 30, 2000)									X									c, e
BV⦿	Sand Point, 7600 Sand Pt Way NE, Seattle (ended Aug 31, 2006 in the process of restarting)							●						●	X	X			b, d
BW⦿ BZ⦿	Beacon Hill, 15th S & Charlestown, Seattle SPECIATION SITE				●		●	●	●	●	●	●	●	●	●	●	●	●	b, d, f
CE	Duwamish, 4752 E Marginal Way S, Seattle SPECIATION SITE	X		●	●		●	●	●		X			●	●	●		●	a, e
CW	James St & Central Ave, Kent	X		●	X		●	●						●	●	●		●	b, d
CX	17711 Ballinger Way NE, Lake Forest Park (ended Jun 4, 1999)	X	X											X	X			X	b, d, f
CZ	Aquatic Center, 601 143rd Ave NE, Bellevue (ended May 31, 2006)						X	X						X				X	b, f

Station ID	Location	PM_{10} Ref	PM_{10} bam	PM_{10} Teom	$PM_{2.5}$ ref	$PM_{2.5}$ bam	$PM_{2.5}$ teom	$PM_{2.5}$ ls	$PM_{2.5}$ bc	O_3	SO_2	NO_Y	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
DA	South Park, 8025 10th Ave S, Seattle (ended Dec 31, 2002)	X			X			X						X	X			X	b, e, f
DB	17171 Bothell Way NE, Lake Forest Park SPECIATION SITE	X	X		●		●	●	●					●	●	●		●	b, d, f
DC⦿	305 Bellevue Way NE, Bellevue				X			●						●				●	a, d
DD	South Park, 8201 10th Ave S, Seattle							●						●				●	b, e, f
DE⦿	City Hall, 15670 NE 85th St, Redmond (ended Dec 14, 2005)				X			X						X				X	a, d
DF⦿	30525 SE Mud Mountain Road, Enumclaw				X			●		●				●	●	●		●	c
DG⦿	42404 SE North Bend Way, North Bend				X		X	●		●				●	●	●		●	c, d, f
DH⦿	2421 148th Ave NE, Bellevue												●						b, d
DK⦿	43407 212th Ave SE, 2 mi west of Enumclaw (ended Sep 6, 2006)														X	X			c
DL⦿	NE 8th St & 108th Ave NE, Bellevue (ended March 4, 2003)												X						a, d
DN⦿	20050 SE 56th, Lake Sammamish State Park, Issaquah									●					●	●			b, d
DP⦿	504 Bellevue Way NE, Bellevue (ended Sep 30, 1999)	X			X														a, d
DZ⦿	Georgetown, 6431 Corson Ave S, Seattle (ended August 31, 2002)											X	X		X				a, d, e, f
EA	Fire Station #12, 2316 E 11th St, Tacoma (ended Dec 31, 2000)	X	X												X				a, e
EP	27th St NE & 54th Ave NE, Tacoma (ended Feb 29, 2000)	X									X				X				b, e, f
EQ	Tacoma Tideflats, 2301 Alexander Ave, Tacoma[11]	X	X	●	X		X	●			X			●	●	●		●	a, e
ER	South Hill, 9616 128th St E, Puyallup	X	X		X	X		●						●	●	●		●	b, f
ES	7802 South L St, Tacoma (began Oct 3, 1999)				●		●	●	●					●	●	●		●	b, f

Station ID	Location	PM_{10} Ref	PM_{10} bam	PM_{10} Teom	$PM_{2.5}$ ref	$PM_{2.5}$ bam	$PM_{2.5}$ teom	$PM_{2.5}$ ls	$PM_{2.5}$ bc	O_3	SO_2	NO_Y	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
FF⦿	Tacoma Indian Hill, 5225 Tower Drive NE, northeast Tacoma														●	●			b, f
FG⦿	Mt Rainier National Park, Jackson Visitor Center									●				●					c
FH⦿	Charles L Pack Forest, La Grande									●									c, f
FL⦿	1101 Pacific Ave, Tacoma (ended Jun30, 2006)												X						a, d
ID	Hoyt Ave & 26th St, Everett (ended Feb 29, 2000)										x				X				a, e, d
IG	Marysville JHS, 1605 7th St, Marysville	X	X		●		●	●	●					●	●	●		●	b, d
IH	20935 59th Place West, Lynnwood (ended Jun 8, 1999)	X		X										X	X			X	a, d
II	6120 212th St SW, Lynnwood				X	X	●	●						●	●			●	b, d
JN⦿	5810 196th Street, Lynwood (ended Jun 30, 2006)												X						a,d
JO	Darrington High School, Darrington 1085 Fir St				●			●	●					●	●	●		●	d, f
JP⦿	2939 Broadway Ave, Everett (ended March 31, 2003)												X						a, d
JQ⦿	44th Ave W & 196th St SW, Lynnwood (ended May 3, 2004)												X						a, d
JS⦿	Broadway & Hewitt Ave, Everett (ended May 21, 2000)												X						a, d
QE	Meadowdale, 7252 Blackbird Dr NE, Bremerton	X				X		●						●	●	●		●	b, f
QF	Lions Park, 6th Ave NE & Fjord Dr, Poulsbo (ended Feb 29, 2000)														X				b, f
QG	Fire Station #51, 10955 Silverdale Way, Silverdale (began Jun 2, 2000)					X		●						●	●	●		●	a, d
RV⦿	Yelm N Pacific Road, 931 Northern Pacific Rd SE, Yelm (began May 2005)									●									c,f

Station ID	Location	PM_{10} Ref	PM_{10} bam	PM_{10} Teom	$PM_{2.5}$ ref	$PM_{2.5}$ bam	$PM_{2.5}$ teom	$PM_{2.5}$ ls	$PM_{2.5}$ bc	O_3	SO_2	NO_Y	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
UB⦿	71 E Campus Dr, Belfair (ended September 30, 2004)									X									c
VK⦿	Fire Station, 709 Mill Road SE, Yelm (began May 1, 2000 - ended in October 2005)									X									c,f

⦿	Station operated by Washington State Department of Ecology	SO_2	Sulfur Dioxide
RV⦿	Shading indicates station currently functioning	NO_x	Nitrogen Oxide
⬤	Indicates parameter currently monitored	CO	Carbon Monoxide
X	Indicates parameter previously monitored	b_{sp}	Light scattering by atmospheric particles (nephelometer)
PM_{10} ref	Particulate Matter 10 micrometers (reference)	Wind	Wind direction & speed
PM_{10} bam	Particulate Matter 10 micrometers (beta attenuation continuous)	Temp	Air temperature (relative humidity also measured at BW)
PM_{10} teom	Particulate Matter 10 micrometers (teom continuous)	AT	Air Toxics
$PM_{2.5}$ ref	Particulate Matter 2.5 micrometers (reference)	VSBY	Visual range (light scattering by atmospheric particles)
$PM_{2.5}$ bam	Particulate Matter 2.5 micrometers (beta attenuation continuous)	PHOTO	Visibility (camera)
$PM_{2.5}$ teom	Particulate Matter 2.5 micrometers (teom continuous)	O_3	Ozone (May through September)
$PM_{2.5}$ ls	Particulate Matter 2.5 micrometers (light scattering nephelometer continuous)		
$PM_{2.5}$ bc	Particulate Matter 2.5 micrometers black carbon (light absorption aethalometer)		

Location

- a Urban Center
- b Suburban
- c Rural
- d Commercial
- e Industrial
- f Residential

Map 1: Active Air Monitoring Network for 2007

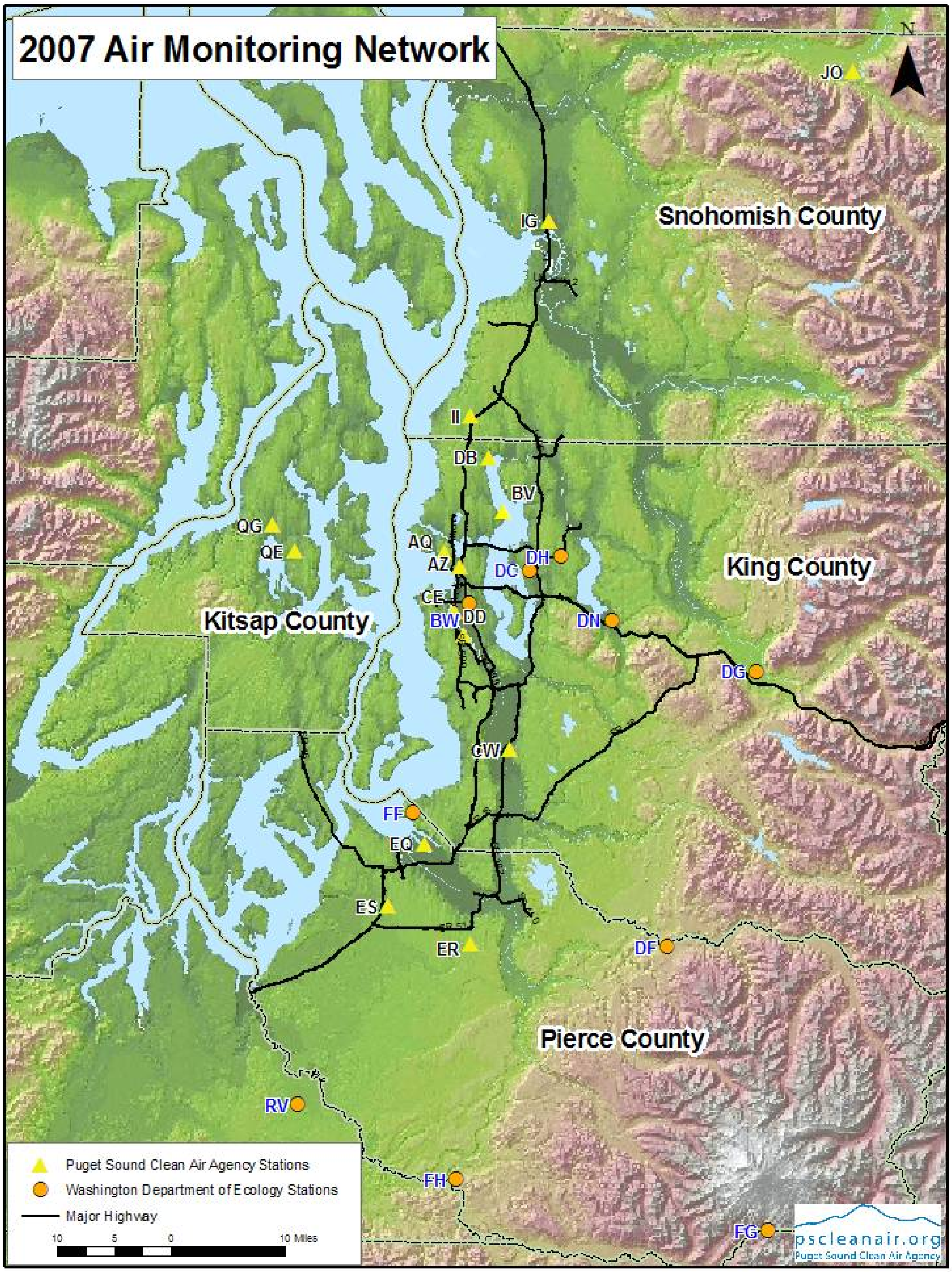


Table 3: Monitoring Methods Used from 1999 to 2007 in Puget Sound Airshed

Pollutant Code	Measurement	Method	Units
Bap	Light Absorption by Particles	Light Absorption by Aethalometer	bap (x 10 exp-4)/m
Bsp	Light Scattering by Particles	Nephelometer - Heated Inlet	bsp (x 10 exp-4)/m
CO	Carbon Monoxide	Gas Nondispersive Infrared Radiation	Parts per Million
NO_x	Nitrogen Oxides (NO_x)	Chemiluminescence	Parts per Million
	Nitric Oxide (NO)	Chemiluminescence	Parts per Million
	Nitrogen Dioxide (NO_2)	Chemiluminescence	Parts per Million
NO_Y	Reactive Nitrogen Compounds (NO_X + other reactive compounds)	Chemiluminescence	Parts per Billion
O_3	Ozone	UV Absorption	Parts per Million
Pb	Lead	Standard High Volume	Micrograms per Standard Cubic Meter
PM_{10} ref	PM_{10} Reference	Reference - Hi Vol Andersen/ GMW 1200	Micrograms per Cubic Meter
PM_{10} bam	PM_{10} Beta Attenuation	Andersen FH621-N	Micrograms per Cubic Meter
PM_{10} teom	PM_{10} Teom	R&P Mass Transducer	Micrograms per Cubic Meter
$PM_{2.5}$ ref	$PM_{2.5}$ Reference	Reference—R&P Partisol 2025	Micrograms per Cubic Meter
$PM_{2.5}$ bam	$PM_{2.5}$ Beta Attenuation	Andersen FH621-N	Micrograms per Cubic Meter
$PM_{2.5}$ teom	$PM_{2.5}$ Teom	R&P Mass Transducer	Micrograms per Cubic Meter
$PM_{2.5}$ ls	$PM_{2.5}$ Nephelometer	Radiance Research M903 Nephelometer	Micrograms per Cubic Meter
$PM_{2.5}$ bc	$PM_{2.5}$ Black Carbon	Light Absorption by Aethalometer	Micrograms per Cubic Meter
RH	Relative Humidity	Continuous Instrument Output	Percent Relative Humidity
SO2	Sulfur Dioxide	UV Fluorescence	Parts per Million
Temp	Temperature	Continuous Instrument Output	Degrees F
TSP	PM Total Hi-Vol	Standard High Volume	Micrograms per Standard Cubic Meter
Vsby	Visual Range	Light Scattering by Nephelometer	Miles
Wind	Wind Speed/ Wind Direction	RM Young 05305 Wind Monitor AQ (old method)	Miles per Hour/ Degrees
	Wind Speed/ Wind Direction	Ultrasonic (new method)	Miles per Hour/ Degrees

IMPAIRED AIR QUALITY—BURN BANS AND SMOG WATCH

BURN BANS

Washington State has a winter impaired air quality program focusing on particulate matter from wood stoves and fireplaces. The Puget Sound Clean Air Agency issues temporary bans on indoor burning (in wood stoves and fireplaces) when air inversions trap fine particle pollution emitted from our chimneys, cars, trucks, and other activities. Outdoor burning of yard waste, in areas where such burning is normally allowed, is also prohibited during burn bans on indoor burning. These burn bans are mandatory.

There are two stages of the indoor burn bans. For a first-stage burn ban, residential burning in fireplaces or uncertified wood stoves is prohibited (unless it is the only adequate source of heat).[7] For a second-stage burn ban, the use of any kind of wood-burning device is prohibited unless it is the only adequate source of heat.

Before 2008 a first-stage burn ban could be declared by the agency when $PM_{2.5}$ levels reached 35µg/m^3 (24-hour average). A second-stage burn ban could be declared when $PM_{2.5}$ levels reached 60 µg/m^3 (24-hour average). In 2008, the Washington State Legislature revised the burn ban triggers to be consistent with the new $PM_{2.5}$ standard. Under the revised statute, a first-stage burn ban is triggered when meteorological conditions are predicted to cause fine particulate levels to exceed 35 µg/m^3 (based on a 24-hour average) within 48 hours. A second-stage burn ban is generally triggered when the following three things have happened: 1) a first-stage burn ban has been enforced and has not been sufficient to reduce the increasing fine particulate pollution trend, 2) $PM_{2.5}$ levels are recorded at or above 25 µg/m^3 (based on a 24-hour average), and 3) forecasted meteorological conditions are not expected to allow $PM_{2.5}$ concentrations to decline. In the past, second-stage burn bans have been very rare; however, with the new burn ban triggers it is likely that there will be more second-stage burn bans in the future.

The agency called three first-stage burn bans in 2007. These burn bans occurred January 13-16, January 28-31, and December 9-11.

Fine particulate levels at five monitoring sites during the January and December burn bans are shown in Figures 6 and 7. These five sites (Darrington and Marysville in Snohomish County, Lake Forest Park and Kent in King County, and Tacoma South L in Pierce County) are shown because they typically register some of the highest fine particulate levels in the region. Figures 6 and 7 show the 24-hour average $PM_{2.5}$ concentrations with Air Quality Index (AQI) shading and a line representing the 35 µg/m^3 federal daily standard. Concentrations are based on $PM_{2.5}$ nephelometer measurements. Each point represents a 24-hour average based on the 12 hours before and after.

[7]Uncertified wood stoves emit more pollution than ones certified by the EPA. To determine if your wood stove is certified, visit our website for more information at http://www.pscleanair.org/actions/woodstoves/basics.aspx.

Even with the burn ban, air quality reached the "unhealthy for sensitive groups" designation for some monitoring sites during these long winter inversions and exceeded the federal daily standard of 35 $\mu g/m^3$. Although some monitors show exceedances of the federal standard, these are not necessarily violations of the standard because the standard is based on a 98^{th} percentile over three years. It's also noteworthy that many of these sites exceeded the agency's health goal of 25 $\mu g/m^3$ during the burn bans.

Burn bans typically occur in November through February. Figure 8 shows the number of days when burn bans have been declared since 1988. A detailed list of these burn bans is included on page A-5 of the Appendix.

Figure 6: $PM_{2.5}$ during January 2007 Burn Bans

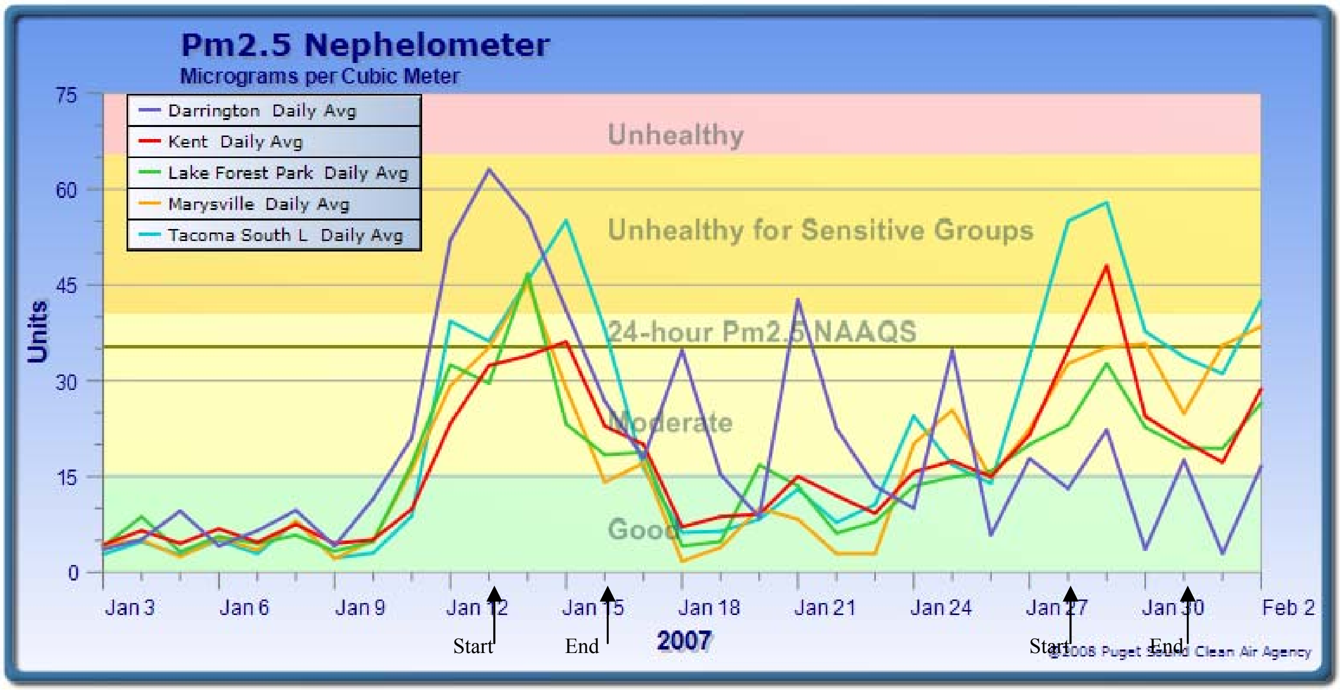


Figure 7: $PM_{2.5}$ during December Burn Ban

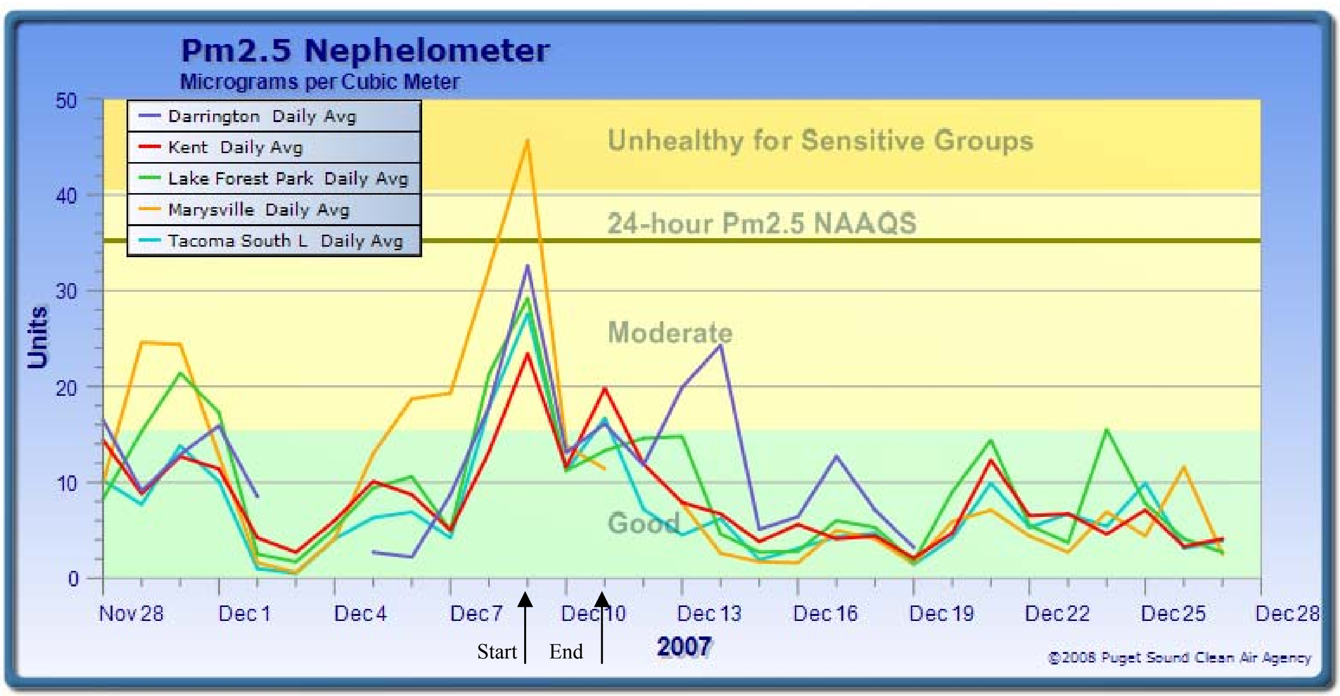
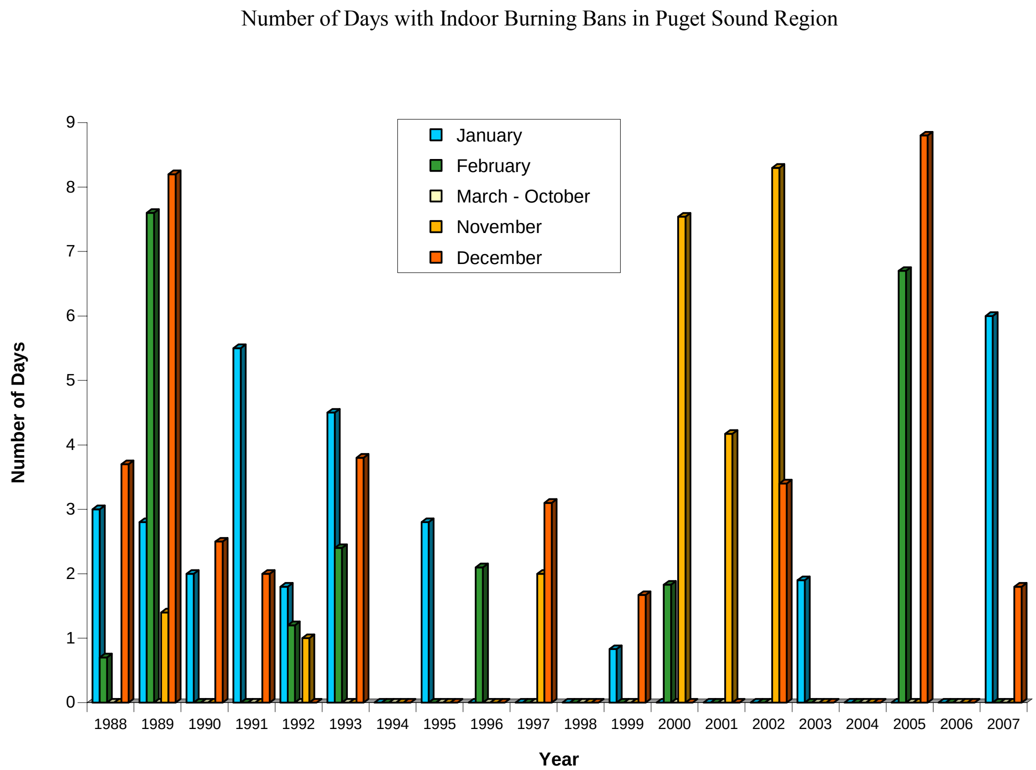


Figure 8: Impaired Air Quality Resulting in Burn Bans



SMOG WATCH

The agency maintains a voluntary air quality program called *smog watch*. During a smog watch, the agency advises residents of potential ozone problems and recommends short-term actions to help reduce ozone precursor emissions. Summer ozone typically becomes a problem on hot stagnant summer days when ozone levels rise. Thus, advisories are driven more by meteorology than by monitored air quality data. The agency calls a smog watch when forecasts predict temperatures in the upper 80s or higher, with little or no wind for at least a 48-hour period.

The agency communicates with meteorologists, traffic reporters, news media, and local businesses and agencies during smog watch advisories. The agency and its partners encourage people to take measures to reduce smog levels. These voluntary actions include driving less (by carpooling, riding transit, teleworking), waiting until it cools off to use gasoline-powered mowers and power equipment, and refueling vehicles during the cooler evening hours.

The agency did not issue any smog watches in 2007. The agency did issue a warning that there could be air quality degradation for July 9 through July 12 and encouraged people to reduce their use of car travel and gasoline-powered equipment. 8-hour ozone concentrations are shown on page A-15 of the Appendix.

REGIONAL EMISSION INVENTORY

INTRODUCTION

The agency conducts emission inventories to identify sources of pollutants. An emission inventory is an estimation of the pollutants emitted into the air during a specified 12-month period. Once estimated, emissions can be reduced through strategies such as improved control technologies, education, and outreach targeting specific behavior changes, regulatory changes, and economic incentives.

The four general categories of anthropogenic (caused by humans) emission sources are listed below, with some major subcategories bulleted. In addition to these four, biogenic (naturally-occurring) sources also emit pollutants. Examples of biogenic emissions include volatile organic compound emissions from trees and plants and nitrous oxide emissions from soil.

1. Point Sources
   Point sources are those that many people consider when thinking of air pollution. These include large industries that emit several tons of pollution or more per year from a single location, often through a smokestack. Historically, point sources contributed a large portion of air pollutants in this area. Today, this category typically represents a very small fraction of pollutant emissions in the Puget Sound area. This large reduction is due to highly effective control technology and regulation, and closure of some regional industrial facilities.

2. Mobile On-Road Sources
   - Gasoline vehicles
   - Diesel vehicles

   Mobile on-road sources include cars, trucks, and buses, both commercial and private. This category includes vehicles that run on gasoline or diesel fuel. On-road mobile sources are the single greatest contributors to air pollution in this region. Reduction strategies include: lower-emitting vehicles such as hybrids, better fuels such as ultra-low sulfur diesel, emission control technology such as diesel particulate filters and oxidation catalysts, idling reduction, and behavior changes such as carpooling and telecommuting.

3. Mobile Non-Road Sources
   - Off-road vehicles and equipment
   - Marine vessels and watercraft
   - Aircraft and airport equipment
   - Railroad engines

   Mobile non-road sources include marine vessels, construction vehicles and equipment, aircraft, trains, and garden equipment. Marine vessel emissions are a concern due to increased foreign shipping activity in local ports. The agency, along with other members of the Puget Sound Maritime Air Forum, completed a comprehensive inventory to estimate marine emissions. More information on this inventory can be found at http://www.maritimeairforum.org/emissions.shtml.

Reduction strategies for mobile non-road sources include: better fuels such as ultra-low sulfur and biodiesel, use of electrical equipment, ship use of land-based electricity while in port (instead of running engines to generate electricity), installation of emission control technology, idling reduction, and alternatives to diesel-fueled vehicles at the regional airport.

4. Stationary Area Sources
   - Outdoor burning
   - Indoor wood burning
   - Other

   Although area sources emit far less than point sources on an individual basis, the large numbers of these activities, often concentrated in residential neighborhoods, make them significant contributors to pollution in this region. The emission inventory lists indoor and outdoor burning area source subcategories separately. These two subcategories contribute significant emissions to fine particulate matter, a pollutant of concern in the Puget Sound area. Burning in a wood stove, pellet stove, or fireplace are examples of indoor burning. Burning stumps and brush to clear land and burning yard waste are examples of outdoor burning.

   Area sources also include small businesses. Small business activities that emit pollutants include solvent loss during surface coating, and degreasing. Road dust is included as an area source, and is a significant source of $PM_{2.5}$.

   Reduction strategies for stationary area sources include: less indoor burning – using cleaner alternatives for heat (natural gas, propane, heat pumps, EPA-certified wood stoves); less outdoor burning – using alternatives for biomass such as chipping and composting; use of low-emission paints and solvents; and improved practices such as closed-loop dry cleaning machines.

2005 Emission Inventory

The agency's 2005 Emission Inventory was released in March of 2008 and is the most recent inventory published by the agency. The 2005 Emission Inventory information sheet and full report are available at http://www.pscleanair.org/news/library/reports/Air_Emission_Inventory_2005_Info_Sheet.pdf and http://www.pscleanair.org/news/library/reports/Air_Emission_Inventory_2005.pdf respectively. Table 4 summarized the estimated 2005 emissions for the Puget Sound region. The inventory shows that individuals create the majority of air pollution. Personal decisions such as commute to work choices, home heating choices, vehicle maintenance frequency, yard waste disposal methods, and yard maintenance equipment choices affect air pollution.

The agency provides information on how individuals can reduce their contribution to regional air pollution at http://www.pscleanair.org/actions/.

The agency uses the emission inventory as a tool to identify which sources have the greatest impact on air quality. Based upon this information, the agency focuses on the largest contributors to regional emissions: 1) fine particulate emissions, 2) greenhouse gases that contribute to climate change, and 3) precursors of ground-level ozone concentrations. For more information on strategies the agency implements to achieve these goals, see the 2005 Emission Inventory information sheet referenced above.

Table 4: 2005 Estimated Criteria Air Pollutant and Greenhouse Gases Emission Inventory (tons)*

General Category	CO	NOx	$PM_{2.5}$	SOx	VOC	CO_2 Eqv
Diesel school buses	120	550	40	20	30	72,000
Other on-road diesel vehicles	9,060	34,410	940	860	1,660	3,928,000
Gasoline school buses	210	30	0	0	20	5,000
Other on-road gasoline vehicles	652,630	46,520	460	770	51,860	14,629,000
On-road liquefied petroleum gas (LPG) vehicles	0	20	0	0	0	15,000
On-road compressed natural gas (CNG) vehicles	100	220	20	0	10	288,000
Aircraft landings & takeoffs	5,990	1,840	30	160	1,580	644,000
Airport ground support equipment	12,630	550	30	30	470	55,000
Locomotives	510	3,840	90	280	190	176,000
Commercial marine vessels	1,530	10,980	570	3,760	430	704,000
Cargo handling equipment at ports	900	1,120	70	80	100	109,000
Misc. gasoline non-road mobile engines	235,060	2,370	390	100	13,770	539,000
Misc. LPG non-road mobile engines	14,400	3,080	20	0	840	190,000
Misc. CNG non-road mobile engines	1,480	270	0	0	0	133,000
Misc. diesel non-road mobile engines	6,670	12,920	1,070	370	1,450	1,215,000
Gasoline recreational boats	20,700	640	10	20	4,490	137,000
Diesel recreational boats	50	320	10	40	10	25,000
Large sources (reporting emissions to the agency)	4,940	6,130	500	1,150	4,180	960,000
Electric power production at large sources	800	1,310	40	420	30	524,000
Natural gas burning by small sources	2,630	4,500	330	30	240	5,268,000
Distillate oil burning by small sources	310	1,310	90	450	20	1,384,000
LPG burning by small sources	60	410	10	0	10	339,000
Indoor wood burning*	27,980	560	3,760	70	13,280	93,000
Land-clearing debris burning	26,310	570	3,320	90	2,160	531,000
Other open burning*	4,870	140	1,040	20	830	28,000
Architectural coating	-	-	-	-	5,810	-
Original equipment surface coating	-	-	-	-	6,920	-
Other surface coating	-	-	-	-	3,410	-
Metal cleaning	-	-	-	-	6,540	-
Petroleum products distribution	-	-	-	-	5,880	-
Consumer products	-	-	-	-	13,570	-
Asphalt application	-	-	-	-	3,890	-
Printing & baking	-	-	-	-	3,360	-
Pesticides application & other evaporation	-	-	-	-	1,080	-
Road fugitive dust	-	-	4,270	-	-	-
Construction & quarrying fugitive dust	-	-	2,900	-	-	-
Commercial meat cooking	-	-	1,440	-	210	-
Enteric fermentation (livestock)	-	-	-	-	-	175,000
Manure management	-	-	-	-	-	482,000
Wastewater treatment	-	-	-	-	20	10,000
Natural gas distribution	-	-	-	-	-	327,000
Non-energy use of fuel	-	-	-	-	-	3,182,000
Nitrous oxide from soils	-	-	-	-	-	211,000
Landfill fugitive methane	-	-	-	-	-	850,000
Cement manufacturing	-	-	-	-	-	523,000
Direct use of nitrous oxide	-	-	-	-	-	52,000
Steel manufacturing & dry cleaning CO_2	-	-	-	-	-	4,000
Power transmission equipment	-	-	-	-	-	190,000
Miscellaneous manufacturing processes	-	-	-	-	-	879,000
Electricity consumption	-	-	-	-	-	8,947,000
Total	**1,029,900**	**134,800**	**21,400**	**8,700**	**148,100**	**47,775,000**

*CO_2 equivalent includes only methane & nitrous oxide emissions for "indoor wood burning" and "other open burning".

AIR QUALITY STANDARDS AND HEALTH GOALS

The national Clean Air Act (CAA), last amended in 1990, requires EPA to set National Ambient Air Quality Standards (NAAQS) for criteria pollutants considered harmful to public health and the environment. These standards are designed to protect the public, including sensitive populations such as asthmatics, children, and the elderly. They are also intended to safeguard public welfare by reducing effects such as decreased visibility and damage to animals, crops, vegetation, and buildings. EPA has established standards for six criteria pollutants including carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and separate standards for the two size ranges of particulate matter. EPA is required to re-visit and update standards every five years, to incorporate the latest health and welfare information.

The state of Washington and the Puget Sound region have adopted these standards, and in the case of sulfur dioxide have also applied a stricter state standard. For more information, EPA air quality standards and supporting rationale are available at http://epa.gov/air/criteria.html. Washington State air quality regulations are available at http://www.ecy.wa.gov/laws-rules/ecywac.html#air.[8] The air quality standards that apply to the Puget Sound airshed are summarized in Table 5.

In addition to air quality standards, the agency has developed an air quality health goal for daily $PM_{2.5}$ concentrations. The agency convened a Particulate Matter Health Committee, comprised of local health professionals, who examined the fine particulate health research.[9] The Health Committee did not consider the current federal standard to be protective of human health. In 1999, the agency adopted a health goal of 25 $\mu g/m^3$ for a daily average, more protective than the federal standard of 35 $\mu g/m^3$. This level is consistent with the American Lung Association's goal and the EPA Clean Air Science Advisory Committee's recommended lower range for the EPA's 2006 ambient air quality standard revision.[10,11] The form of the agency's health goal is "never-to-be-exceeded." The agency did not adopt a separate health goal for the annual $PM_{2.5}$ average.

EPA revised its 8-hour ozone standard on March 27, 2008 from 0.08 ppm to 0.075 ppm after determining that the former standard was not protective of human health.[12] This air quality summary is for data collected in 2007 when the old standard was in effect, therefore the data are compared to the old standard.

EPA has begun the ambient air quality standard review process for lead, and will likely propose a strengthened standard in September 2008.[13]

[8] Washington Administrative Code chapters 173-470, 173-474, and 173-475.
[9] Puget Sound Clean Air Agency. Final Report of the Puget Sound Clean Air Agency $PM_{2.5}$ Stakeholder Group; http://www.pscleanair.org/news/library/reports/pm2_5_report.pdf.
[10] American Lung Association; http://lungaction.org/reports/sota06exec_summ.html.
[11] EPA Clean Air Scientific Advisory Committee (CASAC) Particulate Matter (PM) Review Panel; http://www.epa.gov/sab/panels/casacpmpanel.html
[12] 2008 Revised Ground-Level Ozone Standards; http://www.epa.gov/air/ozonepollution/actions.html.
[13] EPA. National Ambient Air Quality Standards – Lead Standards; http://www.epa.gov/ttnnaaqs/standards/pb/s_pb_index.html.

Table 5: Puget Sound Region Air Quality Standards for Criteria Pollutants for 2007

Pollutant	Standard	Level[a,b]
Ozone[c]	The 3-year average of the 4th highest daily maximum 8-hour average concentration must not exceed the level (round to the nearest 0.01)	0.084 ppm (0.08 ppm)
Particulate Matter (10 micrometers)	The 3 year average of the 99th percentile (based on the number of samples taken of the daily concentrations must not exceed the level (round to the nearest 10)	154 μg/m³ (150 μg/m³)
Particulate Matter (2.5 micrometers)	The 3-year annual average of the daily concentrations must not exceed the level (round to the nearest 0.1)	15.04 μg/m³ (15.0 μg/m³)
	The 3-year average of the 98th percentile (based on the number of samples taken) of the daily concentrations must not exceed the level (round to the nearest 1)	35 μg/m³ (35.4 μg/m³)
Carbon Monoxide	The 1-hour average must not exceed the level more than once per year	35.4 ppm (35 ppm)
	The 8-hour average must not exceed the level more than once per year (round to the nearest 1)	9.4 ppm (9 ppm)
Sulfur Dioxide[d]	Annual arithmetic mean of 1-hour averages must not exceed	0.02 ppm
	24-hour average must not exceed	0.10 ppm
	1-hour average must not exceed	0.40 ppm
	AND no more than twice in 7 consecutive days can the 1-hour average exceed	0.25 ppm
Lead	The quarterly average (by calendar) must not exceed the level (round to the nearest 0.1)	1.54 μg/m³ (1.5 μg/m³)
Nitrogen Dioxide	The annual mean of 1-hour averages must not exceed the level (round to the nearest 0.0001)	0.0534 ppm (0.053 ppm)

[a]Daily concentration is the 24-hour average, measured from midnight to midnight.

[b]EPA adopts rounding conventions. Numbers with no parentheses represent highest values that will meet standards using EPA's rounding convention. Numbers in parentheses represent the rounded standards.

[c]EPA changed the 8-hour ozone standard from 0.08 to 0.075 in March of 2008.

[d]Washington's Ambient Air Standards for SO_2 are more stringent than EPA's standards. These standards can be found at http://apps.leg.wa.gov/WAC/default.aspx?cite=173-474-100.

Pollutants typically have multiple standards with different averaging times; for example, daily and annual standards. Multiple standards are created and enforced to address health impacts as a result of a shorter, high-level exposure versus longer, low-level exposures. These differences are addressed pollutant-by-pollutant in the following sections. Additional information is on EPA's website at http://epa.gov/air/criteria.html.

A distinction exists between "exceeding" and "violating" a standard. In most instances it is allowable for a monitoring site to exceed the standard more than once without causing a violation. This allowance is made to account for possible meteorological aberrances. For example, a carbon monoxide 8-hour average of 10 ppm clearly exceeds the standard. It does not, however, violate the standard if it is the only exceedance that year (the standard allows for one exceedance).

EPA standards typically apply to an "area", which may be defined in different ways. Data are presented for multiple monitoring stations in the following sections because this provides insight into the distribution of pollutants in the Puget Sound area. The summaries that follow show how the Puget Sound airshed compared to federal standards for the year 2006. Some graphs also incorporate the AQI where applicable. AQI shading is shown to aid interpretation of air quality, but does not imply whether or not standards were actually met for each pollutant. Only meeting the conditions listed in Table 5 warrant compliance. Additionally, one graph presents the number of days that our region did not meet the agency's $PM_{2.5}$ health goal.

PARTICULATE MATTER (10 MICROMETERS IN DIAMETER)

Particulate matter (PM) includes both solid matter and liquid droplets suspended in the air. Particles smaller than 2.5 micrometers in diameter are called "fine" particles, or *$PM_{2.5}$*. Particles between 2.5 and 10 micrometers in diameter are called "coarse" particles. *PM_{10}* includes both fine and coarse particles. Coarse particles typically come from crushing or grinding operations and dust from roads. PM_{10} can aggravate respiratory conditions such as asthma. People with respiratory conditions should avoid outdoor exertion if PM_{10} levels are elevated.

All four counties have been below the daily and annual PM_{10} federal standards since the early 1990s. EPA designated the Puget Sound region in attainment for PM_{10} in 2001. PM_{10} is no longer a major concern in the Puget Sound area. In 2006, EPA revoked the annual PM_{10} standard due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution.[14]

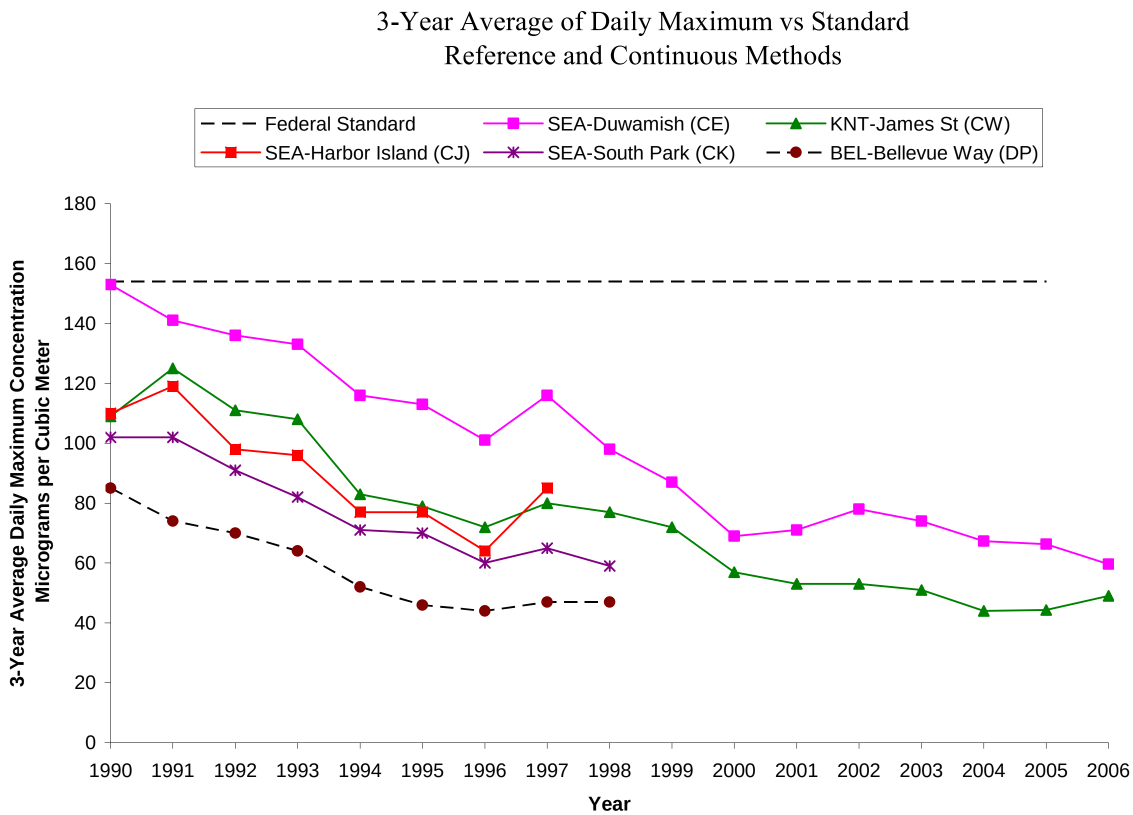
The agency ceased all PM_{10} monitoring in 2006 and has focused its efforts on $PM_{2.5}$ monitoring. Fine particles have a greater impact than coarse particles at locations far from the emitting source because they remain suspended in the atmosphere longer, and travel farther.

Historically, PM_{10} monitoring was required to call burn bans; however, the Washington state burn ban trigger was changed to $PM_{2.5}$ in early 2005.

Figures 9 through 12 show historical PM_{10} data. General information on PM_{10} is presented in question/answer format in the Definitions section and at http://www.epa.gov/oar/particlepollution/.

[14]U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions, 2006; http://www.epa.gov/particles/actions.html.

Figure 9: PM_{10} Daily for King County



Note: 2004 and 2005 values are three year averages of the 99th percentile, based on continuous monitoring at these sites

Figure 10: PM_{10} Daily for Kitsap County

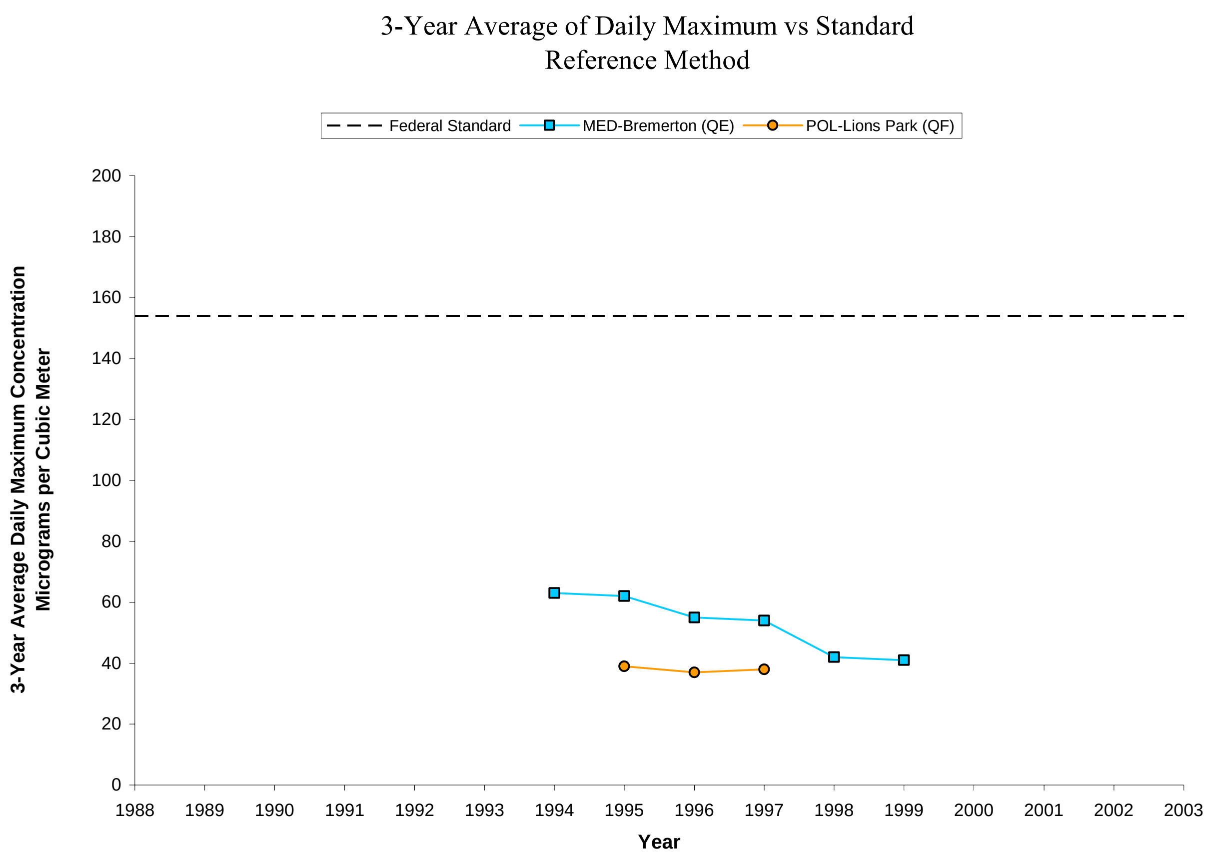


Figure 11: PM_{10} Daily for Pierce County

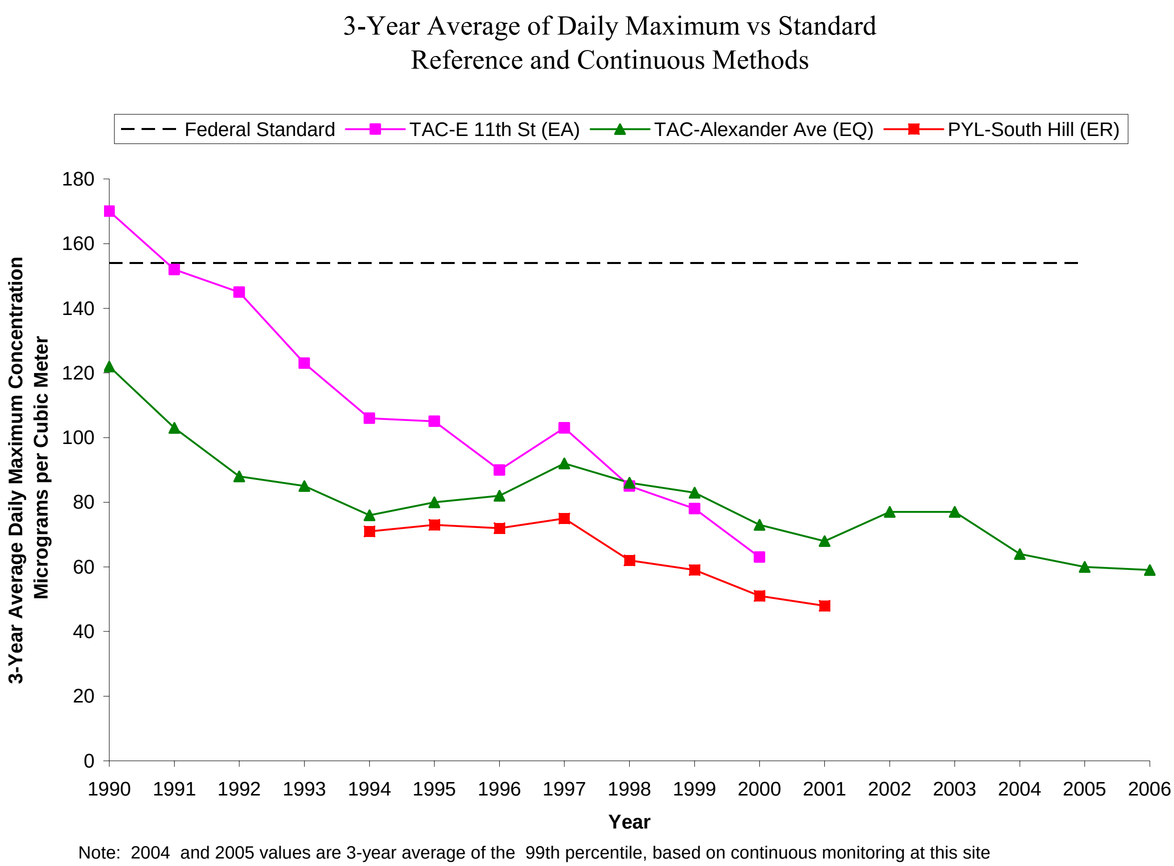
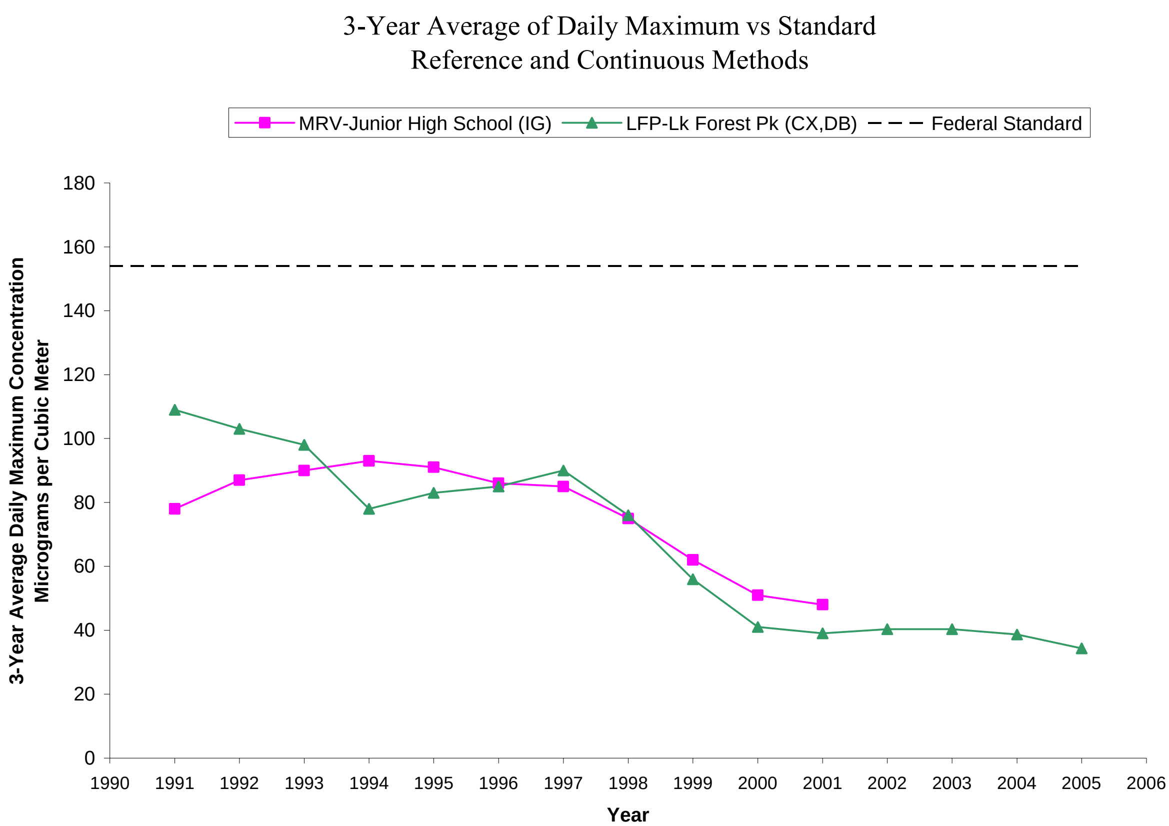


Figure 12: PM_{10} Daily for Snohomish County



Note: 2002, 2003, 2004, and 2005 values are three year averages of the 99th percentile, based on continuous monitoring at this site

PARTICULATE MATTER (2.5 MICROMETERS IN DIAMETER)

HEALTH EFFECTS AND SIGNIFICANCE

Particles smaller than 2.5 micrometers in diameter are called "fine" particulate, or *$PM_{2.5}$*. $PM_{2.5}$ is one of the major air pollution concerns affecting our region. $PM_{2.5}$ primarily comes from wood burning and vehicle exhaust including cars, diesel trucks, and buses. Fine particulate can also be formed in the atmosphere through chemical reactions of pollutant gases.

Exposure to $PM_{2.5}$ can have serious health effects. Fine particles are most closely associated with increased respiratory disease, decreased lung function, and even premature death.[15,16,17,18] Children, older adults, and people with some illnesses are more sensitive and more likely to develop heart or lung problems associated with $PM_{2.5}$.[19,20] People with respiratory or heart disease, older adults, and children should avoid outdoor exertion if $PM_{2.5}$ levels are elevated. $PM_{2.5}$ also significantly affects visibility.

DAILY FEDERAL STANDARD AND HEALTH GOAL

The Puget Sound airshed has been in compliance with the previous daily $PM_{2.5}$ standard of 65 $\mu g/m^3$ from 1997 to 2005.

On September 21, 2006, EPA adopted a new daily standard of 35 $\mu g/m^3$, a level much closer to our health goal of 25 $\mu g/m^3$.[21] The Puget Sound area had three violations of the National Ambient Air Quality Standards (NAAQS) in 2007. Concentrations of the three-year average of the 98th percentile for daily $PM_{2.5}$ violated the new standard of 35 $\mu g/m^3$ at the South L Tacoma monitor located at the south end of Tacoma, in Pierce County. Concentrations at the Marysville and Darrington monitors, both located in Snohomish County, are on the brink of violating the new daily standard.

In addition to the federal standard, our Board of Directors adopted a more stringent goal based on recommendations from our Particulate Matter Health Committee. Monitors in all four counties of our jurisdiction exceed this local health goal of 25 $\mu g/m^3$ during the winter season.

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[15] Pope et al. Lung Cancer, Cardiopulmonary Mortality, and Long–Term Exposure to Fine Particulate Air Pollution. *Journal of the American Medical Association.* 287: pp 1132-1141, March 6, 2002.

[16] Gauderman et al. The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age. *The New England Journal of Medicine.* Volume 351: pp 1057–1067, Number 11, September 9, 2004.

[17] Kunzli et al. Ambient Air Pollution and Atherosclerosis in Los Angeles. *Environmental Health Perspectives.* Volume 113, 2: pp 201-206, February 2005; http://ehp.niehs.nih.gov/members/2004/7523/7523.pdf.

[18] US Environmental Protection Agency (US EPA). Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. EPA-452/R-05-005, June 2005; http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20050630.pdf.

[19] Park et al. Effects of Air Pollution on Heart Rate Variability: The VA Normative Aging Study. *Environmental Health Perspectives.* Volume 113, 3. pp 304-309, March 2005; http://ehp.niehs.nih.gov/members/2004/7447/7447.pdf.

[20] Goss et al. Effect of Ambient Air Pollution on Pulmonary Exacerbations and Lung Function in Cystic Fibrosis. *American Journal of Respiratory Critical Care Medicine.* Volume 169: pp 816-821. January 12, 2004.

[21] U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions, 2006; http://www.epa.gov/particles/actions.html.

Table 6 provides the daily federal standards and the Puget Sound region local health goal.

Table 6: Comparison of Relevant Daily $PM_{2.5}$ Standards and Goals

Standard or Goal	Level (μg/m^3)	Form
Former Daily Federal Standard	65	3-year average of 98th percentile
New Daily Federal Standard (December 2006)	35	3-year average of 98th percentile
Local Daily Health Goal	25	Never to be exceeded

Map 2 shows the 98th percentile of the 3-year average of daily $PM_{2.5}$ concentrations. The map only includes sites with three years of monitoring data from 2005 to 2007.

Map 2: The 98th Percentile 3-Year Average Daily $PM_{2.5}$ Concentrations for 2007*

*Seattle Beacon Hill was down most of 2006 and has fewer data points to calculate the 98th percentile 3-year average.

Figures 13 through 16 show daily 98th percentile averages at each monitoring station in King, Kitsap, Pierce, and Snohomish Counties compared to the current daily federal standards. Points on the graphs represent averages for three consecutive years. For example, the value for 2007 is the average of the 98th percentile daily concentration for 2005, 2006, and 2007. Concentrations for King, Pierce, and Snohomish Counties were measured using the FRM, except where noted.[22] Concentrations for Kitsap County were measured using continuous methods.[23]

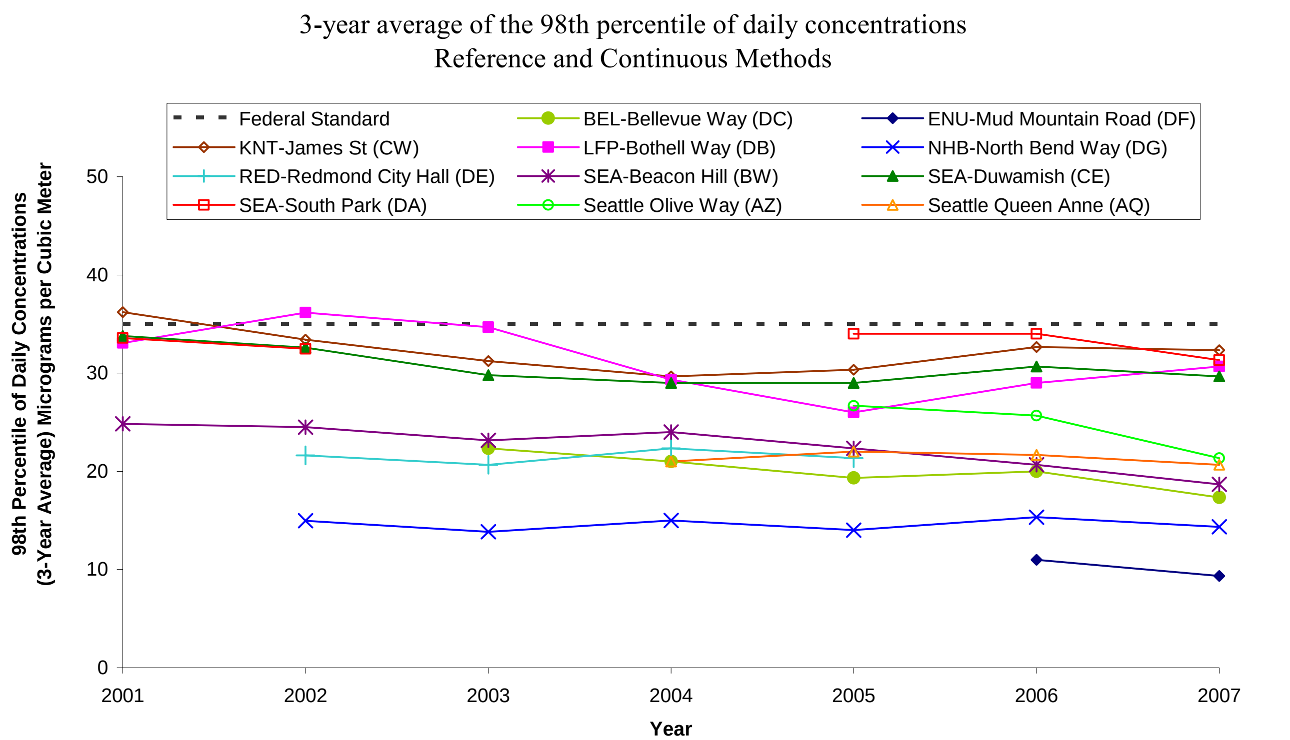
Figure 15 shows that the Tacoma South L Site, located at the south end of Tacoma, violates the new federal standard of 35 μg/m^3. Figure 16 shows that the Marysville monitoring site in Snohomish County is right at the new federal standard of 35 μg/m^3. The Darrington monitor is not shown in Figure 12, since it is a relatively new monitor and there is only one data point for 2007. The three year 98th percentile of daily $PM_{2.5}$ concentration for Darrington cannot be calculated because there is not three years of FRM data; however the Darrington monitor could potentially have a violation in 2008 when three years of FRM data are complete.

Seattle Duwamish Valley, Port of Tacoma, and Kent are in the next highest range of concentrations between 30-35 μg/m^3.

[22]Where possible, continuous method data are compared to the reference method values and calculations are made to determine the degree of difference from the reference method. The differences are then applied to the current continuous values in an attempt to make them "FRM-like."

[23]Continuous concentrations in Kitsap are not adjusted to make them "FRM-like", as there is no site-specific FRM data at the Meadowdale and Silverdale monitoring sites.

Figure 13: PM$_{2.5}$ Daily for King County



Note: Duwamish (CE), Beacon Hill (BW), and LFP (DB) data are FRM from 1999-2007. South Park (DA) data are FRM from 1999-2002, (3 yr avg 2004-06 was FRM in 2004, neph in 2005-2007. Bellevue Way (DC) data are FRM from 2001-2004, neph 2005-07. Redmond (DE) data are FRM from 2000-2002, neph from 2003-2005. Queen Anne (AQ) data are neph from 2002-2007. Olive Way (AZ) data are neph from 2003-2007. North Bend (DG) data are FRM from 2000-2004, neph in 2005-2007. Kent (CW) data are FRM from 1999-2004, neph in 2005-2007. Enumclaw (DF) data are from neph in 2000-2007.

Figure 14: $PM_{2.5}$ Daily for Kitsap County

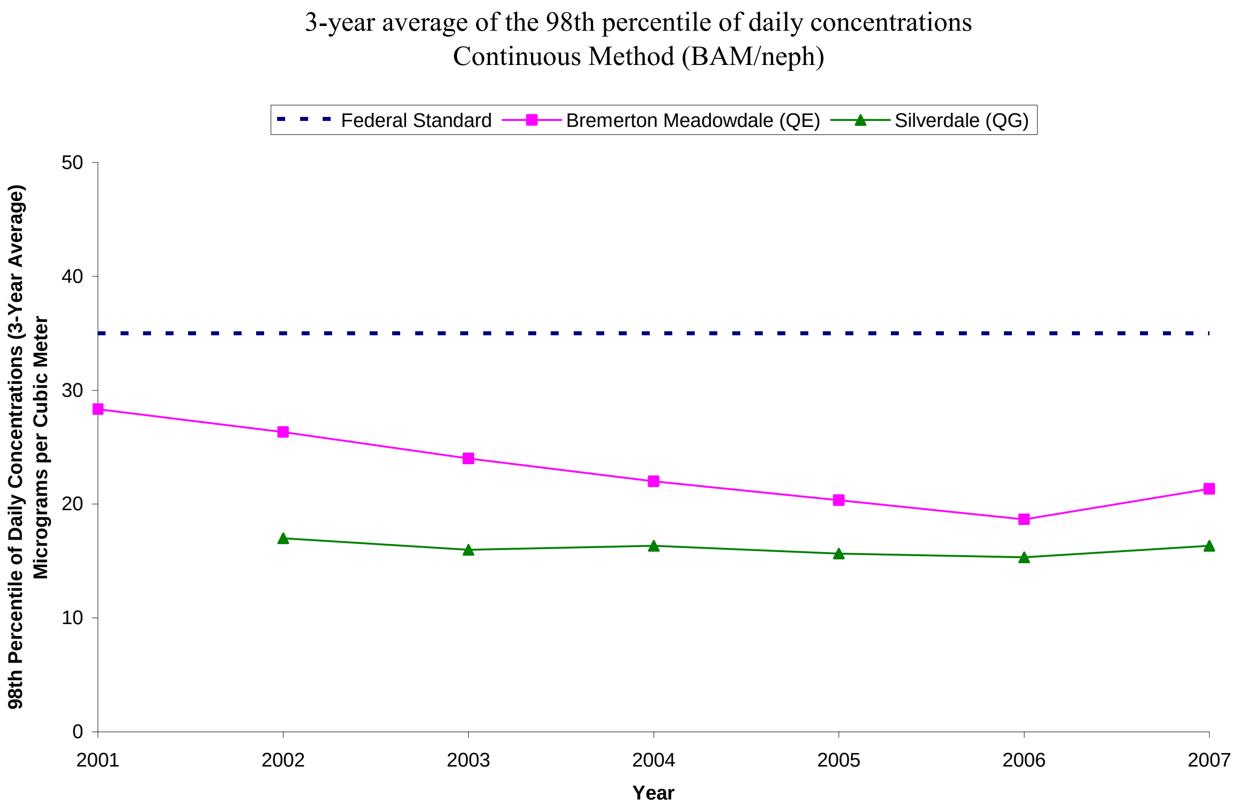
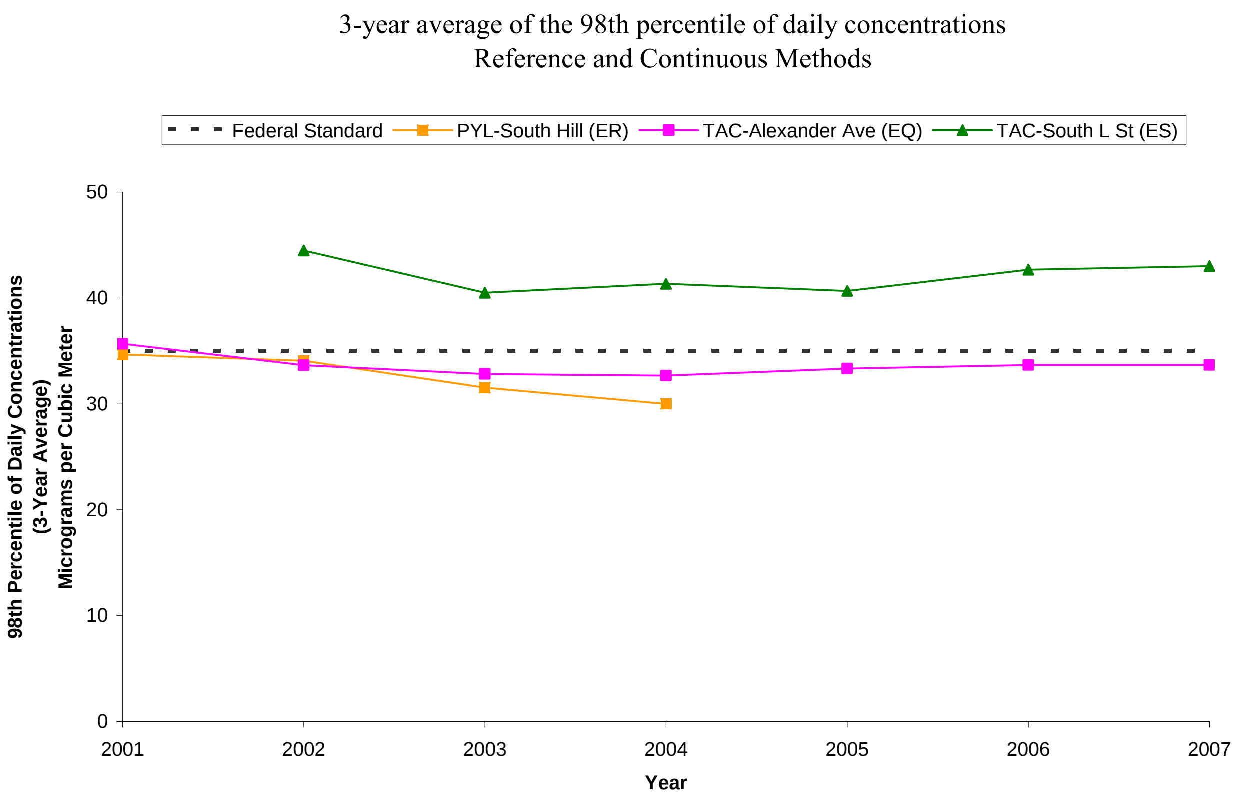
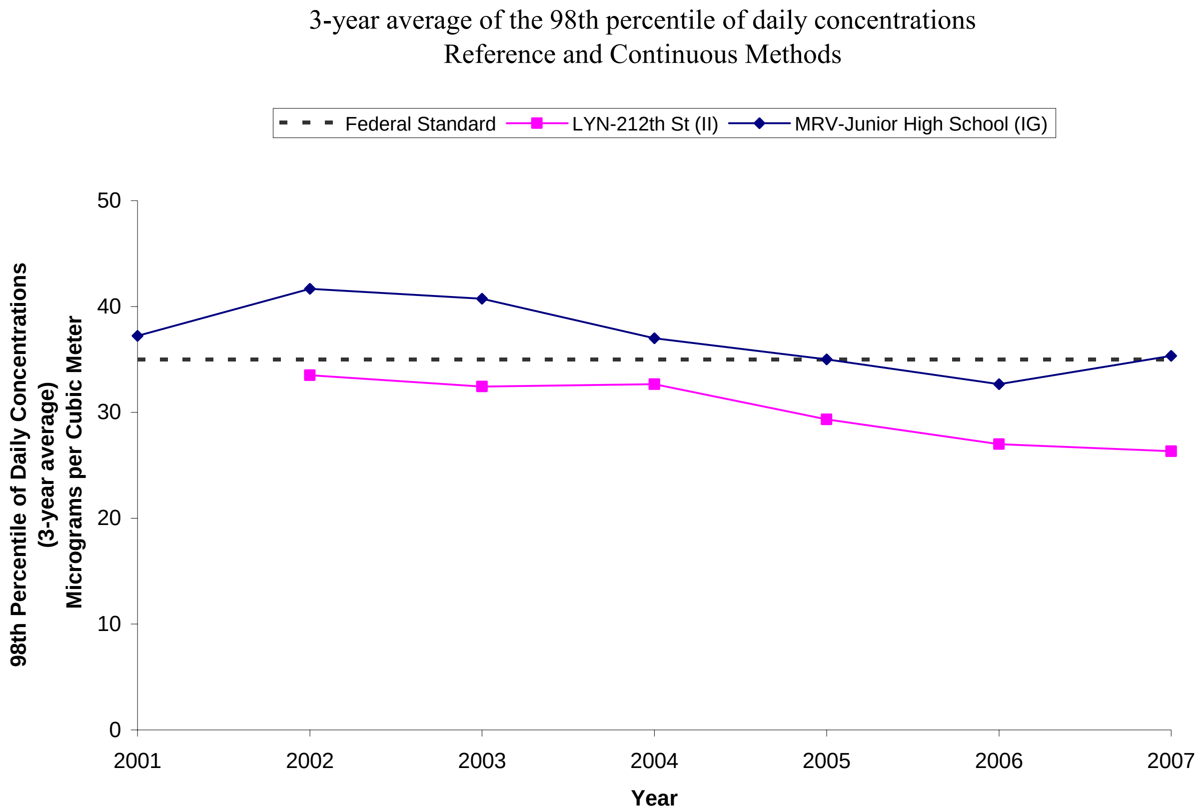


Figure 15: $PM_{2.5}$ Daily for Pierce County



Note: All South L data are FRM from 2000- 2007. Alexander Avenue data are FRM from 1999-2002 and nephelometer from 2003-2007. South Hill data are FRM from 1999-2002 and nephelemeter from 2003-2004; incomplete nephelometer data was collected from South Hill in 2005.

Figure 16: $PM_{2.5}$ Daily for Snohomish County

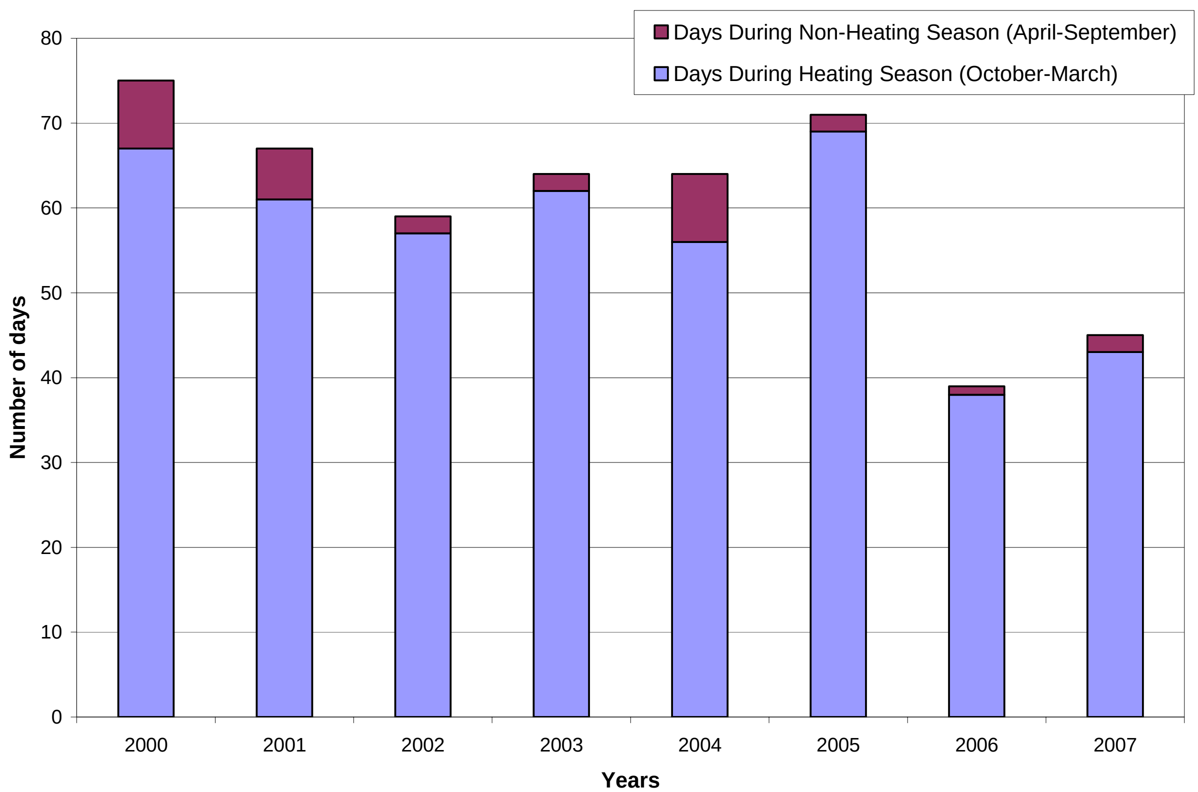


Note: Marysville data are FRM from 1999-2007. Lynnwood (II) data are FRM except 2004 and 2007 which were measured with a nephelometer.

As described in the Air Quality Standards and Health Goals section, the agency also has a daily fine particulate health goal. Many of the monitoring sites in King, Pierce, and Snohomish Counties exceed the agency's daily fine particulate health goal of 25 μg/m^3 for a 24-hour average. This health goal is intended to never be exceeded (unlike the federal standard that is based on the 98th percentile of a 3-year average).

Figure 17 shows the number of days the health goal is exceeded annually in the region, from 2000 to 2007. The shading demonstrates that our highest fine particulate days overwhelmingly take place during the winter wood heating months. While the graph indicates that we may be making slow progress reducing the number of days we exceed the health goal, it also shows that we're falling short of our goal of having zero days exceeding the health goal, especially during winter months.

Figure 17: Days Exceeding the $PM_{2.5}$ Health Goal at One or More Monitoring Sites



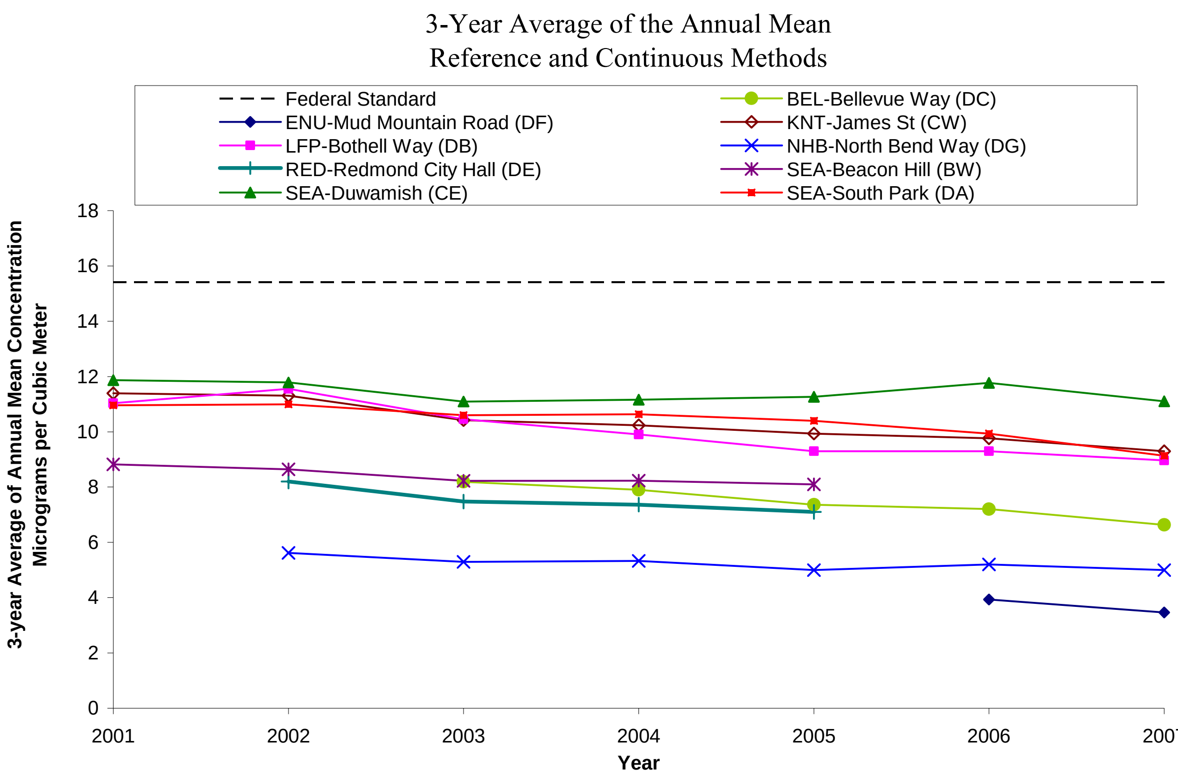
Includes data from all sites in King, Kitsap, Pierce, and Snohomish counties, both daily and continuous methods. The Darrington monitor was added in 2004.

ANNUAL FEDERAL STANDARD

The Puget Sound airshed has been in compliance with the annual $PM_{2.5}$ standard since the EPA promulgated it in 1997. Figures 18 through 21 show annual averages at each monitoring station for King, Kitsap, Pierce, and Snohomish Counties and the federal annual standard. These graphs show data from both the federal reference method (FRM) and continuous method monitors. The federal standard is based on a 3-year average, so each value on the graph is actually an average for three consecutive years. For example, the value for 2007 is the average of the annual averages for 2005, 2006, and 2007.

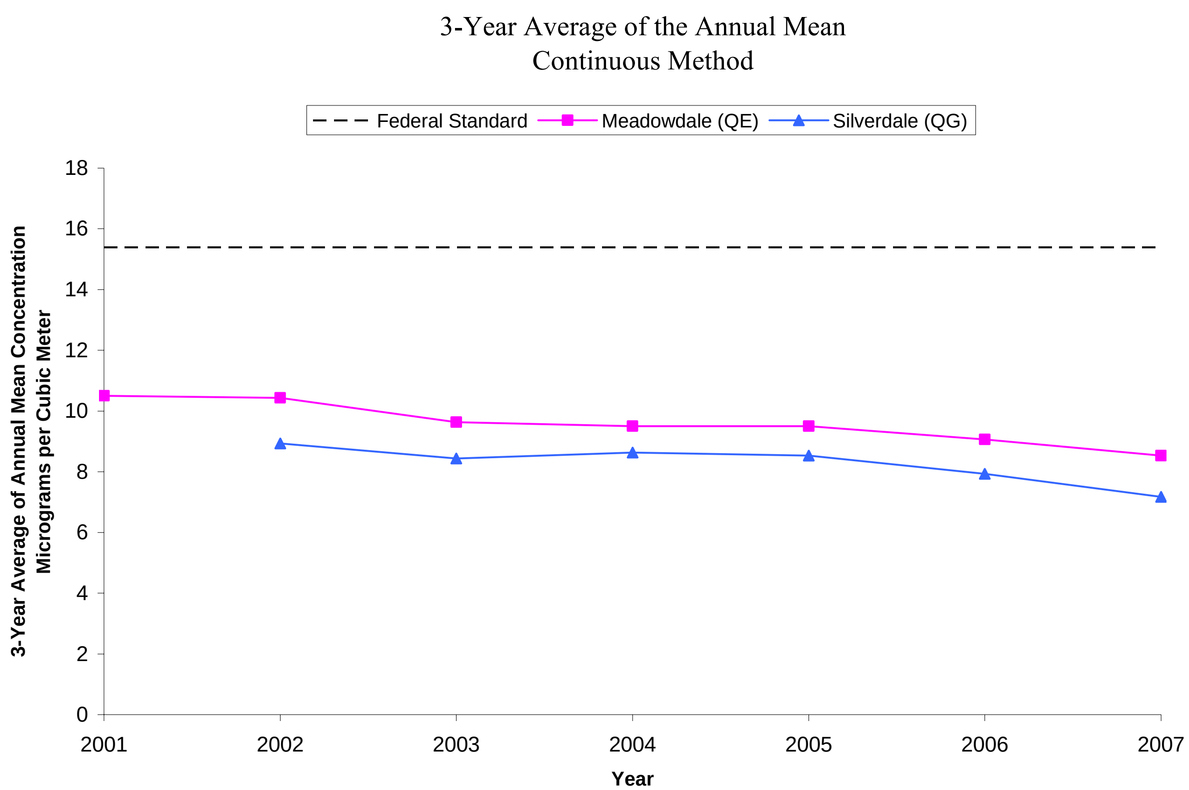
The agency's Health Committee did not recommend an annual $PM_{2.5}$ health goal lower than the federal annual standard (15 $\mu g/m^3$).

Figure 18: Annual $PM_{2.5}$ for King County



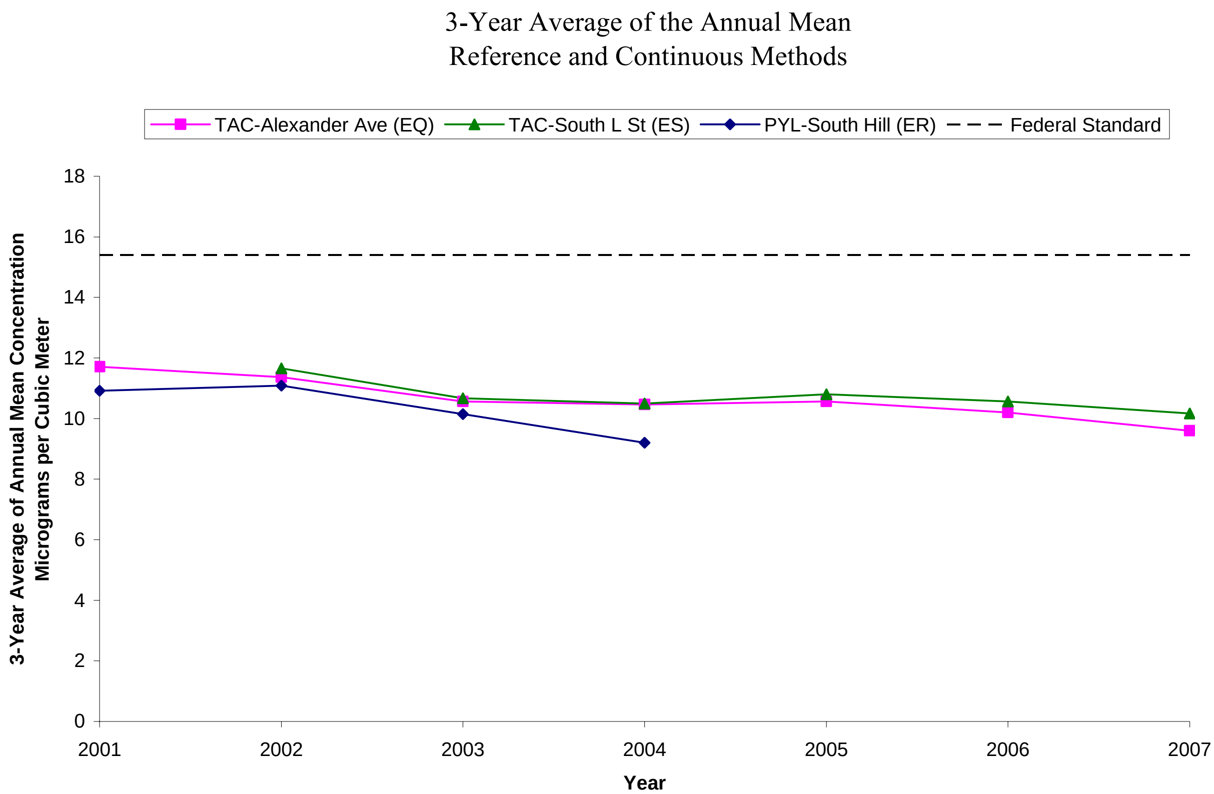
Note: Lake Forest Park (DB), Beacon Hill (BW), and Duwamish (CE) data are FRM from 1999-2007. South Park (DA) data are FRM from 1999-2002, nephelometer from 2003-2007. Redmond (DE) data are FRM from 2000-2002, nephelometer from 2003-2005. Bellevue Way (DC) data are FRM from 2001-2003, nephelometer from 2004-2007. Kent (CW) data are FRM from 1999-2003, nephelometer 2004-2007. North Bend (DG) data are FRM 2000-2004, nephelometer in 2005. Enumclaw (DF) data are FRM in 2004, nephelometer in 2005-2007.

Figure 19: Annual $PM_{2.5}$ for Kitsap County



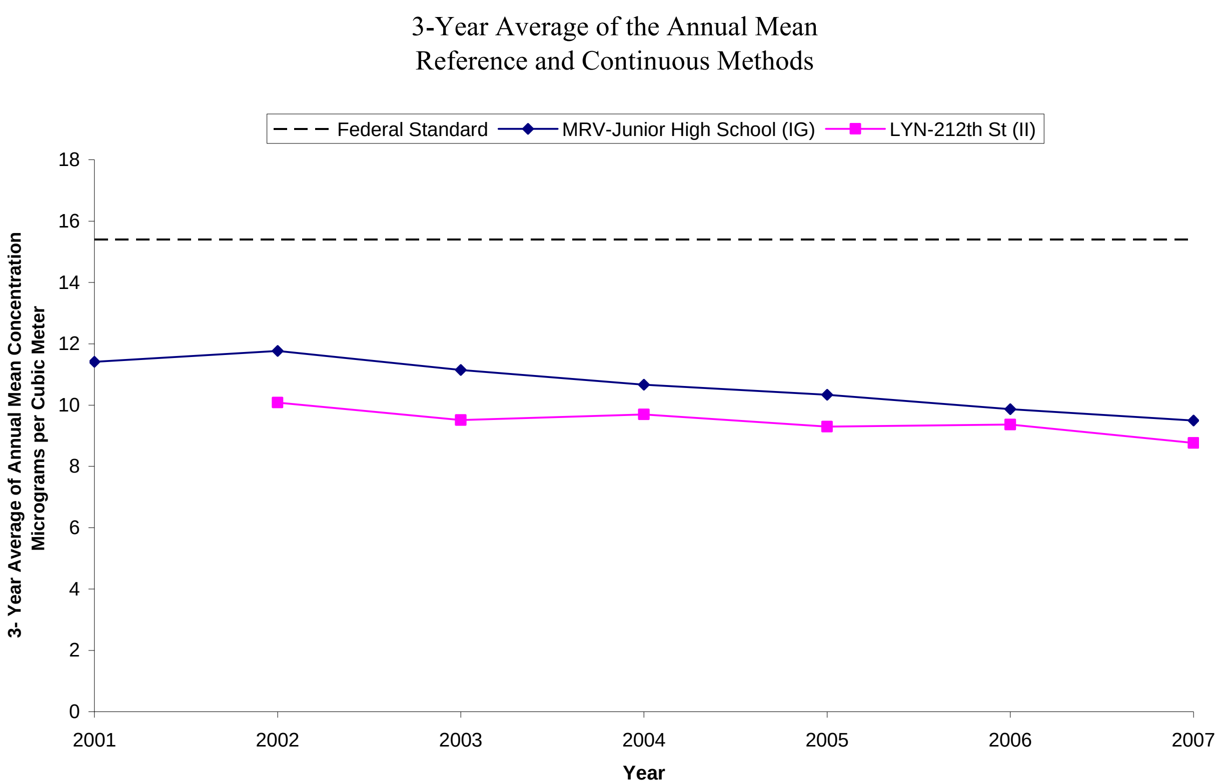
Note: Meadowdale and Silverdale data are BAM (Beta Attenuation Monitor) 1999-2005, nephelometer 2006 and 2007.

Figure 20: Annual $PM_{2.5}$ for Pierce County



Note: South L St. (ES) data are FRM. South Hill (ER) data are FRM from 1999-2002. South Hill (ER) data 2003 and 2004 was measured with a nephelometer. Alexander Ave (EQ) data are FRM from 1999-2002. Alexander Ave (EQ) data 2003-2007 was measured with a nephelometer.

Figure 21: Annual $PM_{2.5}$ for Snohomish County



Note: Marysville (IG) data are FRM from 1999-2007. Lynnwood (II) data are FRM except 2004 and 2007. The 2004 and 2007 values for Lynnwood were measured with a nephelometer.

CONTINUOUS DATA AND SEASONAL VARIABILITY

Continuous monitoring data provide information on how concentration levels vary throughout the year. For example, sites may have elevated $PM_{2.5}$ levels during the winter when residential burning and air stagnations are at their peak, but have low levels of $PM_{2.5}$ during the summer.

Figures 22 through 34 show daily $PM_{2.5}$ concentrations measured at 13 sites during 2007 by continuous analyzers compared to the air quality index (AQI) breakpoints. The 13 monitoring sites characterize different areas and these differences are reflected in the continuous data. Both nephelometer and TEOM monitoring methods are used for continuous monitoring. The nephelometer method uses light scattering and the TEOM method uses mass. These two methods correspond well with each other as can be seen on graphs where both methods were used at certain sites.

EPA has not yet updated the AQI breakpoints to reflect the new $PM_{2.5}$ standard. If updated, we would likely see more monitors register more frequently in the "unhealthy for sensitive groups" and "unhealthy" ranges.

The following discussion describes generalized trends found for different residential and commercial classifications. These trends may be more prevalent from year to year, depending on the meteorology of the site.

Monitors in Residential/Commercial Areas

There are eight monitors located in largely residential areas. These are Lake Forest Park and North Bend in King County, Bremerton Meadowdale in Kitsap County, Puyallup and Tacoma South L in Pierce County, and Darrington, Lynnwood, and Marysville in Snohomish County. Of these monitors Lake Forest Park, Puyallup, Tacoma South L, Darrington, Lynnwood, and Marysville show the greatest seasonal variability with elevated $PM_{2.5}$ concentrations in wood burning months October through March. These sites generally register AQI levels in the "moderate" category and occasionally the "unhealthy for sensitive groups" and even "unhealthy" categories during the winter season. Lower housing density exists at the North Bend and Bremerton Meadowdale sites, and may contribute to lower concentrations that are generally "good" and "moderate" during the winter season. The summer peak at the Puyallup site dramatically reflects the short-term effect of 4^{th} of July fireworks on local air quality.

Monitors in Commercial/Residential Areas

The Bellevue and Kent monitoring sites in King County and Silverdale in Kitsap County are located in a mixture of residential and commercial areas. These sites generally register AQI levels in the "moderate" range during the winter season.

Monitors in Industrial Areas

The Seattle Duwamish monitor in King County and Tacoma Tideflats monitor in Pierce County are industrial, with some wood smoke influence from nearby residential areas. These sites generally register AQI levels in the "moderate" range and occasionally in the "unhealthy for sensitive groups" range during the winter season.

Statistical summaries for $PM_{2.5}$ data (both FRM and continuous monitors) are shown in tables on pages A-7 through A-10 of the Appendix. Summaries of AQI levels based on FRM and continuous monitors are included. The AQI that is reported to the public and used for air quality decisions is the one reflecting the highest concentration, regardless of the method of measurement. The highest daily concentration of $PM_{2.5}$ measured in 2007 was 72 $\mu g/m^3$, measured using the reference sampling method at the Darrington monitor on January 15. For additional information on particulate matter, visit http://www.epa.gov/oar/particlepollution. Information on $PM_{2.5}$ is also presented in a question/answer format in the Definitions section of this document.

Figure 22: Lake Forest Park (DB) $PM_{2.5}$ Daily Averages from Continuous Analyzers

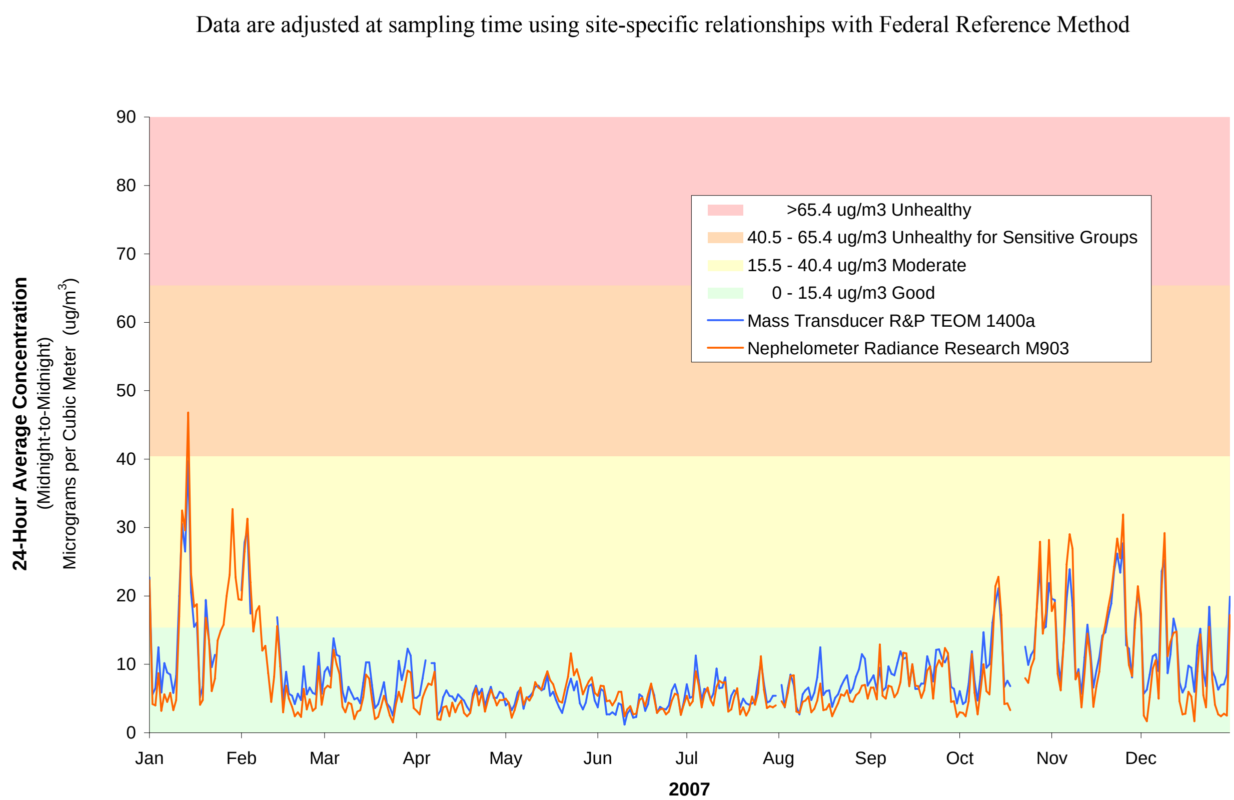


Figure 23: North Bend (DG) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

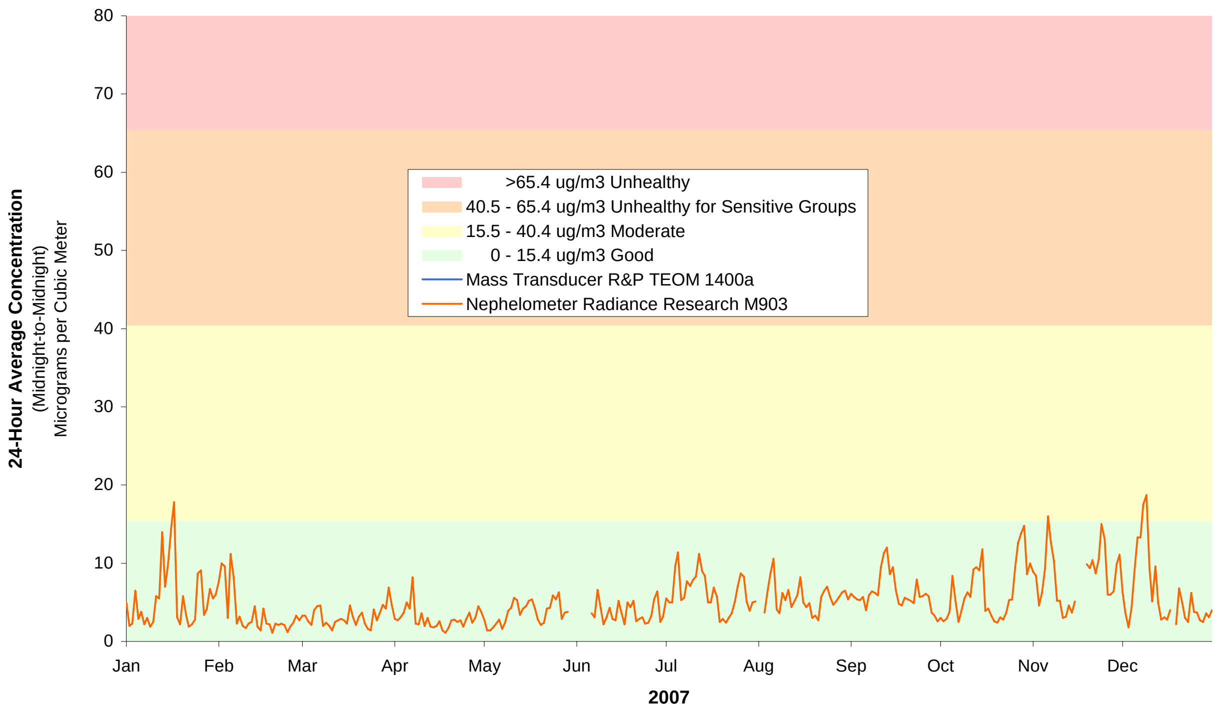


Figure 24: Bremerton, Meadowdale (QE) $PM_{2.5}$ Daily Averages from Continuous Analyzers

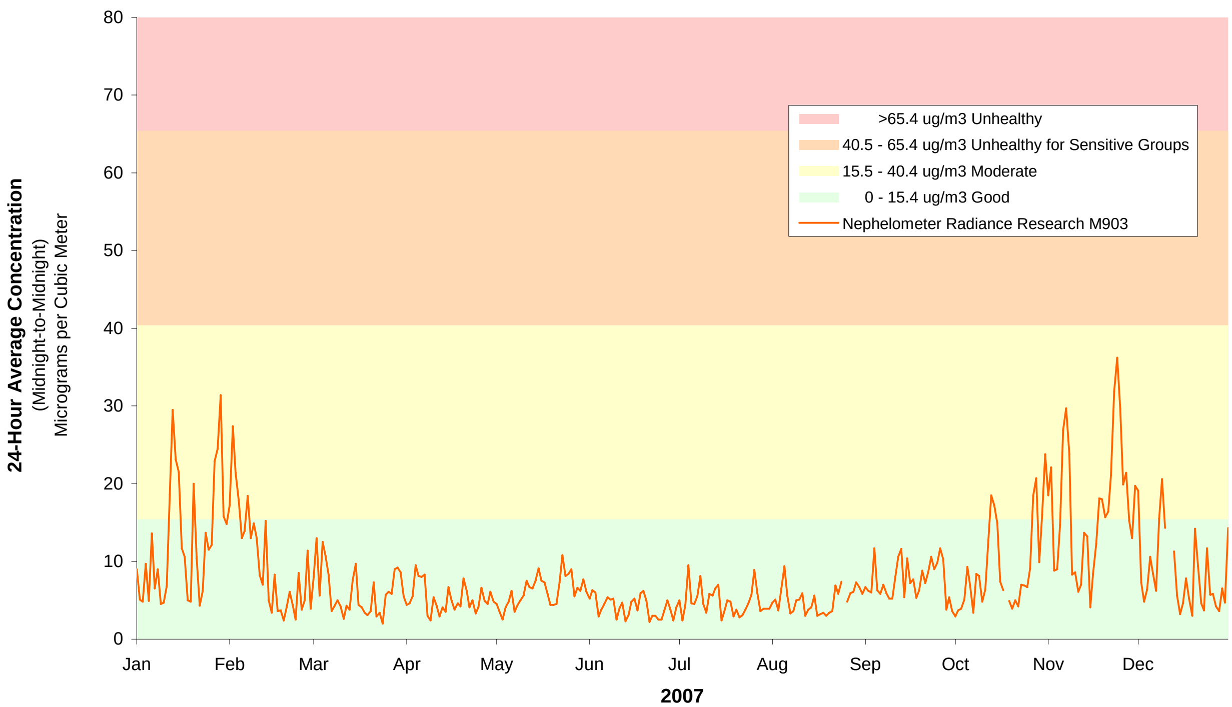


Figure 25: Puyallup (ER) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

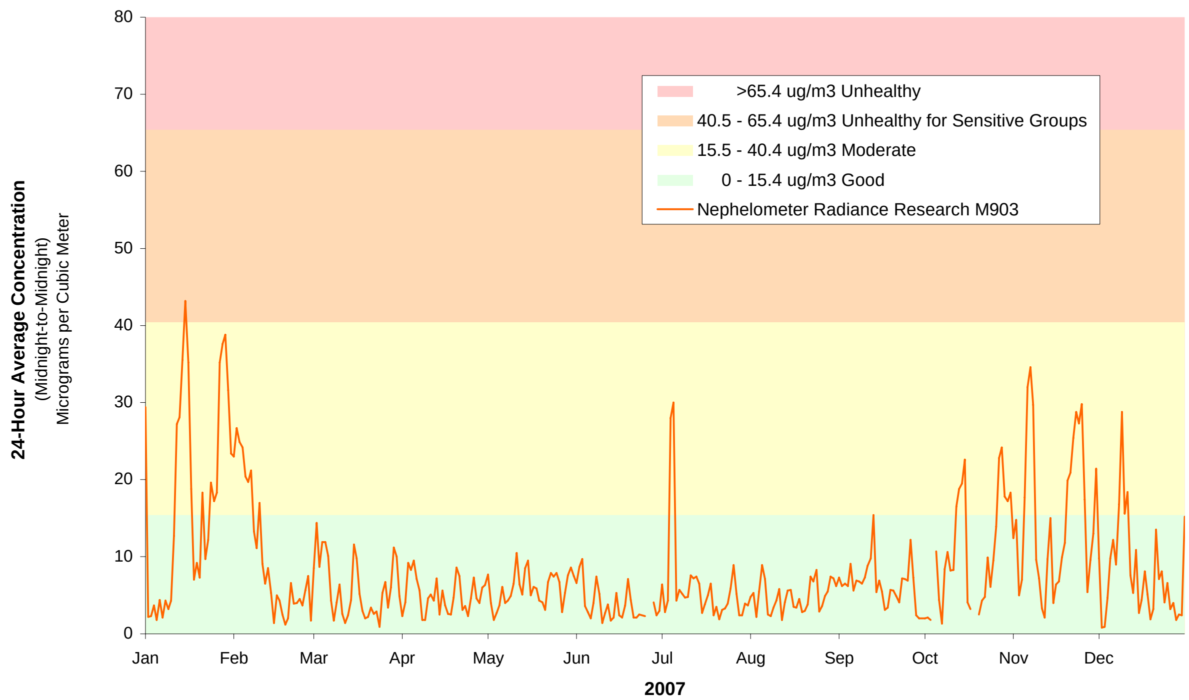


Figure 26: Tacoma, South L Street (ES) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

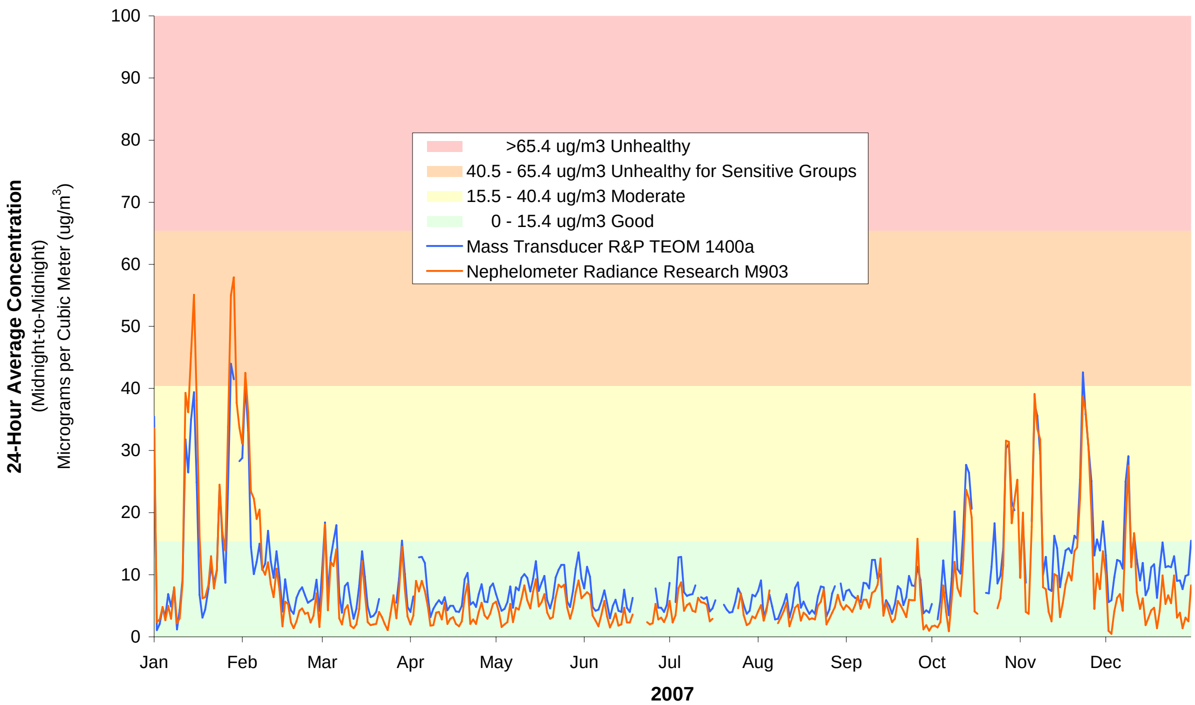


Figure 27: Darrington (JO) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

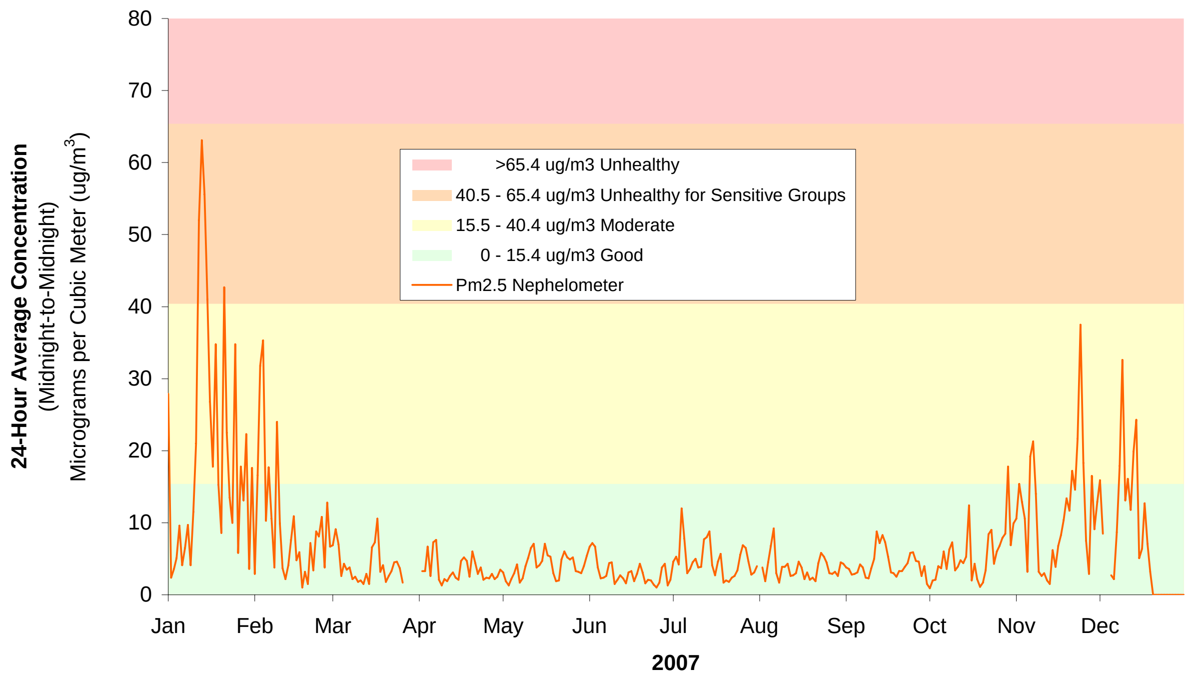


Figure 28: Lynnwood (II) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

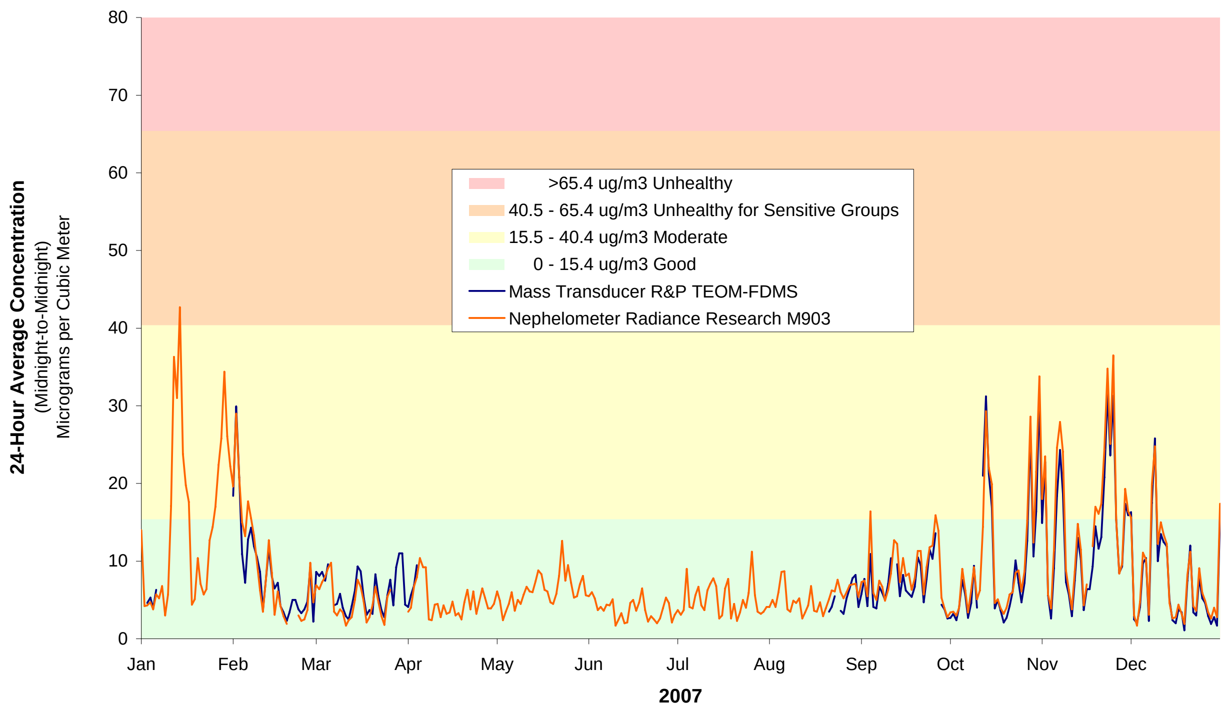


Figure 29: Marysville (IG) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

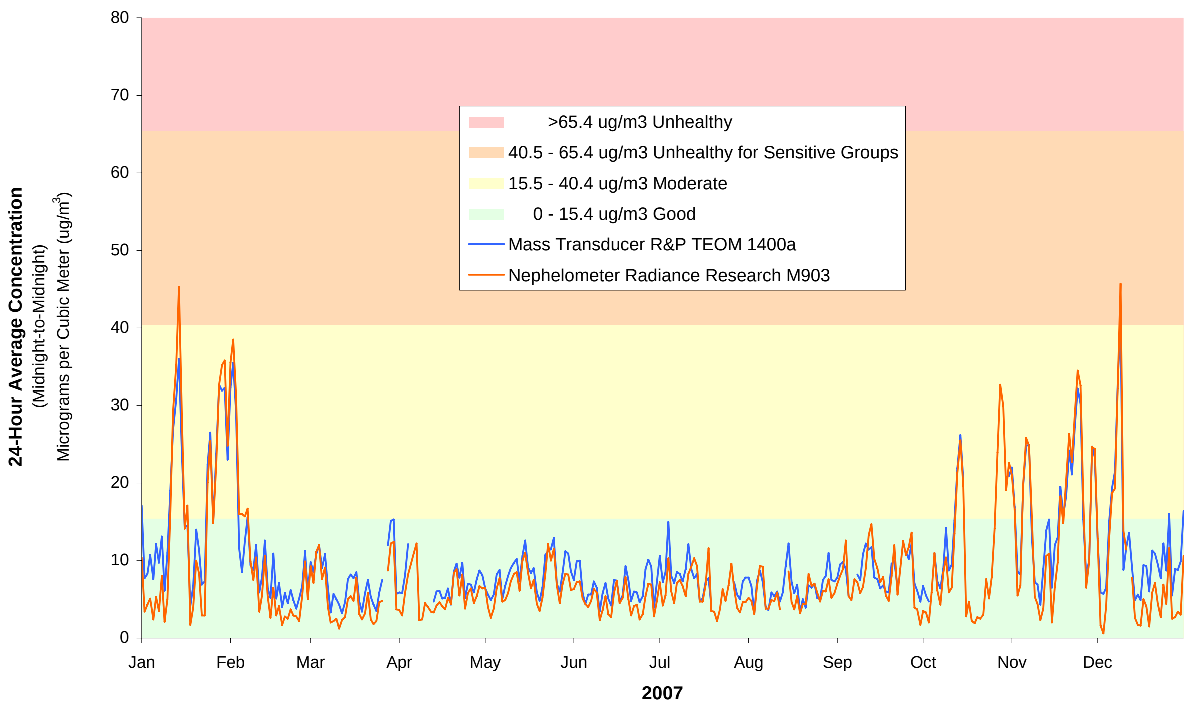


Figure 30: Bellevue, 305 Bellevue Way NE (DC) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

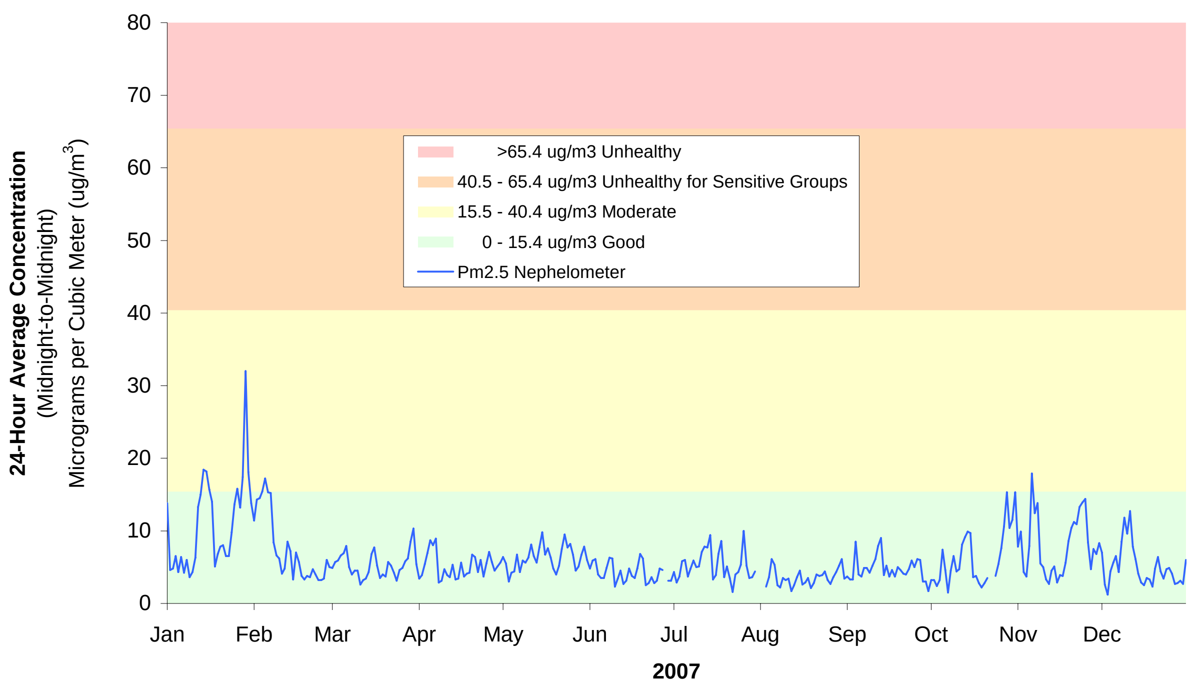


Figure 31: Kent (CW) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data after 8/20/07 was adjusted at sampling time using site-specific relationships with Federal Reference Method

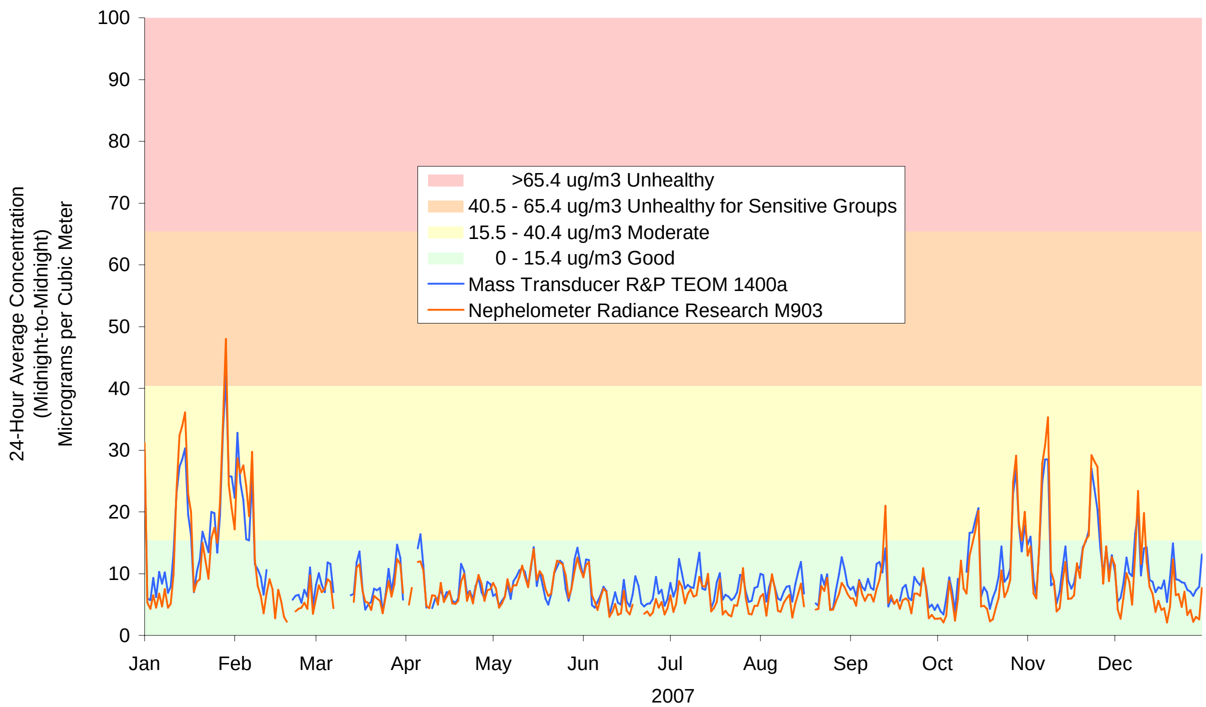


Figure 32: Silverdale (QG) $PM_{2.5}$ Daily Averages from Continuous Analyzers

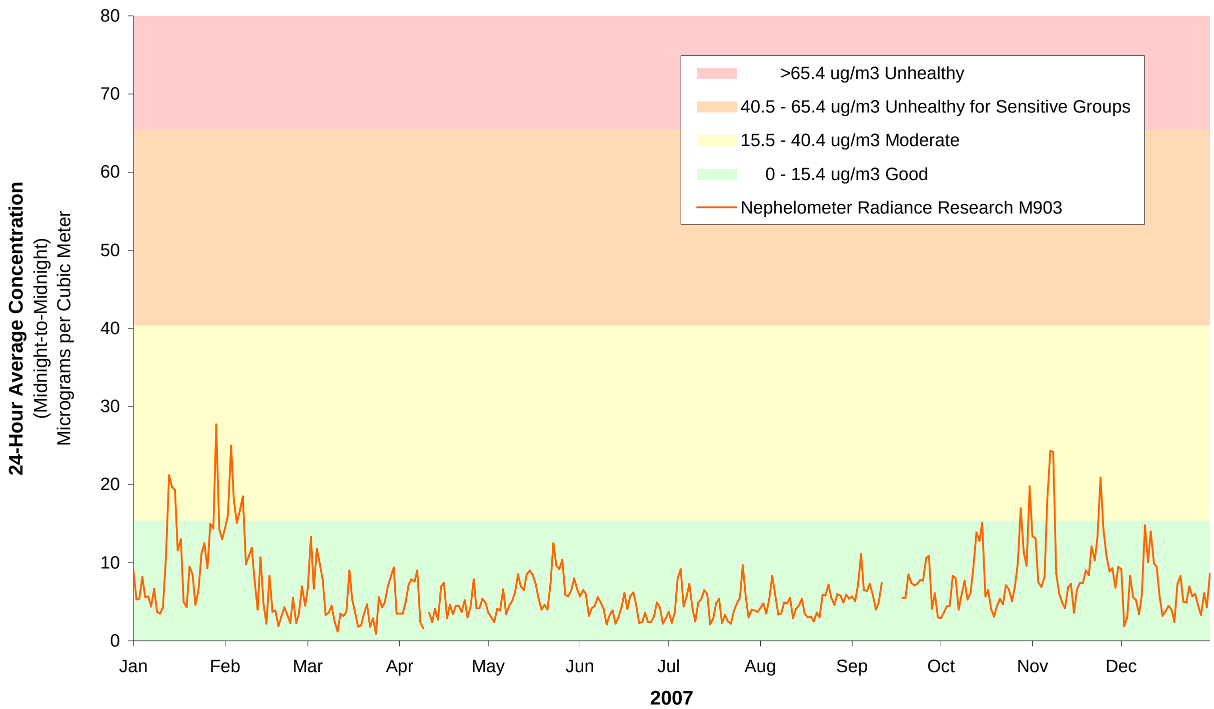


Figure 33: Seattle, Duwamish (CE) $PM_{2.5}$ Daily Averages from Continuous Analyzers

Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

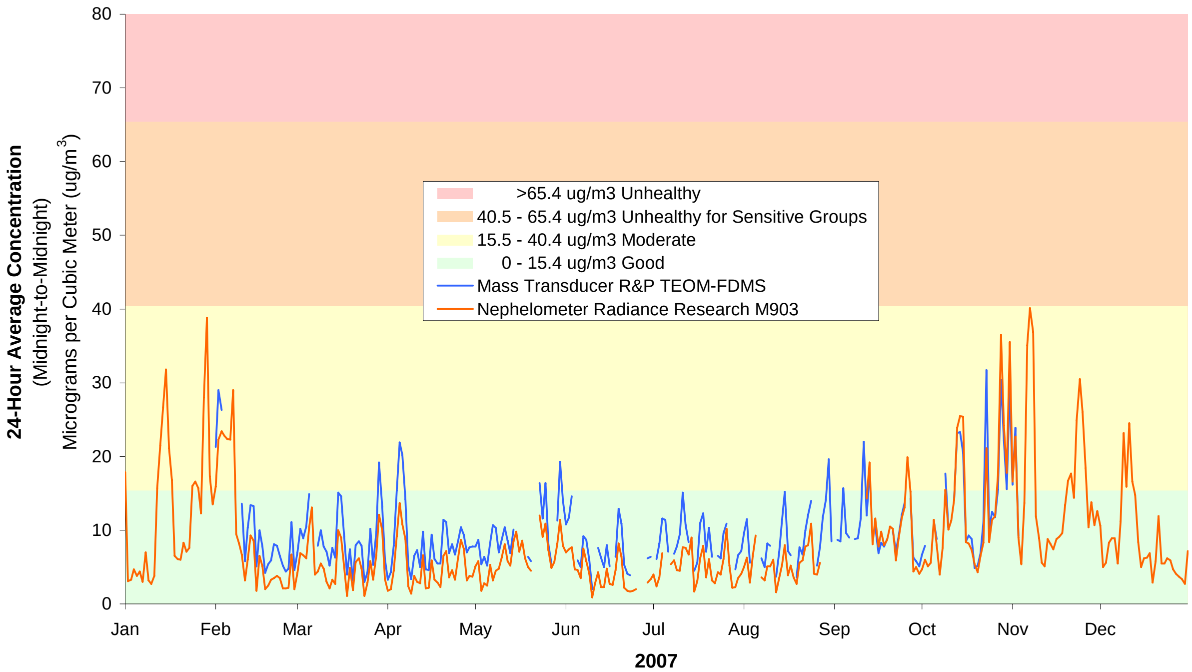
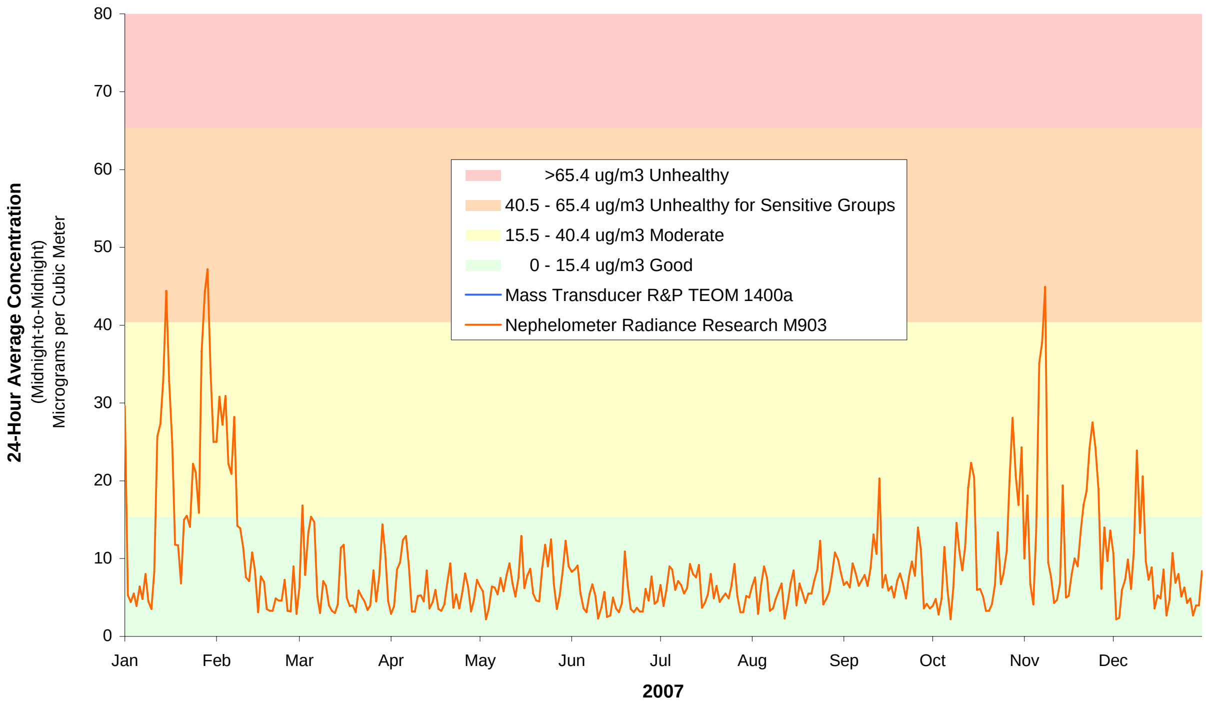


Figure 34: Tacoma, Tideflats $PM_{2.5}$ Daily Averages from Continuous Analyzers

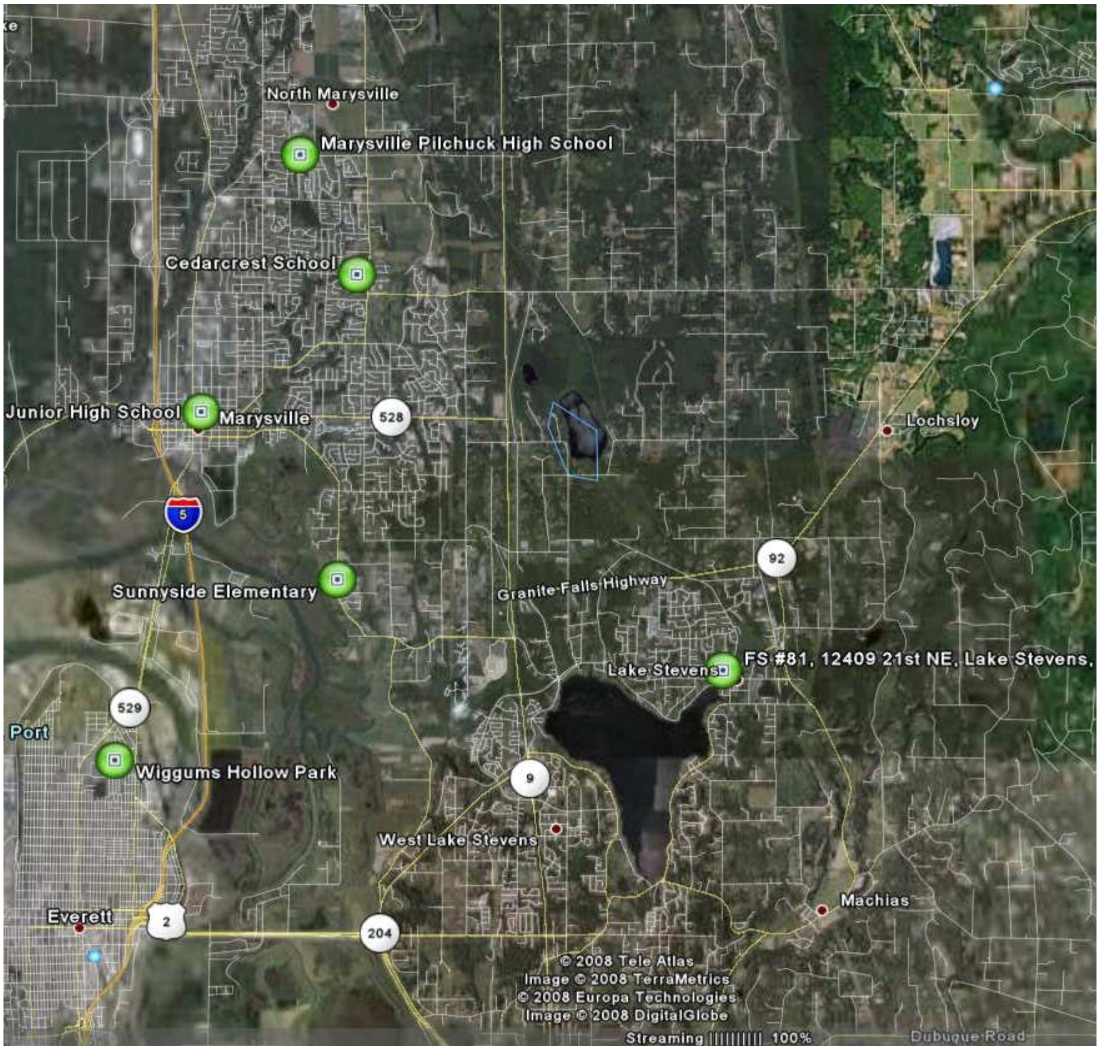
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method



PARTICULATE MATTER - $PM_{2.5}$ SPECIAL MONITORING PROJECT

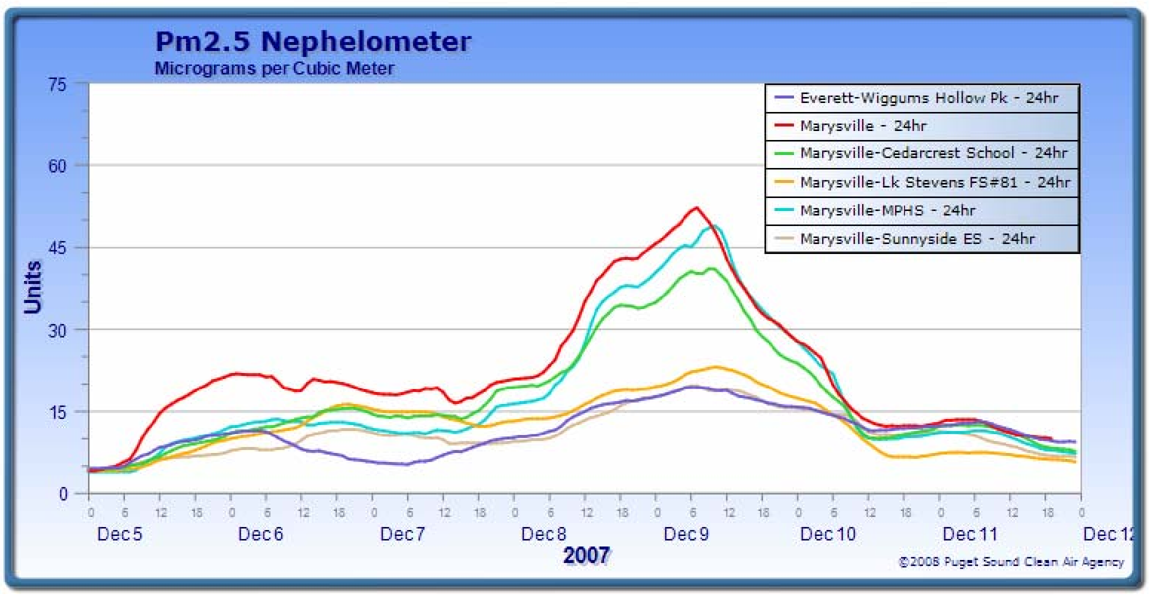
The agency conducted a short-term special monitoring project in 2007 to characterize $PM_{2.5}$ concentrations in the Marysville area. The long-term Marysville monitor at Marysville Junior High shows elevated $PM_{2.5}$ concentrations that are just at the federal standard. Three temporary monitors were installed in Marysville in order to assess $PM_{2.5}$ concentrations in the area. Two additional monitors were installed in Lake Stevens and North Everett to assess $PM_{2.5}$ levels in these areas. The monitoring project's objectives were to determine gradient levels in the area, determine conditions in Lake Stevens and North Everett, and evaluate the relevance of the existing site. The five temporary monitors and the permanent monitor at Marysville Junior High School are shown as green dots in Map 3.

Map 3: Location of Monitors in the 2007 Special Monitoring Project



The results from the Marysville monitoring showed that the existing monitor at Marysville Junior High measured the highest $PM_{2.5}$ levels, and is well-sited. The temporary sites to the north at the Cedercrest School and the Marysville Public High School also had elevated $PM_{2.5}$ levels. Monitors in Lake Stevens and North Everett did not experience elevated concentrations during winter inversions. Figure 35 shows the daily $PM_{2.5}$ levels that occurred during a peak $PM_{2.5}$ occurrence in December 2007.

Figure 35: Daily Concentrations for Marysville Monitoring Project



PARTICULATE MATTER - $PM_{2.5}$ SPECIATION AND AETHALOMETERS

The methods described above show the total amount of fine particulate matter, but do not tell us anything about chemical composition. Although there are no regulatory requirements to go beyond measuring the total mass of fine particulate matter, it's important to know the chemical makeup of particulate matter in addition to its mass. The makeup of fine particulate matter can help the agency determine potential health risks, as particulate matter from different sources have varying toxicities. Those emissions from combustion sources, and specifically diesel combustion engines, are especially toxic. Information on fine particulate composition helped guide the agency's commitment to reduce wood smoke and diesel particulate emissions.[24]

Knowledge about the composition of fine particulate can help to guide emission reduction strategies. For example, if a study of fine particulate shows that a large portion is comprised of wood smoke particulate, then strategies to reduce wood smoke are a priority to reduce total particulate matter concentrations.

Two methods help to inform us about the type of fine particulate matter present in our area: source apportionment modeling of speciation data, and aethalometers.

SPECIATION MONITORING AND SOURCE APPORTIONMENT

Speciation monitoring involves determining the individual fractions of metals and organics in fine particulate matter on different types of filters. These filters are weighed and analyzed to determine the makeup of fine particulate at that site. Over 60 analytes are measured at speciation monitors in the area. Analytes and annual average concentrations are shown on pages A-11 and A-12 of the Appendix. These data can then be used in source apportionment models to estimate contributing sources to $PM_{2.5}$. Some source apportionment models use "fingerprints" from sources, which characterize the chemical fractions emitted by each identified source. The model matches these fingerprints with the speciation data from monitoring sites to estimate how much each source is contributing at that site. Some source apportionment models use statistical analysis of speciation data patterns to estimate how much each source is contributing at that site.

The Washington Department of Ecology conducted speciation monitoring at three monitoring sites in the Puget Sound region in 2007. These sites include:

- Seattle Beacon Hill site – typical urban impacts, mixture of sources (speciation samples collected every third day)
- Tacoma South L – urban residential area, impacts from residential wood combustion (speciation samples collected every sixth day)
- Seattle Duwamish site – industrial area, combination of mobile source, industrial, and limited wood smoke impacts (speciation samples collected every sixth day)

[24]Puget Sound Air Toxics Evaluation, October 2003; http://www.pscleanair.org/airq/basics/psate_final.pdf.

The Tacoma South L site is relatively new, and uses the speciation monitor that was moved from its previous location at Lake Forest Park. The Department of Ecology relocated the Seattle Olive Street and Duwamish monitors in 2007 and 2008, respectively, to other parts of Washington State facing potential $PM_{2.5}$ nonattainment. The Olive Street monitor is not shown because of an incomplete data year. The agency plans to conduct its own speciation monitoring at Seattle Duwamish and the Tacoma Tide Flats beginning in late 2008.

The agency and the University of Washington have historically used these data to conduct source apportionment modeling. This modeling was especially useful to estimate diesel particulate matter and wood smoke particulate concentrations at Beacon Hill.[25]

Several researchers have used speciation data from these sites to better understand air quality. In addition to using speciation data for specific analytes or source apportionment modeling, the agency uses them to qualitatively look at the makeup of fine particulate at our monitoring sites. Using a mass reconstruction equation to simplify analytes into five broad categories, we can look at seasonal differences and compare sites.[26, 27]

Figures 36 through 38 show simplified, major constituents of speciation data from the three speciation sites. Note that the width of each color in the graph represents the amount of matter present in the sample. For example, in all three graphs there is a larger amount of organic carbon present than nitrate.

Major constituents of fine particulate matter in our region include:

- Organic and Elemental Carbon – These are largely from combustion sources.
- Sulfate and Nitrates – These are formed in the atmosphere from sulfur and nitrogen oxides, SO_X, and NO_X. The largest sources of SO_X and NO_X in our area are on-road and non-road mobile sources (gasoline and diesel fuels). Large industrial sources also contribute substantially to SO_X (about 20%). Voluntary and regulatory programs that have started reducing the sulfur content in fuels will begin to reduce the SO_X and sulfates in our area.
- A “soil” component comprised of analytes typically associated with crustal materials – The soil fraction includes aluminum, silicon, calcium, iron, titanium, and potassium.

It is important to note that these are not all fine particulate components, but a simplification.

As expected, the wood smoke site (Tacoma South L) shows more seasonal variability, with carbon concentrations substantially greater in the heating months. These graphs qualitatively show that a large amount of our fine particulate comes from the combustion sources (the carbon fractions). Note that the “dips” in the graph are due to missing data, not to zero level $PM_{2.5}$ concentrations. Also, note that the y-axes on graphs are different.

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[25] Puget Sound Air Toxics Evaluation. October 2003; http://www.pscleanair.org/airq/basics/psate_final.pdf.

[26] Brook, Dann, and Burnett. The Relationship Among TSP, PM_{10}, $PM_{2.5}$, and Inorganic Constituents of Atmospheric Particulate Matter at Multiple Canadian Locations. Journal of Air & Waste Management. Volume 47: pp 2-19. January 1997. Page 6 includes a mass reconstruction equation for soil components.

[27] Jeffrey Brook and Tom Dann. Contribution of Nitrate and Carbonaceous Species to $PM_{2.5}$ Observed in Canadian Cities. Journal of Air & Waste Management. Volume 49: pp 193-199. February 1999. Results demonstrate that organic carbon concentrations should be multiplied by a factor of roughly 1.4 to account for the molecular form.

Figure 36: Seattle Beacon Hill Residential Site – $PM_{2.5}$ Speciation Data 2007

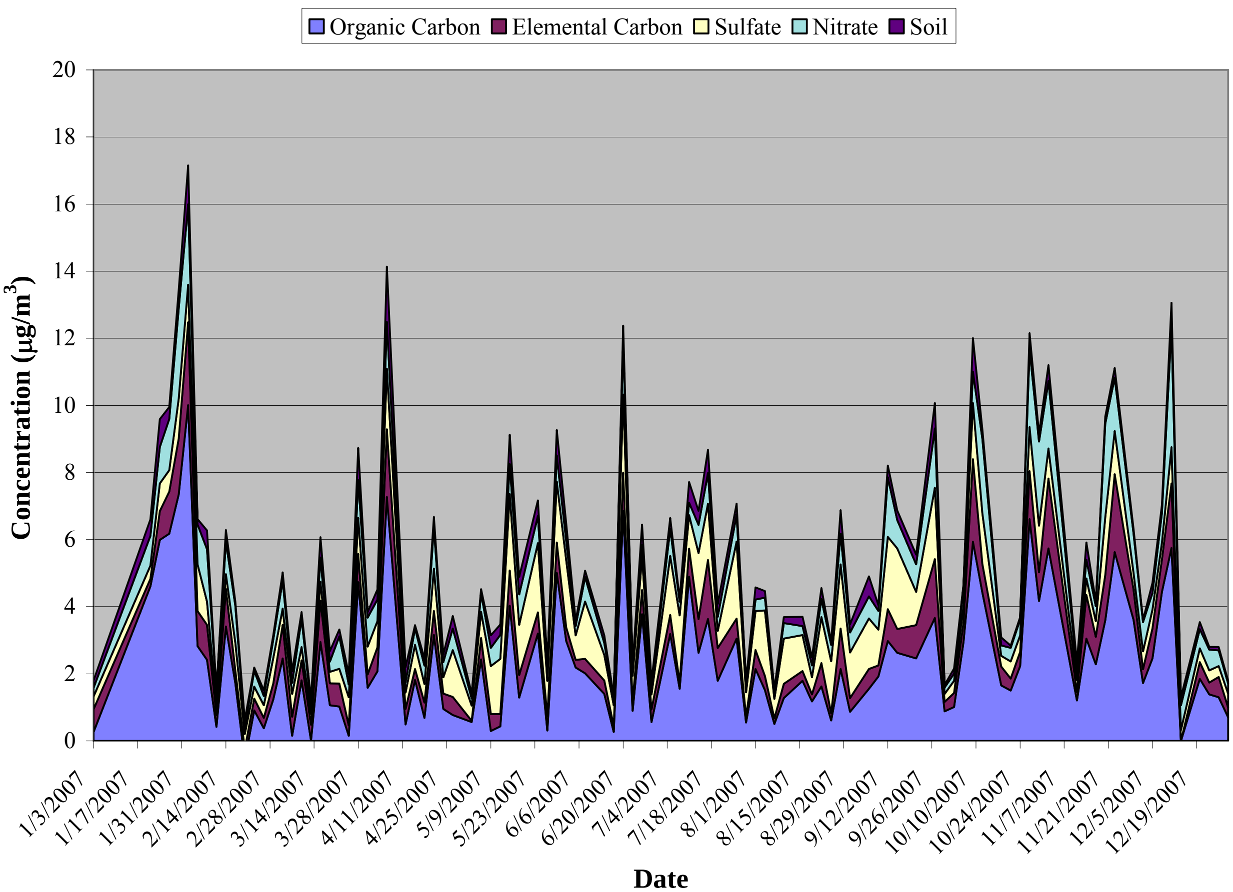


Figure 37: Tacoma South L Residential Site – $PM_{2.5}$ Speciation Data 2007

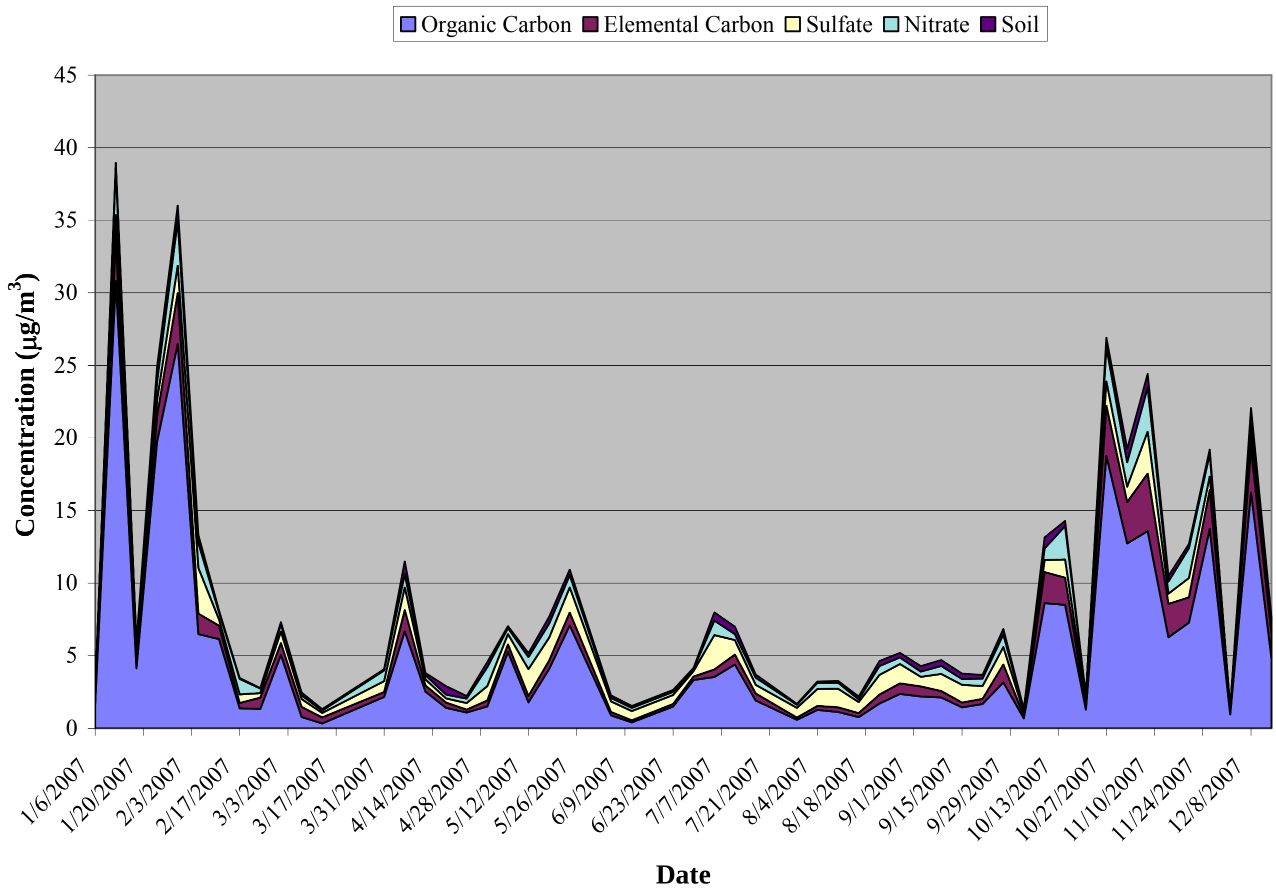
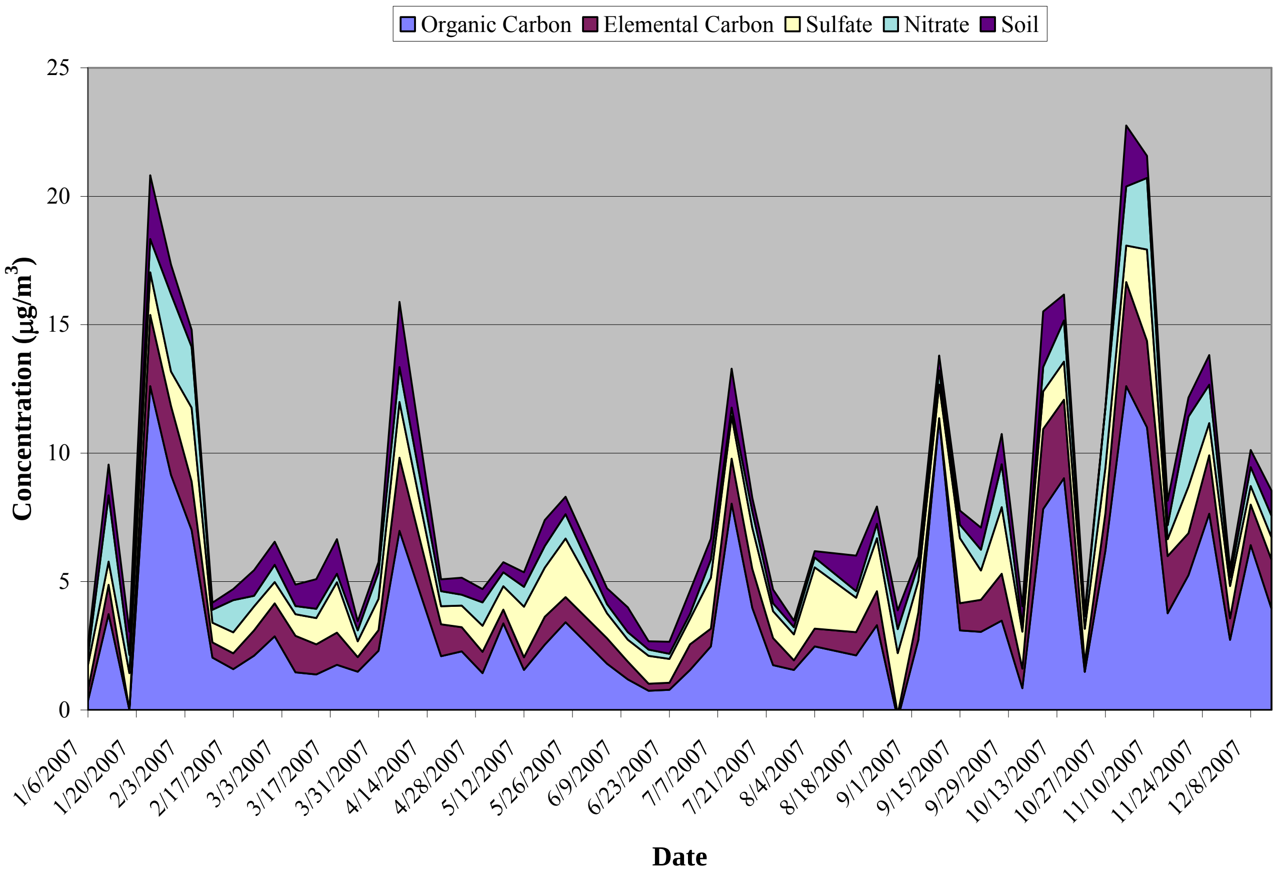


Figure 38: Seattle Duwamish Industrial Mix Site – $PM_{2.5}$ Speciation Data 2007



AETHALOMETER DATA

Aethalometers are monitoring instruments that provide information about the carbon fraction of fine particulate matter. Aethalometers continuously measure light absorption to estimate carbon concentrations. The aethalometer measures two channels, black carbon (BC) and ultraviolet (UV). The instrument translates information into concentrations; concentrations from the black carbon channel correlates well with elemental carbon (EC) speciation data. Qualitatively, the difference between the UV and BC channel (UV-BC) correlates well with organic carbon (OC) speciation data.

Elemental and organic carbon are related to diesel particulate, wood smoke particulate, and particulate from other combustion sources.[28] Unfortunately, neither are uniquely correlated to a particular combustion type – so the information gained from aethalometer data is largely qualitative.

The agency maintains aethalometers at monitoring sites with high particulate matter concentrations, as well as sites with speciation data, so that the different methods to measure carbon may be compared. Page A-13 in the Appendix shows the correlation and equation relating BC (from aethalometers) and EC (from speciation data) at two sites with speciation data: Seattle Duwamish and Tacoma South L. Both show good correlation, with R squared greater than 0.8, with the Tacoma South L site showing the highest correlation of 0.93. For more information on aethalometers, refer to our aethalometer monitoring paper at http://www.pscleanair.org/airq/Aeth-Final.pdf.

A statistical summary of aethalometer black carbon data is presented on page A-14 of the Appendix.

[28] Urban Air Monitoring Strategy – Preliminary Results Using Aethalometer™ Carbon Measurements for the Seattle Metropolitan Area; http://www.pscleanair.org/airq/Aeth-Final.pdf.

OZONE

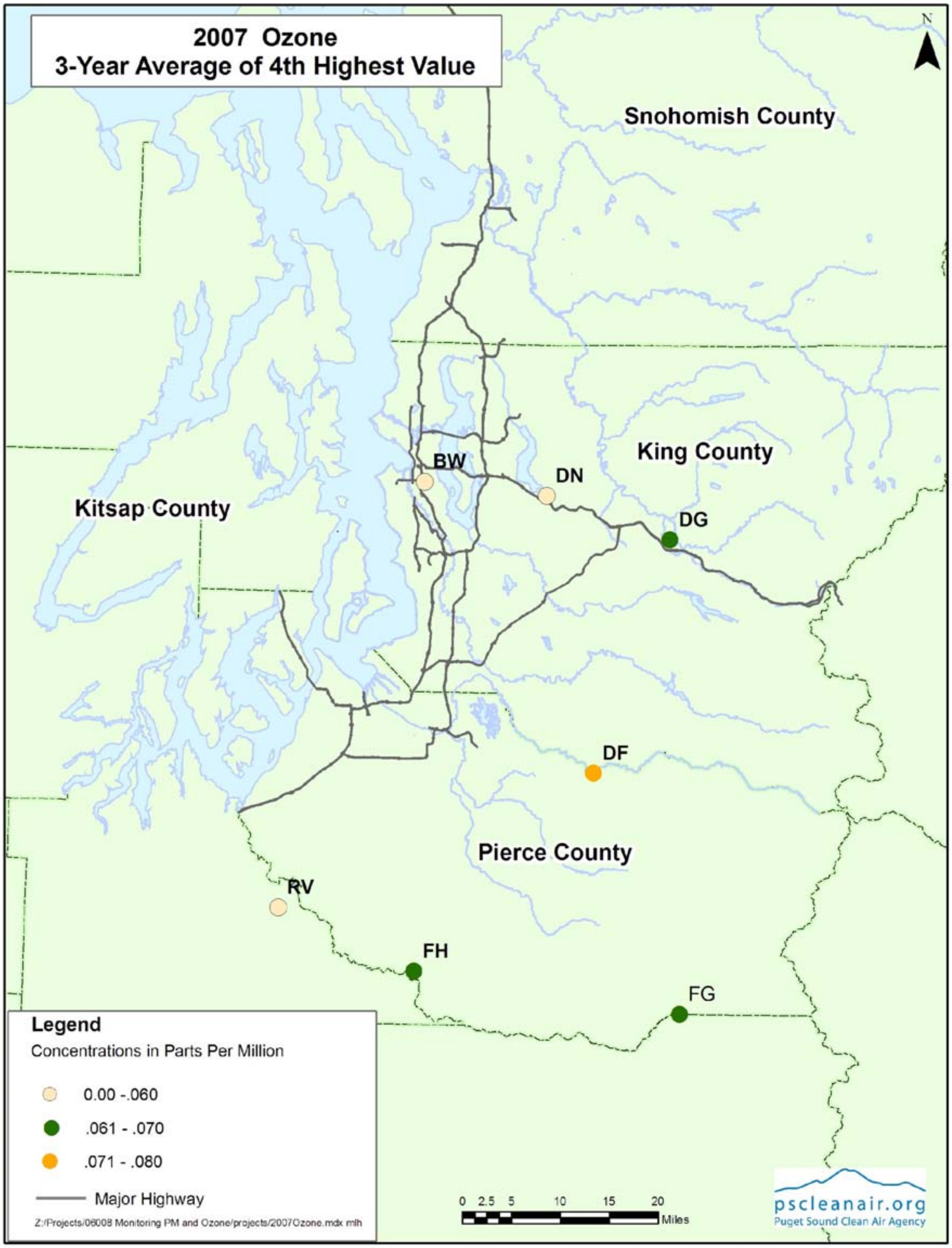
Ozone is a summertime air pollution problem and is not directly emitted by pollutant sources. Ozone forms when photochemical pollutants react with sunlight. These pollutants are called ozone precursors and include volatile organic compounds (VOC) and nitrogen oxides (NO_x), with some influence by carbon monoxide (CO). These precursors come from anthropogenic sources such as mobile sources and industrial and commercial solvent use, as well as natural sources (biogenics). Levels are usually highest in the afternoon because of the intense sunlight and the time required for ozone to form in the atmosphere. Ozone levels are highly affected by weather. The Washington State Department of Ecology monitors ozone from May through September, as this is the time period of concern for elevated ozone levels in the Pacific Northwest.

People sometimes confuse upper atmosphere ozone with ground-level ozone. Stratospheric ozone helps to protect the earth from the sun's rays. In contrast, ozone formed at ground level is unhealthy. Elevated concentrations of ground-level ozone can cause reduced lung function and respiratory irritation, and can aggravate asthma.[29] People with respiratory conditions should limit outdoor exertion if ozone levels are elevated. Ozone has also been linked to immune system effects.[30] Even healthy individuals may experience respiratory symptoms on a high-ozone day. Ground-level ozone can also damage agricultural crops and forests, interfering with their ability to produce food and grow.[31]

The majority of monitoring stations measuring ozone are located in rural regions of the Puget Sound region, although the precursor chemicals that react with sunlight to produce ozone are generated primarily in large metropolitan areas. The photochemical formation of ozone takes several hours. Thus, the highest concentrations of ozone are measured in the communities downwind of these large urban areas. In the Puget Sound region, the hot sunny days favorable for ozone formation also tend to have light north-to-northwest winds. Ozone has typically been transported 10 to 30 miles downwind from the original source by the time the highest concentrations have formed in the afternoon and early evening. Regional meteorology inhibits regular production of elevated ozone levels. These elevated ozone episodes usually occur no more than 3 to 5 days per ozone season. Highest ozone concentrations are measured in areas such as LaGrande Pack Forest and Enumclaw. As shown on Map 4, the highest ozone concentrations occur at monitors southeast of the urban area.

[29] EPA AirNow. How Can Ground-Level Ozone Affect Your Health?; http://www.airnow.gov/index.cfm?action=static.ozone2#3.
[30] EPA Health and Environmental Effects of Ground Level Ozone; http://www.epa.gov/ttn/oarpg/naaqsfin/o3health.html.
[31] EPA Health and Environmental Effects of Ground Level Ozone; http://www.epa.gov/ttn/oarpg/naaqsfin/o3health.html.

Map 4: Ozone 3-year Average of 4th Highest Value for 2007*



* Seattle Beacon Hill was down most of 2006 and has fewer data points to calculate the 98th percentile 3-year average.

Figure 39 presents data for each monitoring station and the 2007 8-hour federal standard, and shows that ozone concentrations in the Puget Sound region have remained below the standard since 1993. Although ozone levels have remained fairly stable, ozone is still a concern for the region because EPA revised its 8-hour ozone standard from 0.08 ppm to 0.075 ppm. Based on EPA's rounding methods, the former standard of 0.08 ppm effectively was 0.084 ppm. The new standard was finalized on March 27, 2008 in response to the determination that the former standard was not sufficiently protective of human health.[32]

The data in this summary are compared to the 2007 ozone standard since the new standard was not in effect until 2008. The federal standard is based on the 3-year average of the 4th highest 8-hour concentration. This means the three highest concentrations can exceed the level of the standard while still maintaining attainment. There is also a 3-year averaging component to the standard. Values presented on the graph are 3-year averages of the 4th highest concentrations. The year on the x-axis represents the last year averaged. For example, concentrations shown for 2007 are an average of 2005, 2006, and 2007 4th highest concentrations. The table on page A-15 of the Appendix shows that the 8-hour standard of 0.08 ppm was exceeded on July 11 at both the Enumclaw Mud Mountain monitor and the LaGrande Pack Forest monitor. The highest 2007 8-hour ozone concentration of 0.090 ppm was recorded on July 11 at the Enumclaw Mud Mountain monitor.

Figure 40 presents 8-hour average data for the months of May through September, as these are the months where ozone levels are greatest. The shading on the graph corresponds to the 2007 AQI breakpoints for ozone, based on the 8-hour average. Figure 41 shows the trend of ozone over the summer for the last ten years. This graph highlights that 2006 ozone levels were higher in the Puget Sound region than they have been since 1998. Concentrations reached the "unhealthy" AQI zone in 2006 and in 1998.

For additional information on ozone, visit www.epa.gov/air/ozonepollution. There is also additional information on ozone in question/answer format in the Definitions section of this document.

[32] 2008 Revised Ground-Level Ozone Standards; http://www.epa.gov/air/ozonepollution/actions.html.

Figure 39: 8-Hour Ozone

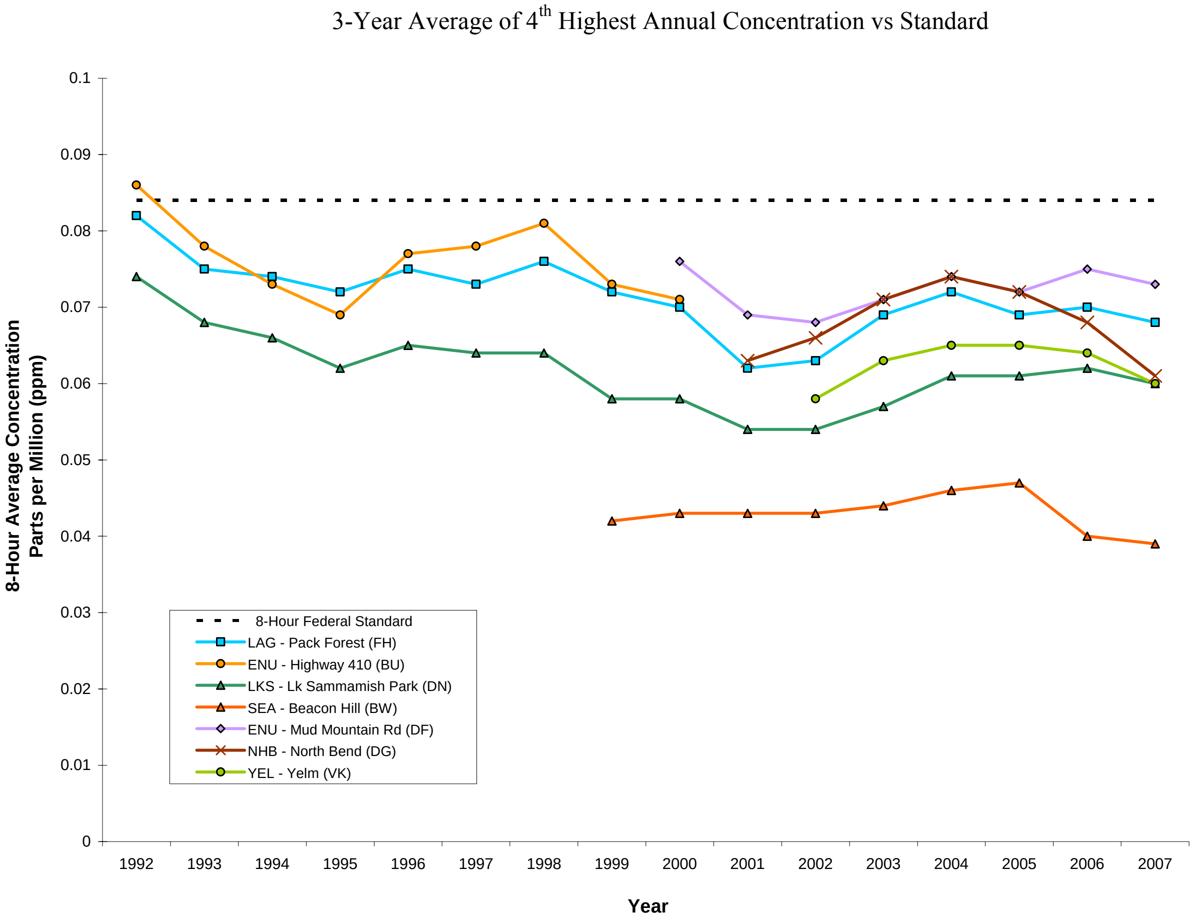


Figure 40: Ozone (O_3) in Puget Sound Region May-September 2007

Daily Maximum 8-Hour Concentration for all sites in the Puget Sound Region

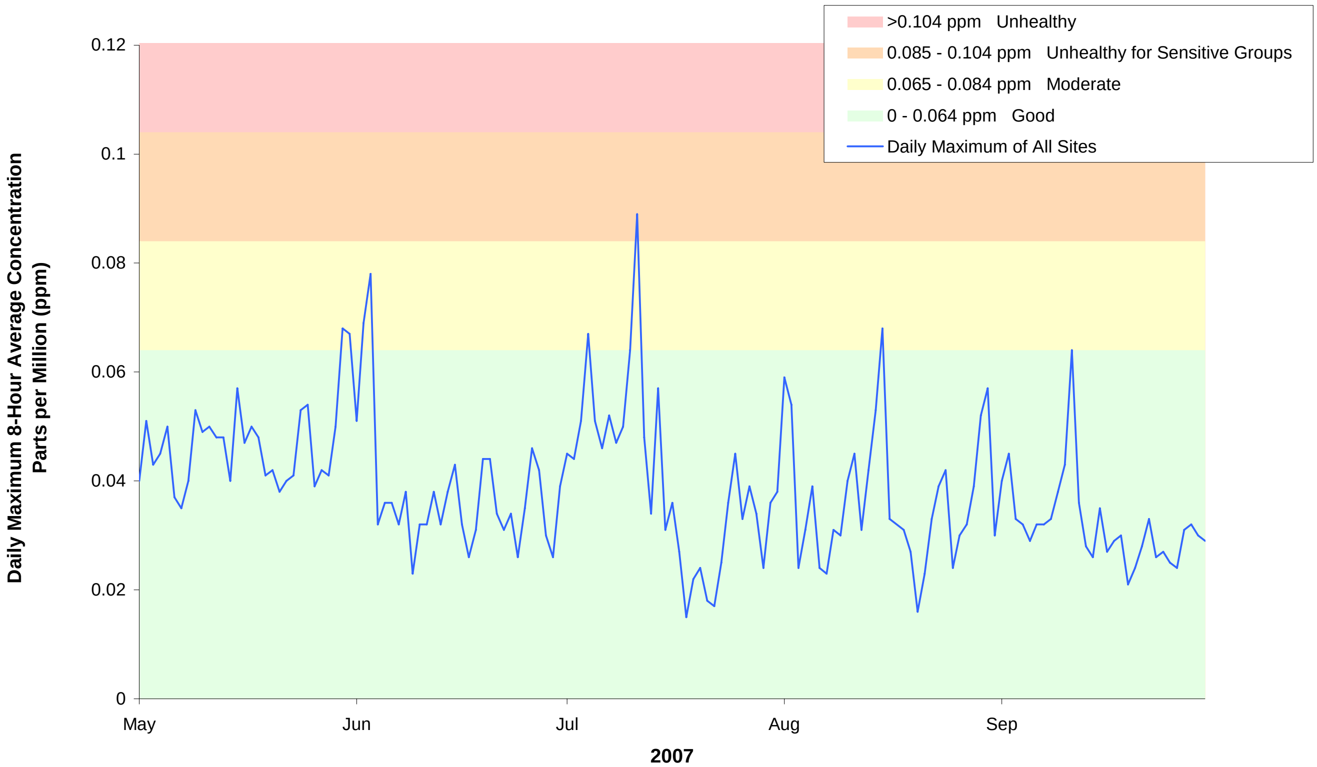
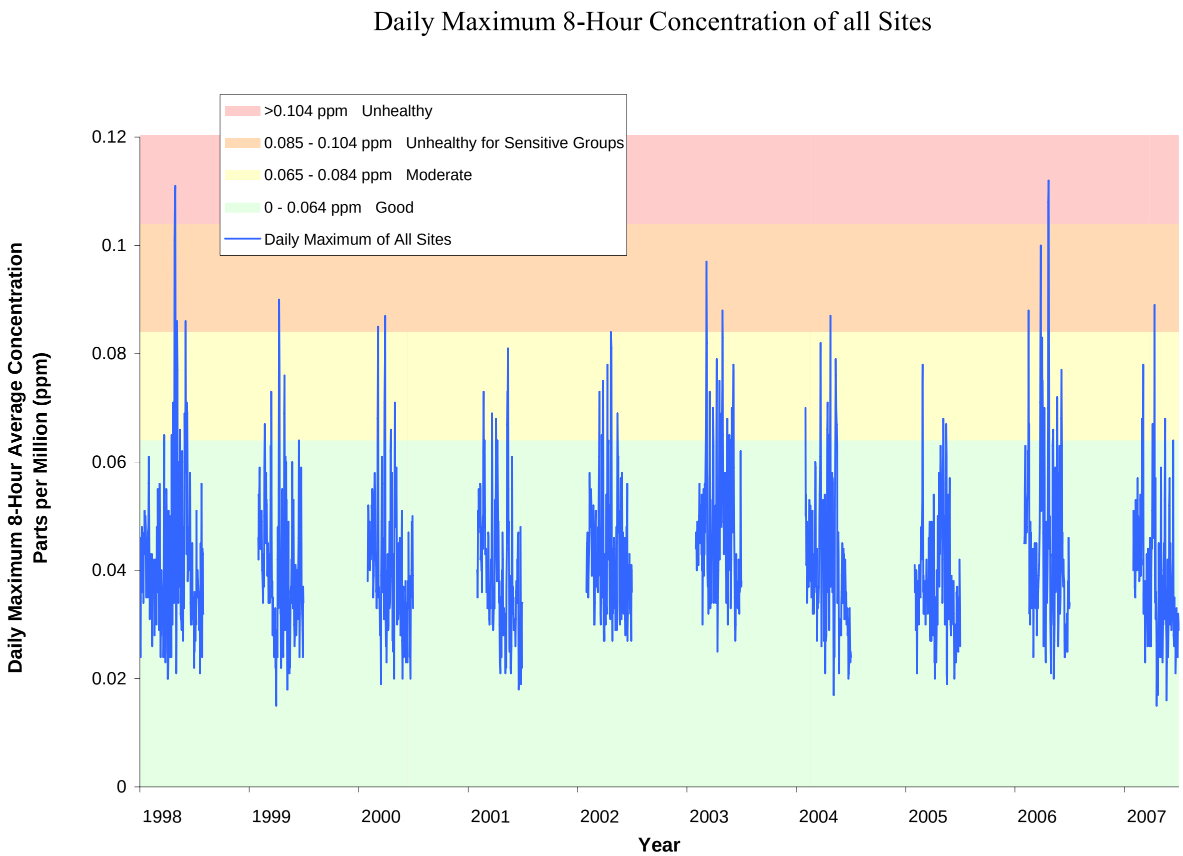


Figure 41: Ozone (O_3) in Puget Sound Region 1998-2007 May-September



NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that forms from the reaction of nitrogen oxide (NO) and oxygen in the atmosphere. NO_2 can cause respiratory symptoms such as coughing, wheezing, and shortness of breath in people with respiratory diseases such as asthma.[33] Long-term exposure can lead to respiratory infections.

The term "NO_X", which is frequently used, is defined as NO + NO_2. NO_2 will react with volatile organic compounds (VOCs) and can result in the formation of ozone. Recently it has been shown that other organic nitroxyl compounds play a significant role in ozone formation including nitric acid (HNO_3) and nitrous acid (HONO). "NO_Y" is a newer term that represents "NO + NO_2 + the other notroxyl compounds."

NO_X, NO + NO_2, can form nitrates in the atmosphere, a component of fine particulate matter. On-road vehicles such as trucks and automobiles are the major sources of NO_X. Industrial boilers and processes, home heaters, and gas stoves also produce NO_X.

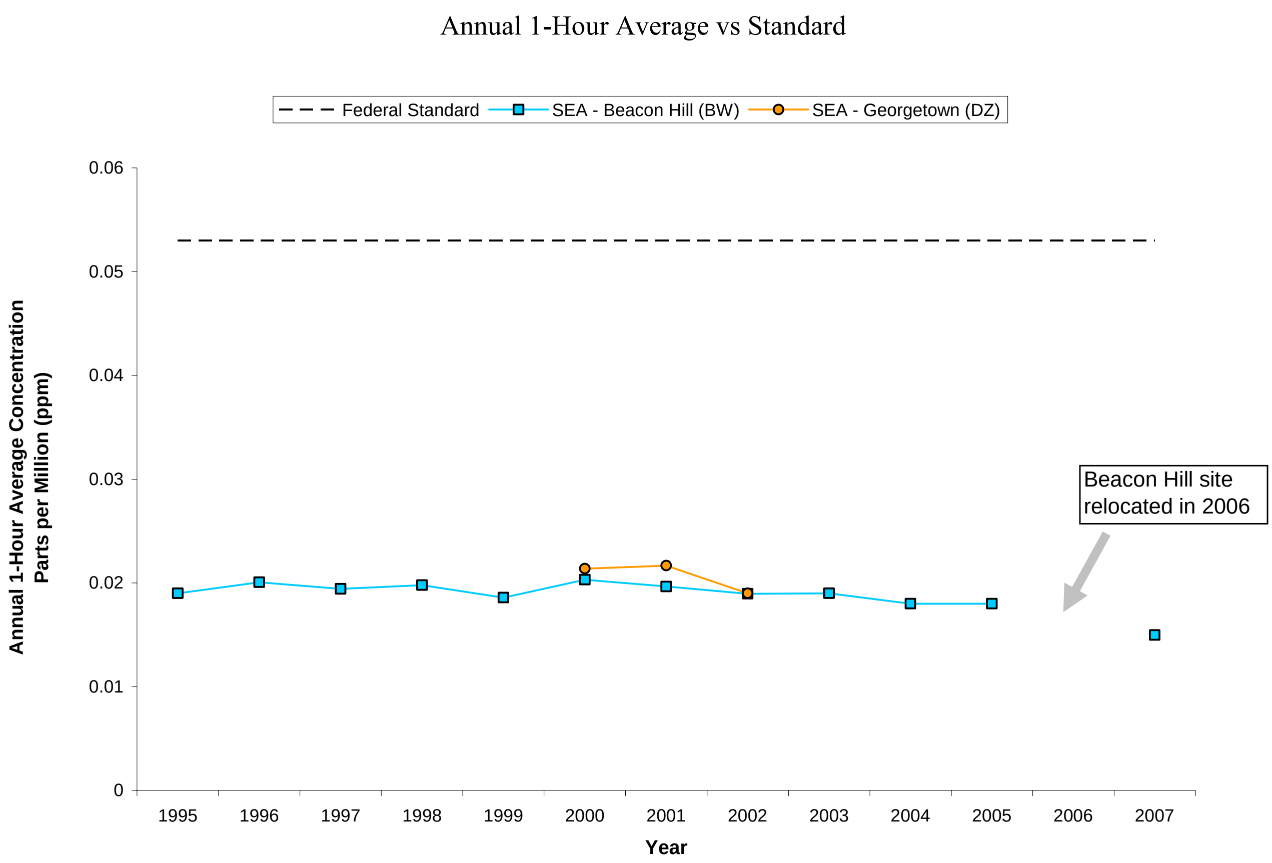
Motor vehicle manufacturers have been required to reduce NO_X emissions from cars and trucks since the 1970s, and emissions have reduced dramatically. NO_2 in itself is not considered a significant pollution problem in the Puget Sound area. However, NO_X emissions are important, as they affect ozone and nitrate formation.

The Washington State Department of Ecology maintains one monitoring site for nitrogen dioxide at the Beacon Hill monitoring site. In 2007, the monitoring technique and equipment changed slightly to record NO_Y instead of NO_X to incorporate the notroxyl compounds, which are important in monitoring ozone formation chemicals and fine particulate matter. The additional notroxyl compounds are in trace amount in comparison to NO_2. Figure 42 shows NO_2 concentrations through 2005. In 2006, no data were recorded due to the relocation of the Beacon Hill monitor to a different location in the same property. In 2007, the concentration of NO_2 is represented as NO_Y - NO since NO_2 is no longer directly recorded. The annual average for each year has consistently been less than half of the federal standard, as shown in Figure 42 and in the statistical summary on page A-16 of the Appendix.

The maximum 1-hour average of NO_Y- NO, measured in 2007, was 0.080 ppm on March 29. Visit www.epa.gov/air/urbanair/nox/index.html for additional information on NO_2.

[33] EPA, Airnow, NO_X Chief Causes for Concern, http://epa.gov/air/urbanair/nox/chf.html.

Figure 42: Nitrogen Dioxide (NO_2) (1995-2005) and Reactive Nitrogen (2007)



CARBON MONOXIDE

Carbon monoxide (CO) is an odorless, colorless gas that can enter the bloodstream through the lungs and reduce the amount of oxygen that reaches organs and tissues. Carbon monoxide forms when the carbon in fuels doesn't burn completely. In cities, 85-95% of all CO emissions may come from motor vehicle exhaust.

Elevated levels of CO in ambient air can occur in areas with heavy traffic congestion, and happen during the colder months of the year when temperature inversions are more frequent. People with cardiovascular disease or respiratory problems may experience chest pain and increased cardiovascular symptoms, particularly while exercising, if CO levels are high. High levels of CO can affect alertness and vision even in healthy individuals.

EPA designated the Puget Sound region as a CO attainment area in 1996.

The Washington State Department of Ecology has conducted all CO monitoring. Historically, CO monitoring stations are located in areas with heavy traffic congestion. These include central business areas, roadsides, and shopping malls. Although urban portions of the Puget Sound region violated the CO standard for many years, CO levels have decreased significantly in the Puget Sound area, primarily due to cleaner car technology. The Department of Ecology has substantially reduced its CO monitoring network, and only the Bellevue 148th Ave site and the Beacon Hill site ran during 2007. Please refer to page A-17 of the Appendix for sampling periods of this site.

The federal CO standard is based on the second highest 8-hour average. Figure 43 shows the second highest 8-hour concentrations and the federal standard for King County. There currently are no CO monitoring stations in Kitsap, Pierce, or Snohomish Counties. Figures 44 and 45 show historical CO monitoring data for Pierce and Snohomish counties. No historical data exists for Kitsap County. These historical graphs show the general downward trend that CO has taken from the early 1990s to 2006.

The maximum 8-hour concentration for CO in 2007 was 2.7 parts per million (ppm) on January 29.

EPA's federal standards also include a 1-hour standard for CO of 35 ppm, not to be exceeded more than once a year. Measured 1-hour concentrations in the Puget Sound area are historically much lower than the 35 ppm standard, and therefore 1-hour CO trends are not graphed.

Statistical summaries for 8-hour and 1-hour average CO data are provided on page A-17 of the Appendix.

For additional information on CO, visit www.epa.gov/air/urbanair/co/index.html. CO information is also provided in question/answer format in the Definitions section of this document.

Figure 43: Carbon Monoxide (CO) for King County

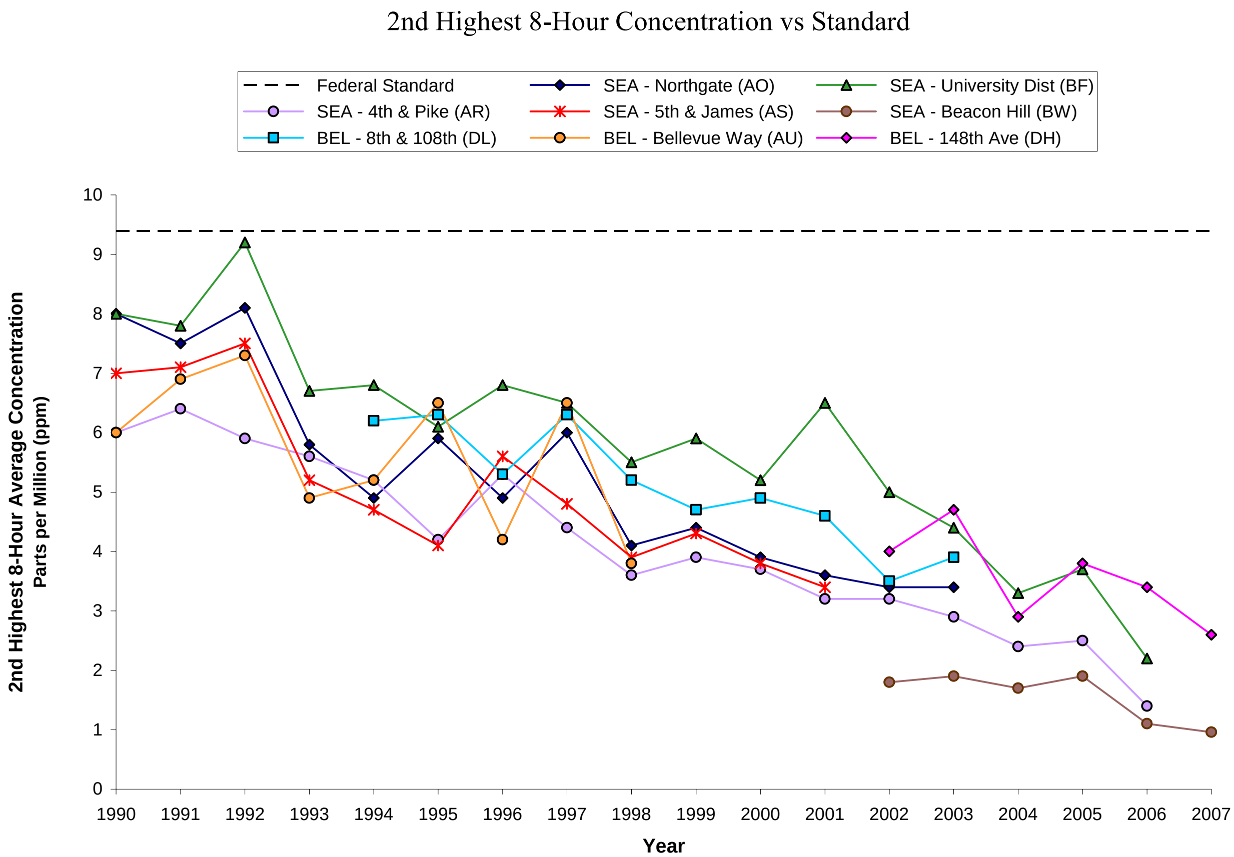


Figure 44: Carbon Monoxide (CO) for Pierce County

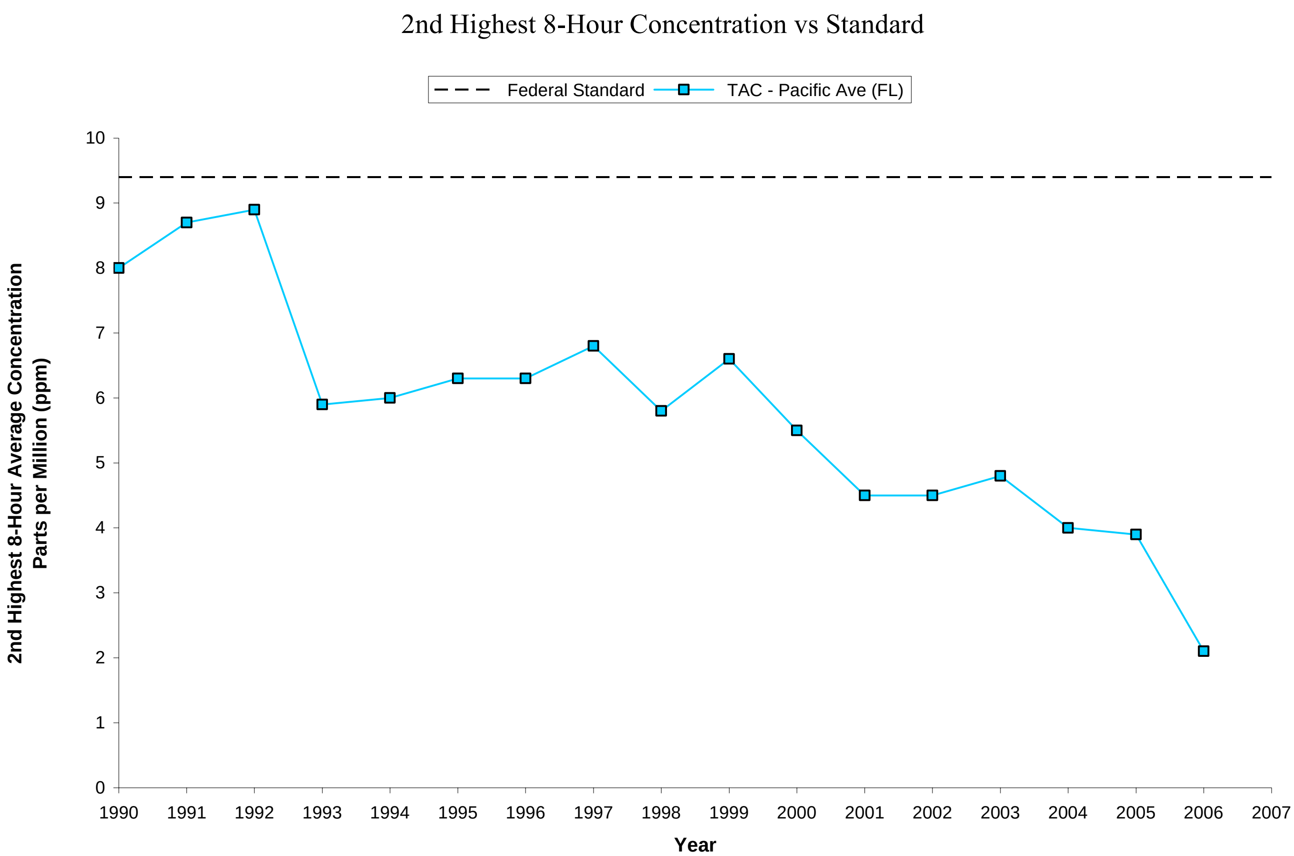
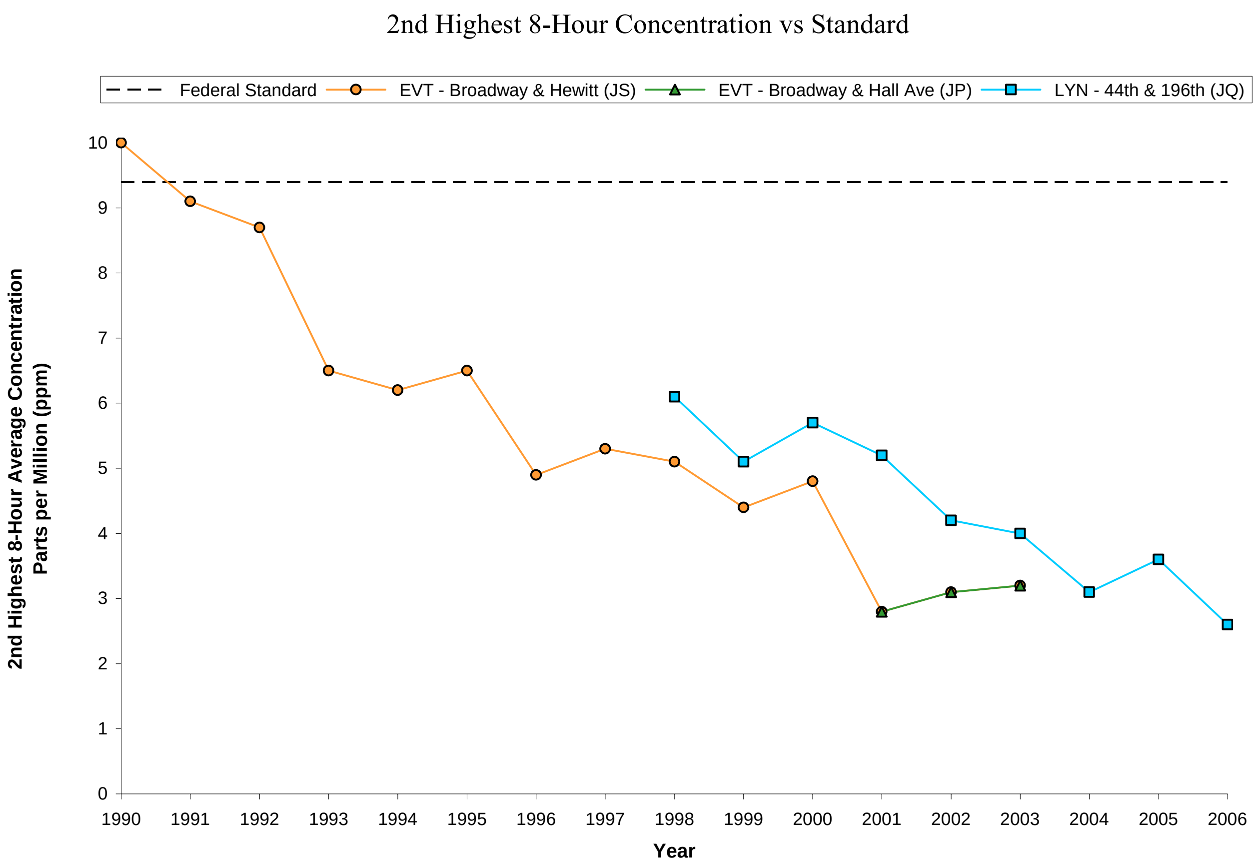


Figure 45: Carbon Monoxide (CO) for Snohomish County



SULFUR DIOXIDE

Sulfur dioxide (SO_2) is a colorless, reactive gas produced by burning fuels containing sulfur, such as coal and oil, and by industrial processes. Historically, the greatest sources of SO_2 were industrial facilities that derived their products from raw materials such as metallic ore, coal, and crude oil, or that burned coal or oil to produce process heat (petroleum refineries, cement manufacturing, and metal processing facilities). Today, on-road vehicles, diesel construction equipment, and marine vessels release significant SO_2 emissions to the air.

People with asthma who are active outdoors may experience bronchoconstriction, where symptoms include wheezing, shortness of breath, and tightening of the chest. People should limit outdoor exertion if SO_2 levels are high. SO_2 can also form sulfates in the atmosphere, a component of fine particulate matter.

The Puget Sound area has experienced a significant decrease in SO_2 from sources such as pulp mills, cement plants, and smelters in the last two decades. Additionally, levels of sulfur in diesel and gasoline fuels are decreasing due to EPA regulations. The Puget Sound Clean Air Agency stopped monitoring for SO_2 in 1999 because of these decreases. Monitoring sites for SO_2 were historically sited in or near former industrial areas. The Washington State Department of Ecology monitored SO_2 at the Beacon Hill site from 2000-2005. In 2006 the SO_2 monitor was relocated to a different location on the same property. The monitor was not operating most of 2006, so no data are reported for that year.

Figures 46 and 47 show the maximum 24-hour and 1-hour concentrations, respectively, at individual monitoring sites. The July 1994 spike shown on these graphs was the result of a short-term release from an Everett paper mill. The maximum measured SO_2 concentrations in 2007 were below all federal and regional standards. The maximum 24-hour and 1-hour Beacon Hill averages in 2007 were 0.039 ppm on September 14 and 0.007 ppm on September 11, respectively.

Statistical summaries for SO_2 data from the Beacon Hill site are available on page A-18 of the Appendix.

Additional information on SO_2 is available at www.epa.gov/air/urbanair/so2/index.html. SO_2 information is also provided in question/answer format in the Definitions section of this document.

Figure 46: Sulfur Dioxide (SO_2) Maximum 24-Hour Average

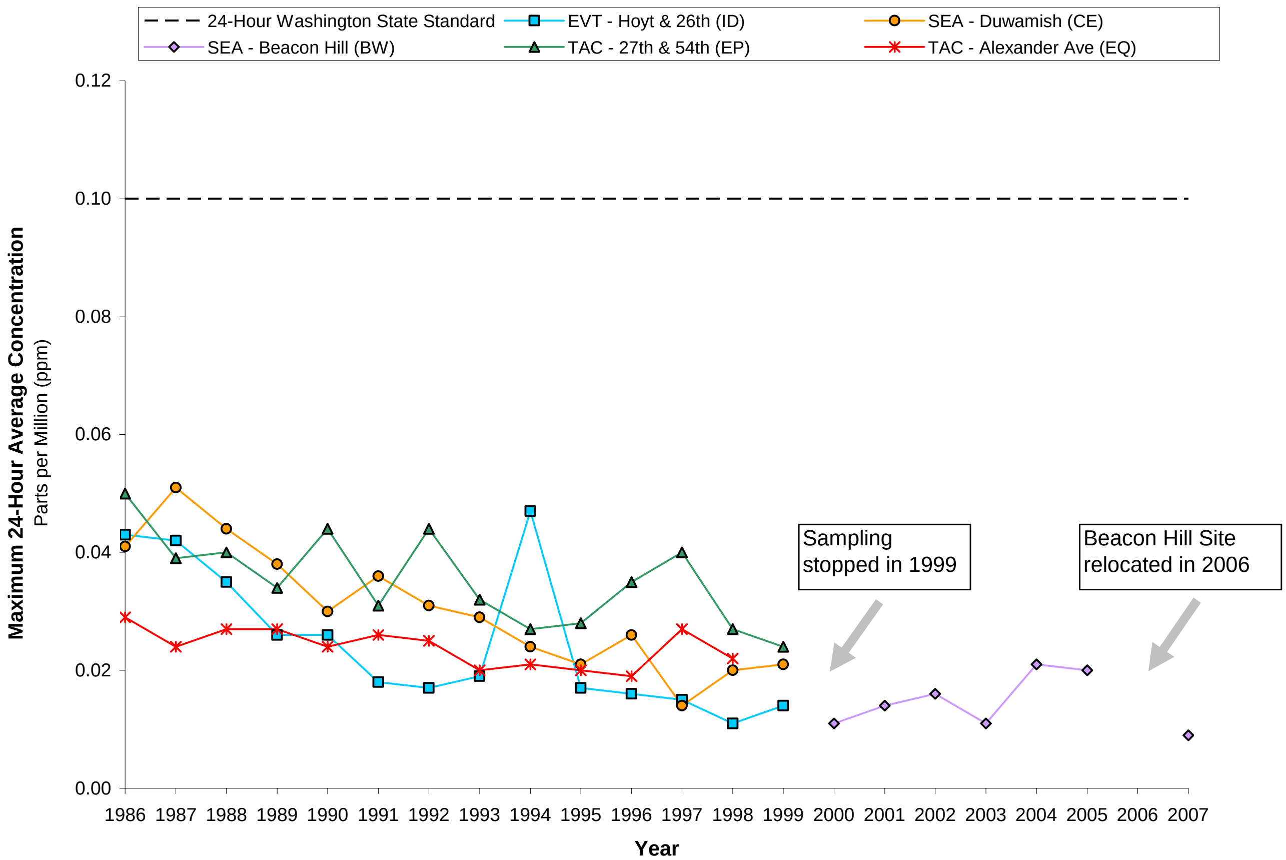
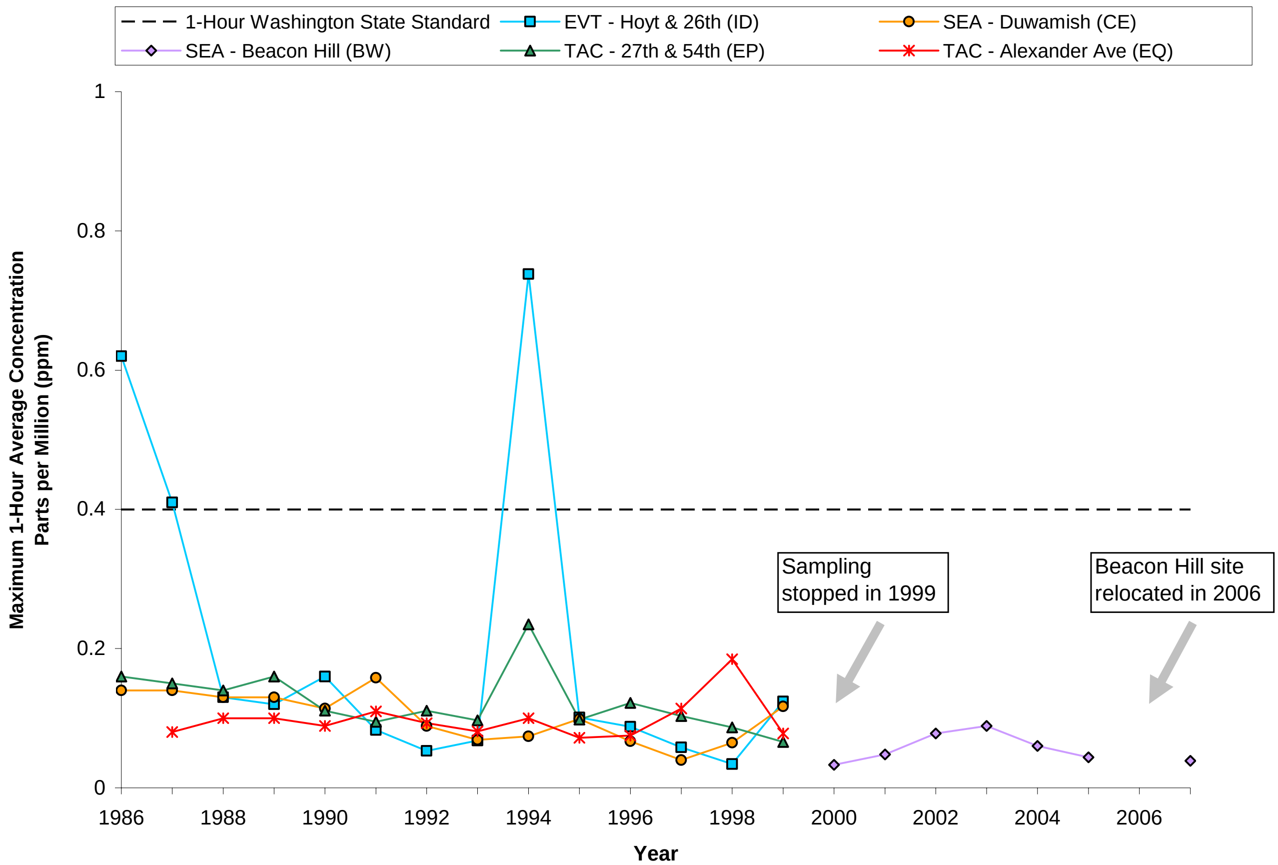


Figure 47: Sulfur Dioxide (SO_2) Maximum 1-Hour Average



LEAD

Lead is a highly toxic metal that was used for many years in household products (e.g., paints), automobile fuel, and industrial chemicals. Locally, airborne lead was associated primarily with automobile exhaust and lead smelters. The large reductions in lead emissions from motor vehicles have changed the nature of the air quality lead problem in the United States. Industrial processes, particularly primary and secondary lead smelters and battery manufacturers, are now responsible for most of the remaining lead emissions.

People, animals, and fish are mainly exposed to lead by breathing and ingesting it in food, water, soil, or dust. Lead accumulates in the blood, bones, muscles, and fat. Infants and young children are especially sensitive to even low levels of lead. Lead can have health effects ranging from behavioral problems and learning disabilities to seizures and death.

According to EPA, the primary sources of lead exposure are lead-based paint, lead-contaminated dust, and lead-contaminated residual soils. See the EPA website at www.epa.gov/ttnatw01/hlthef/lead.html for ways to limit your exposure to these lead sources.

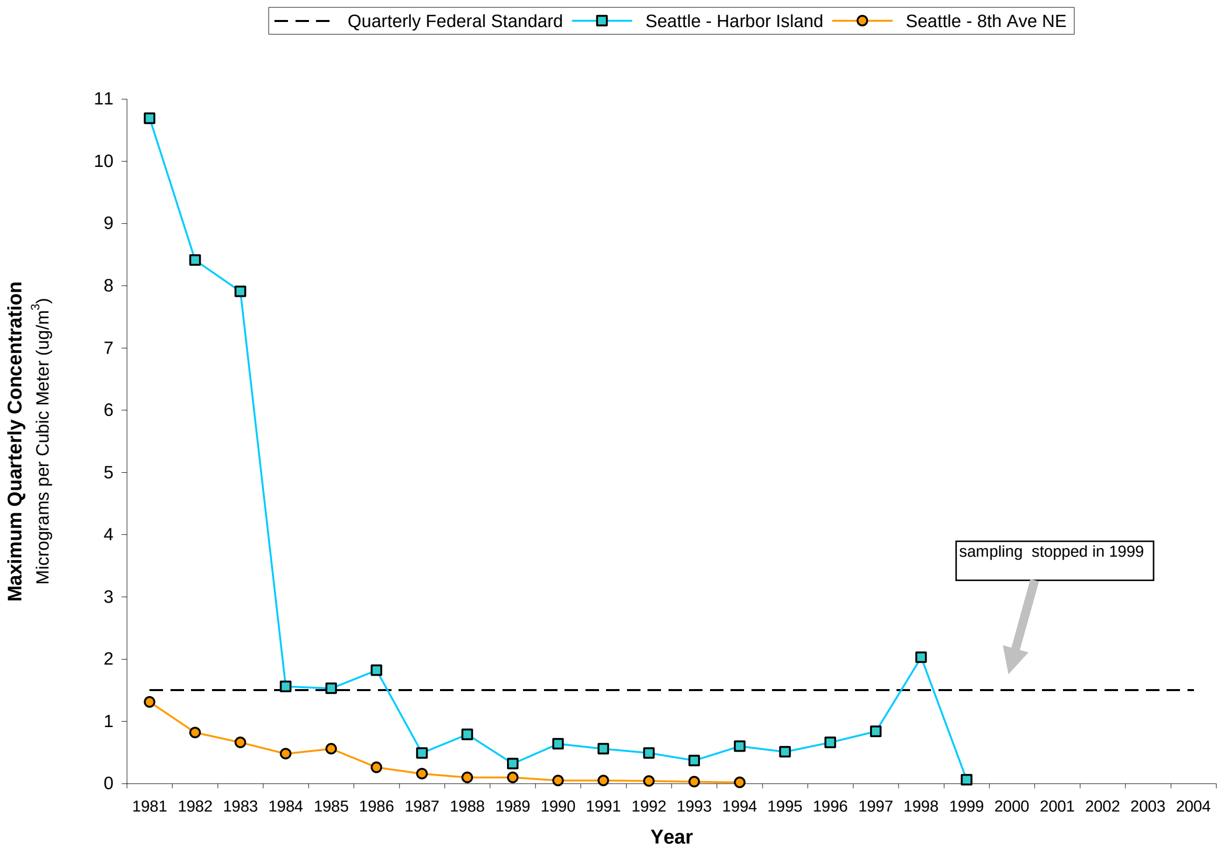
Lead has not been monitored for comparison to the federal standard in the Puget Sound area since 1999.[34] Since the phase-out of lead in fuel and the closure of the Harbor Island secondary lead smelter, lead in ambient air is no longer a public health concern in the region. Figure 48 is included to show the historical reduction of airborne lead in the Puget Sound region. The elevated concentration that violated federal quarterly standards in early 1998 was due to the Harbor Island lead smelter. The smelter ceased all operations in May 1998.

In May 2008, EPA proposed to strengthen the lead standard from 1.5 $\mu g/m^3$ to a range of 0.10 $\mu g/m^3$ to 0.30 $\mu g/m^3$. EPA will finalize this standard in September 2008.[35] Although lead has not been monitored using the federal reference method since 1999, the fine particle fraction of lead is monitored at the Department of Ecology's $PM_{2.5}$ speciation sites. Although the $PM_{2.5}$ speciation only reflects fine PM lead fractions, the lead concentrations are so low that at this time the agency does not expect that the region will exceed a stricter lead standard.

For additional information on lead, visit www.epa.gov/air/lead. Lead information is also available in a question/answer format in the Definitions section of this report.

[34] Lead is a pollutant that is both a criteria air pollutant and an air toxic. Lead is no longer monitored by FRM as a criteria air pollutant in Puget Sound; however, the lead fraction of $PM_{2.5}$ is measured at speciation monitors.
[35] US EPA, National Ambient Air Quality Standard for Lead, Proposed Rule. Federal Register, May 20, 2008; http://www.epa.gov/air/lead/pdfs/20080501_proposal_fr.pdf.

Figure 48: Lead (Pb) Maximum Quarterly Average



VISIBILITY

There are no federal or state standards established for visibility. This parameter is presented (without comparison to a standard) as an indicator of air quality. Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance – usually miles or kilometers – that you can see a black object against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction, the shorter the visual range. Visual range as measured by nephelometer instruments using light-scattering methodology provides an objective approach to measuring visibility at a specific location, but does not address individual perceptions regarding the "quality" of a view on a given day.

Reduced visibility is caused by weather such as clouds, fog, and rain, and air pollution, including fine particles and gases. The major contributor to reduced visual range is fine particulate matter ($PM_{2.5}$), which is transported aloft and may remain suspended for a week or longer. Fine particles have a greater impact than coarse particles at locations far from the emitting source because they remain suspended in the atmosphere longer, and travel farther and more effectively.

Figures 49 through 53 show visibility for the overall Puget Sound area, as well as King, Kitsap, Pierce, and Snohomish Counties. Visibility on these graphs, in units of miles, is determined by continuous nephelometer monitoring. The nephelometer measures light scattering due to particulate matter, and then converts this unit (b_{sp}) into miles, more readily understood. The nephelometer does not take into account meteorology visibility effects such as cloudiness, so the visibility in these graphs is visibility as related to particulate matter. Nephelometer data are shown on page A-9 of the Appendix.

The red line on the graphs represents the monthly average visibility; it is apparent that there are large fluctuations, which correspond to the highest levels of visibility in the summer months and the lowest levels in the winter. The blue line shows a 12-month moving average, which incorporates the average of the previous 12 months to aid in smoothing out this seasonal variation. The blue line shows that the average visibility for the Puget Sound area has steadily increased over the last decade with year-to-year variability caused by meteorology. For the 18-year period from December 1990 through December 2007, the 12-month moving average of visual range increased from 46 miles to 75 miles.

For additional information on visibility, visit http://www.epa.gov/air/visibility/index.html. Visibility information is also available in a question/answer format in the Definitions section of this document.

Figure 49: Puget Sound Visibility

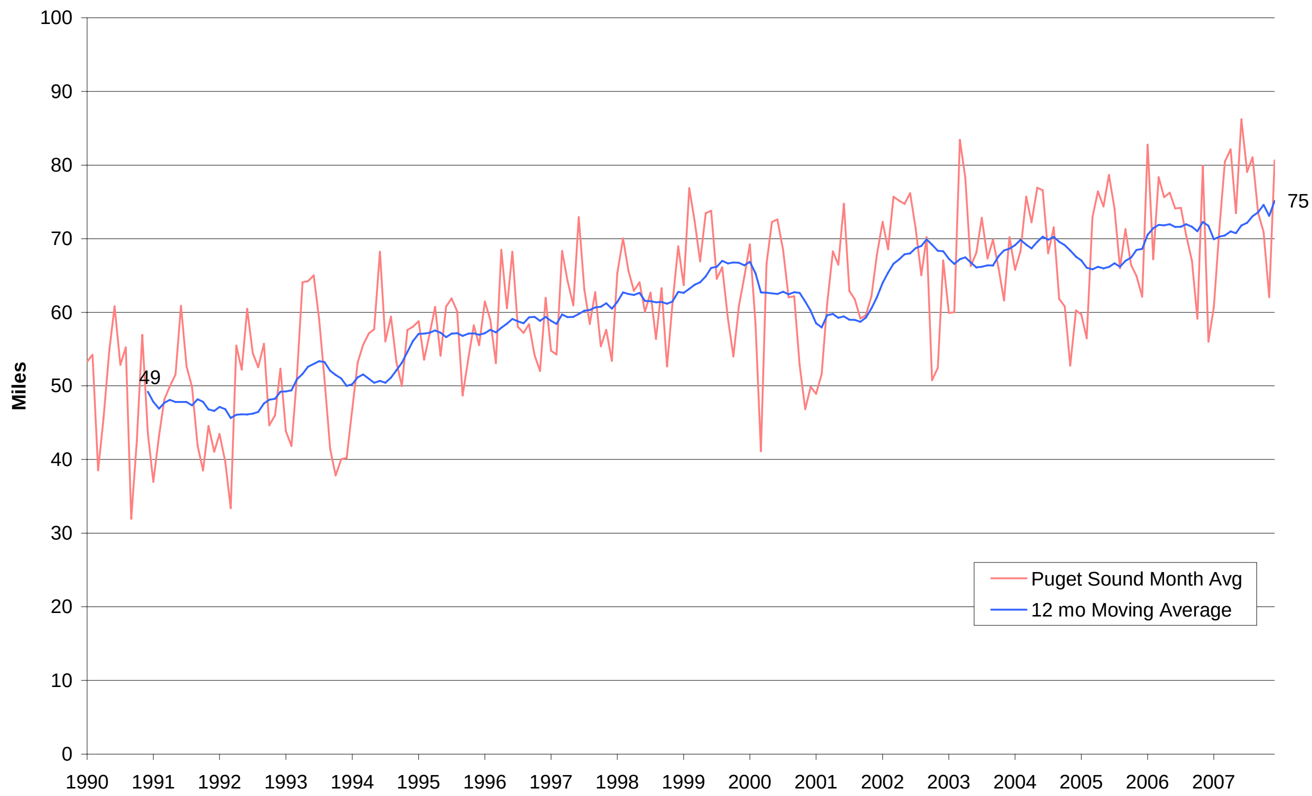


Figure 50: King County Visibility

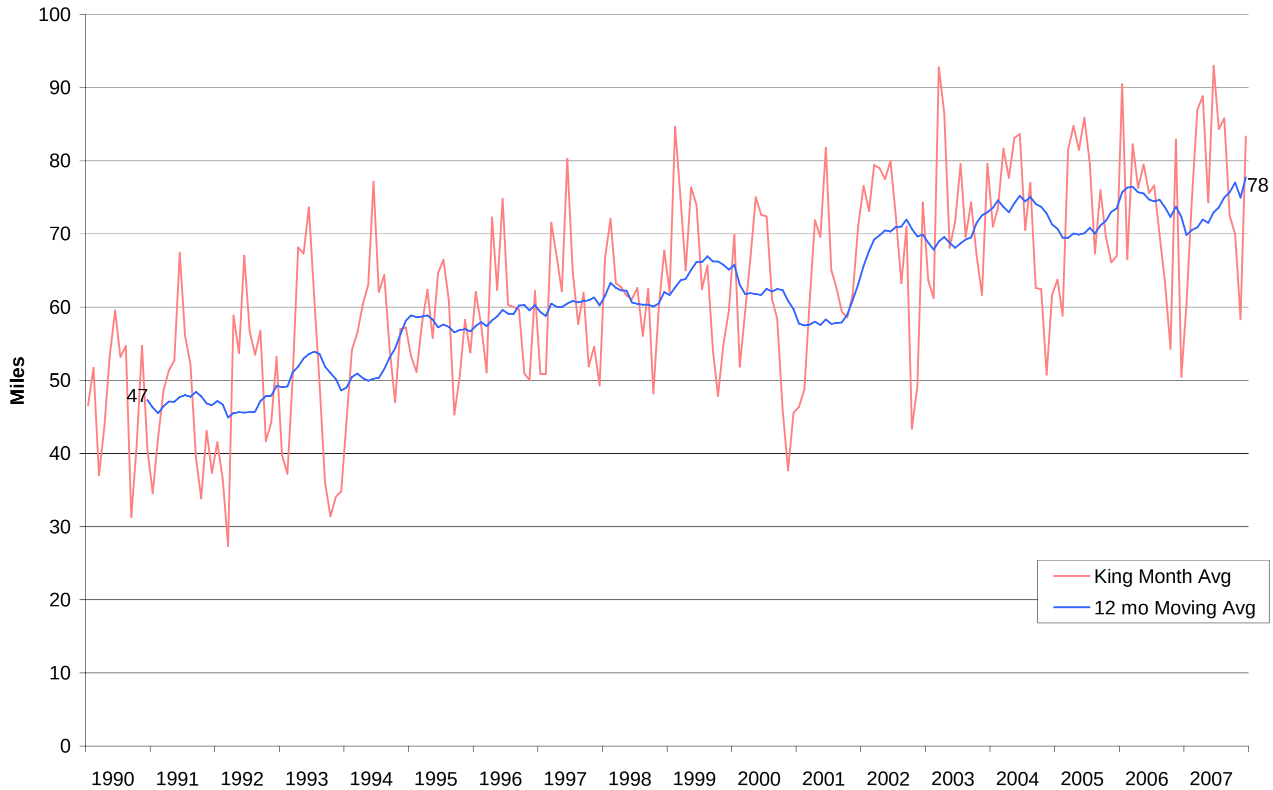


Figure 51: Kitsap County Visibility

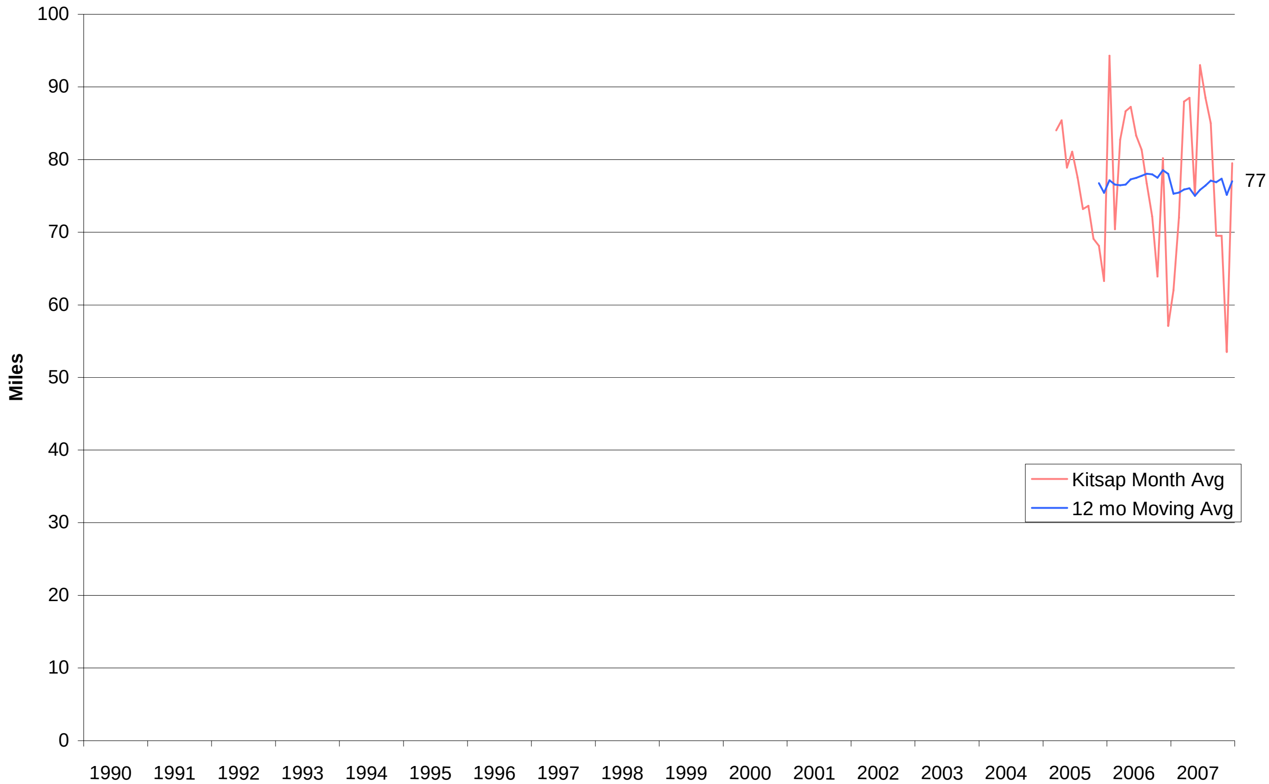


Figure 52: Pierce County Visibility

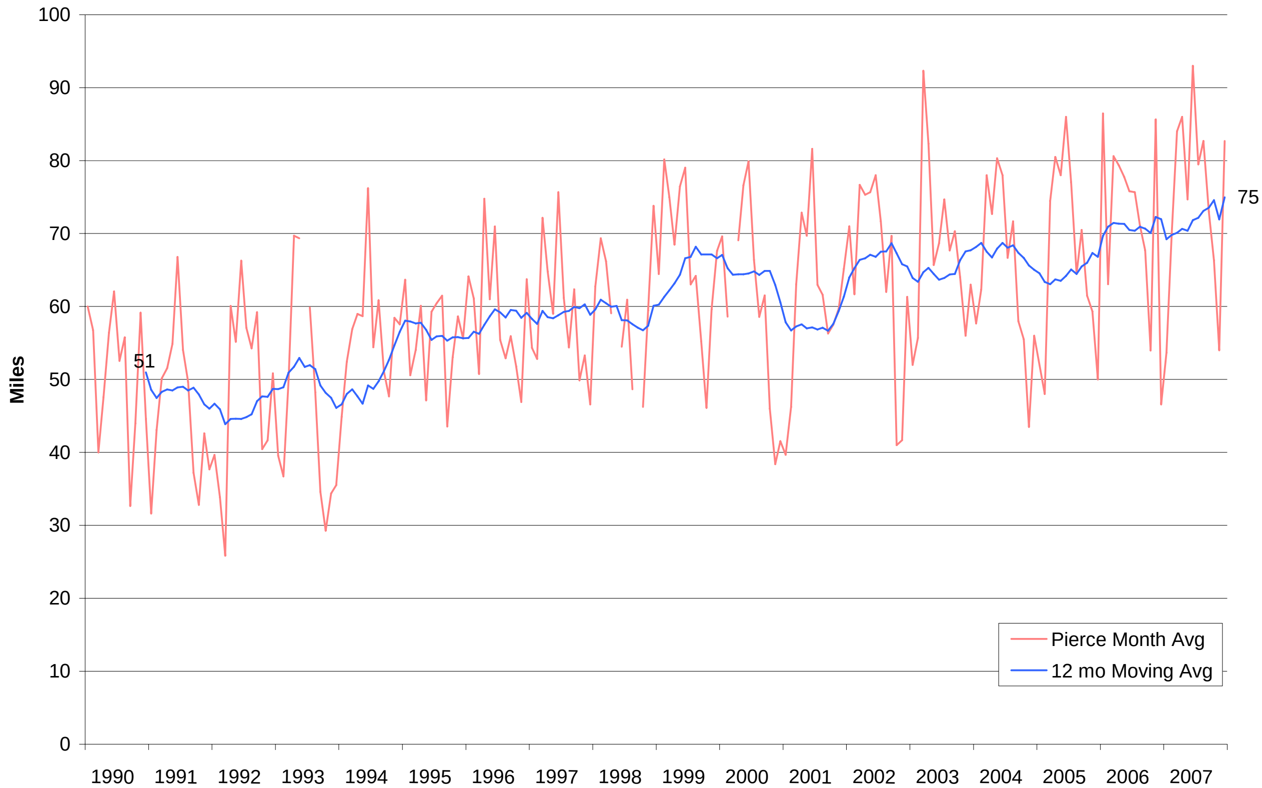
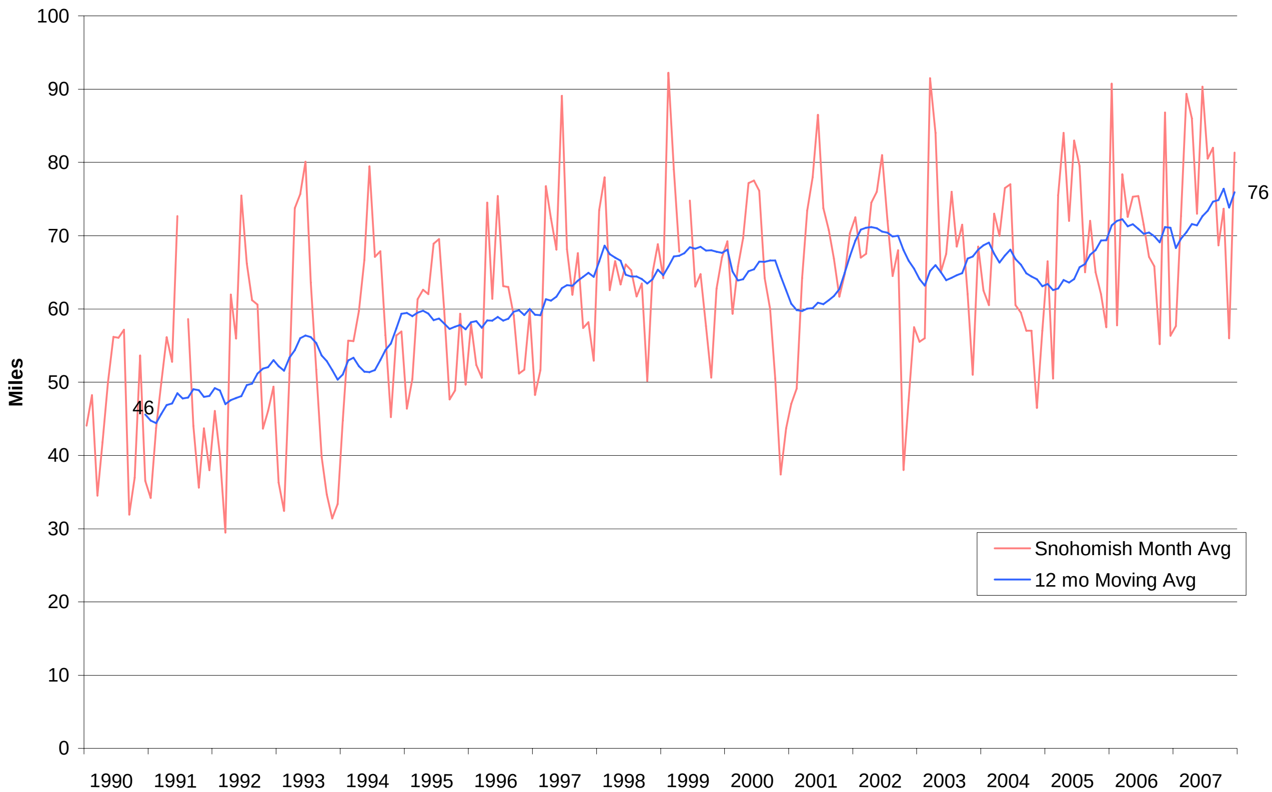


Figure 53: Snohomish County Visibility



AIR TOXICS

The Washington State Department of Ecology (Ecology) monitored for air toxics in 2007 at the Seattle Beacon Hill site. The Beacon Hill site is part of an EPA-sponsored network of National Air Toxics Trends Sites. As in previous years, Ecology monitored toxics every six days. This section presents a relative ranking of these toxics based on potential cancer health risks, as well as annual average graphs. Data for 2006 do not appear on these graphs because the 2006 dataset is incomplete (due to relocation of the Beacon Hill site in 2006). A short description of health effects associated with each air toxic and sources are also provided.

A comprehensive risk evaluation is beyond the scope of this summary report. For more information, see the 2003 Puget Sound Air Toxics Evaluation at http://www.pscleanair.org/airq/basics/psate_final.pdf. For general information on air toxics, see http://www.pscleanair.org/airq/basics/airtoxics.aspx. Air toxics statistical summaries are provided on page A-19 of the Appendix.

RELATIVE RANKING BASED ON CANCER RISK & UNIT RISK FACTORS

Table 8 ranks 2007 air toxics from the Beacon Hill monitoring site according to mean potential cancer risk per million. The ranking shows monitored pollutants ranked from highest concern/risk (#1) to lowest, and is based on risk using the most protective unit risk factor (explained below). Potential cancer risk estimates are shown here to provide a meaningful basis of comparison between pollutants, and are not intended to represent any individual's potential exposure. In order to do this, peoples' exposures would need to be modeled.

Potential cancer risk estimates can be interpreted as the number of potential additional cancers (out of a population of one million) that may develop from exposure to air toxics. A risk level of 1 in a million is commonly used as a screening value, and is used here.[36]

Potential cancer risk is estimated by multiplying the concentration of a pollutant by its unit risk factor (URF), a constant that takes into account its cancer potency. This is shown in the equation below:

$$\textit{Potential cancer risk} = \textit{ambient concentration } (\mu g/m^3) * \textit{unit risk factor } (risk/\mu g/m^3)$$

Unit risk factors are often based on epidemiological studies (studies of diseases occurring in human populations) and are also extrapolated from laboratory animal studies. Unit risk factors are typically based on an assumed 70-year (lifetime) exposure interval, and are available from multiple sources. Two main sources include EPA's Integrated Risk Information System (IRIS) as well as California EPA's Office of Environmental Health and Hazard Assessment (OEHHA). Both of these sources are based on peer-reviewed literature and extensive review.[37,38] We present potential cancer risk estimates based on both IRIS and California EPA values. It should be noted that, if a comprehensive risk assessment were to be performed, it may be preferable to use the most protective unit risk factor in order to be as

[36] US EPA, A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Datasets. EPA-904-B-06-001, February 2006; http://www.gpoaccess.gov/harvesting/airtoxics.pdf.
[37] US EPA, Integrated Risk Information System (IRIS); http://cfpub.epa.gov/ncea/iris/index.cfm.
[38] California EPA, Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, June 25, 2008; http://www.arb.ca.gov/toxics/healthval/healthval.htm.

protective of human health as possible. Available unit risk factors from both IRIS and California EPA are presented in Table 7 below. The cancer rating refers to its "weight of evidence" ranking: A = known carcinogen, B1 = probable carcinogen, based on incomplete human data, B2 = probable carcinogen, based on adequate animal data.[39]

Table 7: 2007 Air Toxics Unit Risk Factors

Air Toxic	IRIS[40] Unit Risk Factor Risk/µg/m^3	OEHHA[41] URF Risk/µg/m^3	Cancer Rating[42]
Formaldehyde	1.3E-05	6E-06	B1
Benzene	7.8E-06	2.9E-05	A
Carbon Tetrachloride	1.5E-05	4.2E-05	B2
Chromium (Hexavalent) (M)	1.2E-02	1.5E-01	A
Chloroform	2.3E-05	5.3E-06	B2
Arsenic (M)	4.3E-03	3.3E-03	A
1,3-Butadiene	3E-05	1.7E-04	A
Acetaldehyde	2.2E-06	2.7E-06	B2
Nickel (Subsulfide) (M)	4.8E-04	2.6E-04	A
Tetrachloroethylene	not assessed	5.9E-06	B2
Trichloroethylene	not assessed	2E-06	B2
Cadmium (M)	1.8E-03	4.2E-03	B1
Lead (M)	not assessed	1.2E-05	B2
Beryllium (M)	2.4E-03	2.4E-03	B1
Dichloromethane	4.7E-07	1E-06	B2
Vinyl Chloride	8.8E-6	7.8E-05	A

Risks presented in this table are based on annual average concentrations. Risks based on 95th percentile concentrations (a more protective statistic than presented in Table 7) are presented on page A-20 of the Appendix. Page A-20 also lists the frequency (percentage) of samples that were over the cancer screening level of 1 in a million risk.

[39]International Agency for Research on Cancer; http://monographs.iarc.fr/.
[40]Integrated Risk Information System, EPA; http://www.epa.gov/iris/.
[41]California EPA, Consolidated Table of OEHHA/ARB Approved Risk Assessment Values, June 25, 2008; http://www.arb.ca.gov/toxics/healthval/healthval.htm.
[42]Ratings per 1986 EPA guidelines.

Table 8: 2007 Beacon Hill Air Toxics Ranking
(Average Potential Cancer Risk Estimate per 1,000,000)

Air Toxic	Rank	Average Risk with IRIS URF	Average Risk with OEHHA URF	Risk Range
Carbon Tetrachloride	1	11	30	11-30
Benzene	2	6	23	6-23
1,3-Butadiene	3	3	15	3-15
Formaldehyde	4	12	5	5-12
Chromium 6 TSP	5	1	7	1-7
Chloroform	6	3	1	1-3
Arsenic PM_{10} (M)	7	3	3	3
Acetaldehyde	8	2	3	2-3
Nickel PM_{10} (M)	9	1	1	1
Tetrachloroethylene	10	na	1	1
Trichloroethylene	11	na	<1	<1
Cadmium PM_{10} (M)	11	<1	<1	<1
Lead PM_{10} (M)	11	na	<1	<1
Beryllium PM_{10} (M)	11	<1	<1	<1
Dichloromethane	11	<1	<1	<1

M = metal

PM_{10} = fine particles less than 10 micrometers in diameter

TSP = total suspended particulate

na = no unit risk factor available from this source

The two air toxics that present the majority of potential health risk in the Puget Sound area, diesel particulate matter and wood smoke particulate, are not included in the table. No direct monitoring method currently exists for these toxics. 2007 modeling was not conducted for this report.

HEALTH EFFECTS OTHER THAN CANCER

Air toxics can also have chronic non-cancer health effects. These include respiratory, cardiac, immunological, nervous system, and reproductive system effects.

In order to determine non-cancer health risk, each air toxic was compared to its reference concentration, as established by California EPA (the most comprehensive dataset available). A reference concentration (RfC) is considered a safe level for toxics for non-cancer health effects.

Only one air toxic, acrolein, failed the screen for non-cancer health effects, with measured concentrations consistently exceeding the reference concentration. Acrolein irritates the lungs, eyes, and nose, and is a combustion by-product.[43] Reference concentrations and hazard indices are shown for each air toxic on page A-21 of the Appendix. A hazard index is the concentration of a pollutant (either mean or other statistic) divided by the reference concentration. Typically, no adverse non-cancer health effects for that pollutant are associated with a hazard index less than 1, although it is important to consider that people are exposed to many pollutants at the same time.

Acute non-cancer health effects were not explored, because the Beacon Hill air toxics concentrations are based on 24-hour samples.

AIR TOXICS GRAPHS

Annual average concentrations are shown on the following pages for air toxics collected from 2000 to 2007 at Beacon Hill. An eight-year period is a relatively short time to characterize trends, and the annual average concentrations increase and decrease from year-to-year. Nonetheless, data show that annual average concentrations have typically decreased from 2000 to 2007. Graphs are not presented for metals because fewer years are available, and few exceed potential cancer risk screening levels. Federal ambient air concentration standards have not been set for air toxics, so graphs do not include reference lines for federal standards.

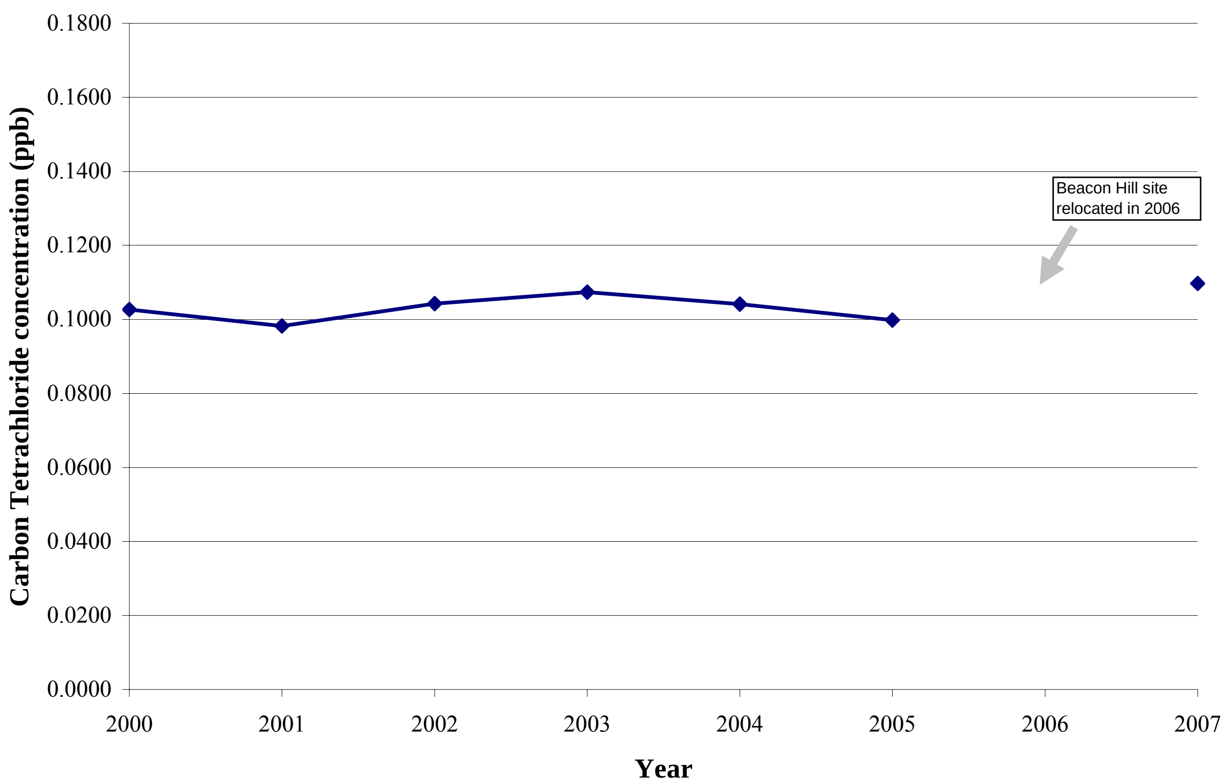
[43] EPA, Acrolein Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/acrolein.html.

Carbon Tetrachloride

The EPA lists carbon tetrachloride as a probable human carcinogen. Carbon tetrachloride inhalation is also associated with liver and kidney damage.[44] Carbon tetrachloride was widely used as a solvent for both industry and consumer users, and was banned from consumer use in 1996. Trace amounts are still emitted by local sewage treatment plants. Carbon tetrachloride is relatively ubiquitous and has a long half-life; concentrations are similar in urban and rural areas. Carbon tetrachloride's 2007 average potential cancer risk range estimate at Beacon Hill was 11-to-30 in a million.

The agency does not target efforts at reducing carbon tetrachloride emissions, as it has already been banned.

Figure 54: Carbon Tetrachloride Annual Average Concentrations at Beacon Hill, 2000-2007



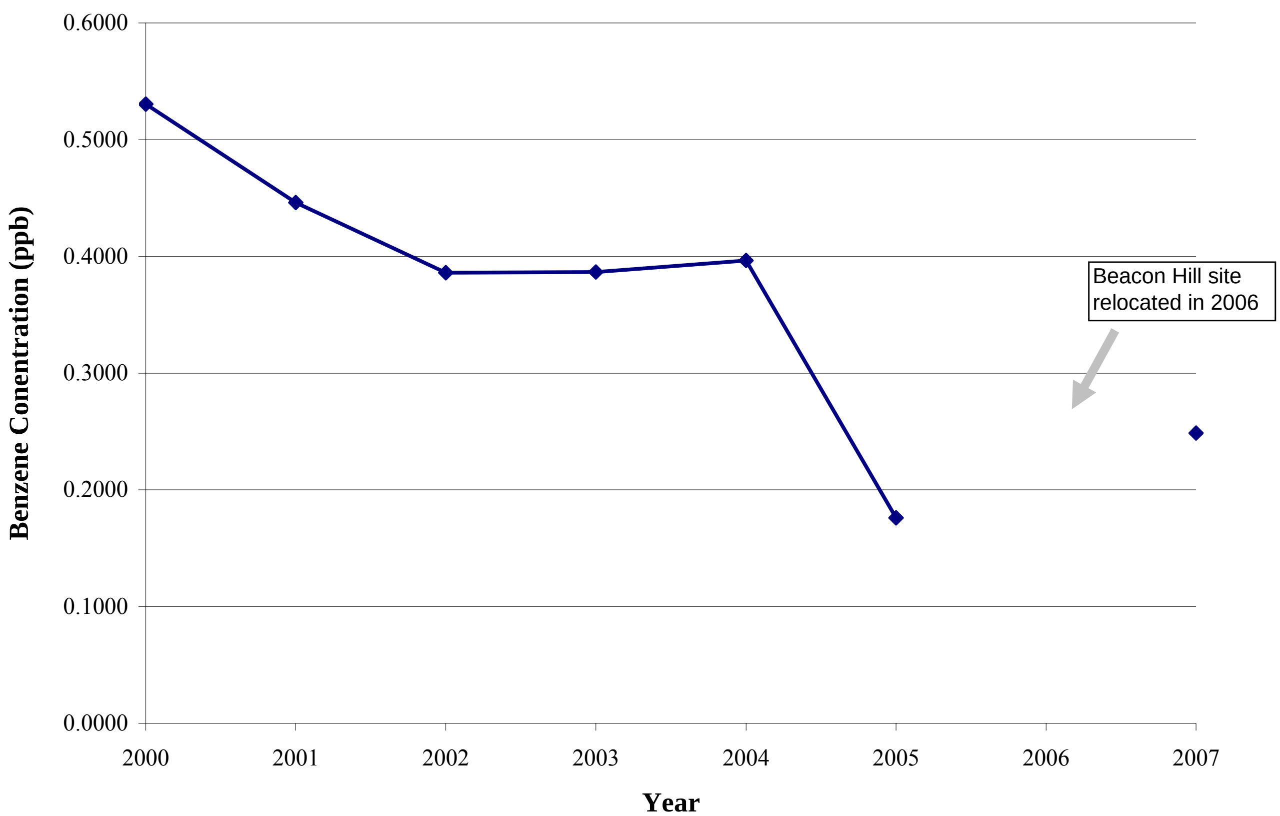
[44]EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/carbonte.html.

Benzene

The EPA lists benzene as a known human carcinogen. Benzene inhalation is also linked with blood, immune, and nervous system disorders.[45] This air toxic comes from a variety of sources, including car/truck exhaust, wood burning, evaporation of industrial solvents, and other combustion. Benzene's 2007 average potential cancer risk range estimate at Beacon Hill was 6-to-23 in a million.

Benzene levels are likely decreasing in our area due to factors including: less automobile pollution with newer, cleaner vehicles coming into the fleet; major refiners in the area reducing benzene gasoline content, and fewer gas station emissions due to better compliance (vapor recovery at the pump and during filling of gas station tanks).

Figure 55: Benzene Annual Average Concentrations at Beacon Hill, 2000-2007



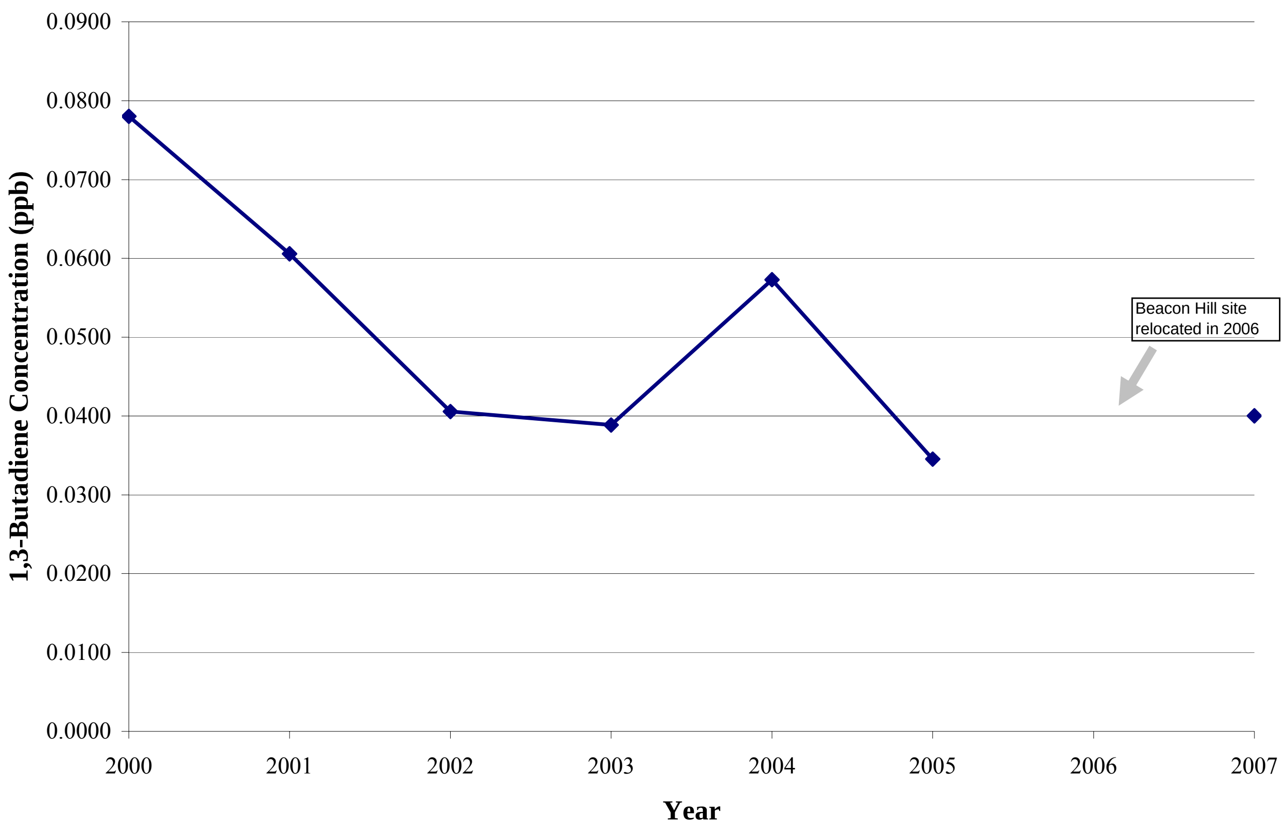
[45]EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/benzene.html.

1,3-Butadiene

The EPA lists 1,3-butadiene as a known human carcinogen. 1,3-Butadiene inhalation is also associated with neurological effects.[46] Primary sources of 1,3-butadiene include cars, trucks, buses, and wood burning. 1,3-Butadiene's 2007 average potential cancer risk range estimate at Beacon Hill was 3-to-15 in a million.

Agency efforts that target vehicle exhaust and wood stoves emission reductions also reduce 1,3-butadiene emissions.

Figure 56: 1,3-Butadiene Annual Average Concentrations at Beacon Hill, 2000-2007



[46]EPA Hazard Summary; http://www.epa.gov/ttnatw01/hlthef/butadien.html.

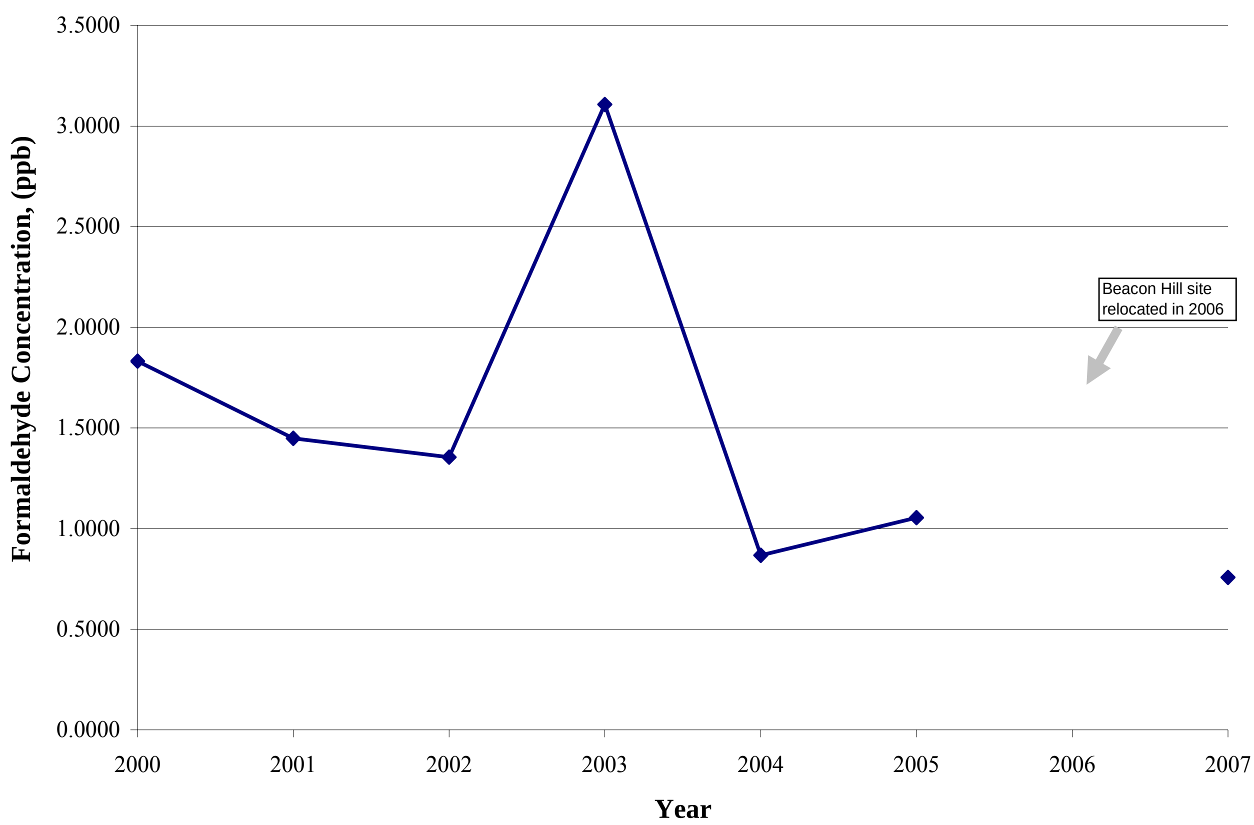
Formaldehyde

The EPA lists formaldehyde as a probable human carcinogen. Formaldehyde inhalation is also associated with eye, nose, throat, and lung irritation.[47] Sources of ambient formaldehyde include automobiles, trucks, wood burning, and other combustion. Formaldehyde's 2007 average potential cancer risk range estimate at Beacon Hill was 5-to-12 in a million.

The increase in formaldehyde 2003 concentrations is due to nine anomalous sampling days in July 2003 when levels were roughly 10 times the normal levels. It is possible that a local formaldehyde source was present at the Beacon Hill reservoir during this month, and inadvertently affected the monitors.

Agency efforts that target vehicle exhaust and wood stove emission reductions also reduce formaldehyde emissions.

Figure 57: Formaldehyde Annual Average Concentrations at Beacon Hill, 2000-2007



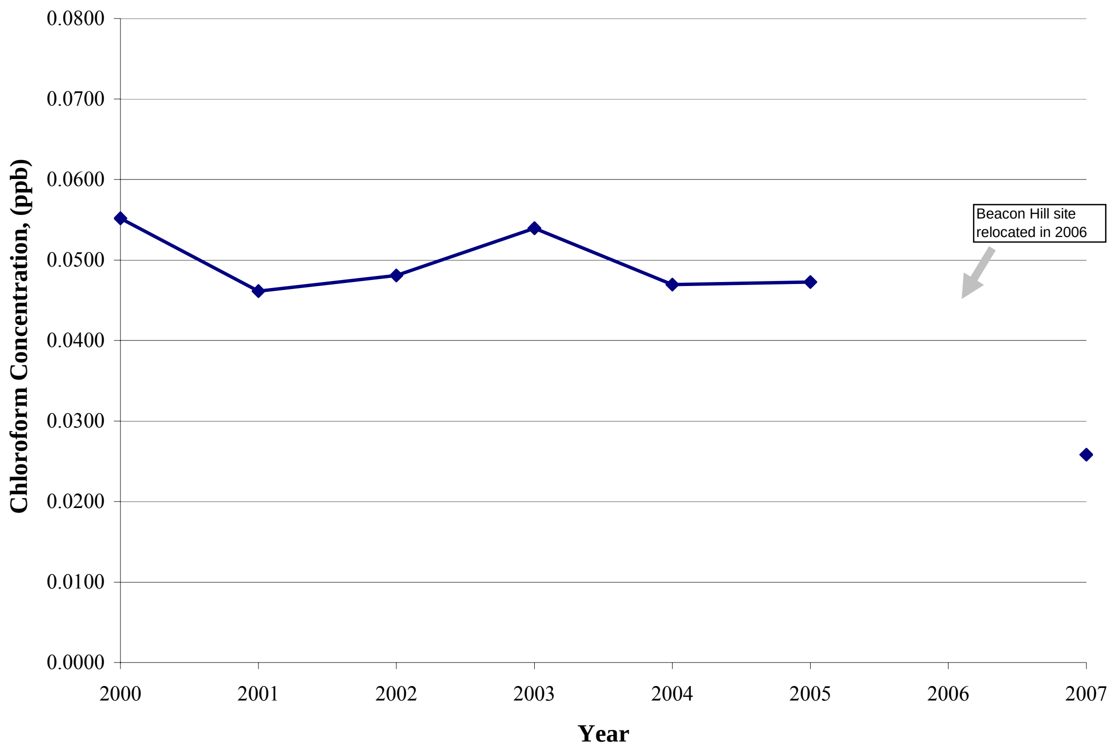
[47]EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/formalde.html.

Chloroform

The EPA lists chloroform as a probable human carcinogen. Chloroform inhalation is also associated with central nervous system effects and liver damage.[48] Main sources of chloroform are water treatment plants and reservoirs. The Beacon Hill monitoring site is located at the Beacon Hill Reservoir; concentrations measured and risks estimated are likely not representative of actual regional concentrations and potential risk (they are likely higher than typical levels). Chloroform's 2007 average potential cancer risk range estimate at Beacon Hill was 1-to-3 in a million. The Beacon Hill 2006 monitor location change and construction between 2005 and 2007 that included covering the Beacon Hill reservoir, potentially contributed to reduced 2007 chloroform emissions and concentrations.

The agency does not prioritize efforts to reduce chloroform emissions, as it doesn't likely present risk in areas other than those directly adjacent to reservoirs.[49]

Figure 58: Chloroform Annual Average Concentrations at Beacon Hill, 2000-2007



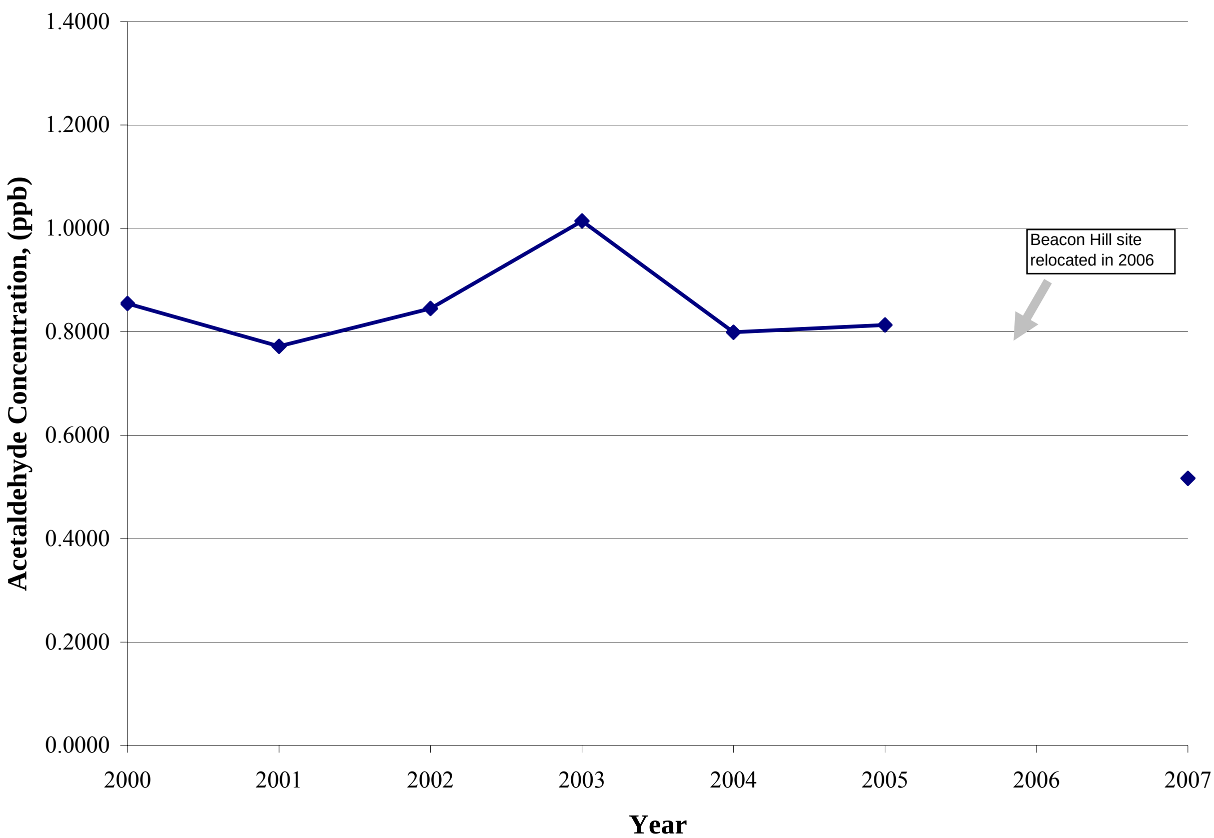
[48]EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/chlorofo.html.
[49]Seattle Public Utilities. 2005 Water Quality Analysis shows detectable levels of trihalomethanes; http://www.ci.seattle.wa.us/util/stellent/groups/public/@spu/@fob/@wqs/documents/webcontent/cos_005087.pdf. Trihalomethanes include chloroform, dichlorobromomethane, dibromochloromethane, and bromoform; http://www.ci.seattle.wa.us/util/About_SPU/Water_System/Water_Quality/GLOSSARYO_200312020916386.asp.

Acetaldehyde

The EPA lists acetaldehyde as a probable human carcinogen. Acetaldehyde inhalation is also associated with irritation of eyes, throat, and lungs, and effects similar to alcoholism.[50] Main sources of acetaldehyde include wood burning and car/truck exhaust. Acetaldehyde's 2007 average potential cancer risk range estimate at Beacon Hill was 2-to-3 in a million.

Agency efforts that target vehicle exhaust and wood stove emission reductions also reduce acetaldehyde emissions.

Figure 59: Acetaldehyde Annual Average Concentrations at Beacon Hill, 2000-2007



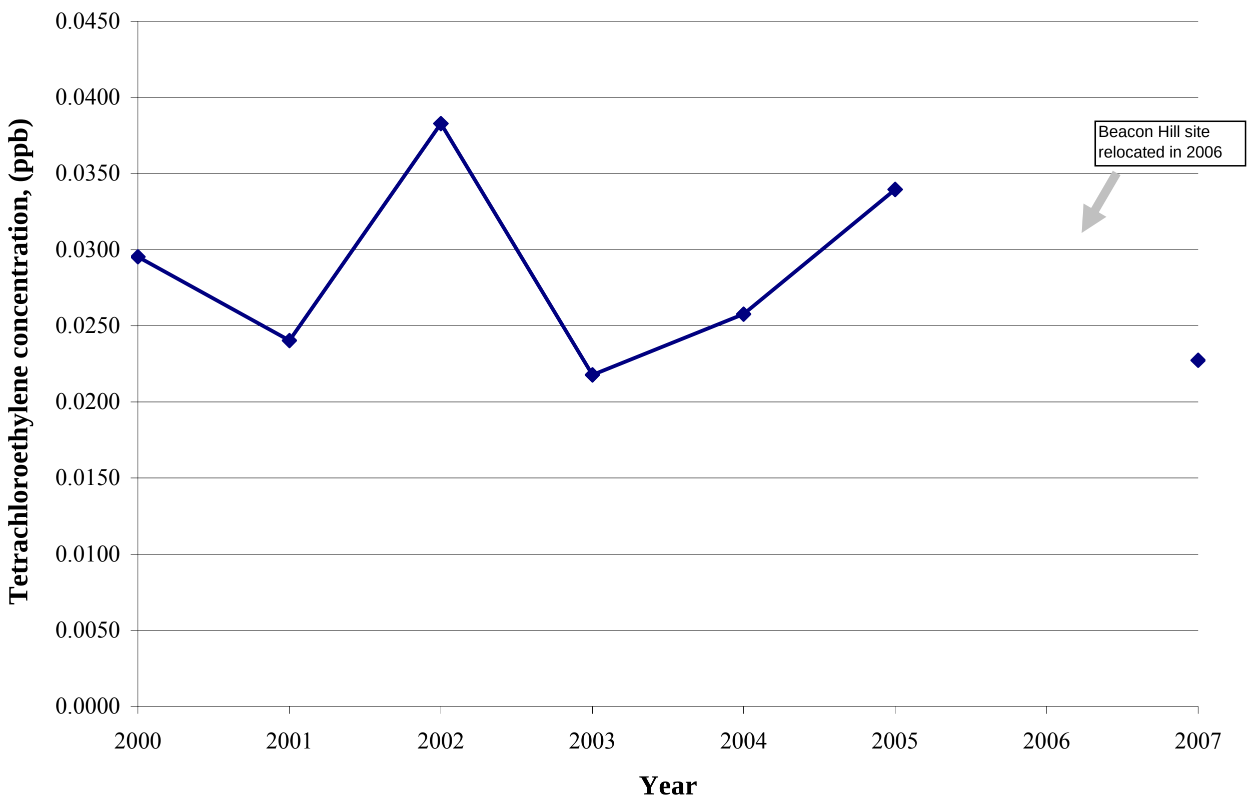
[50]EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/acetalde.html.

Tetrachloroethylene

EPA lists tetrachloroethylene, also known as "perc" or perchloroethylene, as a probable human carcinogen. Tetrachloroethylene inhalation is also associated with central nervous system effects, liver and kidney damage, and cardiac arrhythmia.[51] Dry cleaners are the main source of tetrachloroethylene. Tetrachloroethylene's 2007 average potential cancer risk estimate at Beacon Hill was 1 in a million.

In an effort to reduce perc emissions and exposures, the agency has required local dry cleaners to adopt closed systems and perform regular inspection and maintenance.[52]

Figure 60: Tetrachloroethylene Annual Average Concentrations at Beacon Hill, 2000-2007



[51]EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/tet-ethy.html. Tetrachloroethylene fact sheet; http://www.weblakes.com/toxic/TETRACHLOROETHYLENE.HTML.
[52]Agency Regulations, Article 3, Section 3.03; http://www.pscleanair.org/regulated/reg3/reg3.pdf.

Trichloroethylene

EPA lists trichloroethylene as a probable/possible human carcinogen. Trichloroethylene is also associated with central nervous system effects.[53] Local sources of trichloroethylene include solvents used for degreasing and surface-coating operations. Trichloroethylene's 2007 average potential cancer risk estimate at Beacon Hill was less than 1 in a million, based on estimated concentrations. More than 75% of the trichloroethylene dataset was below the laboratory report detection limit – and so no graph of estimated concentrations is presented.

The agency's works with and regulates solvent-using businesses to reduce trichloroethylene emissions.

METALS

Table 8 (2007 Beacon Hill Air Toxics Ranking), shown previously in this section, includes estimated potential cancer risks for several PM_{10} metals monitored at Beacon Hill, as well as total suspended particulate (TSP) hexavalent chromium. Hexavalent chromium and arsenic posed the greatest potential cancer risks. All metals were below non-cancer screening levels (see Appendix page A-19).

Health effects from exposure to these and other monitored metals are listed below, along with local sources.

Hexavalent Chromium

Chromium is present in two chemical states in our airshed, trivalent and hexavalent. Trivalent chromium occurs naturally, while hexavalent comes from human activities and is much more toxic. EPA lists hexavalent chromium as a known carcinogen, associated primarily with lung cancer. Exposure to hexavalent chromium is also associated with adverse respiratory, liver, and kidney effects.[54] Sources of hexavalent chromium include chrome electroplaters, as well as combustion of distillate oil, and combustion of gasoline and diesel fuels (car, truck, and bus exhaust).

In recent years, the monitoring method for total suspended particulate (TSP) hexavalent chromium has improved. The estimated average potential cancer risk range for hexavalent chromium at Beacon Hill was 1-to-7 in a million.

The agency's permitting program works with and regulates industrial chromium to reduce hexavalent chromium emissions.

[53] EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/tri-ethy.html.
[54] EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/chromium.html.

Arsenic

EPA lists arsenic as a known carcinogen. Exposure to arsenic is also associated with skin irritation, and liver and kidney damage.[55] Arsenic is used to treat wood, and combustion of distillate oil is also a source of arsenic in the Puget Sound area. Arsenic's 2007 average potential cancer risk estimate at Beacon Hill was 3 in a million.

Nickel

EPA lists nickel as a known human carcinogen. Nickel is also associated with dermatitis and respiratory effects.[56] Combustion of gasoline and diesel fuels (car, truck, and bus exhaust) is a main source of nickel in the Puget Sound area. Nickel's 2007 average potential cancer risk estimate at Beacon Hill was 1 in a million.

Cadmium

EPA lists cadmium as a probable human carcinogen. Cadmium exposures are also associated with kidney damage.[57] Combustion of distillate oil is a main source of cadmium in the Puget Sound area. Cadmium's 2007 average potential cancer risk estimate at Beacon Hill was less than 1 in a million.

Lead

EPA lists lead as a probable human carcinogen. Lead is associated primarily with central nervous system effects, and is also associated with reproductive and digestive effects.[58] Lead is especially harmful to children.

Lead is not present at significant levels in ambient air in the Puget Sound area, although a local source includes steel foundries. National ambient levels declined dramatically after leaded gasoline was phased out.

Lead can be present in indoor environments, particularly in homes with lead paint that is disturbed (peeling or crumbling). For more information, visit EPA's website at http://www.epa.gov/lead/leadinfo.htm. Lead's 2007 average potential cancer risk estimate at Beacon Hill was less than 1 in a million.

Lead is uniquely listed as both an air toxic and a criteria pollutant. For more information on the review of the national ambient air quality standards for lead, please see page 86.

[55] EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/arsenic.html.
[56] EPA Hazard Summary; http://www.epa.gov/iris/subst/0273.htm.
[57] EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/cadmium.html.
[58] EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/lead.html.

Beryllium

EPA has classified beryllium as a probable human carcinogen. Beryllium exposures are also associated with lung inflammation and immunological effects.[59] Beryllium sources include combustion of coal and fuel oil that contain beryllium, and tobacco smoke. Beryllium's 2007 average potential cancer risk estimate was less than 1 in a million, based on estimated concentrations. More than 75% of the beryllium dataset was below the laboratory report detection limit.

Manganese

EPA lists manganese as "not classifiable" for cancer. Manganese exposures are primarily associated with central nervous system effects.[60] Manganese is naturally-occurring and is usually present in the air in small amounts. Additional local sources include steel foundries and blasting of metal parts. 2007 manganese levels in the Puget Sound area are below levels indicating health risk, with a hazard index of less than 1.

[59] EPA Hazard Summary; http://www.epa.gov/ttn/atw/hlthef/berylliu.html.
[60] EPA National Air Toxics Assessment; http://www.epa.gov/ttnatw01/hlthef/manganes.html.

DEFINITIONS

GENERAL DEFINITIONS

Air Quality Index

Table 9: 2007 Calculation and Breakpoints for the Air Quality Index (AQI)

Breakpoints for Criteria Pollutants							AQI Categories	
0_3 (ppm) 8-hour	**0_3 (ppm) 1-hour[(a)]**	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI value	Category
0.000–0.064	—	0.0–15.4	0–54	0.0–4.4	0.000–0.034	(b)	0–50	Good
0.065–0.084	—	15.5–40.4	55–154	4.5–9.4	0.035–0.144	(b)	51–100	Moderate
0.085–0.104	0.125–0.164	40.5–65.4	155–254	9.5–12.4	0.145–0.224	(b)	101–150	Unhealthy for sensitive groups
0.105–0.124	0.165–0.204	65.5–150.4	255–354	12.5–15.4	0.225–0.304	(b)	151–200	Unhealthy
0.125–0.374	0.205–0.404	150.5–250.4	355–424	15.5–30.4	0.305–0.604	0.65–1.24	201–300	Very unhealthy
(c)	0.405–0.504	250.5–350.4	425–504	30.5–40.4	0.605–0.804	1.25–1.64	301–400	Hazardous
(c)	0.505–0.604	350.4–500.4	505–604	40.5–50.4	0.805–1.004	1.65–2.04	401–500	

[(a)]Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a small number of areas where an AQI based on 1-hour ozone values would be safer. In these cases, in addition to calculating the 8-hour ozone value, the 1-hour ozone value may be calculated, and the greater of the two values reported.

[(b)]NO_2 has no short-term National Ambient Air Quality Standard (NAAQS) and can generate an AQI only above a value of 200.

[(c)]8-hour O_3 values do not define higher AQI values (above 300). AQI values above 300 are calculated with 1-hour 0_3 concentrations.

Table 10: 2008 Calculation and Breakpoints for the Air Quality Index (AQI)

Breakpoints for Criteria Pollutants							AQI Categories	
0_3 (ppm) 8-hour	**0_3 (ppm) 1-hour[(a)]**	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI value	Category
0.000–0.059	—	0.0–15.4	0–54	0.0–4.4	0.000–0.034	(b)	0–50	Good
0.060–0.075	—	15.5–40.4	55–154	4.5–9.4	0.035–0.144	(b)	51–100	Moderate
0.076–0.095	0.125–0.164	40.5–65.4	155–254	9.5–12.4	0.145–0.224	(b)	101–150	Unhealthy for sensitive groups
0.096–0.115	0.165–0.204	65.5–150.4	255–354	12.5–15.4	0.225–0.304	(b)	151–200	Unhealthy
0.116–0.374	0.205–0.404	150.5–250.4	355–424	15.5–30.4	0.305–0.604	0.65–1.24	201–300	Very unhealthy
(c)	0.405–0.504	250.5–350.4	425–504	30.5–40.4	0.605–0.804	1.25–1.64	301–400	Hazardous
(c)	0.505–0.604	350.4–500.4	505–604	40.5–50.4	0.805–1.004	1.65–2.04	401–500	

[(a)]Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a small number of areas where an AQI based on 1-hour ozone values would be safer. In these cases, in addition to calculating the 8-hour ozone value, the 1-hour ozone value may be calculated, and the greater of the two values reported.

[(b)]NO_2 has no short-term National Ambient Air Quality Standard (NAAQS) and can generate an AQI only above a value of 200.

[(c)]8-hour O_3 values do not define higher AQI values (above 300). AQI values above 300 are calculated with 1-hour 0_3 concentrations.

For more information on the AQI and the pollutants it measures, see www.epa.gov/airnow/aqibroch.

Airshed

A geographic area that shares the same air, due to topography, meteorology, and climate.

Air Toxics

Air toxics are broadly defined as over 400 pollutants that the agency considers potentially harmful to human health and the environment. These pollutants are listed in the Puget Sound Clean Air Agency Regulation III at http://www.pscleanair.org/regulated/reg3/asil.pdf. Hazardous air pollutants (see below) are checked on this list to identify them as a subset of air toxics. Air toxics are also called Toxic Air Contaminants (TAC) under Regulation III.

Certified Wood Stove and Fireplace Inserts

A wood stove or fireplace insert that has been certified by EPA or Washington State to meet emission limits. Certified wood stoves and inserts emit significantly less pollution than non-certified stoves and inserts and are identified by an EPA certification label. Visit http://www.pscleanair.org/actions/woodstoves/default.aspx to learn more about certified wood burning devices.

Criteria Air Pollutant (CAP)

The Clean Air Act of 1970 defined *criteria pollutants* and provided EPA the authority to establish ambient concentrations for these criteria pollutants to protect public health. EPA periodically has revised the original concentration limits and methods of measurement, most recently in 2008. The six criteria air pollutants are: particulate matter (10 micrometers and 2.5 micrometers), ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead.

Hazardous Air Pollutant (HAP)

A *hazardous air pollutant* is an air contaminant listed in the Federal Clean Air Act, Section 112(b). 188 pollutants are currently listed as HAPs by EPA. They are listed by EPA at http://www.epa.gov/ttn/atw/188polls.html. They are also included under Puget Sound Clean Air Agency Regulation III.

R Squared (R^2)

The *R squared (R^2)* is a statistical measure from 0 to 1 that indicates how well a regression line approximates data points. An R^2 of 1 indicates a perfect fit.

Temperature Inversions

The earth gains and loses most of its energy at its surface. It is warmed by solar heating during the day and cooled by radiation emissions at night. During the late morning and afternoon hours, the air near the surface is warmer than the air aloft and allows for good pollutant dispersion (vertical mixing may be 1,500 meters or more). At night with clear skies, the surface radiates heat into outer space, creating cooler air at the surface and warmer air aloft. Warmer air above cooler air (temperature inversion) is a stable condition and limits the upward movement of pollution because the warmer air acts as a barrier. With little or no wind, pollutants are trapped near the surface (vertical mixing may be 200 meters or less) and can reach high levels of concentration.

Uncertified Wood Stove or Fireplace Insert

A wood stove or insert that is not certified by the EPA. These wood burning devices emit twice as much pollution as certified devices.

Unit Risk Factor (URF)

A unit risk factor is a measure of a pollutant's cancer risk based on a 70-year inhalation exposure period. The units are risk/concentration. Unit risk factors are multiplied by concentrations to estimate potential cancer risk.

Volatile Organic Compound (VOC)

An organic compound that participates in atmospheric photochemical reactions. This excludes all compounds determined to have negligible photochemical reactivity by EPA and listed in 40 CFR 51.100(s) in effect July 1, 2005.

Visibility/Regional Haze

Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance – usually miles or kilometers – that you can see a black object against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction you have, the shorter your visual range will be. Reduced visibility (or visual range) is caused by weather (clouds, fog, and rain) and air pollution (fine particles and gases).

CRITERIA AIR POLLUTANTS

Ozone (O_3)

- **What is it?**
  Ozone, a bluish-colored gas molecule with a strong odor, is composed of three atoms of oxygen. In the upper atmosphere, ozone occurs naturally and partially absorbs the sun's harmful ultraviolet rays. Ozone at ground level is a summertime air pollution problem.
- **How is it caused?**
  Ozone forms when photochemical pollutants from cars, trucks, and industrial sources react with sunlight. Ozone-forming pollutants include NO_X and VOCs. Even gasoline-powered yard equipment, paints, solvents, and boat motors contribute.
- **When does it happen?**
  Ozone pollution is most common in the summer months, when sunlight and stable atmospheric conditions occur. Ozone levels are usually highest in the afternoon, as sunlight photochemically transforms NO_X and VOCs into ozone.
- **Who is affected?**
  Adults and children who are active outdoors, people with respiratory disease such as asthma, and people with unusual sensitivity to ozone. During physical activity, ozone penetrates deeper into the lungs and can do more damage.

Ozone is a very reactive gas. For this reason, high concentrations of ozone can cause respiratory distress and disease in humans, decreased yields of agricultural crops and forests, and damage to some rubber products, plastics, and paints used outdoors. National crop losses from ozone exposure are estimated at $3 billion to $5 billion annually. Forest losses are harder to estimate.

- **What are the health effects?**
  Ozone can cause coughing and throat irritation, make deep vigorous breathing more difficult, and increase the chance of respiratory infections. It increases sensitivity to allergens and can trigger asthma attacks. The damage it causes to the lungs heals within a few days, but repeated or prolonged exposure may cause permanent damage.
- **What can I do about it?**
  If ozone levels are high and you have a respiratory condition or are normally active outdoors, try to limit your outdoor exertion. When the agency calls a smog watch, drive less and avoid the use of gasoline-powered yard equipment and the use of gasoline-fueled recreation vehicles.

  In the United States, management of ozone and other photochemical oxidants has been a major goal of federal and state clean air legislation (Clean Air Act). Although many of the pollution control efforts required by the CAA have been implemented, efforts to decrease ozone pollution have been only partially successful.

  In the Puget Sound region the ozone trend is flat; however, EPA revised its standards from 0.08 parts per million to 0.075 parts per million in March 2008. Preliminary ozone data from the summer of 2008 indicate that the Puget Sound region has violated this standard.

- **Where is it measured?**
  Unlike other pollutants monitored here in the Puget Sound region, ozone is formed by precursors that react in the atmosphere. Winds transport ozone and chemical emissions from one area to another. For the Puget Sound region, ozone precursors are emitted into the air in industrial areas of the Everett-Seattle-Tacoma urban corridor and subsequently travel southeasterly to more rural areas as they react to form ozone. The highest concentrations are measured downwind in areas such as North Bend, Enumclaw, and Eatonville. As a result, for the Puget Sound airshed the majority of sites that measure ozone are located in rural areas south to southeast of Seattle and Tacoma. See Map 1 on page 19 for locations of active monitoring sites. The Washington State Department of Ecology maintains all ozone monitoring stations.

Particulate Matter ($PM_{2.5}$ and PM_{10})

- **What is it?**
  Particulate matter (PM) includes both solid matter and liquid droplets suspended in the air. Particles smaller than 2.5 micrometers in diameter are called “fine” particles, or $PM_{2.5}$. Particles between 2.5 and 10 micrometers in diameter are called “coarse” particles. PM_{10} includes both fine and coarse particles. $PM_{2.5}$ is one of the major air pollution challenges facing the Puget Sound region.

- **How is it caused?**
  - $PM_{2.5}$ comes from all types of combustion, including wood burning, vehicle exhaust, and industrial emissions. It can also be formed in the atmosphere by chemical reactions of pollutant gases.
  - The "coarse" particles in PM_{10} typically come from crushing or grinding operations and dust from roads.
- **When does it happen?**
  Highest $PM_{2.5}$ concentrations typically occur in the winter months, when wood smoke is a contributor and meteorology is conducive to inversions.
- **Who is affected?**
  Everyone. People with asthma or heart or lung diseases, the elderly, and children are particularly susceptible. $PM_{2.5}$ also significantly affects visibility.
- **What are the health effects?**
  Fine particulates ($PM_{2.5}$) pose a greater risk to human health than coarse particulates, because they penetrate deeper into the respiratory system.
  - $PM_{2.5}$ exposure can result in serious health effects, especially respiratory and cardiac effects. People with heart or lung diseases are at increased risk of attacks or premature death. Children and the elderly are more likely to develop heart or lung problems.
  - PM_{10} can aggravate respiratory conditions such as asthma.
- **What can I do about it?**
  - If $PM_{2.5}$ levels are high, people with respiratory or heart disease, the elderly, and children should avoid outdoor exertion.
  - Reduce $PM_{2.5}$ emissions by upgrading a wood burning heat source to a cleaner source of heat. See options at http://www.pscleanair.org/actions/woodstoves/default.aspx.
  - If PM_{10} levels are high, people with respiratory conditions should avoid outdoor exertion.
- **Where is it measured?**
  Due to the health risks associated with $PM_{2.5}$, it is monitored throughout the Puget Sound region. The majority of $PM_{2.5}$ monitoring stations are maintained by the agency.

Carbon Monoxide (CO)

- **What is it?**
  CO is an odorless, colorless gas that can enter the bloodstream through the lungs and reduce the amount of oxygen that reaches organs and tissues.
- **How is it caused?**
  Carbon monoxide forms when the carbon in fuels doesn't burn completely. 60% of all CO comes from vehicle exhaust, and up to 95% occurs in cities.
- **When does it happen?**
  CO pollution is worse in cold weather because fuels burn less efficiently in low temperatures. It is usually at its peak during morning and evening rush hours.

- **Who is affected?**
  People with cardiovascular disease, such as angina, or cardiovascular or respiratory problems; also possibly fetuses and young infants.
- **What are the health effects?**
  Chest pain and increased cardiovascular symptoms, particularly while exercising. High levels of CO can affect alertness and vision even in healthy individuals.
- **What can I do about it?**
  If CO levels are high, limit exertion and avoid sources of CO such as heavy traffic.
- **Where is it measured?**
  CO monitoring stations are located in areas with heavy traffic congestion. These include central business areas, roadsides, and shopping malls. The Washington State Department of Ecology conducts all CO monitoring, and substantially reduced its CO monitoring network in 2006.

Sulfur Dioxide (SO_2)

- **What is it?**
  Sulfur dioxide is a colorless, reactive gas.
- **How is it caused?**
  SO_2 is produced by burning sulfur-containing fuels such as coal and oil, and by industrial processes.
- **Where does it happen?**
  The highest concentrations of SO_2 are usually near large industrial sources.
- **Who is affected?**
  People with asthma who are active outdoors.
- **What are the health effects?**
  Bronchoconstriction, which can cause wheezing, shortness of breath, and tightening of the chest. When exposure to SO_2 ends, the symptoms should clear up within an hour.
- **What can I do about it?**
  If SO_2 levels are high, limit your outdoor exertion.
- **Where is it measured?**
  Because the large primary sources of SO_2 in the Puget Sound area no longer exist, the agency has not monitored for SO_2 since the end of 1999. The Washington State Department of Ecology maintains an SO_2 monitor at its Beacon Hill Seattle site.

Lead (Pb)

- **What is it?**
  Lead is a highly toxic metal that was used for many years in household products, automobile fuel, and industrial chemicals.

- **How is it caused?**
  Locally, airborne lead is associated primarily with automobile exhaust and lead smelters. Since the phase-out of lead in fuels, however, cars and trucks are no longer a significant source of lead. Also, the lead smelter on Seattle's Harbor Island ceased operation at the end of 1998.
- **When does it happen?**
  Lead concentrations are likely to be highest near sources where current or former lead smelting/processing operations caused particle fallout, especially in nearby soils such as unpaved parking lots.
- **Who is affected?**
  Everyone. Children six years and younger are most at risk.
- **What are the health effects?**
  Lead can have health effects ranging from behavioral problems and learning disabilities to seizures and death.
- **What can I do about it?**
  According to EPA, the primary sources of lead exposure are lead-based paint, lead-contaminated dust, and lead-contaminated residual soils. Refer to EPA's website for ways to limit your exposure to these lead sources.
- **Where is it measured?**
  Due to the phase-out of leaded fuels and the closure of Seattle's lead smelter in 1998, the agency no longer monitors for airborne lead.

Nitrogen Dioxide (NO_2)

- **What is it?**
  Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that forms from the reaction of nitrogen oxide (NO) and oxygen in the atmosphere. NO_2 will react with VOCs and can result in the formation of ozone.
- **How is it caused?**
  High temperature combustion sources such as power plants and automobiles are major producers of NO. Home heaters and gas stoves can also produce NO.
- **When does it happen?**
  NO_2 pollution is greatest in cold weather. It follows a similar trend to CO.
- **Who is affected?**
  People with respiratory diseases such as asthma; also children.
- **What are the health effects?**
  NO_2 can cause respiratory symptoms such as coughing, wheezing, and shortness of breath. Long-term exposure can lead to respiratory infections.

- **What can I do about it?**
  Since the 1970s, motor vehicle manufacturers have been required to reduce NO emissions from cars and trucks. It is not a significant pollution problem in the Puget Sound area.
- **Where is it measured?**
  NO_2 is not a major concern of the Puget Sound region and is no longer measured directly. The Washington State Department of Ecology monitors NO_Y - NO at Beacon Hill.

POLLUTION SOURCES

Anthropogenic Emissions

Any emissions released as a result of human activity.

Area Sources

Also called stationary area sources. Stationary pollution sources where each individual source emits pollutants below the thresholds for a point source facility. Sources include wood stoves/fireplaces, outdoor burning, architectural surface coating, automobile painting, commercial/consumer solvents, dry cleaning, printing, stationary diesel engines, small utility engines, and construction activities.

Biogenics

Natural emission sources such as trees, plants, grass, crops, and soils. Biogenics emissions are generally VOCs, specifically non-methane hydrocarbons.

Emission Factor

A value derived from source tests, material balance calculations, or engineering comparisons with similar processes used to estimate emissions from process quantities or activity levels.

Non-road Mobile Sources

Farm vehicles, on-site construction/industrial vehicles, logging equipment, small marine craft, aircraft, trains, ocean-going ships, tugs, ferries, and lawn and garden equipment.

On-road Mobile Sources

Cars, trucks, sport utility vehicles, and buses.

Point Sources

Facilities that have annual air contaminant emissions equal to or exceeding 100 tons per year of CO; 25 tons per year of nitrogen oxides (NO_x), PM_{10}, $PM_{2.5}$, sulfur oxides (SO_x) such as SO_2 and sulfur trioxide (SO_3), or volatile organic compounds (VOC); or 2 tons per year of any single HAP or 6 tons per year of facility total HAP.

pscleanair.org
Puget Sound Clean Air Agency

PUGET SOUND CLEAN AIR AGENCY **www.pscleanair.org**

2007
Air Quality Data Summary Appendix

October 2008

Working Together for Clean Air

Air Quality Index
1980 – 2007

King County															
	Days in Each Air Quality Category					Pollutant Determining the AQI							Highest Value		
						All Days				Unhealthy Days					
Year	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	PM	CO	SO_2	O_3	PM	CO	O_3	AQI	Date	Pollutant
1980	73	275		18	0	95	270	1		1	17		194	Jan 23	PM
1981	69	267		28	1	109	254	2		5	24		213	Jan 15	CO
1982	86	268		10	1	96	264	5		1	10		214	Feb 6	PM
1983	98	258		9	0	101	261	3		0	9		183	Jan 28	CO
1984	146	218		2	0	111	242	13		2	0		103	Dec 6	PM
1985	150	202		10	3	156	206	3		6	7		204	Dec 12	PM
1986	130	226		8	1	113	246	6		1	8		206	Jan 7	PM
1987	120	238		7	0	119	246	0		3	4		184	Feb 6	PM
1988	215	146		5	0	67	298	1		2	3		150	Dec 3	CO
1989	231	134		0	0	129	233	3		0	0		100	Jan 19 #	CO
1990	216	145		4	0	139	201	6	19	0	0	4	131	Aug 11	O_3
1991	229	136		0	0	140	190	8	27	0	0	0	100	Dec 15 #	CO
1992	206	159		1	0	103	230	1	32	0	1	0	167	Feb 3	CO
1993	240	125		0	0	118	235	1	11	0	0	0	88	Jan 11	PM
1994	293	70		2	0	72	270	1	22	0	0	2	134	Jul 21	O_3
1995	299	66		0	0	95	249	5	16	0	0	0	89	Jan 3	CO
1996	297	69		0	0	85	252	2	27	0	0	0	100	Oct 9	CO
1997	302	63		0	0	117	230	0	18	0	0	0	94	Jan 16	PM
1998	317	46		2	0	111	228	0	26	0	0	2	114	Jul 27 #	O_3
1999	267	92	6	0	0	251	60	0	54	5	0	1	134	Jan 4	PM
2000	241	118	7	0	0	288	25		53	5	0	2	114	Nov 21	PM
2001	273	86	6	0	0	295	10		60	6	0	0	118	Nov 10	PM
2002	262	99	4	0	0	275	11		79	4	0	0	113	Nov 27	PM
2003	268	95	2	0	0	250	5		110	0	0	2	132	Jun 6	O_3
2004	256	105	5	0	0	280	2		84	4	0	1	132	Dec 18	PM
2005	254	106	5	0	0	302	3		60	5	0	0	117	Dec 11	PM
2006	268	87	6	4	0	273	2		90	6	0	4	169	Jul 22	O_3
2007	285	77	3	0	0	278	0		87	2	0	1	115	Jan 29	PM
Totals	6091	3976	44	110	6	4568	4723	61	875	58	83	19			

PM = Particulate Matter CO = Carbon Monoxide SO_2 = Sulfur Dioxide O_3 = Ozone # = 1st Occurrence

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM_{10}).

In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle ($PM_{2.5}$) and 8-hour ozone (O_3) standards.

Air Quality Index
1990 – 2007

Kitsap County															
Days in Each Air Quality Category						**Pollutant Determining the AQI**							**Highest Value**		
			Unhealthy for Sensitive		Very	All Days				Unhealthy Days					
Year	Good	Moderate	Groups	Unhealthy	Unhealthy	PM	CO	SO_2	O_3	PM	CO	O_3	AQI	Date	Pollutant
1990															
1991															
1992	353	8		0	0	361				0			68	Nov 25	PM
1993	343	12		0	0	355				0			62	Jan 11	PM
1994	364	1		0	0	248	117			0	0		54	Dec 23	CO
1995	361	4		0	0	86	279			0	0		57	Jan 5	CO
1996	361	1		0	0	206	156			0	0		51	Mar 2	PM
1997	361	1		0	0	362				0			55	Jan 15	PM
1998	347	9		0	0	356				0			87	Nov 8	PM
1999	333	32	0	0	0	365				0			81	Jan 5 #	PM
2000	290	75	0	1	0	366				1			159	Jul 4	PM
2001	320	42	0	0	0	362				0			91	Dec 25	PM
2002	324	41	0	0	0	365				0			78	Nov 2	PM
2003	318	47	0	0	0	365				0			78	Nov 3	PM
2004	340	26	0	0	0	366				0			80	Jul 4	PM
2005	328	35	2	0	0	365				2			136	Jul 4	PM
2006	339	25	1	0	0	365				1			105	Dec 17	PM
2007	322	42	0	0	0	364				0			92	Nov 24	PM
Totals	5404	401	3	1	0	5257	552	0	0	4	0	0			

PM = Particulate Matter   CO = Carbon Monoxide SO_2 = Sulfur Dioxide O_3 = Ozone   # = 1st Occurrence

Note: In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle ($PM_{2.5}$) and 8-hour ozone (O_3) standards.

Air Quality Index
1980 – 2007

Pierce County															
	Days in Each Air Quality Category					Pollutant Determining the AQI							Highest Value		
			Unhealthy for Sensitive		Very	All Days				Unhealthy Days					
Year	Good	Moderate	Groups	Unhealthy	Unhealthy	PM	CO	SO_2	O_3	PM	CO	O_3	AQI	Date	Pollutant
1980	83	271		12	0	256	107	3		4	8		160	Apr 12	PM
1981	74	278		10	3	222	137	6		1	12		227	Jan 12	CO
1982	119	242		4	0	255	101	9		0	4		167	Dec 30	CO
1983	140	222		3	0	228	128	9		1	2		137	Dec 23	PM
1984	162	198		6	0	207	149	10		0	6		117	Jan 19 #	CO
1985	140	213		12	0	252	109	4		1	11		165	Dec 13	PM
1986	161	197		7	0	247	114	4		2	5		167	Oct 23	CO
1987	173	177		13	2	227	136	2		5	10		220	Feb 5	CO
1988	226	132		8	0	184	175	7		3	5		183	Jan 27	CO
1989	260	103		2	0	217	121	27		0	2		117	Nov 30 #	CO
1990	271	91		3	0	219	87	41	18	1	0	2	118	May 5	PM
1991	261	103		1	0	247	85	12	21	0	1	0	117	Jan 31	CO
1992	260	106		0	0	231	83	27	25	0	0	0	100	Feb 3 #	CO
1993	289	76		0	0	247	82	23	13	0	0	0	89	Feb 1	CO
1994	313	51		1	0	235	75	31	24	0	0	1	105	Jul 21	O_3
1995	307	58		0	0	239	97	13	16	0	0	0	83	Jan 3	PM
1996	322	44		0	0	206	119	23	18	0	0	0	78	Oct 9	CO
1997	316	49		0	0	262	75	16	12	0	0	0	84	Jan 16	PM
1998	338	25		2	0	213	112	25	15	0	0	2	120	Jul 27	O_3
1999	265	97	3	0	0	318	1	1	45	3	0	0	139	Jan 4	PM
2000	242	110	13	1	0	318	2		46	14	0	0	153	Dec 6	PM
2001	271	83	11	0	0	306	2		57	11	0	0	139	Nov 10	PM
2002	267	88	9	1	0	291	1		73	10	0	0	158	Nov 27	PM
2003	265	92	8	0	0	264	1		100	8	0	0	122	Jan 7	PM
2004	251	110	5	0	0	272			94	5	0	0	133	Nov 5	PM
2005	275	82	8	0	0	276	2		87	8	0	0	120	Dec 10	PM
2006	283	71	7	4	0	270			95	8	0	3	170	Dec 17	PM
2007	298	57	10	0	0	261			104	9	0	1	137	Jan 29	PM
Totals	6632	3426	74	90	5	6970	2101	293	863	94	66	9			

PM = Particulate Matter   CO = Carbon Monoxide SO_2 = Sulfur Dioxide O_3 = Ozone   # = 1st Occurrence

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM_{10}).

In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle ($PM_{2.5}$) and 8-hour ozone (O_3) standards.

Air Quality Index
1980 – 2007

Snohomish County

	Days in Each Air Quality Category					Pollutant Determining the AQI							Highest Value		
			Unhealthy for Sensitive		Very	All Days				Unhealthy Days					
Year	Good	Moderate	Groups	Unhealthy	Unhealthy	PM	CO	SO_2	O_3	PM	CO	SO_2	AQI	Date	Pollutant
1980	340	19		0	0	356		3		0		0	60	Jan 23	PM
1981	350	11		0	0	340		21		0		0	62	Jan 16	PM
1982	334	30		1	0	277	70	18		0	1	0	117	Dec 30	CO
1983	308	56		1	0	191	150	24		0	1	0	117	Nov 30	CO
1984	309	57		0	0	105	217	44		0	0	0	92	Sep 28	PM
1985	300	64		1	0	152	166	47		0	1	0	117	Dec 11	CO
1986	324	41		0	0	169	148	48		0	0	0	89	Jan 25	CO
1987	203	158		3	0	96	250	18		0	3	0	117	Jun 26 #	CO
1988	174	184		8	0	15	345	6		0	8	0	133	Sep 13 #	CO
1989	150	213		2	0	26	338	1		0	2	0	133	Feb 10	CO
1990	166	197		2	0	29	335	1		0	2	0	117	Mar 2 #	CO
1991	188	176		1	0	32	333	0		0	1	0	117	Dec 16	CO
1992	180	186		0	0	34	332	0		0	0	0	100	Feb 4 #	CO
1993	237	128		0	0	56	306	0	3	0	0	0	79	Jan 11	PM
1994	294	71		0	0	28	334	1	2	0	0	0	78	Dec 30	CO
1995	316	49		0	0	59	294	1	11	0	0	0	78	Jul 7	CO
1996	340	26		0	0	54	299	0	13	0	0	0	67	Jul 26	O_3
1997	348	17		0	0	210	151	0	4	0	0	0	67	Jan 14	PM
1998	353	11		1	0	143	219	3		1	0	0	153	Dec 22	PM
1999	300	62	3	0	0	260	105	0		3	0	0	129	Jan 3	PM
2000	253	79	5	0	0	301	36			5	0		113	Jul 4	PM
2001	290	73	2	0	0	356	9			2	0		111	Nov 10	PM
2002	288	69	8	0	0	343	22			8	0		116	Nov 4	PM
2003	282	80	3	0	0	364	1			3	0		108	Nov 4	PM
2004	290	74	2	0	0	364	2			2	0		107	Nov 5	PM
2005	288	72	5	0	0	360	5			5	0		139	Dec 11	PM
2006	301	57	7	0	0	364	1			7	0		143	Dec 17	PM
2007	288	70	6	1	0	365	0			7	0		155	Jan 15	PM
Totals	7794	2330	41	21	0	5449	4468	236	33	43	19	0			

PM = Particulate Matter CO = Carbon Monoxide SO_2 = Sulfur Dioxide O_3 = Ozone # = 1st Occurrence

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM_{10}).

In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle ($PM_{2.5}$) and 8-hour ozone (O_3) standards.

Burn Bans
1988 – 2007

1988
- Jan 25(0830) - Jan 28 (0830)
- Feb 5 (1630) - Feb 6 (0930)
- Dec 1 (1430) - Dec 2 (0800)
- Dec 4 (1430) - Dec 5 (1400)
- Dec 16 (1430) - Dec 18 (1430)

1989
- Jan 19 (1430) - Jan 20 (1430)
- Jan 24 (1430) - Jan 26 (0930)
- Feb 6 (1430) - Feb 8 (0930)
- Feb 10 (1430) - Feb 16 (0930)
- Nov 29 (1430) - Dec 2 (0930)
- Dec 22 (1430) - Dec 23 (1430)

1990
- Jan 19 (1430) - Jan 21 (1430)
- Dec 7 (1430) - Dec 8 (0930)
- Dec 25 (1430) - Dec 27 (0815)*
  *(Dec 26 1430 – Dec 27 0815) 2nd Stage

1991
- Jan 5 (1430) - Jan 6 (0930)
- Jan 21 (1430) - Jan 24 (1500)*
  *(Jan 22 0930 – Jan 24 1500) 2nd Stage
- Jan 29 (1430) - Jan 31 (0830)
- Dec 15 (1430) - Dec 17 (1430)*
  *(Dec 16 1430 – Dec 17 0930) 2nd Stage

1992
- Jan 8 (1430) - Jan 9 (0930)
- Jan 19 (1430) - Jan 20 (1430)
- Feb 5 (1000) - Feb 6 (1430)
- Nov 25 (1430) - Nov 26 (1430)

1993
- Jan 11 (1430) - Jan 13 (0830)
- Jan 15 (1430) - Jan 16 (0700)
- Jan 17 (1430) - Jan 19 (0600)
- Jan 31 (1430) - Feb 3 (0830)
- Dec 20 (1430) - Dec 21 (1430)
- Dec 26 (1430) - Dec 29 (0830)

1994 None

1995
- Jan 4 - Jan 7

1996
- Feb 14 (1430) - Feb 16 (1630)

1997
- Nov 13 (1500) - Nov 15 (1500)
- Dec 4 (1500) - Dec 7 (1800)

1998 None

1999
- Jan 5 (1400) - Jan 6 (1000)
- Dec 29 (1400) - Dec 31 (0600)

2000
- Feb 18 (1400) - Feb 20 (1000)
- Nov 15 (1700) - Nov 23 (0600)

2001
- Nov 8 (1400) - Nov 12 (1800)

2002
- Nov 1 (1500) - Nov 6 (0900)
- Nov 27 (1000) - Dec 4 (1000)

2003
- Jan 7 (1500) - Jan 9 (1300)

2004 None

2005
- Feb 21 (1600) - Feb 28 (0800)
- Dec 9 (1700) - Dec 18 (1200)

2006 None

2007
- Jan 13 (1400) - Jan 16 (1500)
- Jan 28 (1400) - Jan 31 (1400)
- Dec 9 (1400) - Dec 11 (0930)

PARTICULATE MATTER (PM_{10}) – Continuous TEOM Sampling Method

Micrograms per Cubic Meter

Equivalent Sampling Methods: B - BetaAtten ANDERSEN FH62I-N Glass Fiber strip
T - Mass Transducer R&P TEOM 1400a Teflon Coated Glass Fiber

2007

		Number of	Quarterly Arithmetic Averages				Year Arith	99th	Max
Location	Method	Values	1st	2nd	3rd	4th	Mean	Percentile	Value
Duwamish, 4752 E Marginal Way S, Seattle	T	351	22.7	19.2	18.6	21.7	20.6	52	60
James St & Central Ave, Kent	T	354	17.7	13.0	13.9	15.6	15.1	42	62
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	324	20.5	16.0	16.7		17.7	50	65

Notes
(1) Sampling occurs continuously for 24 hours each day.
Quarterly averages are shown only if 75 percent or more of the data is available.
(2) Annual averages are shown only if there are at least three quarterly averages.

Summary of Maximum Observed Concentrations and Values >60

Location	Method	Jan 29 Mon	Feb 2 Fri
Duwamish, 4752 E Marginal Way S, Seattle	T		60
James St & Central Ave, Kent	T		62
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	65	

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Method	Good	Moderate	Unhealthy for Sensitive Groups
Duwamish, 4752 E Marginal Way S, Seattle	T	350	1	0
James St & Central Ave, Kent	T	352	2	0
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	322	2	0

PARTICULATE MATTER ($PM_{2.5}$) –Reference Sampling Method

Micrograms per Cubic Meter

Reference Sampling Method: R&P Partisol 2025 Sampler Teflon Filter

2007

Location	Number of Values	Quarterly Arithmetic Averages				Year Arith Mean	98th Percentile	Max Value
		1st	2nd	3rd	4th			
Darrington HS, 1085 Fir St, Darrington	195	9.9	4.2	5.1	9.1	7.1	36	72
Marysville JHS, 1605 7th St, Marysville	359	11.1	6.1	6.5	12.0	8.9	36	48
17171 Bothell Way NE, Lake Forest Park	119	10.2	5.3	5.9	12.0	8.4	30	35
Duwamish, 4752 E Marginal Way S, Seattle	119	10.8	7.4	8.2	12.0	9.6	26	37
7802 South L St, Tacoma	117	13.8	5.9	5.2	13.8	9.7	45	59

Notes
(1) Sampling occurs for a 24 hour period from midnight to midnight.
Quarterly averages are shown only if 75 percent or more of the data is available.
(2) Annual averages are shown only if there are at least three quarterly averages.

Summary of Maximum Observed Concentrations and Values >40

Location	Jan 12 Fri	Jan 14 Sun	Jan 15 Mon	Feb 2 Fri	Nov 23 Fri	Dec 9 Sun
Darrington HS, 1085 Fir St, Darrington	48	52	72			
Marysville JHS, 1605 7th St Marysville		47		41		48
17171 Bothell Way NE, Lake Forest Park	35	--				--
Duwamish, 4752 E Marginal Way, Seattle		--	37			--
7802 South L St, Tacoma	45	--	59	47	45	--

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Darrington HS, 1085 Fir St, Darrington	176	16	2	1
Marysville JHS, 1605 7th St, Marysville	314	42	3	
17171 Bothell Way NE, Lake Forest Park	104	15		
Duwamish, 4752 E Marginal Way S, Seattle	104	15		
7802 South L St, Tacoma	98	15	4	

PARTICULATE MATTER ($PM_{2.5}$) – Continuous TEOM Sampling Method

Micrograms per Cubic Meter

Equivalent Sampling Methods: T - Mass Transducer R&P TEOM 1400a Tef-coat Glass Fiber

2007

Location	Method	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	98th Percentile	Max Value
Marysville JHS, 1605 7th St, Marysville	T	327	11.3	7.4	8.1	12.1	9.7	31	37
6120 212th St SW, Lynnwood	T	195				10.1	10.1		32
17171 Bothell Way NE, Lake Forest Park	T	359	9.7	5.9	8.0	11.2	8.9	25	36
James St & Central Ave, Kent	T	342	13.2	7.8	8.3	10.9	10.1	28	42
7802 South L St, Tacoma	T	339	11.6	6.9	7.0	12.3	9.5	33	44

Notes
(1) Sampling occurs continuously for 24 hours each day.
Quarterly averages are shown only if 75 percent or more of the data is available.
(2) Annual averages are shown only if there are at least three quarterly averages.

Summary of Maximum Observed Concentrations and Values >40

Location	Method	Jan 14 Sun	Jan 28 Sun	Jan 29 Mon	Nov 23 Fri	Dec 9 Sun
Marysville JHS, 1605 7th St, Marysville	T					37
6120 212th St SW, Lynnwood	T	--	--	--	32	
17171 Bothell Way NE, Lake Forest Park	T	36				
James St & Central Ave, Kent	T			42		
7802 South L St, Tacoma	T		44	42		

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Method	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Marysville JHS, 1605 7th St, Marysville	T	289	38		
6120 212th St SW, Lynnwood	T	171	24		
17171 Bothell Way NE, Lake Forest Park	T	324	35		
James St & Central Ave, Kent	T	303	38	1	
7802 South L St, Tacoma	T	299	38	2	

PARTICULATE MATTER ($PM_{2.5}$) – Continuous Nephelometer Sampling Method

Micrograms per Cubic Meter

Sampling Method: Equivalent - Radiance Research M903 Nephelometer

2007

Location	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	98th Percentile	Daily Max Value
Darrington HS, 1085 Fir St, Darrington	344	11.8	3.5	4.2	9.2	7.2	34.8	63
Marysville JHS, 1605 7th St, Marysville	361	10.3	5.9	6.7	11.7	8.7	34.5	46
6120 212th St SW, Lynnwood	356	10.1	5.0	6.2	11.2	8.1	29.3	43
17171 Bothell Way NE, Lake Forest Park	360	10.2	5.1	5.9	11.6	8.2	29.0	47
Queen Anne Hill, 400 W Garfield St, Seattle	349	7.2	4.7	6.4	7.8	6.5	21.4	30
Olive & Boren, Seattle	351	7.7	5.1	6.4	8.3	6.9	20.4	26
Duwamish, 4752 E Marginal Way S, Seattle	342	9.1	5.2	6.5	12.4	8.3	30.5	40
South Park, 8025 10th Ave S, Seattle	354	10.1	6.6	6.4	10.4	8.4	28.5	40
305 Bellevue Way NE, Bellevue	359	7.9	5.2	4.5	6.4	6.0	15.8	32
42404 SE North Bend Way, North Bend	352	4.1	3.4	6.0	6.8	5.1	14.0	19
James St & Central Ave, Kent	349	12.0	7.3	6.3	10.3	9.0	30.8	48
Port of Tacoma, 2301 Alexander Ave, Tacoma	365	12.7	6.1	6.8	11.0	9.2	33.9	47
7802 South L St, Tacoma	345	12.4	4.4	4.7	11.0	8.1	38.7	58
South Hill, 9616 128th St E, Puyallup	360	11.3	5.0	5.8	11.2	8.3	32.0	43
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	361	9.5	5.2	5.8	11.6	8.0	26.9	36
10955 Silverdale Way NW, Silverdale	358	7.9	5.1	5.3	8.1	6.6	19.7	28

Notes
(1) Sampling occurs continuously for 24 hours each day.
Quarterly averages are shown only if 75 percent or more of the data is available.
(2) Annual averages are shown only if there are at least three quarterly averages.
(3) All data values are correlated using site-specific relationships with Federal Reference Method samplers.

Summary of Maximum Observed Concentrations and Values >40

Location	Jan 12 Fri	Jan 13 Sat	Jan 14 Sun	Jan 15 Mon	Jan 21 Sun	Jan 28 Sun	Jan 29 Mon	Feb 2 Fri	Nov 7 Wed	Nov 8 Thu	Nov 24 Sat	Dec 9 Sun
Darrington HS, 1085 Fir St, Darrington	52	63	56	41	43							
Marysville JHS, 1605 7th St, Marysville			45									46
6120 212th St SW, Lynnwood			43									
17171 Bothell Way NE, Lake Forest Park			47									
Queen Anne Hill, 400 W Garfield St, Seattle									30			
Olive & Boren, Seattle									30			
Duwamish, 4752 E Marginal Way S, Seattle									40			
South Park, 8025 10th Ave S, Seattle							39					
305 Bellevue Way NE, Bellevue							32					
42404 SE North Bend Way, North Bend												19
James St & Central Ave, Kent							48					
Port of Tacoma, 2301 Alexander Ave, Tacoma				44		44	47			45		
7802 South L St, Tacoma			46	55		55	58	43				
South Hill, 9616 128th St E, Puyallup				43								
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co											36	
10955 Silverdale Way NW, Silverdale							28					

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Darrington HS, 1085 Fir St, Darrington	310	29	5	
Marysville JHS, 1605 7th St, Marysville	314	45	2	
6120 212th St SW, Lynnwood	312	43	1	
17171 Bothell Way NE, Lake Forest Park	313	46	1	
Queen Anne Hill, 400 W Garfield St, Seattle	326	23		
Olive & Boren, Seattle	335	16		
Duwamish, 4752 E Marginal Way S, Seattle	295	47		
South Park, 8025 10th Ave S, Seattle	311	43		
305 Bellevue Way NE, Bellevue	350	9		
42404 SE North Bend Way, North Bend	348	4		
James St & Central Ave, Kent	311	37	1	
Port of Tacoma, 2301 Alexander Ave, Tacoma	319	42	4	
7802 South L St, Tacoma	301	39	5	
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	322	39		
10955 Silverdale Way NW, Silverdale	343	15		

$PM_{2.5}$ Speciation Analytes Monitored in 2007
Average Annual Concentrations in Micrograms per Cubic Meter[a]

Analyte	Beacon Hill (101 samples) Average (ug/m3)	Duwamish (55 samples) Average (ug/m3)	Tacoma South L (53 samples) Average (ug/m3)	Average Minimum Detection Level (ug/m3)
Ammonium	4.23E-01	4.57E-01	4.14E-01	
Nitrate	0.81	0.89	0.83	
Potassium	NA	NA	NA	
Sodium	1.50E-01	2.24E-01	1.69E-01	
Sulfate	1.00	1.42	0.98	
Elemental Carbon	0.74	1.30	1.03	
Organic Carbon Blank Adjusted	2.45	3.84	5.39	
Total Carbonaceous Mass	3.19	5.14	6.42	
Soil[b]	0.33	0.84	0.34	
Reconstructed Fine Mass - Urban $PM_{2.5}$[c]	5.76	8.68	8.99	
Total PM2.5 Mass	8.2	9.8	11.9	
XRF - Aluminum	NA	2.77E-02	NA	1.20E-02
XRF - Antimony	NA	NA	NA	2.89E-02
XRF - Arsenic	NA	9.76E-04	NA	1.27E-03
XRF - Barium	NA	NA	NA	1.48E-02
XRF - Bromine	1.43E-03	2.59E-03	2.20E-03	1.31E-03
XRF - Cadmium	NA	NA	NA	1.31E-02
XRF - Calcium	2.62E-02	1.50E-01	2.26E-02	5.06E-03
XRF - Cerium	NA	NA	NA	1.74E-02
XRF - Cesium	NA	NA	NA	1.94E-02
XRF - Chlorine	5.48E-02	1.14E-01	1.07E-01	6.26E-03
XRF - Chromium	NA	2.21E-03	NA	1.89E-03
XRF - Cobalt	NA	NA	NA	1.11E-03
XRF - Copper	7.74E-03	5.16E-03	3.44E-03	1.40E-03
XRF - Europium	NA	NA	NA	4.51E-03
XRF - Gallium	NA	NA	NA	1.92E-03
XRF - Gold	NA	NA	NA	3.46E-03
XRF - Hafnium	NA	NA	NA	7.38E-03
XRF - Indium	NA	NA	NA	1.42E-02
XRF - Iridium	NA	NA	NA	4.12E-03
XRF - Iron	6.29E-02	1.35E-01	5.81E-02	1.55E-03
XRF - Lanthanum	NA	NA	NA	1.48E-02
XRF - Lead	NA	5.25E-03	NA	3.25E-03
XRF - Magnesium	NA	NA	NA	1.26E-02
XRF - Manganese	6.78E-03	1.38E-02	NA	1.61E-03
XRF - Mercury	NA	NA	NA	4.84E-03
XRF - Molybdenum	NA	NA	NA	5.17E-03
XRF - Nickel	2.50E-03	2.54E-03	1.28E-03	1.11E-03
XRF - Niobium	NA	NA	NA	3.23E-03
XRF - Phosphorus	NA	NA	NA	9.72E-03
XRF - Potassium	4.59E-02	7.91E-02	1.08E-01	5.23E-03

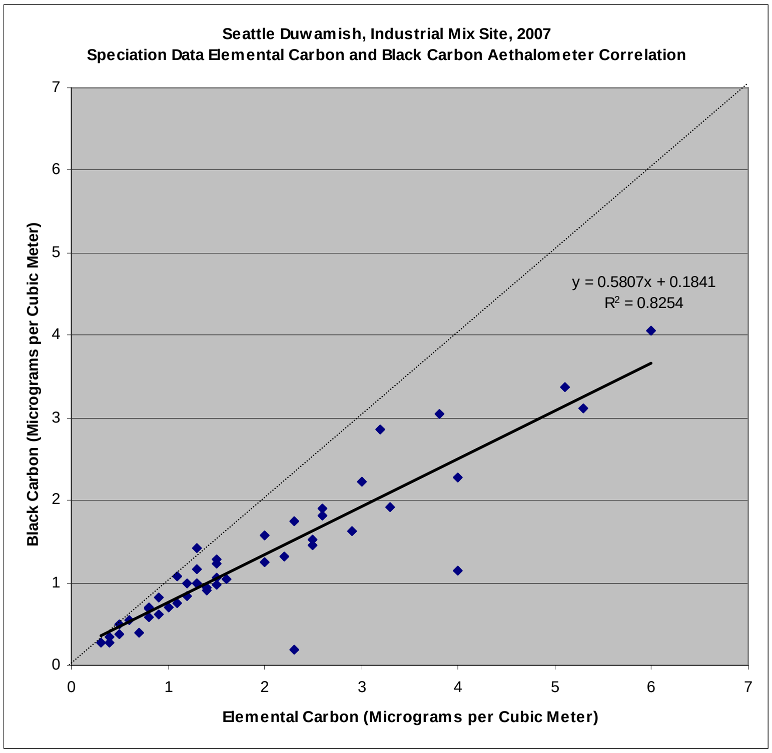
Analyte	Beacon Hill (101 samples) Average (ug/m3)	Duwamish (55 samples) Average (ug/m3)	Tacoma South L (53 samples) Average (ug/m3)	Average Minimum Detection Level (ug/m3)
XRF - Rubidium	NA	NA	NA	1.58E-03
XRF - Samarium	NA	NA	NA	4.45E-03
XRF - Scandium	NA	NA	NA	1.55E-02
XRF - Selenium	NA	NA	NA	1.57E-03
XRF - Silicon	3.97E-02	8.48E-02	5.27E-02	9.32E-03
XRF - Silver	NA	NA	NA	1.05E-02
XRF - Sodium	9.36E-02	1.93E-01	9.67E-02	3.76E-02
XRF - Strontium	NA	NA	NA	1.93E-03
XRF - Sulfur	3.22E-01	4.75E-01	3.25E-01	6.64E-03
XRF - Tantalum	NA	NA	NA	6.09E-03
XRF - Terbium	NA	NA	NA	4.04E-03
XRF - Tin	NA	NA	NA	1.91E-02
XRF - Titanium	NA	4.10E-03	NA	3.85E-03
XRF - Tungsten	NA	NA	NA	4.60E-03
XRF - Vanadium	3.36E-03	8.06E-03	NA	2.61E-03
XRF - Yttrium	NA	NA	NA	2.16E-03
XRF - Zinc	7.93E-03	2.18E-02	1.22E-02	2.04E-03
XRF - Zirconium	NA	NA	NA	3.13E-03

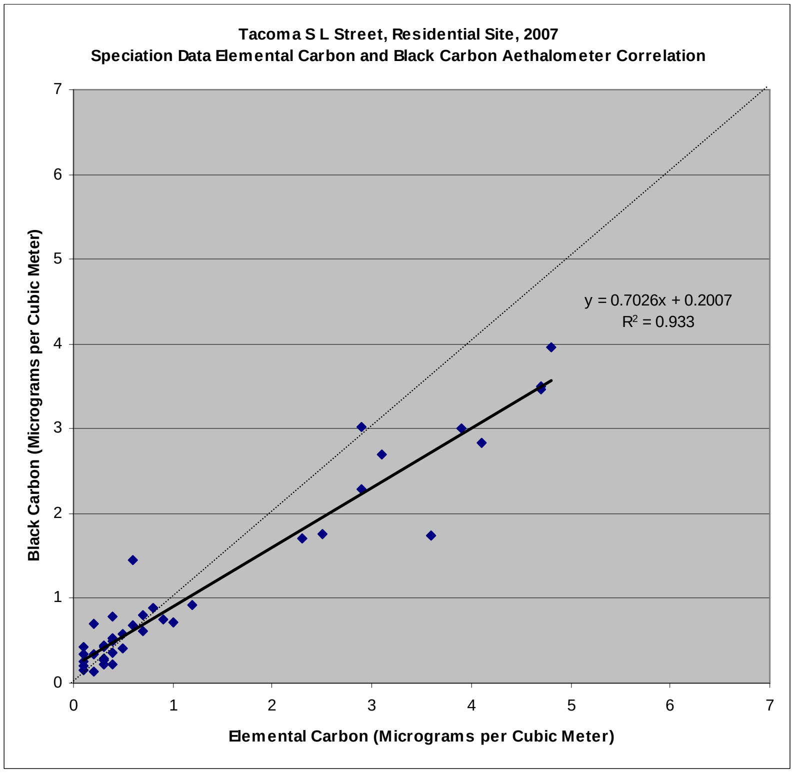
[a]NA = Levels below detection or <75% data completeness.

[b]Soil calculation = 2.2 * Aluminum + 2.49 * Silicon + 1.63 * Calcium + 2.42 * Iron + 1.94 * Titanium.

[c]Reconstructed Fine Mass = Ammonium Sulfate Mass + Ammonium Nitrate Mass + Organics Mass + Light Absorbing Carbon Mass (units = $\mu g/m^3$).

Aethalometer and Speciation Data Correlations





Note: aethalometer and speciation data are collected at Beacon Hill also; however, there was less than 75% for 2007 so the correlation is not shown in this report.

$PM_{2.5}$ BLACK CARBON

Micrograms per Cubic Meter

Sampling Method: Light Absorption by Aethalometer

2007

Location	Number of Values	Quarterly Arithmetic Averages				Annual Mean	Max Value
		1st	2nd	3rd	4th		
Darrington HS, 1085 Fir St, Darrington	355	0.8	0.4	0.6	0.8	0.6	3.1
Marysville JHS, 1605 7th St, Marysville	309	1.2	0.8	0.8		1.0	4.4
17171 Bothell Way NE, Lake Forest Park	349	1.3	0.5	0.7	1.6	1.0	4.5
Olive & Boren, Seattle	274	1.9	1.3			1.6	4.4
Duwamish, 4752 E Marginal Way S, Seattle	317		1.2	1.6	2.6	1.9	8.2
7802 South L St, Tacoma	285	1.3	0.4		2.0	1.1	6.6

Notes

(1) Sampling occurs continuously for 24 hours each day.
Quarterly averages are shown only if 75% or more of the data is available.

(2) Annual averages are shown only if there are at least three quarterly averages.

Summary of Maximum Observed Concentrations

Location	Jan 14 Sun	Feb 2 Fri	Oct 23 Tue	Nov 7 Wed	Nov 18 Sun
Darrington HS, 1085 Fir St, Darrington	3.1				
Marysville JHS, 1605 7th St, Marysville		4.4		--	
17171 Bothell Way NE, Lake Forest Park	4.5			--	
Olive & Boren, Seattle			--	--	4.4
Duwamish, 4752 E Marginal Way S, Seattle			8.2		
7802 South L St, Tacoma				6.6	

-- Indicates no sample on specified day

OZONE 8-HOUR CONCENTRATIONS
(Parts per Million)
2007

Location / Continuous Sampling Period(s)	2007 Six Highest Daily 8-Hour Concentrations		4th Highest Daily 8-Hour Concentration			3-Year Average of 4th Highest 8-Hour Concentration
	Value	Date	2005	2006	2007	2005 - 2007
Beacon Hill, 15th S & Charlestown	.051	30 May				
Seattle, Wa	.049	2 Jun				
1 Mar-31 Dec	.048	11 May				
	.047	15 May	.043	.029	.047	.040
	.045	5 May				
	.045	12 May				
20050 SE 56th	.064	30 May				
Lake Sammamish State Park, Wa	.061	11 Jul				
1 May-30 Sep	.060	2 Jun				
	.059	3 Jun	.054	.070	.059	.061
	.058	4 Jul				
	.053	10 Jul				
42404 SE North Bend Way,	.069	15 Aug				
North Bend, Wa	.059	11 Jul				
1 May-6 Sep	.058	4 Jul				
	.057	31 May	.061	.067	.057	.062
	.057	14 Jul				
	.057	30 Aug				
30525 SE Mud Mountain Road,	.090	11 Jul				
Enumclaw, Wa	.078	3 Jun				
1 May-30 Sep	.070	2 Jun				
	.068	30 May	.063	.088	.068	.073
	.067	4 Jul				
	.064	10 Jul				
Charles L Pack Forest	.085	11 Jul				
La Grande, Wa	.068	30 May				
17 May-30 Sep	.067	31 May				
	.064	4 Jul	.061	.080	.064	.068
	.062	10 Jul				
	.061	2 Jun				
931 Northern Pacific Rd SE,	.069	30 May				
Yelm, Wa	.060	31 May				
1 May-30 Sep	.059	2 Jun				
	.055	11 Jul	.059	.068	.055	.061
	.054	11 Sep				
	.053	15 Aug				

Notes
(1) All ozone stations are operated by the Washington State Department of Ecology.
(2) Ending times are reported in Pacific Standard Time.
(3) For equal concentration values the date and time refer to the earliest occurrences.
(4) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
(5) At all stations ozone was measured using the continuous ultraviolet photometric detection method.

REACTIVE NITROGEN

(Parts per Million)
2007

Monthly and Annual Arithmetic Averages

Location	Monthly Arithmetic Averages							No of 1 Hour Samples	Year Arith Mean
	Jan	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	Jul		
Beacon Hill, 15th S & Charlestown, Seattle		 .014	.016 .016	.015 .017	.013 .020	.012 .017	.013	7472	.015

Maximum and Second Highest Concentrations

Location / Continuous Sampling Periods(s)	1 Hour Average		
	Value	Date	End Time
Beacon Hill, 15th S & Charlestown, Seattle 13 Feb - 31 Dec	.080 .076	29 Mar 29 Mar	2000 1900

Notes
(1) Ending times are reported in Pacific Standard Time.
(2) For equal concentration values the date and time refer to the earliest occurrences.
(3) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
(4) At all stations nitrogen dioxide was measured using the continuous chemiluminescence method.

CARBON MONOXIDE
(Parts per Million)
2007

Location / Continuous Sampling Period(s)	Six Highest Concentrations					Number of 8 Hour Averages Exceeding 9 ppm	Number of Days 8 Hour Average Exceeded 9 ppm
	1 Hour Average			8 Hour Average			
	Value	Date	End Time	Value	Date		
2421 148th Ave NE Bellevue 1 Jan-31 Dec	3.9	2 Feb	2000	2.7	29 Jan	0	0
	3.5	29 Jan	1800	2.6	2 Feb		
	3.4	15 Jan	1800	2.3	1 Feb		
	3.4	29 Jan	1900	2.3	8 Dec		
	3.3	31 Jan	0800	2.1	15 Jan		
	3.2	1 Feb	1900	2.0	31 Jan		
Beacon Hill, 15th S and Charlestown Seattle 2 Feb-31 Dec	1.4	6 Apr	0700	1.0	7 Nov	0	0
	1.4	11 Sep	0800	1.0	11 Sep		
	1.3	7 Nov	1800	0.9	7 Feb		
	1.3	11 Sep	0600	0.9	23 Oct		
	1.3	7 Feb	1900	0.9	6 Nov		
	1.2	23 Oct	0900	0.8	11 Dec		

Notes
(1) All carbon monoxide stations are operated by the Washington State Department of Ecology.
(2) Ending times are reported in Pacific Standard Time.
(3) For equal concentration values the date and time refer to the earliest occurrences.
(4) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
(5) At all stations carbon monoxide was measured using the continuous nondispersive infrared method.

SULFUR DIOXIDE
(Parts per Million)
2007

Monthly and Annual Arithmetic Averages

Location	Monthly Arithmetic Averages							No of 1 Hour Samples	Year Arith Mean
	Jan	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	Jul		
Beacon Hill, 15th S & Charlestown, Seattle		 .001	 .002	.001 .001	.001 .002	.001 .001	.002	5983	.001

Maximum and Second Highest Concentrations for Various Averaging Periods

Location / Continuous Sampling Periods(s)	1 Hour Average			24 Hour Average	
	Value	Date	End Time	Value	Date
Beacon Hill, 15th S & Charlestown, Seattle 10 Apr-31 Dec	.039 .031	14 Sept 11 Sept	0800 1000	.007 .006	11 Sept 17 July

Notes
(1) Ending times are reported in Pacific Standard Time.
(2) For equal concentration values the date and time refer to the earliest occurrences.
(3) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
(4) Sulfur dioxide was measured using the continuous ultraviolet fluorescence method.

2007 Beacon Hill Air Toxics Statistical Summary for Air Toxics Gases (units in parts per billion)

	benzene	1,3-butadiene	carbon tetrachloride	chloroform	dichloromethane	tetrachloroethylene	trichloroethylene	acrolein
2007 count	60	60	60	60	60	60	60	60
NDs (reported as 0)	0	0	0	2	0	3	37	2
Median (ppb)	0.193	0.030	0.104	0.024	0.096	0.017	0.000	0.137
Mean (ppb)	0.249	0.040	0.110	0.026	0.113	0.023	0.008	0.161
95%tile (ppb)	0.572	0.110	0.150	0.042	0.242	0.051	0.036	0.351
Max (ppb)	0.847	0.149	0.155	0.054	0.370	0.084	0.059	0.390
MDL (ppb)	0.024	0.018	0.015	0.017	0.015	0.011	0.018	0.025
# below MDL	0	10	0	3	0	13	49	2
% below MDL	0%	17%	0%	5%	0%	22%	82%	3%

NDs – nondetects – reported as “0” in dataset.

MDL – minimum detection limit provided by laboratory. Concentrations provided below this value are estimates.

Trichloroethylene is shaded because greater than 75% of its samples were below limits of detection. Statistics are shown, but a graph in the main text is not presented because of the level of uncertainty in quantification.

100% of samples were below detection for vinyl chloride and 1-2 dichloropropane. The health screening values (cancer and non-cancer) for vinyl chloride are well above the detection limit, so it is unlikely that vinyl chloride concentrations pose any health risk. No health screening values are available for 1-2 dichloropropane. Cancer screening values are concentrations set at a potential risk of 1 in a million.

2007 Beacon Hill Air Toxics Statistical Summary for PM_{10} Metals (units in nanograms per cubic meter)

	Arsenic	Cadmium	Chromium	Cr+6 TSP	Lead	Manganese	Nickel
2007 count	57	57	57	59	57	57	57
NDs (reported as 0)	0	0	0	0	0	0	0
Median (ng/m3)	0.591	0.087	3.770	0.029	3.195	7.195	1.380
Mean (ng/m3)	0.768	0.126	3.948	0.046	4.224	13.353	2.167
95%tile (ng/m3)	1.738	0.292	6.722	0.124	9.628	41.960	6.448
Max (ng/m3)	2.770	0.480	8.010	0.206	13.100	91.700	7.160
MDL (ng/m3)	0.009	0.008	0.142	0.0074	0.018	0.016	0.088
# below MDL	0	0	0	8	0	0	0
% below MDL	0%	0%	0%	14%	0%	0%	0%

100% of samples were below detection limit for beryllium. The health screening values (cancer and non-cancer) for beryllium are well above the detection limit, so it is unlikely that beryllium concentrations pose any health risk. Cancer screening values are concentrations set at a potential risk of 1 in a million.

2007 Beacon Hill Potential Cancer Risk Estimates per 1,000,000 – 95th Percentile
Percentage of samples greater than cancer screen value

AIR TOXIC	RISK BASED ON 95TH PERCENTILE CONCENTRATIONS IRIS	RISK BASED ON 95TH PERCENTILE CONCENTRATIONS OEHHA	RANGE	% OF SAMPLES> IRIS SCREEN	% OF SAMPLES> OEHHA SCREEN
Benzene	14	53	14-53	100%	100%
1,3-Butadiene	7	42	7-42	20%	98%
Carbon Tetrachloride	15	41	15-41	100%	100%
Formaldehyde	26	12	12-26	100%	98%
Chromium 6 (M)	2	19	2-19	19%	88%
Arsenic (M)	8	6	6-8	100%	96%
Chloroform	5	1	1-5	43%	8%
Acetaldehyde	4	5	4-5	100%	85%
Nickel (M)	3	2	2-3	33%	14%
Tetrachloroethylene	na	2	2	NA	28%
Trichloroethylene	na	<1	<1	NA	0%
Cadmium (M)	<1	1	<1-1	0%	11%
Lead (M)	na	<1	<1	NA	0%
Beryllium (M)	<1	<1	<1	0%	0%
Dichloromethane	<1	1	<1-1	0%	3%
Vinyl chloride	<1	<1	<1	0%	0%

Shaded air toxics have >75% of samples with estimated concentrations (values below the reported laboratory detection limit).

Screening value used is concentration equivalent to an estimated 1 in a million potential cancer risk.

Non-cancer Reference Concentrations (RfC) and Hazard Indices

Air Toxic	Non-Cancer Chronic RfC OEHHA (ug/m3)	Mean Hazard Index
Benzene	60	0.013
1,3-butadiene	20	0.004
Carbon tetrachloride	40	0.018
Chloroform	300	0.000
Dichloromethane	400	0.001
Tetrachloroethylene	35	0.004
Trichloroethylene	600	0.000
Acrolein	0.06	14.436
Acetaldehyde	9	0.102
Formaldehyde	3	0.305
Arsenic PM10 (M)	0.03	0.026
Beryllium PM10 (M)	0.007	0.000
Cadmium PM10(M)	0.02	0.006
Cr+6 TSP (M)	0.2	0.000
Lead PM10 (M)	na	na
Manganese PM10 (M)	0.2	0.067
Nickel PM10(M)	0.05	0.043