110 Union Street, Suite 500
Seattle, Washington 98101

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

2004
Air Quality Data Summary

July 2005

Working Together for Clean Air

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The 2004 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

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 (CAPs). 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)
- Ozone
- Nitrogen Dioxide
- Carbon Monoxide
- Sulfur Dioxide
- Lead

This 2004 Air Quality Data Summary includes additional information that hasn't been in previous reports. This change reflects that criteria air pollutants alone do not comprehensively define an area's air quality. This report summarizes air toxics that are monitored locally by the Washington State Department of Ecology. Air toxics are broadly defined by the Agency as a category that covers over 400 air pollutants. These pollutants are associated with a range of adverse health effects, primarily cancer. Integrating criteria pollutants and air toxics is consistent with improvements in emissions inventories, monitoring programs, and health evaluations.

The Puget Sound Clean Air 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 www.pscleanair.org and https://fortress.wa.gov/ecy/aqp/Public/aqn.shtml. We encourage you to visit our website to find more extensive air quality data, educational materials, monthly air quality summaries, and discussions of current topics.

We are expanding and refining our Internet site to better serve the residents of the Puget Sound region. We want your feedback on our air quality data and program. Please submit your comments via email to Mary Hoffman at maryh@pscleanair.org or call at 206-689-4006.

[1] The Agency's jurisdiction covers Snohomish, King, Pierce, and Kitsap counties.

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 directly following the executive summary. 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, which are monitored most rigorously in the Puget Sound region. Data are presented graphically and as statistical summaries, including comparisons to the ambient air quality standards and relevant health goals. A presentation of visibility based on fine particulate measurement is also included.

Air toxics monitored by the Washington State Department of Ecology are also presented. Air toxics data are not as comprehensive as criteria air pollutant data. Unlike criteria air pollutants, air toxics do not have federal standards. Instead of a comparison of concentrations to standards, air toxics are ranked based on potential cancer risk.

Executive Summary for 2004

The Agency, along with partners, continued to monitor the region's air quality in 2004. While the area enjoys improving air quality in many ways, our airshed is faced with new challenges. Some of these challenges are related to economic growth in our region, particularly in terms of vehicles on roadways and growth in shipping of goods.

Criteria air pollutant levels have decreased over the last decade to levels below the federal standard due to better control of air pollution. However, two remain a concern in our area. Daily concentrations of fine particulate matter, while not violating or exceeding federal standards, do not meet the local health goal at monitoring stations in three of our four counties.[2] Ozone levels, while not violating federal standards, have not fallen far below the standard.

Air toxics are present in our airshed at levels that pose adverse health effects.[3] These health effects include but are not limited to increased cancer risk and respiratory, cardiovascular, and neurological effects.

Many of the same sources that produce criteria and toxic air pollutants also generate greenhouse gases. Climate change is a new area of focus in our Northwest region.[4]

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

There are multiple ways to measure the quality of our ambient air. Some are summarized in the following pages for 2004.

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[2] The federal standard for daily $PM_{2.5}$ concentrations is currently 65 µg/m^3. Our Board of Directors adopted a more stringent goal based on recommendations of our Particulate Matter Health Committee. The Committee conducted a systematic review of health data and determined that a daily average of 25 µg/m^3 is protective of human health.

[3] Puget Sound Final Air Toxics Evaluation. 2003. http://www.pscleanair.org/news/other/psate_final.pdf.

[4] Roadmap for Climate Change: Reducing Greenhouse Gas Emissions in Puget Sound. http://www.pscleanair.org/specprog/globclim/cpsp/pdf/rptfin.pdf.

Air Quality Index (AQI)

The AQI is a nationwide standard developed by the EPA for the criteria pollutants, and is used to report daily air quality. The number of "good" AQI days continued to dominate regionally in the Puget Sound area in 2004. However, air quality degraded into "moderate" or "unhealthy for sensitive groups" for brief periods.

The table below shows the AQI breakdown by percentage in each category for 2004. Pierce County registered the highest AQI value of 137 on November 5th. The greatest pollutant level determines the AQI. Fine particulate matter ($PM_{2.5}$) determined the AQI on November 5th. $PM_{2.5}$ typically determines the AQI in the Puget Sound area on days considered unhealthy for sensitive groups.

2004 AQI Ratings

County	AQI Rating (% of year)				Highest AQI
	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	
Snohomish	76%	23%	1%	-	116
King	70%	28%	2%	-	132
Pierce	67%	31%	2%	-	137
Kitsap	93%	7%	0%	-	80

Emissions Inventory

A 2004 inventory demonstrates that on-road vehicles continue to be the most significant contributors to both criteria pollutant and air toxics emissions in the Puget Sound airshed. Area sources such as outdoor and indoor burning are major contributors of $PM_{2.5}$ emissions.

Impaired Air Quality -- Burn Bans and Smog Watches

The Agency did not issue any burn bans in 2004, as the PM_{10} concentration required to initiate one was not reached. 2004 was the last full year with a PM_{10} burn ban "trigger". 2005 legislation changed the burn ban criteria to a fine particulate ($PM_{2.5}$) trigger. This new criteria will enable the Agency to better protect public health by issuing burn bans more effectively.

The Agency issued two Smog Watches in summer 2004: one from July 22nd through July 25th, and another from August 10th through August 14th. The Agency issued the watches because hot weather conditions and meteorology were conducive to ozone formation and entrapment. Ozone is often referred to as "smog." The Agency worked with meteorologists, news media, and local businesses to encourage people to take measures to reduce smog levels at this time.

Criteria Air Pollutants and Visibility

The Puget Sound area did not violate any National Ambient Air Quality Standards (NAAQS) in 2004. The area kept its status as maintenance for particulate matter, ozone, and carbon monoxide.

In most cases, pollutant concentrations fell well below standards. Ozone concentrations, while not violating the federal standard, have not reduced as significantly. With the exception of ozone, no criteria pollutants exceeded the federal standard in 2004. The 8-hour ozone standard of 0.084 ppm was exceeded once in 2004: 0.087 ppm on July 24th at the Enumclaw and North Bend monitoring sites.[5]

While federal NAAQS were achieved by the required statistical tests of monitored values, air quality in the region still falls short of local health goals. Daily concentrations of fine particulate matter ($PM_{2.5}$) at monitoring stations in King, Snohomish, and Pierce counties continue to exceed the health goal set by the Agency's Particulate Matter Health Committee.[6]

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

Air Toxics

Air toxics monitored by the Washington State Department of Ecology in 2004 are at levels consistent with 2000 levels, when air toxics monitoring was begun in the region. A comprehensive risk evaluation based on 2001 data demonstrated that air toxics are present in ambient air at levels associated with adverse health effects.[7] This evaluation showed that diesel particulate matter is the air toxic associated with the majority of potential cancer health risk in our area. Unfortunately, there is no direct monitoring method to measure diesel particulate matter. The Agency, the Washington Department of Ecology, and the University of Washington are using advanced monitoring methods to characterize indicators of diesel particulate matter.

Air toxics ambient concentrations have only been collected in this area for five years, a time period too short to characterize trends. Air toxics that were *monitored directly in 2004* were ranked according to potential cancer risk. Formaldehyde and benzene, both from vehicles and other combustion, presented

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[5] The July 24th ozone concentration exceeded the federal standard; however, it did not violate the standard. In order to violate the 8-hour ozone standard, the three-year average of the 4th highest 8-hour concentration must exceed 0.084 ppm.

[6] The federal standard for daily $PM_{2.5}$ concentrations is currently 65 $\mu g/m^3$. Our Board of Directors adopted a more stringent goal based on recommendations of our Particulate Matter Health Committee. The Committee conducted a systematic review of health data and determined that a daily average of 25 $\mu g/m^3$ is protective of human health.

[7] Puget Sound Final Air Toxics Evaluation. 2003. http://www.pscleanair.org/news/other/psate_final.pdf.

the highest potential cancer risk. Chromium and arsenic, from combustion of distillate oil, wood, and industrial facilities, ranked highest among seven air toxics metals monitored in 2004. It is important to note that this ranking does not include diesel particulate matter.

Air Quality Index

The 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.[8] The "worst denominator" determines the 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 on page 104 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.

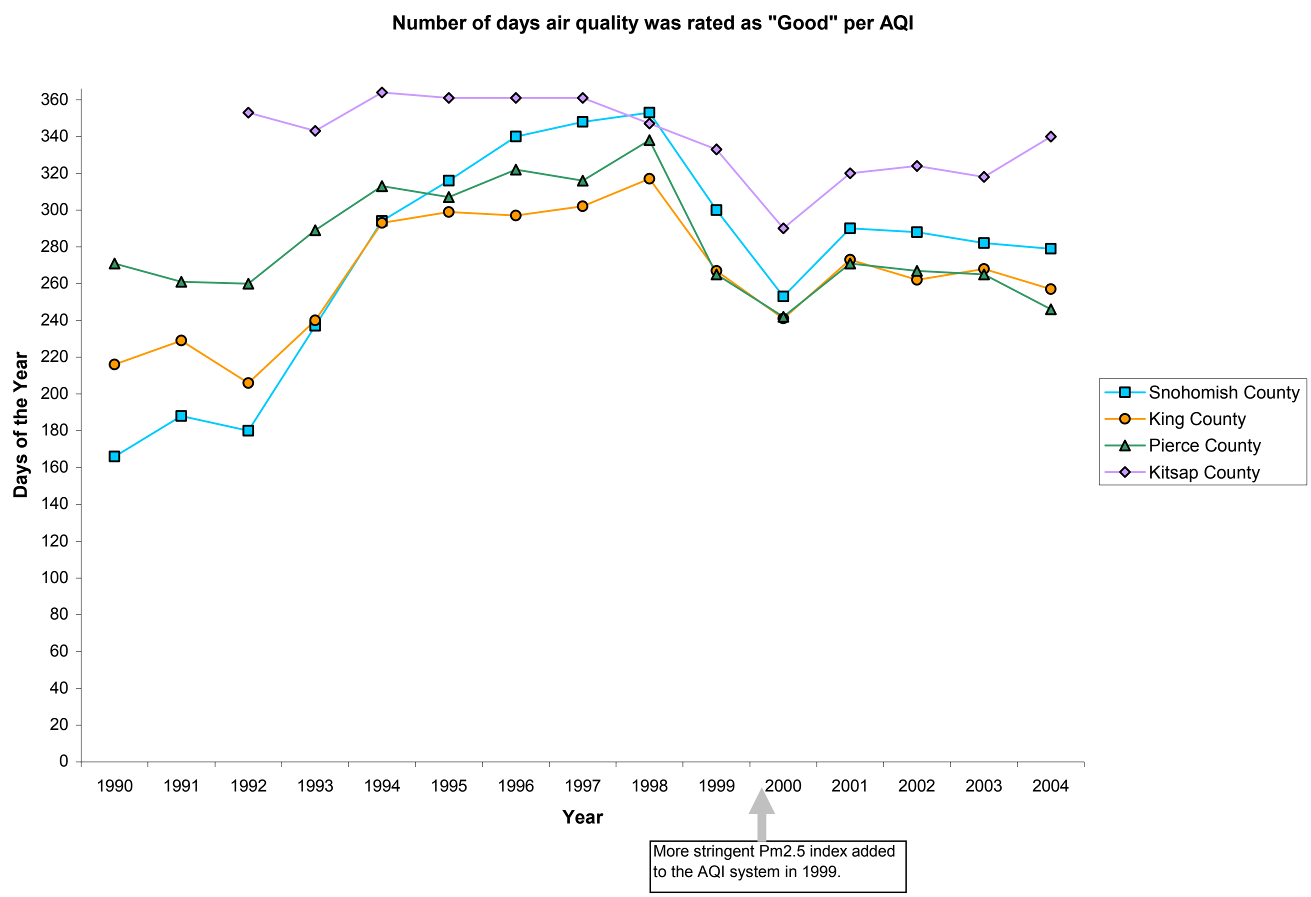
The AQI is a national index, so the values and colors used to show local air quality and the associated level of health concern will be the same throughout the United States. Current and archived AQI values for Puget Sound can be found on our website at www.pscleanair.org.

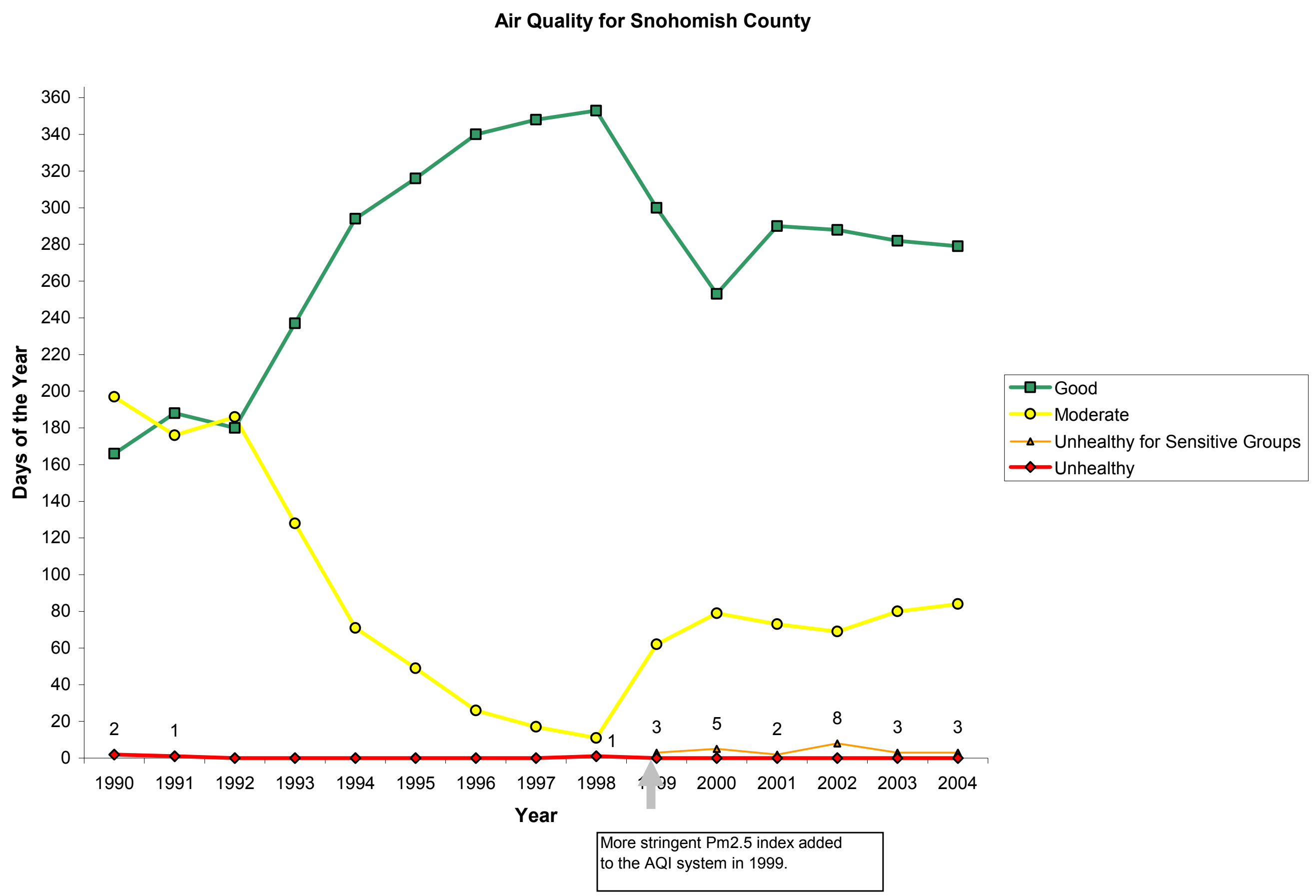
The number of "good" air quality days continues to dominate regionally in the Puget Sound area. However, air quality degraded into "moderate" or "unhealthy for sensitive groups" for brief periods. The table presented in the executive summary shows the AQI breakdown by percentage in each category for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

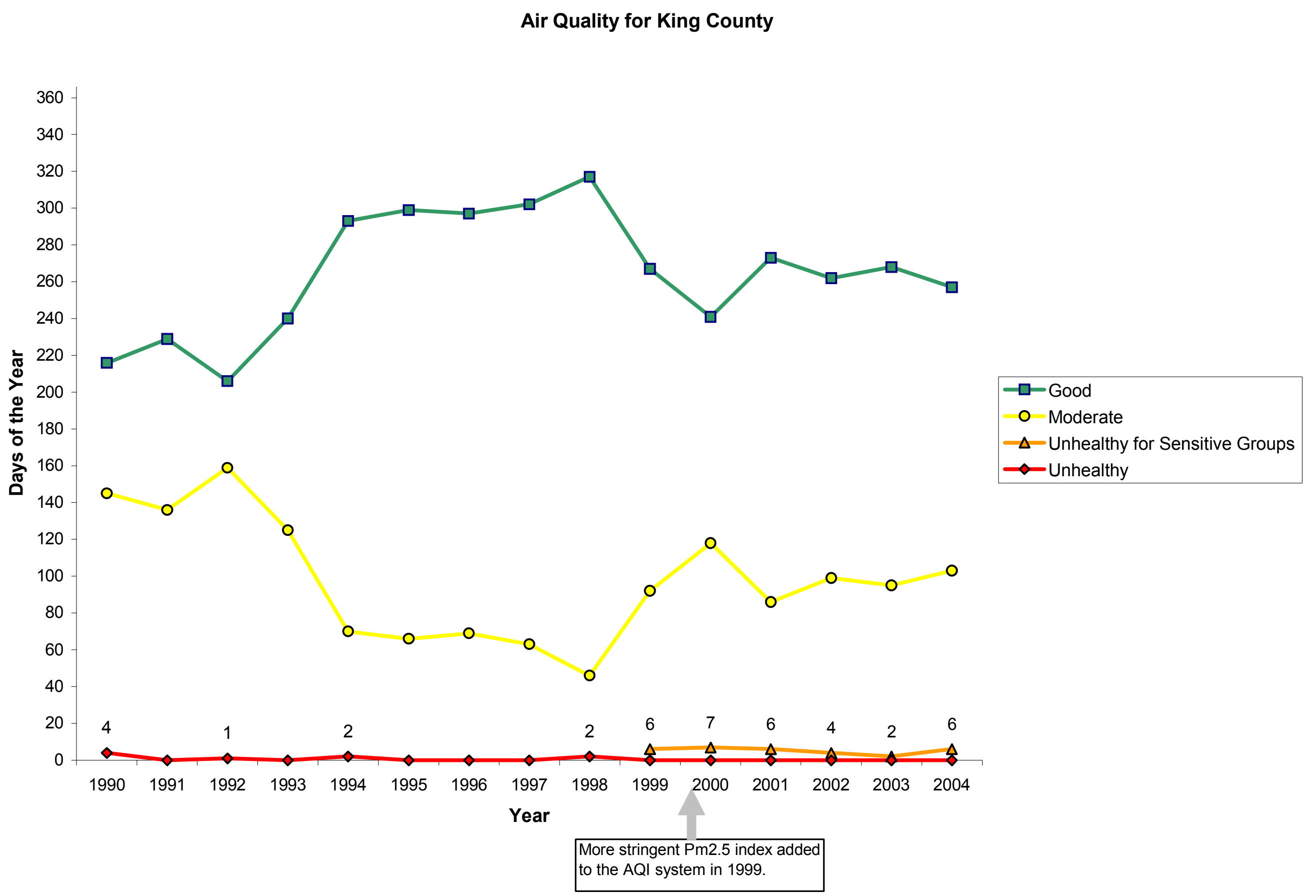
The graph on page 8 presents the annual number of "good" days for each of the four counties. The number of "good" days has been relatively constant over the last few years for each county. Lower numbers of "good" days now can not be directly compared with the numbers before 1999, when $PM_{2.5}$ was added to the index and the "unhealthy" category was divided into "unhealthy" and "unhealthy for sensitive groups."

[8] Lead is not included in the AQI.

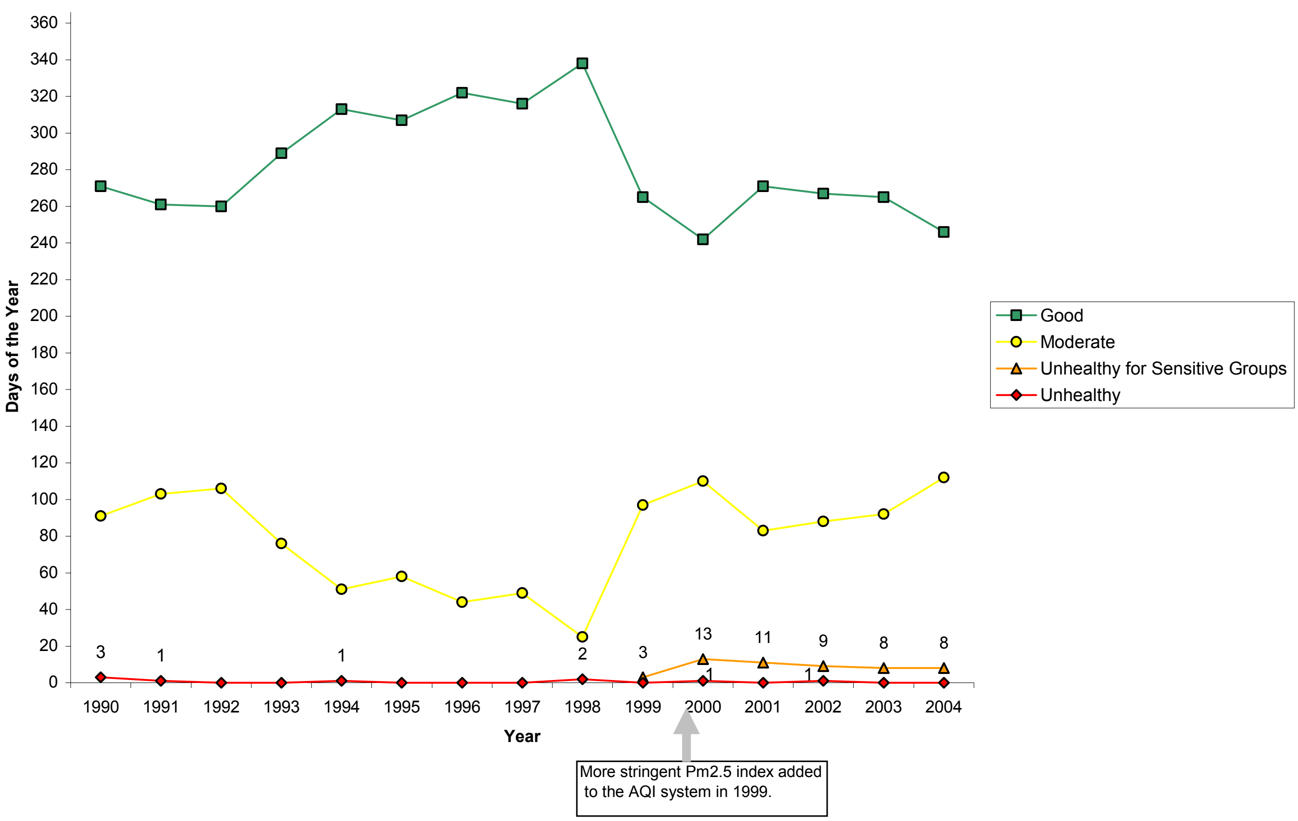
Graphs on pages 9 through 12 present all types of days recorded for Snohomish, King, Pierce, and Kitsap. Graphs include numbers adjacent to the "unhealthy for sensitive groups" and "unhealthy" lines for clarification of the number of days with these designations. Pages A-1 through A-4 of the Appendix present summaries for each county.

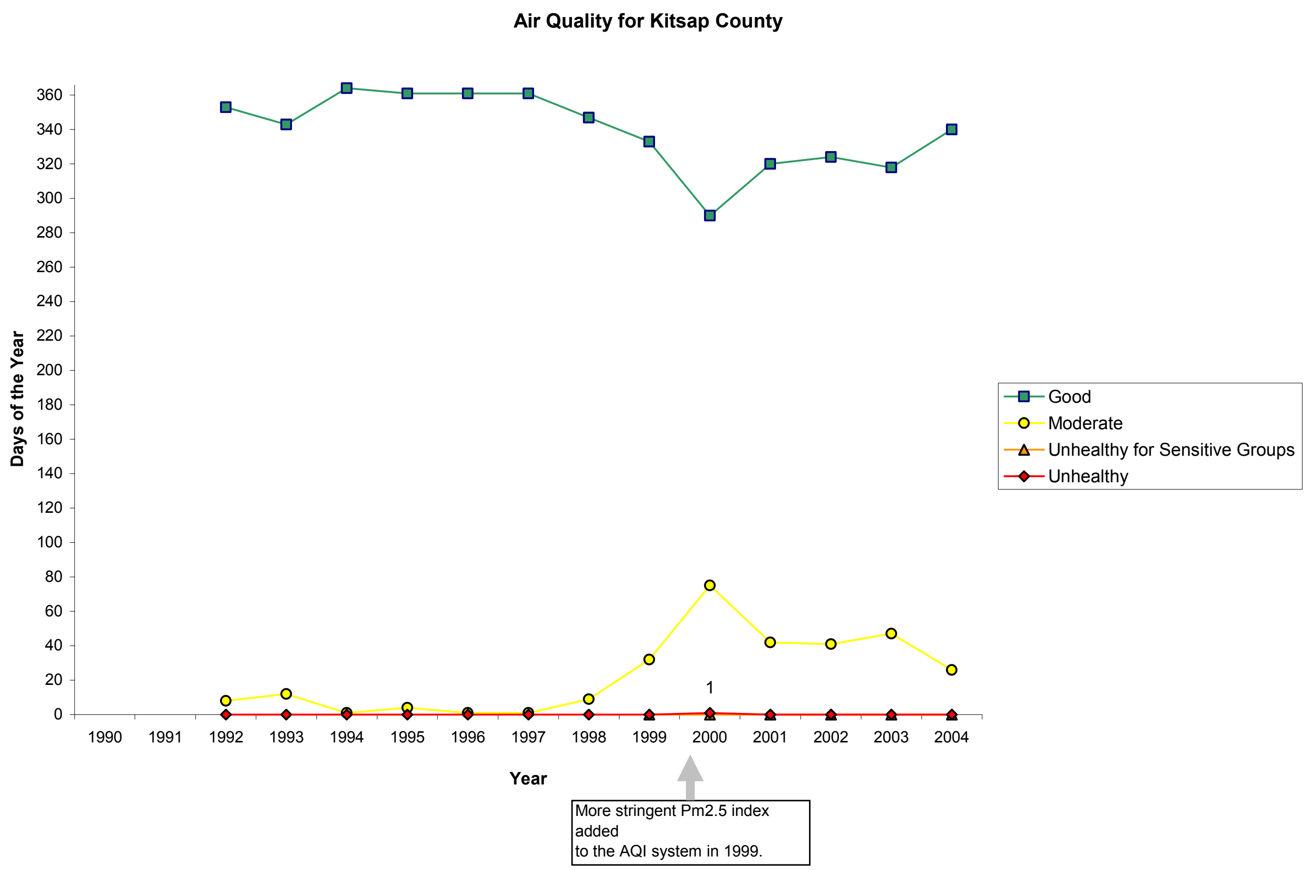



Air Quality for Snohomish County
Days of the Year
Year
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
More stringent Pm2.5 index added to the AQI system in 1999.


Air Quality for King County
Days of the Year
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
4
1
2
2
6
7
6
4
2
6
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
More stringent Pm2.5 index added to the AQI system in 1999.

Air Quality for Pierce County




Air Quality for Kitsap County
Days of the Year
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
More stringent Pm2.5 index added
to the AQI system in 1999.

Monitoring Network

The Agency and the Washington State Department of Ecology operate the Puget Sound 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 currently working with theWashington State Department of Ecology and other local air agencies to improve the efficiency of the telemetry network.

The table on pages 15 through 19 presents a summary of the monitoring stations used and parameters monitored from 1999 through 2004. Some parameters were monitored for only part of this time frame.

Monitoring stations are located in different types of areas in the Puget Sound region. Most are located in highly populated areas. Monitors are also located in representative rural areas. The EPA provides specific siting criteria. These criteria were developed to ensure a consistent and representative picture of air quality in the overall area. The monitoring network map on page 20 shows monitoring stations that were active in 2004, and reflects this attempt at a representative picture.

The station IDs shown on the map correspond with table identification letters. These same identification numbers 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 group of sources (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, they measure particulate matter using more than one method. These additional methods help engineers and scientists to 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.

The table on page 21 lists the methods used for the criteria pollutants. Additional information on these methods is available at EPA's website: http://www.epa.gov/ttn/amtic/. Information on air toxics monitoring methods is available at http://www.epa.gov/ttn/amtic/airtox.html.

Fine Particulate Monitoring – Federal Reference Method and Continuous Methods

Fine particulate ($PM_{2.5}$) is measured using a variety of methods in the Puget Sound region. The EPA considers the federal reference method (FRM) to be the most accurate way to determine $PM_{2.5}$ concentrations.[9] This method involves pulling in air (at a given flow rate) and trapping particles of a certain size (in this case $PM_{2.5}$) on a filter. The filter is then weighed and divided by 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 timely information.

The Agency uses the FRM as well as three continuous methods to provide more time-relevant data. These methods determine fine particulate matter concentration differently:

- the nephelometer uses scattering of light
- the tapered element oscillating microbalance (TEOM) measures mass
- the beta-ray attenuation monitor (BAM) measures beta-ray transmission across a filter tape

Special Monitoring Projects

In addition to the network described in this section and presented on the map on page 20, the Agency occasionally conducts short-term monitoring projects to address specific data needs. Two special projects were conducted in 2004: one monitoring sulfur dioxide and nitrogen oxide in south and west Seattle, and another measuring fine particulate matter in Snohomish County. Please refer to our website for additional information on special projects.

[9] The EPA also accepts continuous methods that have been adjusted to make them "FRM-like."

Monitoring Network for 1999-2004

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_x	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
AO⦿	Northgate, 310 NE Northgate Way, Seattle												●						b, d, f
AQ	Queen Anne Hill, 400 W Garfield St, Seattle (began Mar 1, 2001) (photo/visibility included)							●						●				●	a, d, f
AR⦿	4th Ave & Pike St, 1424 4th Ave, Seattle												●						a, d
AS⦿	5th Ave & James St, Seattle (ended Feb 28, 2001)												●						a, d
AU⦿	622 Bellevue Way NE, Bellevue (ended Jul 30, 1999)												●						a, d
AZ	Olive Way & Boren Ave, 1624 Boren Ave, Seattle SPECIATION SITE[10] (began Jan 16, 2003)							●	●					●	●			●	a, d
BF⦿	University District, 1307 NE 45th St, Seattle												●						b, d
BU⦿	Highway 410, 2 miles E of Enumclaw (ended Sep 30, 2000)									●									c, e
BV⦿	Sand Point, 7600 Sand Pt Way NE, Seattle														●	●			b, d
BW⦿	Beacon Hill, 15th S & Charlestown, Seattle SPECIATION SITE[10]				●		●	●	●	●	●	●	●	●	●	●	●	●	b, d, f
CE	Duwamish, 4752 E Marginal Way S, Seattle[11] SPECIATION SITE[10]	●		●	●		●	●	●		●			●	●			●	a, e

[10] Fine particulate ($PM_{2.5}$) speciation monitoring was conducted at four sites in 2004: Seattle Olive (AZ), Seattle Beacon Hill (BW), Seattle Duwamish (CE), and Lake Forest Park (DB).

[11] PM_{10} reference method monitoring ended 12/23/03.

Monitoring Network for 1999-2004

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_x	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
CW	James St & Central Ave, Kent[11]	●		●	●		●	●						●	●			●	b, d
CX	17711 Ballinger Way NE, Lake Forest Park (ended Jun 4, 1999)	●	●											●	●			●	b, d, f
CZ	Aquatic Center, 601 143rd Ave NE, Bellevue (began Oct 1, 2000)						●	●						●				●	b, f
DA	South Park, 8025 10th Ave S, Seattle (ended Dec 31, 2002)	●			●			●						●	●			●	b, e, f
DB	17171 Bothell Way NE, Lake Forest Park (began Mar 10, 1999)[12] SPECIATION SITE[10]	●	●		●		●	●	●					●	●			●	b, d, f
DC⦿	305 Bellevue Way NE, Bellevue (began Nov 2, 2000)				●			●						●					a, d
DD	South Park, 8201 10th Ave S, Seattle (began Jan 6, 2003)							●						●				●	b, e, f
DE⦿	City Hall, 15670 NE 85th St, Redmond (began Aug 4, 1999)				●			●						●					a, d
DF⦿	30525 SE Mud Mountain Road, Enumclaw				●					●									c
DG⦿	42404 SE North Bend Way, North Bend (began Jan 3, 1999)				●		●	●		●				●	●	●			c, d, f
DH⦿	2421 148th Ave NE, Bellevue (began Jan 1, 2000)												●						b, d
DK⦿	43407 212th Ave SE, 2 mi west of Enumclaw														●	●			c
DL⦿	NE 8th St & 108th Ave NE, Bellevue												●						a, d

[12] PM_{10} reference method monitoring ended 9/28/01.

Monitoring Network for 1999-2004

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_x	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
DN⦿	20050 SE 56th, Lake Sammamish State Park, Issaquah									●									b, d
DP⦿	504 Bellevue Way NE, Bellevue (ended Sep 30, 1999)	●			●														a, d
DZ⦿	Georgetown, 6431 Corson Ave S, Seattle (began Feb 1, 2000)											●	●		●				a, d, e, f
EA	Fire Station #12, 2316 E 11th St, Tacoma (ended Dec 31, 2000)	●	●												●				a, e
EP	27th St NE & 54th Ave NE, Tacoma (ended Feb 29, 2000)	●									●				●				b, e, f
EQ	Port of Tacoma, 2301 Alexander Ave, Tacoma[11]	●	●		●		●	●			●			●	●			●	a, e
ER	South Hill, 9616 128th St E, Puyallup[12]	●	●		●	●		●						●	●			●	b, f
ES	7802 South L St, Tacoma (began Oct 3, 1999)				●		●	●	●					●	●			●	b, f
FF⦿	5225 Tower Drive NE, northeast Tacoma														●	●			b, f
FG⦿	Mt Rainier National Park, Jackson Visitor Center (began May 1, 1999)									●									c
FH⦿	Charles L Pack Forest, La Grande									●									c, f
FL⦿	1101 Pacific Ave, Tacoma												●						a, d
ID	Hoyt Ave & 26th St, Everett (ended Feb 29, 2000)										●				●				a, e, d
IG	Marysville JHS, 1605 7th St, Marysville[12]	●	●		●		●	●						●	●			●	b, d
IH	20935 59th Place West, Lynnwood (ended Jun 8, 1999)	●		●										●	●			●	a, d
II	6120 212th St SW, Lynnwood (began Oct 1, 1999)				●		●	●						●	●			●	b, d

Monitoring Network for 1999-2004

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_x	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
JP⦿	2939 Broadway Ave, Everett (began Apr 1, 2001)												●						a, d
JQ⦿	44th Ave W & 196th St SW, Lynnwood												●						a, d
JS⦿	Broadway & Hewitt Ave, Everett (ended May 21, 2000)												●						a, d
QE	Meadowdale, 7252 Blackbird Dr NE, Bremerton[13]	●				●									●				b, f
QF	Lions Park, 6th Ave NE & Fjord Dr, Poulsbo (ended Feb 29, 2000)														●				b, f
QG	Fire Sta #51, 10955 Silverdale Way, Silverdale (began Jun 2, 2000)				●	●									●				a, d
UB⦿	71 E Campus Dr, Belfair (began May 1, 2002)									●									c
VK⦿	Fire Station, 709 Mill Road SE, Yelm (began May 1, 2000)									●									c. f

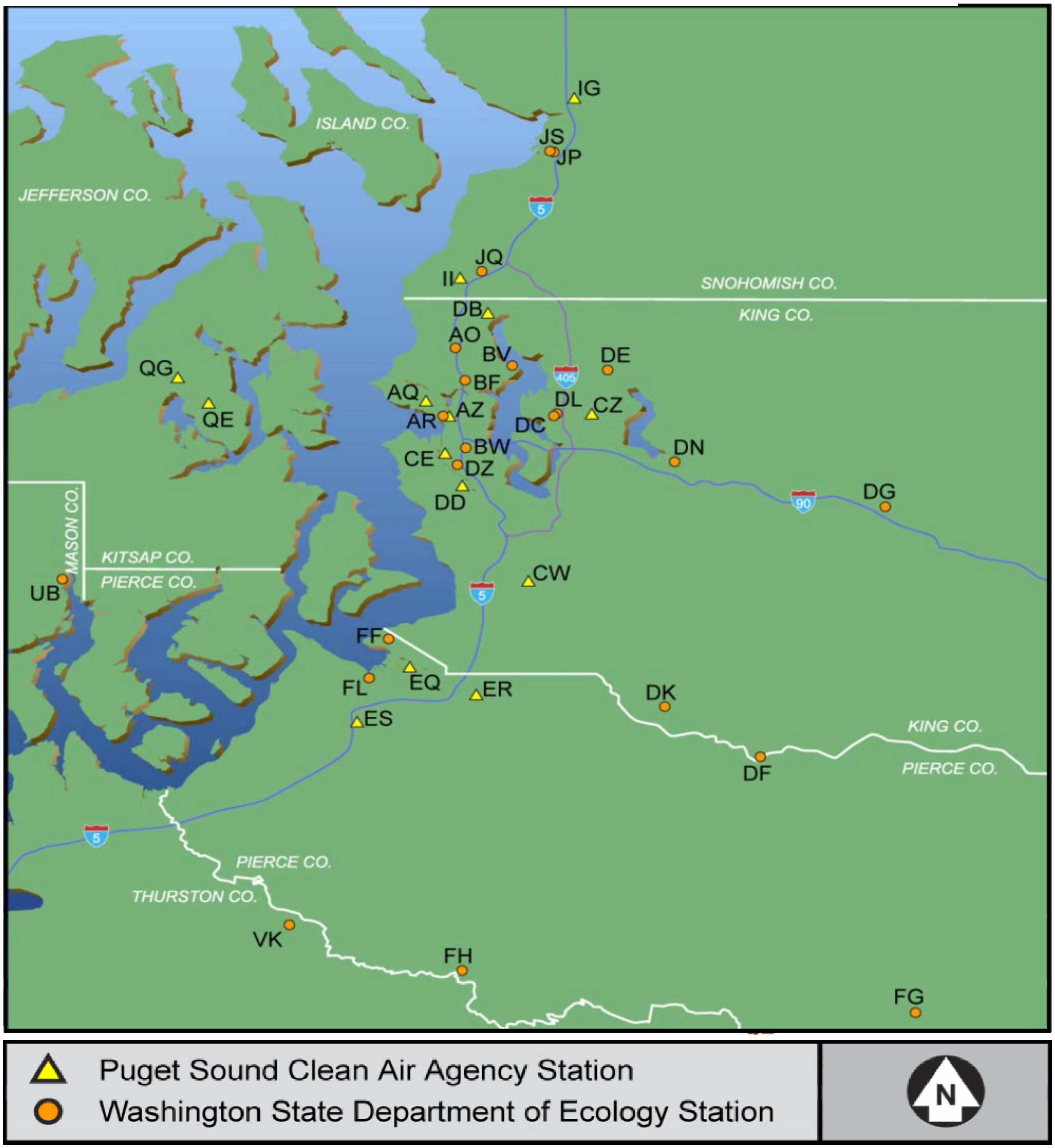
[13] PM_{10} reference method monitoring ended 12/26/99

Monitoring Network Table Notes:

⦿	Station operated by Washington State Department of Ecology
CX	Italics indicate a station not currently operating
PM_{10} ref	Particulate Matter 10 micrometers (reference)
PM_{10} bam	Particulate Matter 10 micrometers (beta attenuation continuous)
PM_{10} teom	Particulate Matter 10 micrometers (teom continuous)
$PM_{2.5}$ ref	Particulate Matter 2.5 micrometers (reference)
$PM_{2.5}$ bam	Particulate Matter 2.5 micrometers (beta attenuation continuous)
$PM_{2.5}$ teom	Particulate Matter 2.5 micrometers (teom continuous)
$PM_{2.5}$ ls	Particulate Matter 2.5 micrometers (light scattering nephelometer continuous)
$PM_{2.5}$ bc	Particulate Matter 2.5 micrometers black carbon (light absorption aethalometer continuous)
O_3	Ozone (May through September)
SO_2	Sulfur Dioxide
NO_x	Nitrogen Oxide
CO	Carbon Monoxide
b_{sp}	Light scattering by atmospheric particles (nephelometer)
Wind	Wind direction & speed
Temp	Air temperature (relative humidity also measured at Beacon Hill)
AT	Air Toxics
VSBY	Visual range (light scattering by atmospheric particles)
PHOTO	Visibility (camera)

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

2004 Monitoring Station Locations



Monitoring Methods Used from 1999 to 2004 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
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
SO_2	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	RM Young 05305 Wind Monitor AQ	Miles per Hour
	Wind Direction	RM Young 05305 Wind Monitor AQ	Degrees

Impaired Air Quality—Burn Bans and Smog Watch

Burn Bans

Washington state has a winter impaired air quality program targeting sources of particulate matter from wood stoves and fireplaces. According to the Agency's *Regulation I, Article 13 Solid Fuel Burning Device Standards*, the first stage of impaired air quality is reached when at any monitoring station:

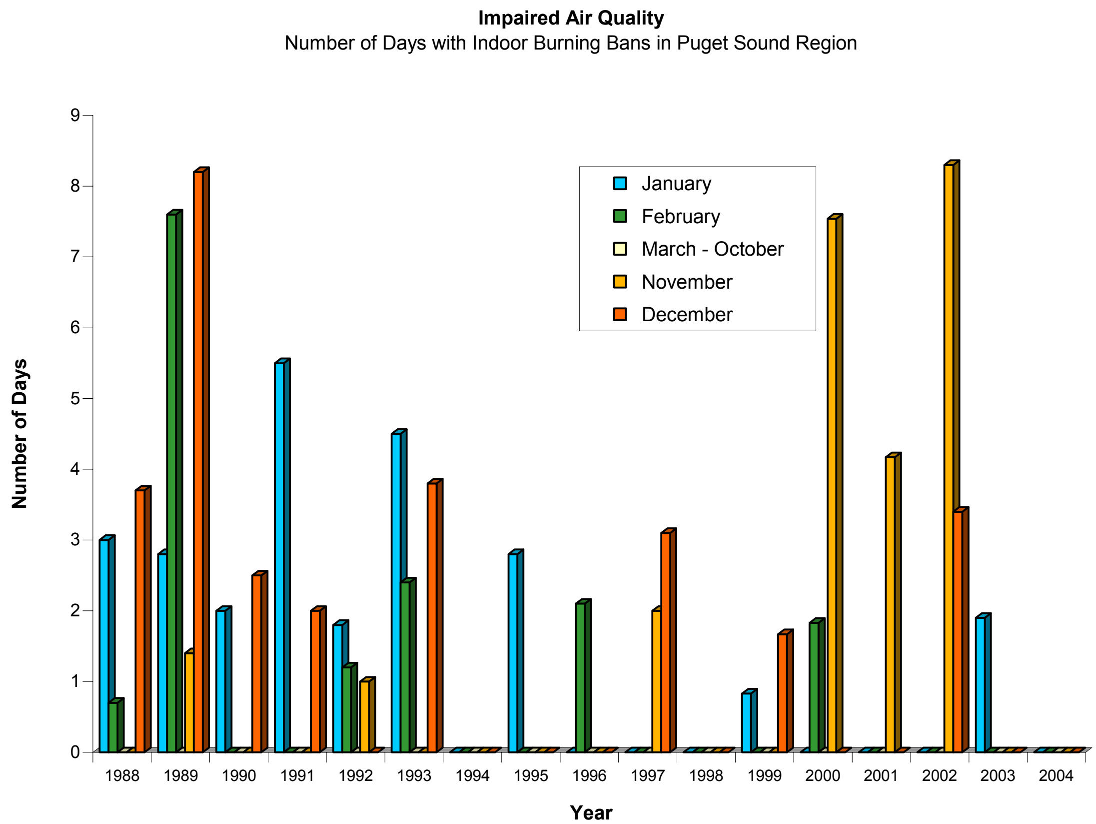
- PM_{10} concentrations (24-hour average) reach 60 µg/m^3, or
- Carbon monoxide concentrations (8-hour average) reach 8 ppm

At these levels, a first-stage burn ban may be declared. 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).[14] A second-stage burn ban may be declared when PM_{10} levels reach 105 µg/m^3 (24-hour average). For a second-stage burn ban, the use of any kind of wood-burning device is prohibited. The Agency has not issued a second-stage burn ban since 1991.

In decisions related to burn bans, the Agency considers that $PM_{2.5}$ levels, as the fine particulate fraction (<2.5 micrometers), are more indicative of wood smoke than PM_{10}, which also contains a coarse particulate fraction (2.5-10 micrometers). The Washington State Legislature passed a bill in early 2005 to reflect this. In the future, elevated fine particulate matter concentrations will trigger burn bans.

Burn bans typically occur in November through February. No burn bans were issued in 2004. The graph on page 23 shows the number of days when burn bans have been declared since 1988.

[14] Uncertified wood stoves emit much 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/burning/indoor/index.shtml#facts.



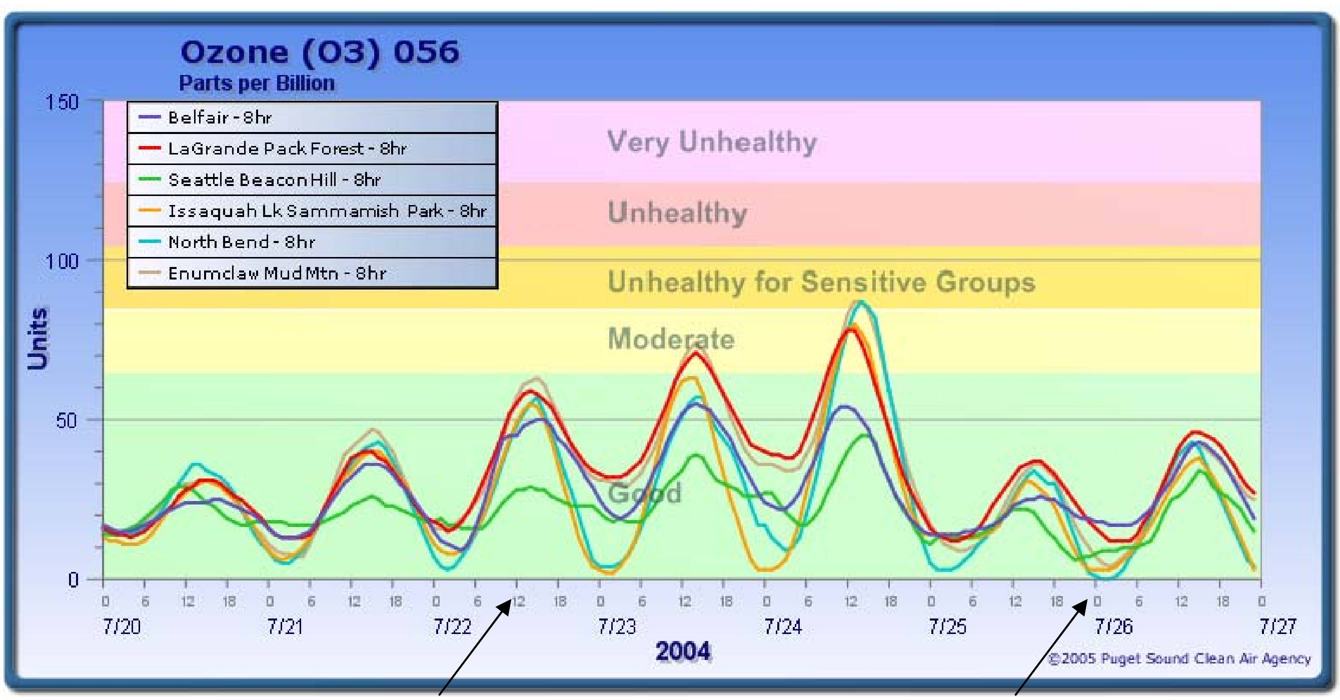
Smog Watch

The Agency maintains a voluntary air quality program called Smog Watch. This program addresses causes of summer smog between June and September through outreach awareness. Smog Watch advises residents of potential smog problems and recommends short-term actions to help reduce ozone levels. Summer smog typically becomes a problem on hot stagnant summer days when ozone accumulates. 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 included 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.

There were two Smog Watches issued during the summer of 2004. The first was issued on July 22nd and lasted through July 25th. The second Smog Watch was issued on August 10th and lasted through August 14th. Both periods included hot weather and large domes of high pressure that trapped pollutants near the surface. The graphs on the following pages show AQI ozone levels at six different monitoring sites before, during, and after these periods.[15] The arrows on the graphs mark the beginning and end of Smog Watches. The North Bend and Enumclaw monitoring sites moved into the "unhealthy for sensitive groups" AQI group during the July Smog Watch. Ozone was the 'driving pollutant' for the AQI during this time period. 8-hour ozone concentrations are shown on page A-11 of the Appendix.

July 2004 Smog Watch Event



Smog Watch Started

Smog Watch Ended

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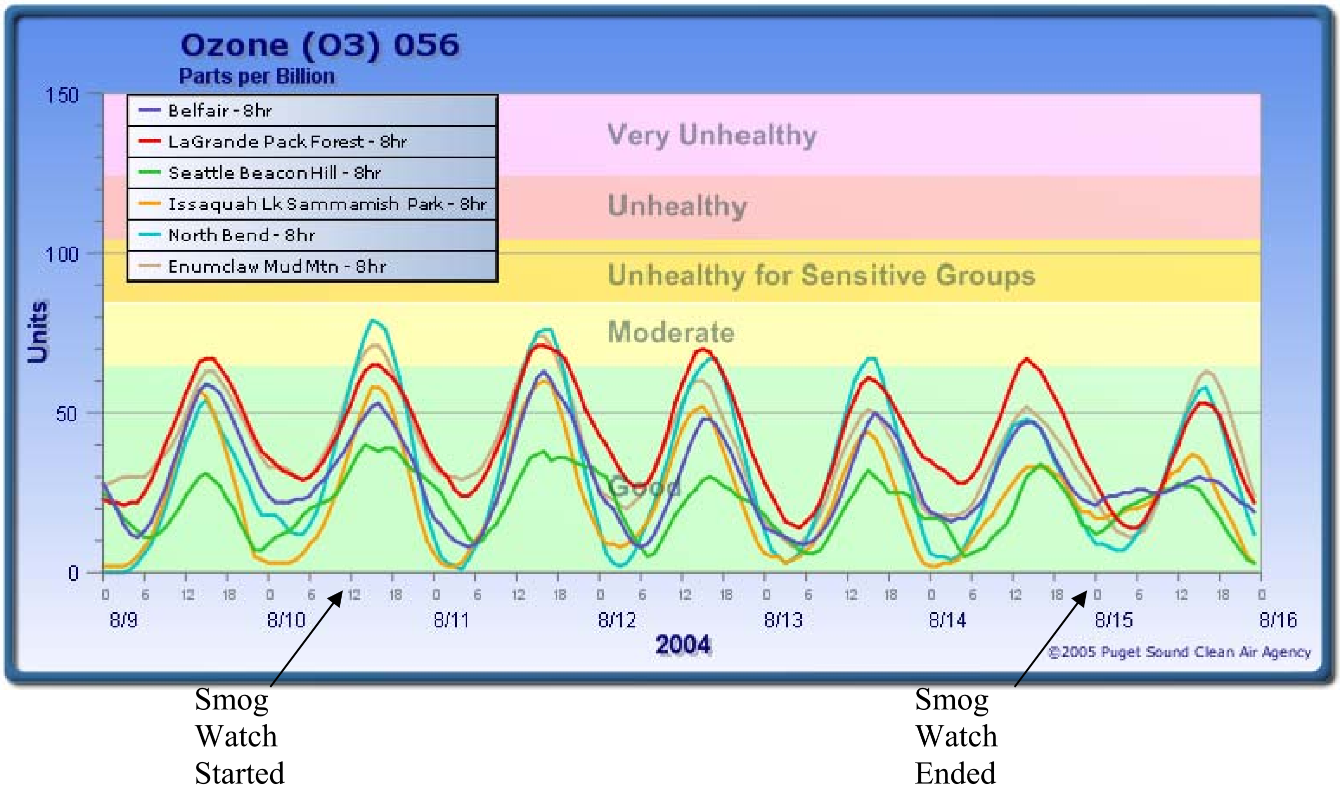
[15] Ozone AQI levels are based on 8-hour ozone concentrations. The number "056" on these graphs is the pollutant code for ozone.

August 2004 Smog Watch Event



Regional Emissions Inventory

Introduction

This section presents an air emissions inventory summary for four criteria air pollutants: carbon monoxide(CO), nitrogen oxides (NO_X), fine particulate matter ($PM_{2.5}$), and sulfur dioxide (SO_2). An emission inventory is also presented for volatile organic compounds (VOCs). VOCs, like NO_X, are precursors of ozone, another criteria air pollutant. This section also summarizes greenhouse gas and air toxics emission inventories.

The Agency conducts emission inventories to identify sources of pollutants. Once identified, emissions can be reduced through strategies such as improved control technologies, education and outreach targeting specific behavior changes, regulatory changes, and economic incentives.

The National Emission Inventory (NEI) is prepared by the EPA every three years with input from local and state agencies. The Agency conducts comprehensive emission inventories for criteria air pollutants and air toxics in NEI years. 2002 was the last NEI year. A complete description of the 2002 NEI, including detailed appendices, is presented in the Agency's 2003 AQDS.

The criteria air pollutant inventory presented below is an interim-year inventory, which means the Agency made adjustments to the 2002 NEI inventory. These adjustments may include the most recently available activity levels such as: vehicle miles traveled, acres burned, and updated population information and surveys. Readers familiar with the 2003 AQDS will note that emission inventory estimates are very similar to the 2004 inventory presented below.

Source Categories

Four general categories characterize anthropogenic (caused by humans) emission sources. The four general categories are listed below, with some major subcategories bulleted. In addition to these four, biogenic (naturally-occurring) sources also emit pollutants. Examples include volatile organic compounds emissions from trees and plants and nitrous oxides 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 improved control technology and regulation, and closure of some large industrial facilities, particularly smelters.

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, and behavior changes such as carpooling and teleworking.

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. The 2004 emission inventory separates mobile non-road sources into three subcategories: off-road vehicles and equipment, marine vessel emissions, and aircraft and airport emissions. 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, recently committed to an exhaustive inventory of greater Puget Sound to quantify emissions. This inventory will provide a level of detail beyond the NEI inventory.

Reduction strategies for mobile non-road sources include: better fuels such as ultra-low sulfur and biodiesel, use of electrical lawn equipment, ship use of land-based electricity while in port (instead of running engines to generate electricity), 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 make them significant contributors to pollution in this region. The 2004 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 commercial businesses. Small business activities that emit pollutants include solvent loss during surface coating, and degreasing. Road dust is also included as an area source, significant for $PM_{2.5}$.

Reduction strategies for stationary area sources include: less indoor burning and cleaner indoor burning (use of EPA-certified wood stoves and inserts), less outdoor burning (including larger areas where burning is prohibited), use of low-emission paints and solvents, and improved practices such as closed-loop dry cleaning machines.

2004 Emission Inventory

The Agency modified the 2002 draft NEI to estimate 2004 emissions for criteria air pollutants, VOCs, and carbon dioxide. Carbon dioxide is presented as a major greenhouse gas. The 2004 inventory includes anthropogenic sources listed above. Biogenic emissions sources such as vegetation and soil are also included where appropriate.

As with any emission inventory, the 2004 inventory has a level of uncertainty. This uncertainty comes from estimation of activity levels, such as how often people burn wood in a fireplace, or how far and often people drive in their cars. Surveys designed to provide this data inevitably have limitations in sample size, population reached, and results interpretation. In addition to activity level uncertainty, there is also the question of the emission factors themselves. These values designate how much of a pollutant is released from a certain activity, and are typically developed by EPA, in consultation with state and local air agencies and industry. Some of these emission factors are based on several studies, and some are based on only a few. Emission factors may also vary under different circumstances. Additional information on emission factors and how they are derived is available on EPA's website at http://www.epa.gov/oar/oaqps/efactors.html.

The following table presents the contributions from each major source category for criteria pollutants, VOCs, and carbon dioxide. $PM_{2.5}$ is listed for particulate matter.

Puget Sound Region 2004 Estimated Criteria Air Pollutant Emission Inventory Summary (thousands of tons)[16]

Source Category	$PM_{2.5}$	NO_x	SO_x	CO	VOC
Point Sources (Large Facilities)	**1**	**8**	**3**	**6**	**4**
On-road Mobile Sources	**2**	**106**	**4**	**931**	**80**
On-road Gasoline Vehicles	*1*	*63*	*3*	*920*	*78*
On-road Diesel Vehicles	*1*	*42*	*1*	*11*	*2*
Non-Road Mobile Sources	**4**	**41**	**5**	**315**	**25**
Marine Vessels and Watercraft	*2*	*14*	*2*	*28*	*6*
Off-road Vehicles and Equipment	*2*	*23*	*2*	*261*	*17*
Aircraft and Airport Equipment	*0.2*	*3*	*0.2*	*26*	*2*
Stationary Area Sources	**23**	**9**	**1**	**59**	**74**
Outdoor Burning	*10*	*2*	*0.5*	*30*	*4*
Indoor Wood Burning	*4*	*1*	*0.1*	*25*	*13*
Other Sources	*9*	*6*	*0.1*	*3*	*57*
Biogenic Sources	**0**	**2**	**0**	**0**	**71**
Totals	**29**	**165**	**12**	**1,311**	**255**

This 2004 inventory demonstrates that on-road vehicles continue to be the most significant contributor to criteria pollutant emissions in the Puget Sound airshed. Area sources are the major contributor of $PM_{2.5}$ emissions**.** Each pollutant is discussed briefly below, and information in the table above is presented in graphs.

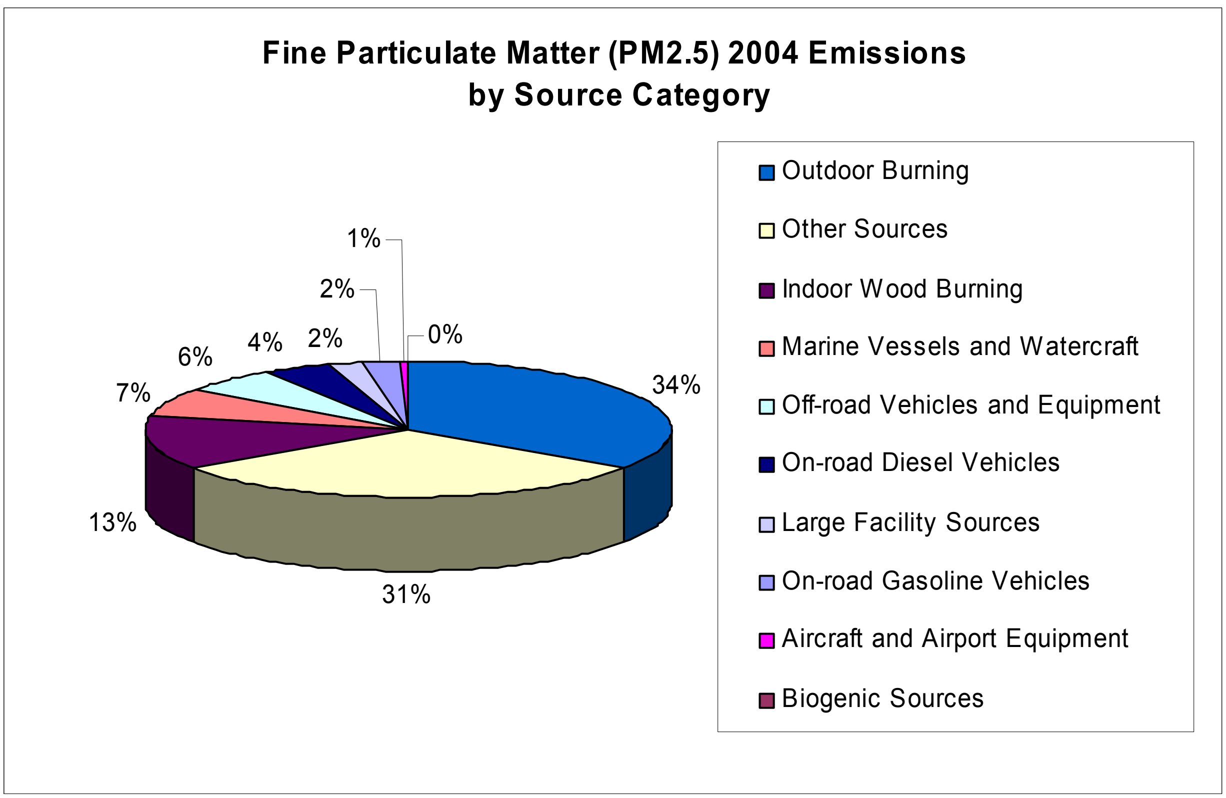
[16] Totals represent rounding to the nearest thousand tons and are not simply the sum of the rounded subcategory values.

Particulate Matter ($PM_{2.5}$)

Burning wood (included in stationary area soures) is clearly the largest contributor to fine particulate matter in the Puget Sound area. Outdoor and indoor wood burning estimates combined contribute almost half of the fine particulate contribution of all area sources. Less burning and cleaner burning practices are the reduction strategies to reduce emissions from these categories.

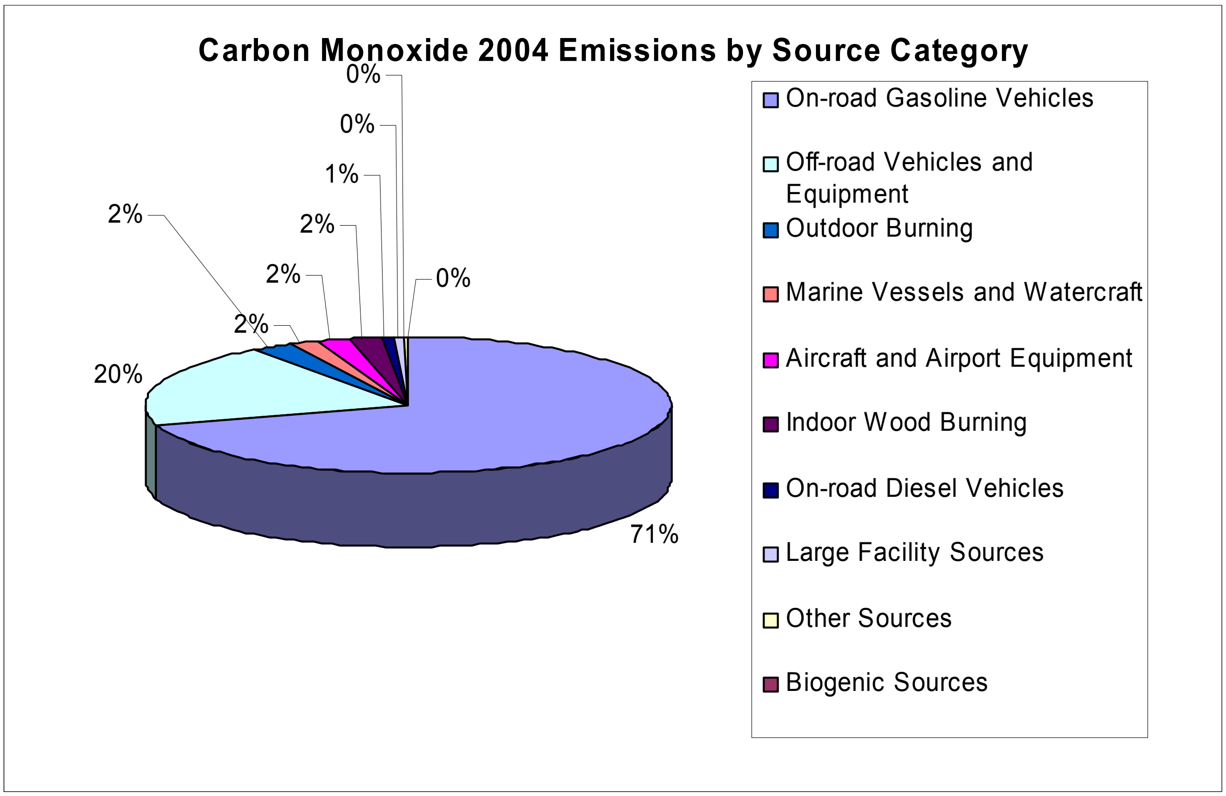
The "Other" category for $PM_{2.5}$, with 31% of emissions, is largely made up of dust from paved and unpaved roads and dust from construction. Fine particulate from cooking, particularly charbroiling and deep frying, is also included in this category.

All mobile sources, including on-road and non-road, contribute 20% of overall $PM_{2.5}$ emissions in the Puget Sound area.



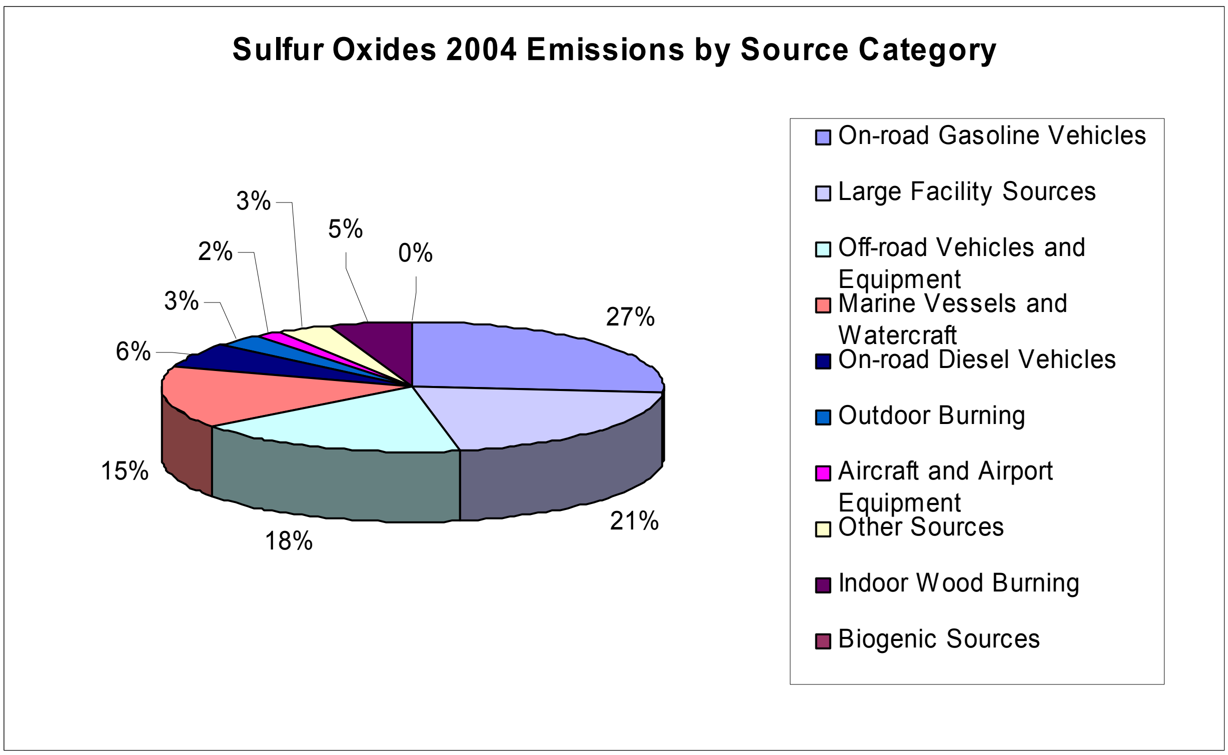
Carbon Monoxide

On-road gasoline vehicles, such as cars, trucks, and SUVs, are clearly the greatest contributor of carbon monoxide (CO) emissions in the Puget Sound area. CO is not a pollutant prioritized for reduction strategies in the Puget Sound area, as ambient levels are typically very low.



Sulfur Dioxide

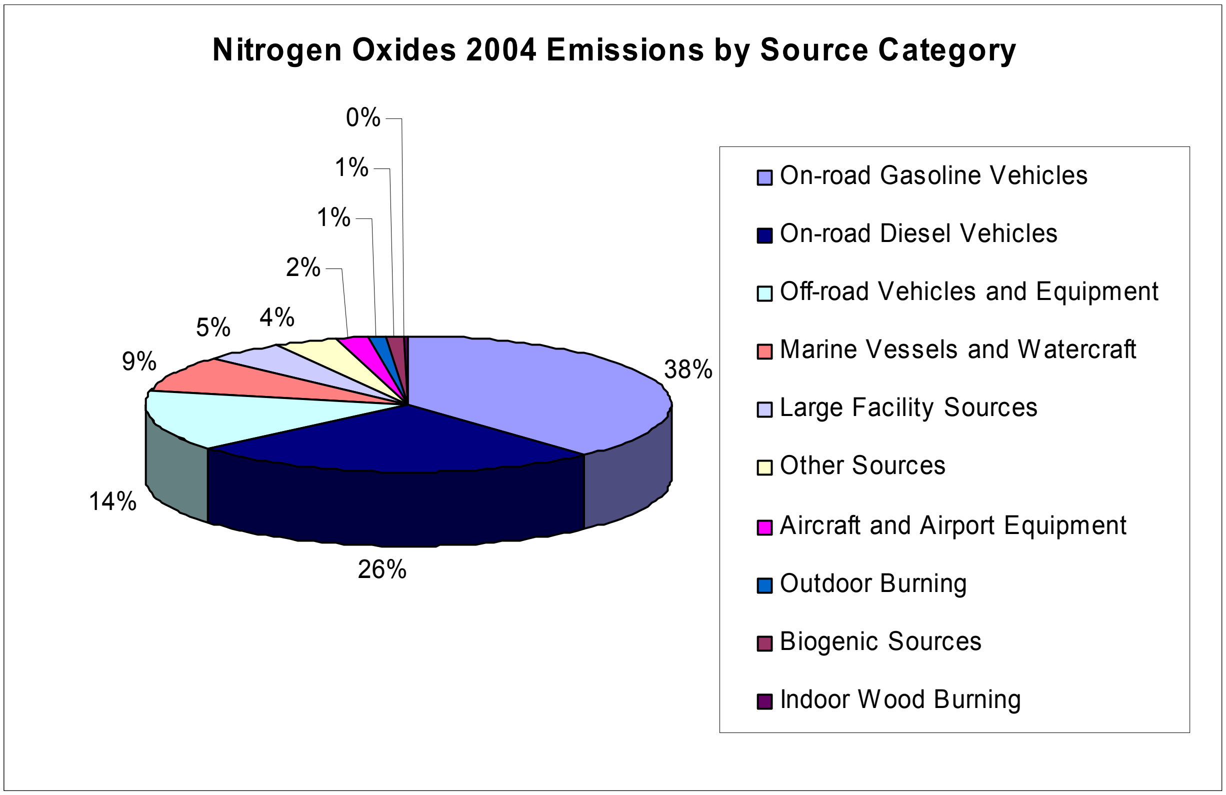
On-road gasoline vehicles comprise the greatest portion of contributors of SO_x emissions, with almost one third of the total contribution.[17] Large facilities and off-road vehicles and equipment also contributed a significant portion, with over 20% and almost 20%, respectively. Greater distribution and use of ultra-low sulfur fuel is the main strategy to reduce SO_x emissions from these sources.



[17] Sulfur oxides include predominantly sulfur dioxide, as well as other oxides of sulfur.

Nitrogen Oxides

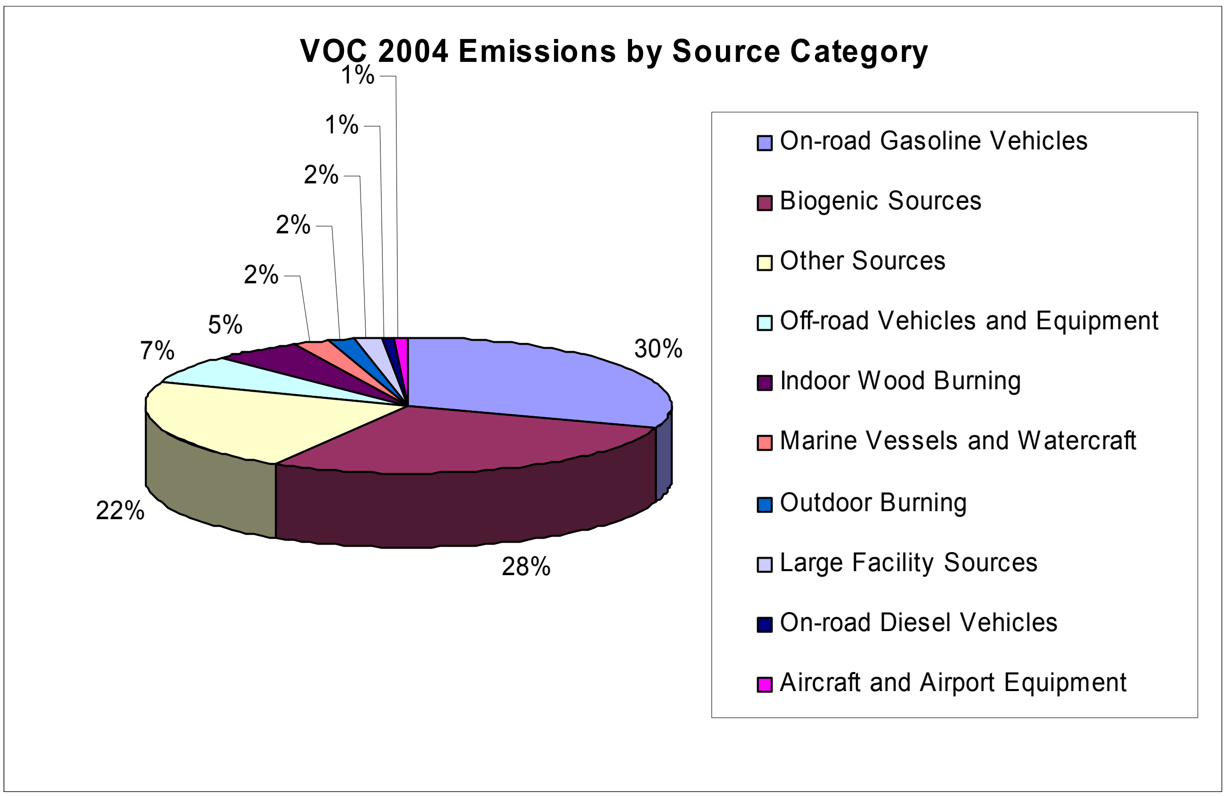
On-road vehicles are the greatest source of emissions of nitrogen oxides (NO_X), with 64% of the total source contribution between gasoline and diesel vehicles. In addition to being a criteria air pollutant, NO_X also contributes to the formation of ozone, another criteria air pollutant.[18]



[18] Nitrogen dioxide is a criteria pollutant. Nitrogen oxides (NO_X) include nitrogen dioxide as well as other oxides of nitrogen.

Volatile Organic Compounds

VOCs are a primary precursor for ozone, a criteria pollutant. The graph below shows that on-road vehicles contribute a large portion of VOC emissions, with 30% of the total. Biogenic sources are also a significant contributor of VOC emissions (28%), since trees and plants release significant quantities of VOCs. The "Other" category includes evaporation of VOCs from paints, solvents, and fuels. Indoor burning and outdoor burning are shown as 5% and 2% contributors, respectively, in this annual emission inventory. The EPA emission factor for calculating VOCs from fireplace burning may be high when compared to open burning VOC factors, hence, indoor burning VOC emissions may not be as significant as presented here.



Greenhouse Gases

The Agency conducted a complete greenhouse gas emissions inventory for year 2000 emissions as part of its Climate Protection Advisory Committee process. This inventory included the six types of gases included in the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. This inventory showed that the transportation sector contributed half of all greenhouse gases in the Puget Sound area. A complete description of this inventory and the roadmap to reduce global warming emissions in our area is provided in the report.[19]

[19] Roadmap for Climate Protection: Reducing Greenhouse Gas Emissions in Puget Sound. The Puget Sound Clean Air Agency Climate Protection Advisory Committee. http://www.pscleanair.org/specprog/globclim/cpsp/pdf/rptfin.pdf.

Air Toxics

As described earlier in this report, air toxics are a large group of pollutants associated with adverse health effects. Some air toxics are also VOCs. The Agency conducted an air toxics emissions inventory for the 2002 NEI, and is currently working on the 2005 NEI air toxics inventory. Due to the large number of pollutants involved, the Agency will not complete an interim-year air toxics inventory.

The chart below is based on the 2002 emissions inventory and represents emissions from hazardous air pollutants, a subset of 188 air toxics designated by EPA. The categories are not broken down as completely as other pollutants: non-road mobile is not broken down into subcategories, for example.

On-road gasoline vehicles contributed the greatest amount of air toxics. Emissions of toluene, xylenes, and benzene made up the majority of this contribution. Formaldehyde, an air toxic of concern, also has significant emissions from on-road vehicles.

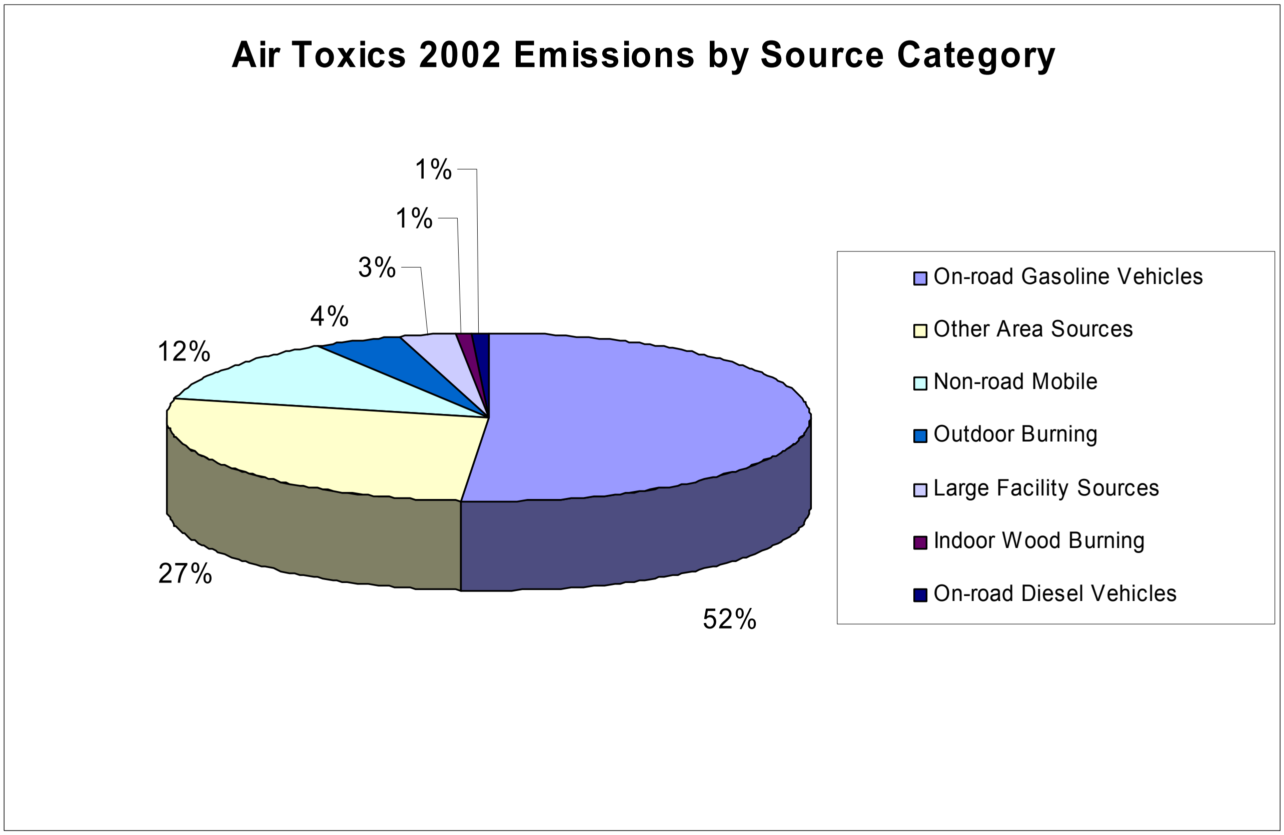
Two significant area source categories are shown individually on the chart below, outdoor (4%) and indoor burning (1%). Toluene and formaldehyde are two significant air toxics in these burning groups. The "Other" section of area sources (27% of total) includes emissions from a variety of sources, primarily industrial, commercial, and residential solvent use.

It is ***very important*** to note that the chart below shows only the estimated amount of pollutant emitted. It is essential to look at both the amount and toxicity of air toxics when assessing risk and prioritizing reductions. A perfect example is diesel exhaust. Although diesel vehicles contribute a small amount to the total amount of air toxics (less than 1%), this small amount translates to high risk because of the high toxicity of diesel particulate matter, a component of diesel exhaust. Thus, diesel vehicles are highly prioritized for emission reductions.

The air toxics of greatest concern in the Puget Sound area include diesel particulate matter, wood smoke, benzene, formaldehyde, acetaldehyde, chromium, 1,3-butadiene, and acrolein. These toxics are of concern because of the amount of them in our local airshed, as well as their toxicity.

Actions for reducing these main toxics of concern include installing retrofit technology on diesel vehicles and equipment, substituting cleaner cars such as hybrids for older dirtier ones, and replacing wood burning with cleaner alternatives (propane, natural gas, or electricity).

More specific information about the 2002 air toxics inventory is available upon request.


Air Toxics 2002 Emissions by Source Category
1%
1%
3%
4%
12%
27%
52%
On-road Gasoline Vehicles
Other Area Sources
Non-road Mobile
Outdoor Burning
Large Facility Sources
Indoor Wood Burning
On-road Diesel Vehicles

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 primarily protect the general 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. The EPA has established standards for six criteria pollutants. The list below contains seven pollutants, which includes two size ranges of particulate matter.

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, the EPA air quality standards and supporting rationale are available on the web 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.[20] The air quality standards that apply to the Puget Sound airshed are summarized in the table on page 39.

In addition to air quality standards, the Agency has developed an air quality health goal for $PM_{2.5}$. The Agency convened a Particulate Matter Health Committee, comprised of local health professionals, and conducted an extensive process to examine the fine particulate standard.[21] The Health Committee does not consider the federal standard to be protective of human health. The Agency adopted a health goal of 25 $\mu g/m^3$ for a daily average, well below the current 65 $\mu g/m^3$.

The EPA is also currently in the process of potentially revising the fine particulate NAAQS. Preliminary recommendations for a new standard propose daily and annual averages lower than current federal standards.[22,23] EPA may propose a new, lower fine particulate NAAQS in late 2005 based on these recommendations. Such a move may bring the federal standard closer to the Agency's local health goal of 25 $\mu g/m^3$.

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[20] Washington Administrative Code chapters 173-470, 173-474, and 173-475

[21] Final Report of the Puget Sound Clean Air Agency $PM_{2.5}$ Stakeholder group. http://www.pscleanair.org/news/other/pm2_5_report.pdf.

[22] EPA Fine Particulate Staff Paper. http://www.epa.gov/airlinks/pdfs/pmstaff2_fact.pdf.

[23] Clean Air Science Advisory Committee (CASAC) DRAFT Review of Staff Paper. http://www.epa.gov/sab/pdf/casac_pmrp_mtg_april_6-7_2005_2nd_draft_pm_staff_paper-ra_draft_report_v2.pdf.

Puget Sound Region Air Quality Standards for Criteria Pollutants

Pollutant	Standard	Level
Ozone	The daily maximum 1-hour average must not exceed the level more than an average of once per year over a 3-consecutive-year period (no longer applicable June 15, 2005)	0.12 ppm
	The 3-year average of the 4th highest daily maximum 8-hour average concentration must not exceed the level	0.084 ppm
Particulate Matter (10 micrometers)	The 3-year annual average of the daily concentrations must not exceed the level	54 $\mu g/m^3$
	The 3-year average of the 99th percentile (based on the number of samples taken) of the daily concentrations must not exceed the level	154 $\mu g/m^3$
Particulate Matter (2.5 micrometers)	The 3-year annual average of the daily concentrations must not exceed the level	15.4 $\mu g/m^3$
	The 3-year average of the 98th percentile (based on the number of samples taken) of the daily concentrations must not exceed the level	65 $\mu g/m^3$
Carbon Monoxide	The 1-hour average must not exceed the level more than once per year	35 ppm
	The 8-hour average must not exceed the level more than once per year	9.4 ppm
Sulfur Dioxide	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	1.5 $\mu g/m^3$
Nitrogen Dioxide	The annual mean of 1-hour averages must not exceed the level	0.053 ppm

Note: Daily concentration is the 24-hour average, measured from midnight to midnight.

Note: EPA adopts a rounding convention. Values in this table may look slightly different than values on EPA's website. The numbers in this table are those used to determine if an area is in compliance.

Pollutants typically have multiple standards with different averaging times; for example, hourly and 8-hour average. Multiple standards are created and enforced to address different health impacts that happen 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, and additional information is on the EPA website listed on the previous page.

A distinction exists between "exceeding" and "violating" a standard; the two are not equivalent. This distinction is due to the nature of the standards. In most instances it is allowable for an area to exceed the standard a few times. 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).

The 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 the standards above for the year 2004. Some graphs also incorporate the AQI and health goals where applicable. AQI shading and health goals are shown to aid interpretation of air quality, but do not imply whether or not standards were actually met for each pollutant; only meeting the conditions listed in the table on page 39 warrant compliance.

Particulate Matter (10 micrometers)

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 high.

The federal PM_{10} standard is currently being reviewed along with the fine particulate standard. EPA may choose to change PM_{10} in the future to include only the coarse particles, ranging from diameters 2.5-10 micrometers.

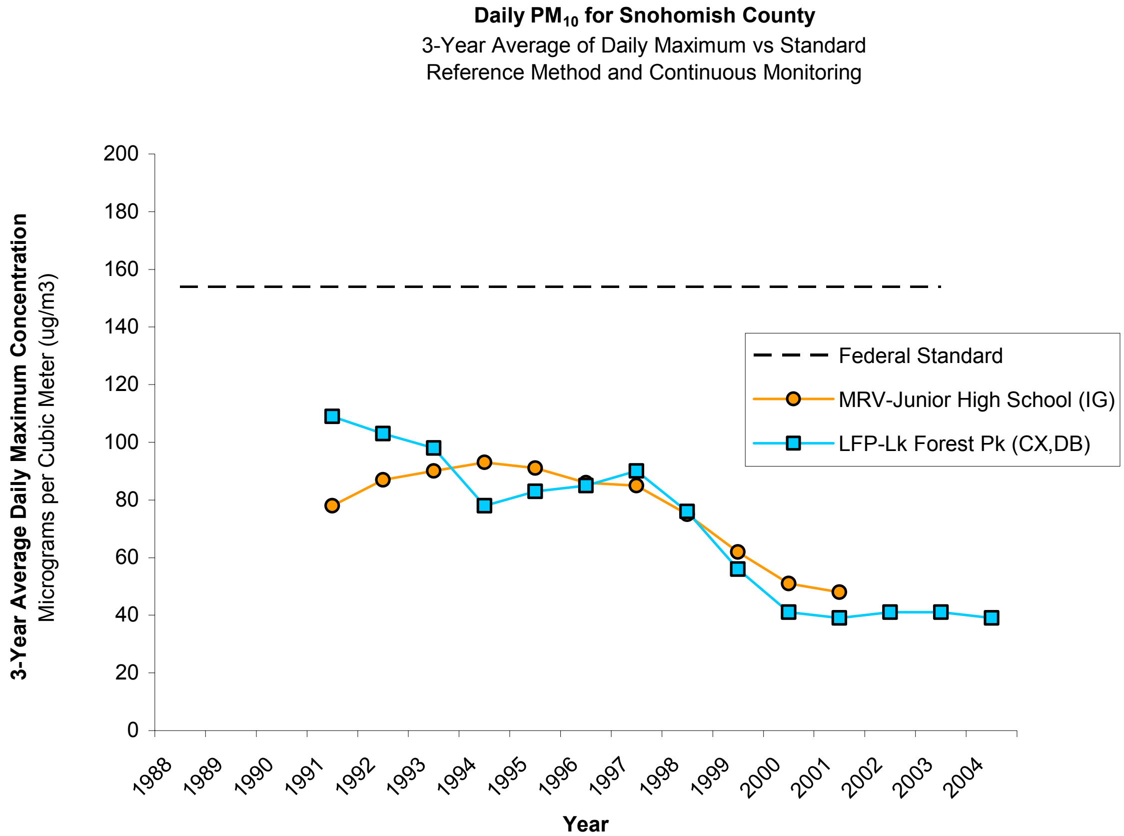
PM_{10} is currently monitored in the Puget Sound area using continuous methods at four monitoring sites. Continuous data is more helpful than reference method data in many ways, as it informs of air quality in near real time. Historically, monitoring PM_{10} was required to call burn bans.[24] The Agency ceased monitoring PM_{10} with the federal reference method in 2003.

All four counties have been below the daily and annual PM_{10} federal standards since the early 1990s, and EPA designated the Puget Sound region in attainment for PM_{10} in 2001.

The graphs on the following pages show daily PM_{10} concentrations compared to the federal standard. These graphs include historical reference method monitoring prior to 2004, and the 2004 values represent three-year averages calculated using continuous methods.[25] A statistical summary of 2004 continuous method PM_{10} concentrations is provided on page A-5 of the Appendix. The highest daily PM_{10} concentration was 196 $\mu g/m^3$ on April 27th at the Port of Tacoma monitoring site. Although this concentration exceeds the federal standard, it does not violate the standard, which is based on the 99th percentile of a three-year average. Visit www.epa.gov/air/urbanair/pm/index.html for additional information on PM_{10}. More information on PM_{10} is also presented in question/answer format in the definitions section of this document.

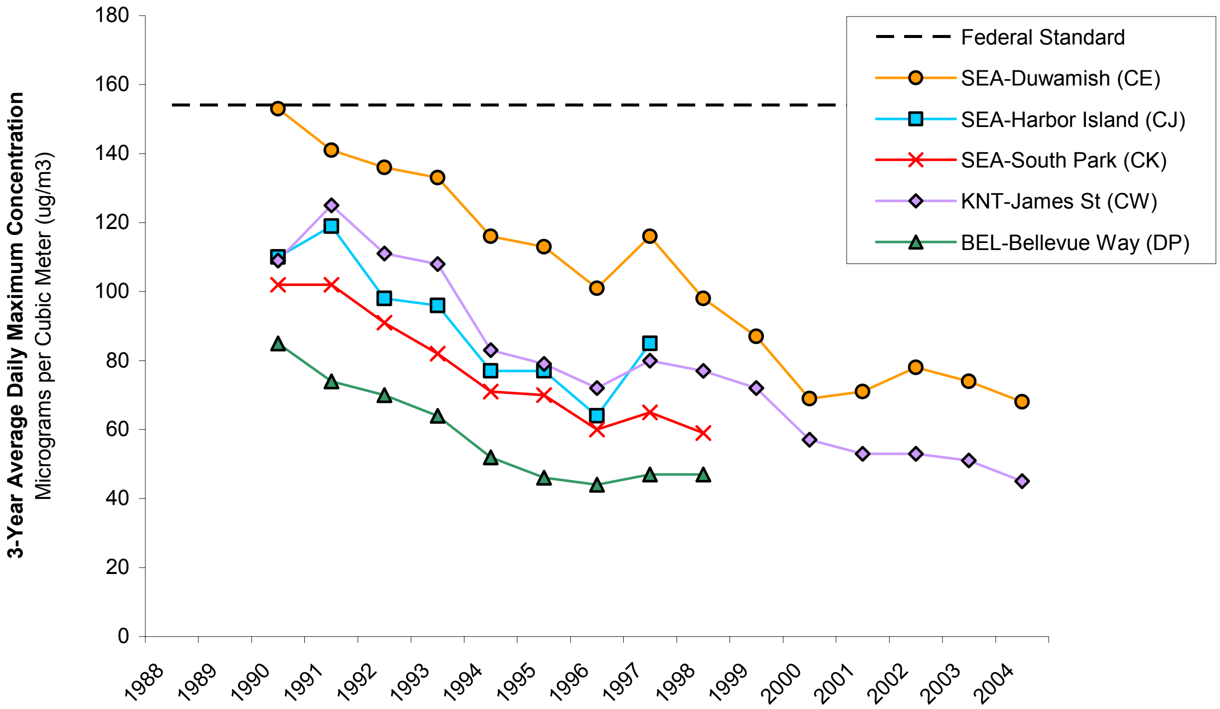
[24] The Washington state burn ban trigger was changed to $PM_{2.5}$ in early 2005.

[25] Concentrations measured with reference method are maximum daily concentrations. Concentrations measured with continuous methods are the 99th percentile of daily concentrations. Reference method data demonstrate very similar values for maximum and 99th percentile, in many cases identical. Thus, this difference in statistical measure does not strongly affect graphs.



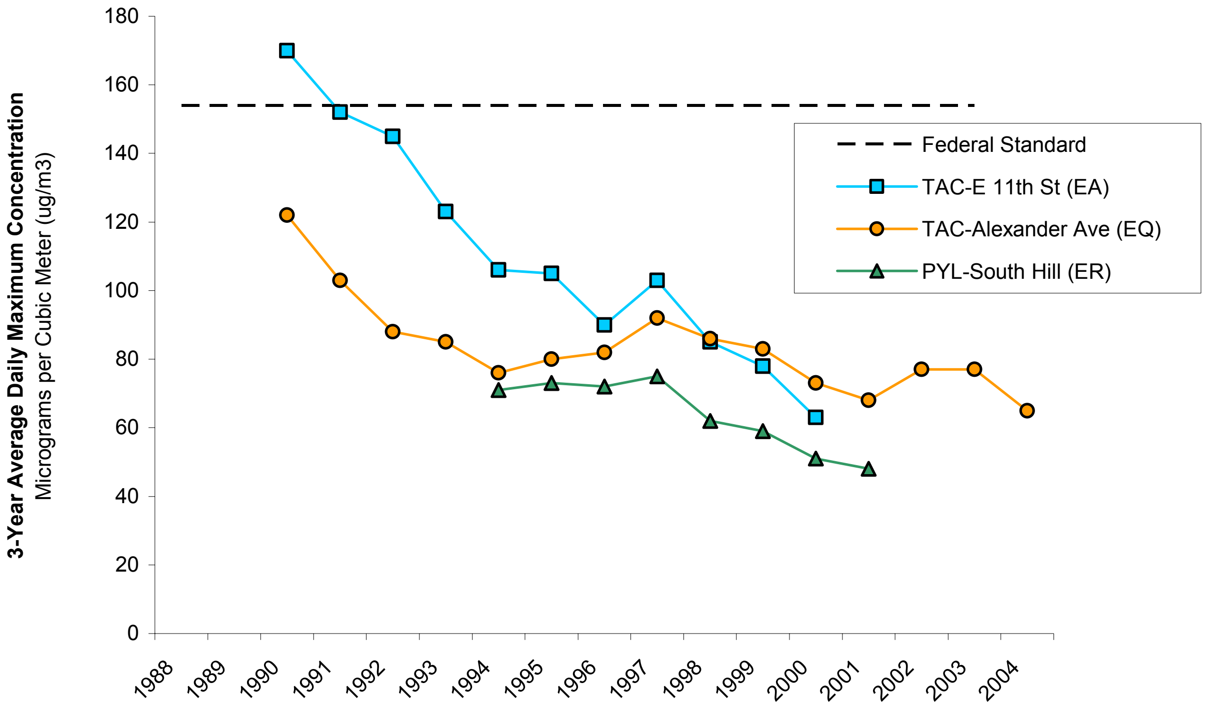
Note: 2002, 2003, and 2004 values are three year averages of the 99th percentile, based on continuous monitoring at this site

Daily PM_{10} for King County
3-Year Average of Daily Maximum vs Standard
Reference Method and Continous Monitoring



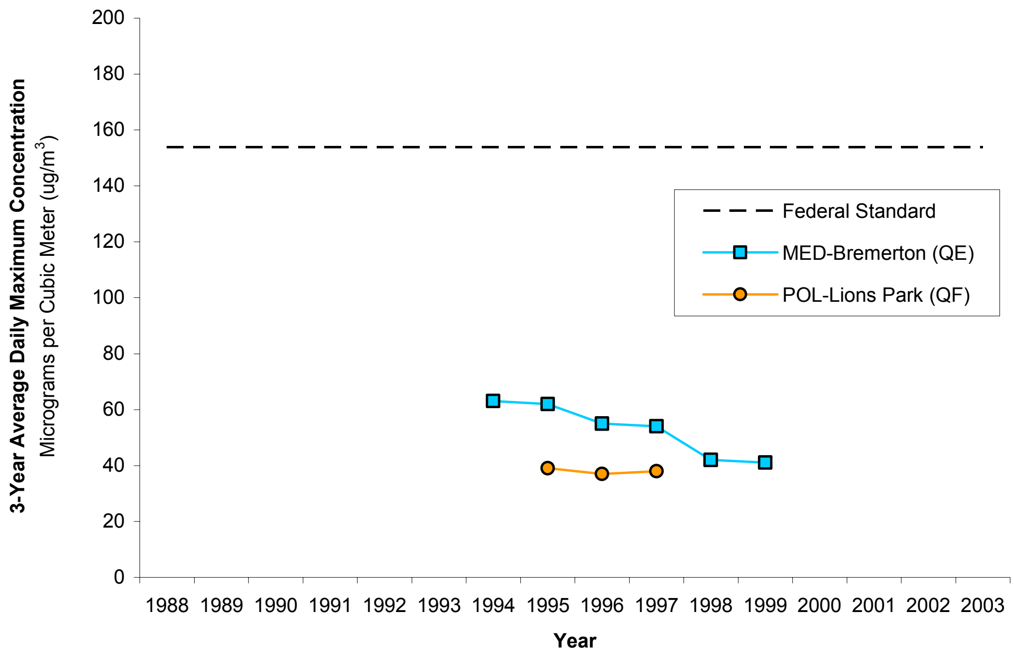
Note: 2004 values are three year averages of the 99th percentile, based on continuous monitoring at these sites.

Daily PM_{10} for Pierce County
3-Year Average of Daily Maximum vs Standard
Reference Method and Continuous Monitoring



Note: 2004 value is 3-year average of the 99th percentile, based on continuous monitoring at this site.

Daily PM_{10} for Kitsap County
3-Year Average of Daily Maximum vs Standard
Reference Method



Particulate Matter (2.5 micrometers)

Health effects and significance

Particles smaller than 2.5 micrometers in diameter are called “fine” particulate, or $PM_{2.5}$. The Agency considers $PM_{2.5}$ one of the major air pollution concerns affecting our region. $PM_{2.5}$ generally comes from wood burning and other area sources, as well as vehicle exhaust including cars, diesel trucks, and buses. Fine particulate can also be formed secondarily 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.[26,27,28] Children, older adults, and people with some illnesses are more sensitive and more likely to develop heart or lung problems associated with $PM_{2.5}$.[29,30] People with respiratory or heart disease, older adults, and children should avoid outdoor exertion if $PM_{2.5}$ levels are high. $PM_{2.5}$ also significantly affects visibility.

As described in the *Air Quality Standards and Health Goals* section, the Agency has a fine particulate health goal in addition to the national standard for fine particulate. This health goal is shown in addition to the federal standard on the following graphs.

Monitoring – daily federal standard and health goal

The graphs in this section use data primarily from the federal reference method (FRM). In some instances, data from continuous methods are included.[31] 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.”

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

[27] 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: 1057–1067. Number 11. September 9, 2004.

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

[29] 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.

[30] 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.

[31] Continuous methods are briefly described in the *Monitoring Network* section of this report.

The Puget Sound airshed has been in compliance with both daily and annual standards for $PM_{2.5}$ since 1999. Although the daily NAAQS is met, it is clear that many of the monitoring sites in Snohomish, King, and Pierce counties exceed the Agency's daily fine particulate health goal of 25 $\mu g/m^3$ for a 24-hour average. The health goal is shown with a dotted green line on graphs.

The graphs on pages 50 through 53 show daily 98th percentile averages at each monitoring station in Snohomish, King, Pierce, and Kitsap counties against the federal standard and the Agency's health goal. The NAAQS 98th percentile is set for a 3-year average. For purposes of these graphs, however, the 3-year average is not taken because there are so few years to show. Concentrations for Snohomish, King, and Pierce counties were measured with the FRM, except where noted. Concentrations for Kitsap County were measured with continuous methods.[32]

Monitoring – annual federal standard

The graphs on pages 54 through 56 show annual averages at each monitoring station for Snohomish, King, and Pierce counties, against the federal standard. These graphs show only data from FRM monitors. The Agency's Health Committee did not recommend a lower value for the annual standard, and so there is no additional health goal for the fine particulate annual standard. The federal standard calls for a 3-year average; however, annual averages are plotted on these graphs because 3-year averages would result in only a few data points. Nonetheless, it is easily seen that the annual standard of 15.4 $\mu g/m^3$ was not exceeded at any of the monitoring stations, and that a 3-year average would also not exceed the standard.

Monitoring – continuous data and seasonal variability

Graphs on pages 57 through 68 show daily $PM_{2.5}$ concentrations measured at 12 sites during 2004 by continuous analyzers (nephelometer, TEOM, or BAM) set against a backdrop of AQI breakpoints. Several sites are monitored by both nephelometer and TEOM. The two methods, one using light scattering and the other mass, correspond well with each other.

The 12 monitoring sites characterize different areas and these differences are reflected in the continuous data. The four sites most associated with high residential wood burning exhibit the greatest seasonal variability, with a pattern of higher $PM_{2.5}$ concentrations in winter months (October – March). These four sites include Marysville, Tacoma South L, Lake Forest Park, and Lynnwood. These sites register AQI levels in the "unhealthy for sensitive groups" range occasionally in the winter months.

[32] 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.

The Seattle Duwamish and Tacoma Port sites are industrial, but with some wood smoke influence as well in winter months. The Kent site is both residential and commercial. These three sites also register AQI levels in the "unhealthy for sensitive groups" range in winter months.

The Bellevue monitoring site is similar to the Kent site with both residential and commercial, but is in an area with more natural gas heating and less wood burning. The topography at the Bellevue site is also different than the Kent site. Its graph reflects these differences, with very little seasonal variation, and low concentrations.

Four monitoring sites are presented that exhibit low concentrations and low seasonal variability. These areas have lower housing density, and likely less wood smoke impact. The four sites include: Bremerton Meadowdale, Puyallup, North Bend, and Silverdale.

All $PM_{2.5}$ data, from FRM and continuous monitors, are shown in tables on pages A-6 through A-9 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 2004 was 57 $\mu g/m^3$, measured at South L Street in Tacoma on November 5th. For additional information on particulate matter, visit www.epa.gov/air/urbanair/pm/index.html. Information on $PM_{2.5}$ is also presented in a question/answer format in the definitions section of this document.

$PM_{2.5}$ Speciation – relevance and practice

Not all $PM_{2.5}$ is created equal. The methods described above inform us about 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 amount of fine particulate matter, it's important to know what type of particulate matter is present in addition to its mass. The makeup of fine particulate matter can inform about potential health risks and also help to guide emissions reduction strategies. For example, if study of fine particulate shows that a large portion is comprised of wood smoke particulate, then strategies to reduce wood smoke are appropriate 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.

Source apportionment modeling requires several steps and several years of data from a site. First, speciation data are collected. Speciation monitoring involves collecting the individual fractions of various metals and organics in fine particulate matter on different types of filters. These filters are then weighed and analyzed to determine the makeup of fine particulate at that site. These data are then used in source apportionment models to estimate contributing sources to $PM_{2.5}$. 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 to determine how much each source is contributing.

The Agency currently conducts speciation monitoring at several sites. The Agency and the University of Washington used this data to conduct source apportionment modeling.[33] This modeling was especially useful to estimate diesel particulate matter and wood smoke particulate concentrations at Beacon Hill. The Washington State Department of Ecology and the University of Washington are currently conducting additional apportionment modeling on more recent Beacon Hill data.

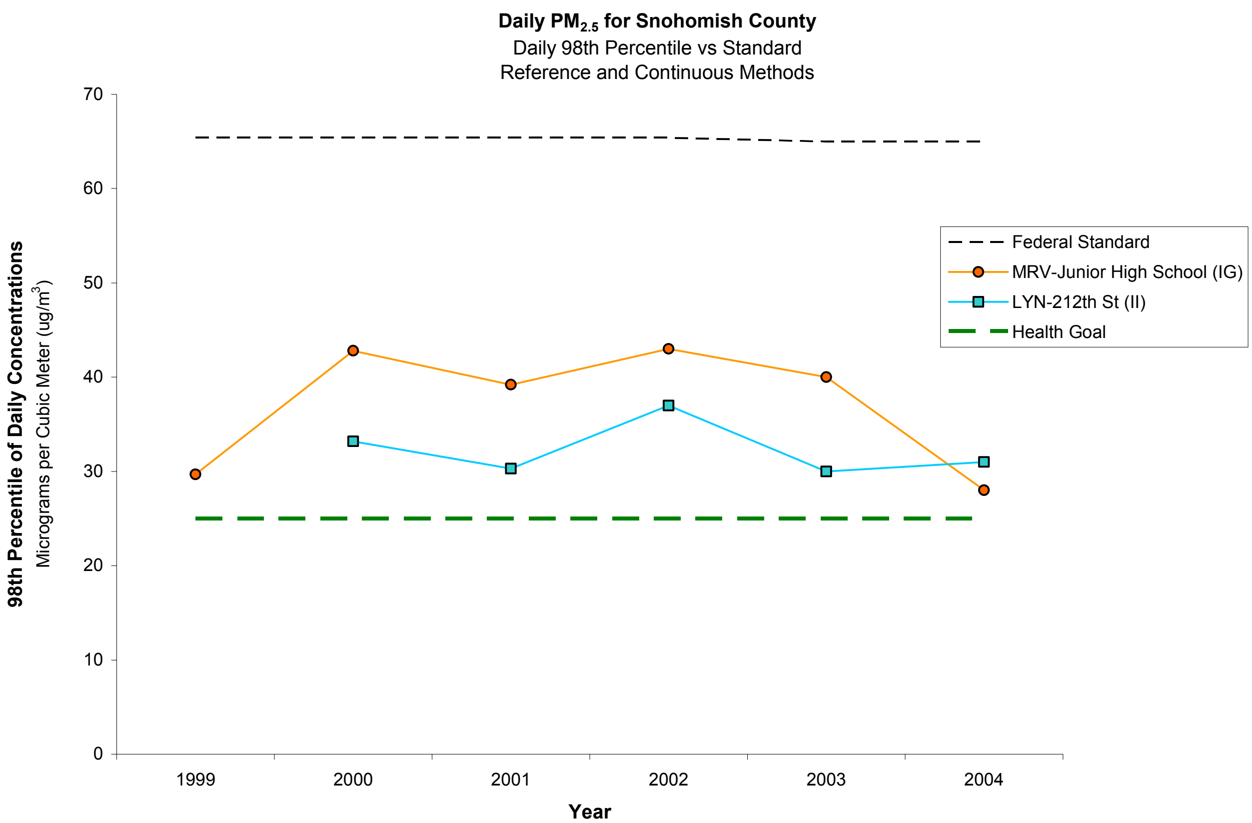
Aethalometers are monitoring instruments that inform about the components of particulate matter by measuring light absorption. Aethalometers continuously measure ultraviolet absorption to estimate black carbon concentrations. These values are indicators of sources such as wood smoke particulate, diesel particulate matter, and particles from other combustion sources.[34] The Agency placed aethalometers at monitoring sites with high particulate matter concentrations and is analyzing data from these sites. Speciation monitoring is also conducted at some of these sites so that the different methods may be compared.[35]

A statistical summary of aethalometer black carbon data is presented on page A-10 of the Appendix.

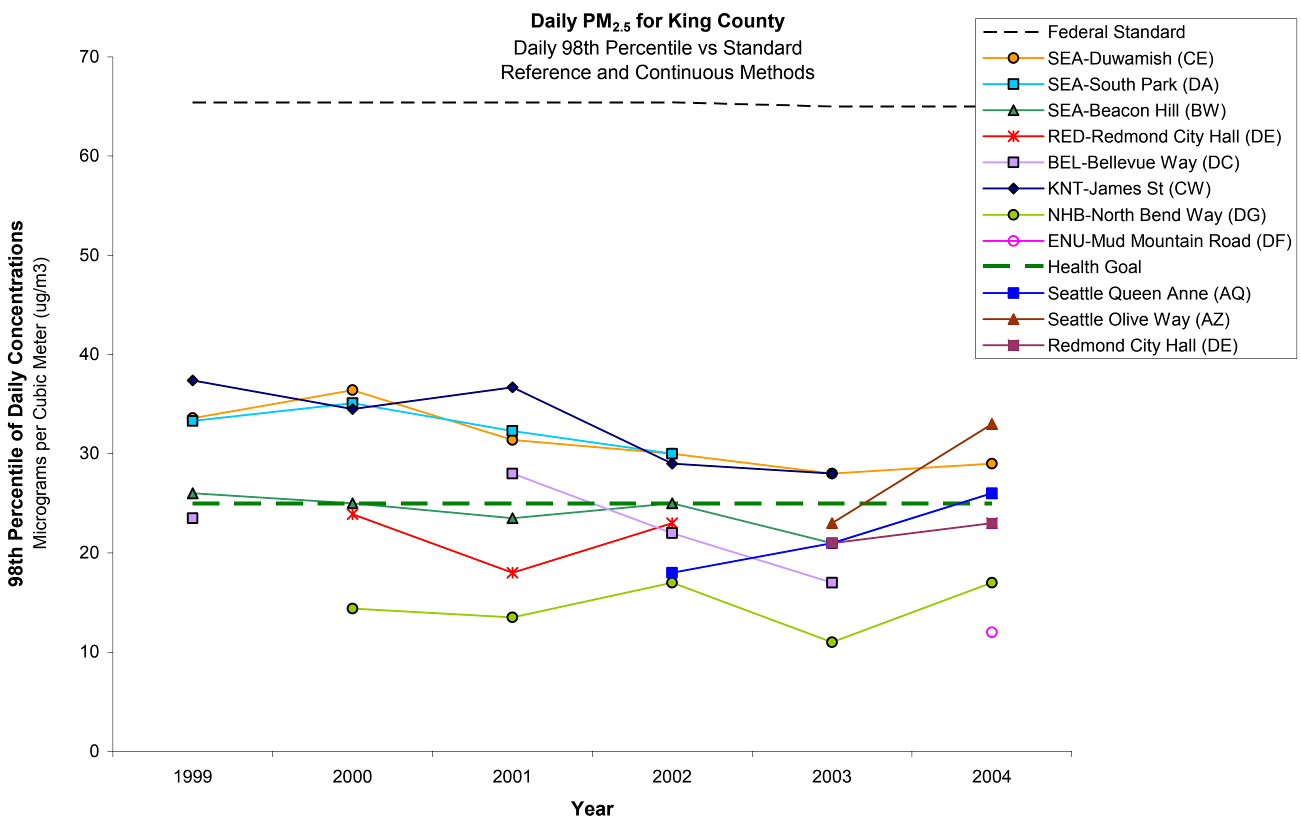
[33] Puget Sound Air Toxics Evaluation. 2003.

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

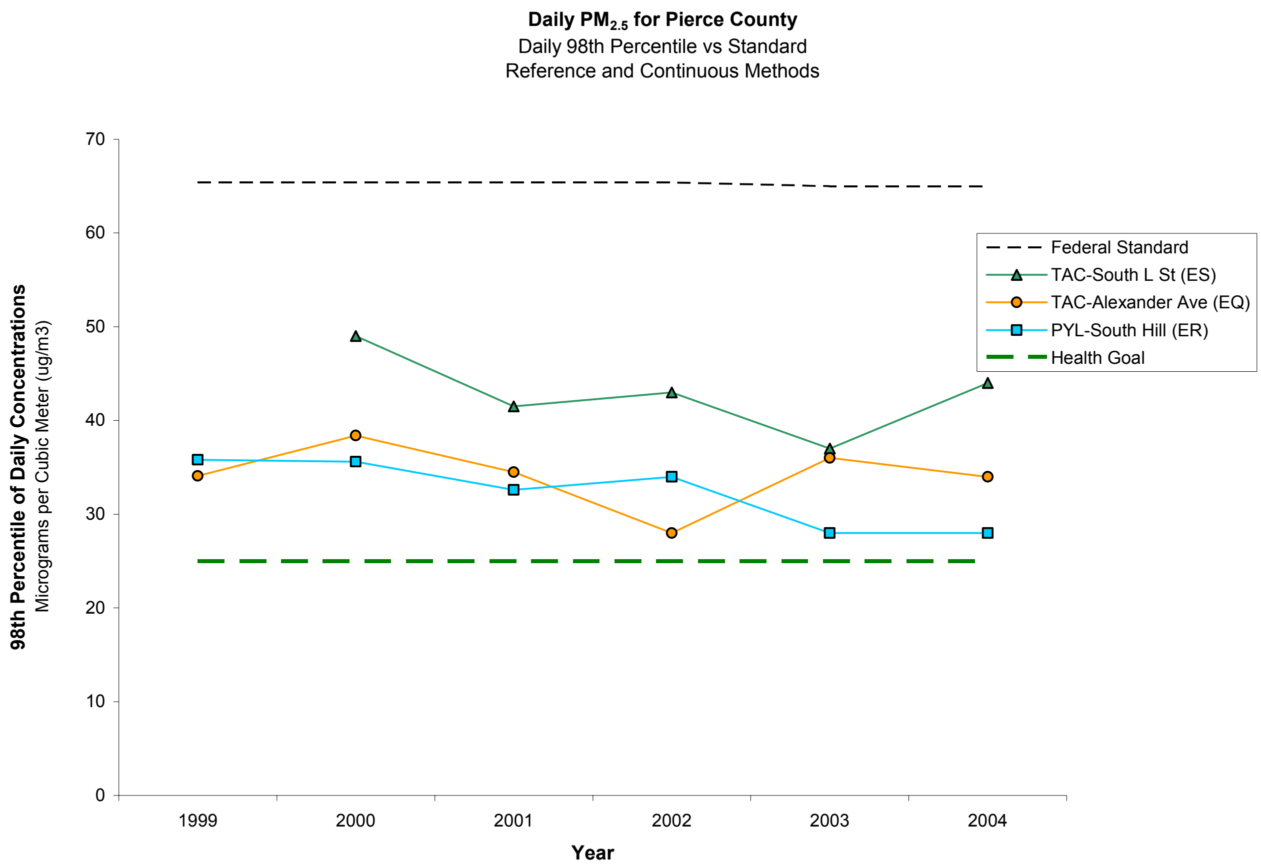
[35] Both aethalometer and fine particulate ($PM_{2.5}$) speciation monitoring were conducted at four sites in 2004: Seattle Olive (AZ), Seattle Beacon Hill (BW), Seattle Duwamish (CE), and Lake Forest Park (DB).



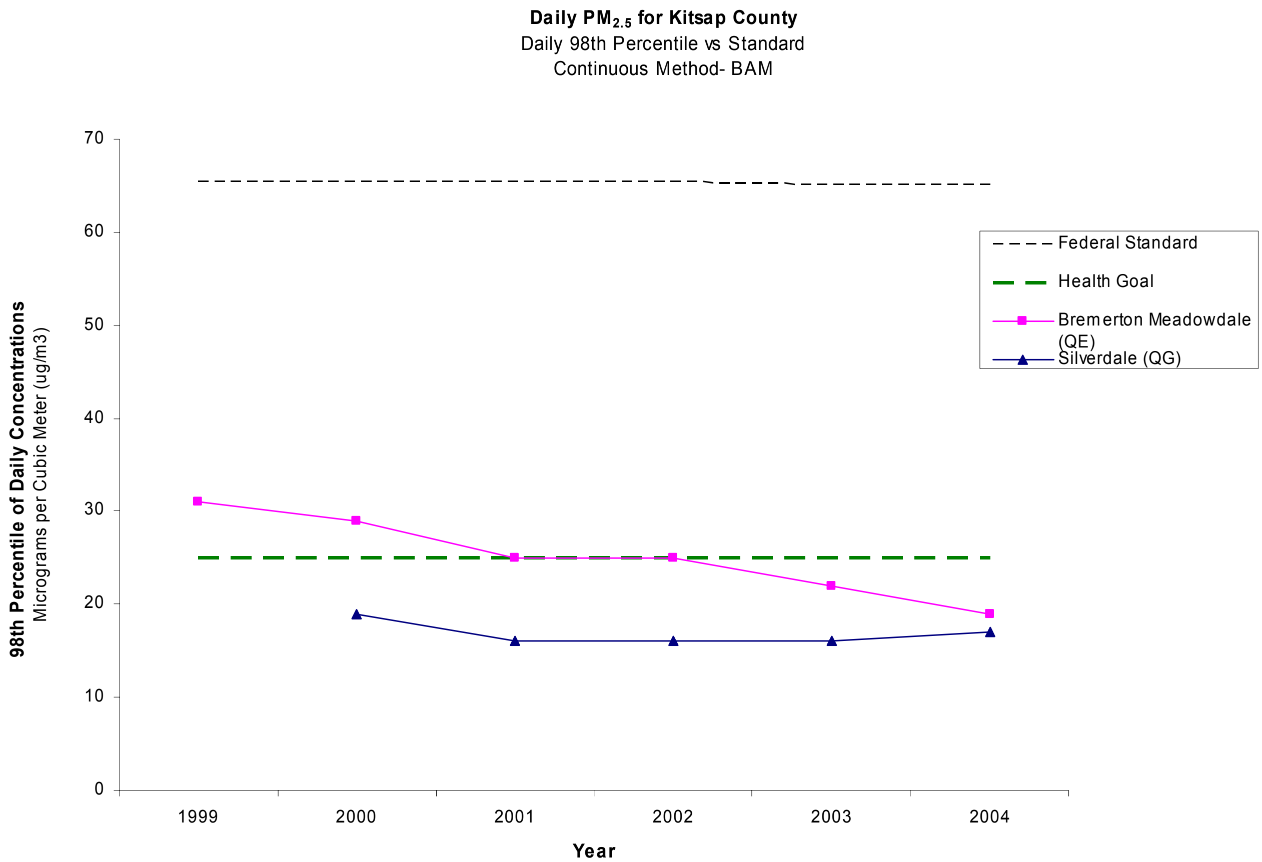
Note: 2004 value for Lynwood (II) was measured with continuous nephelometer

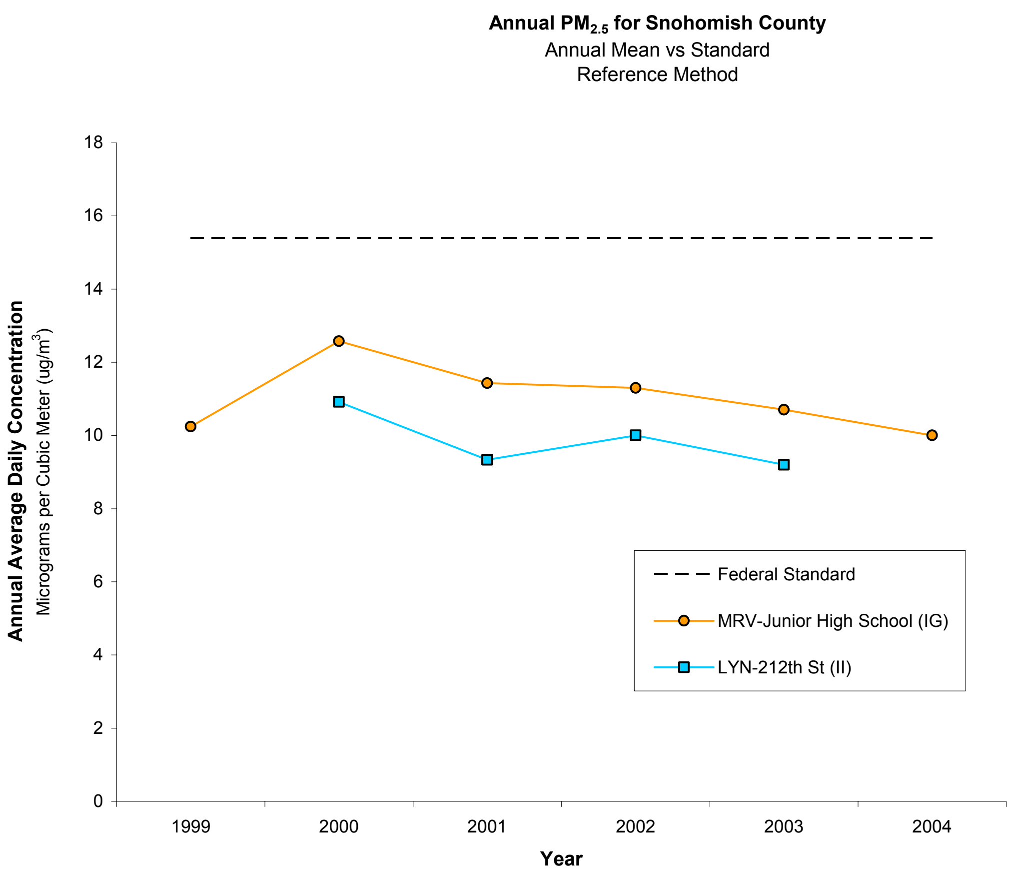


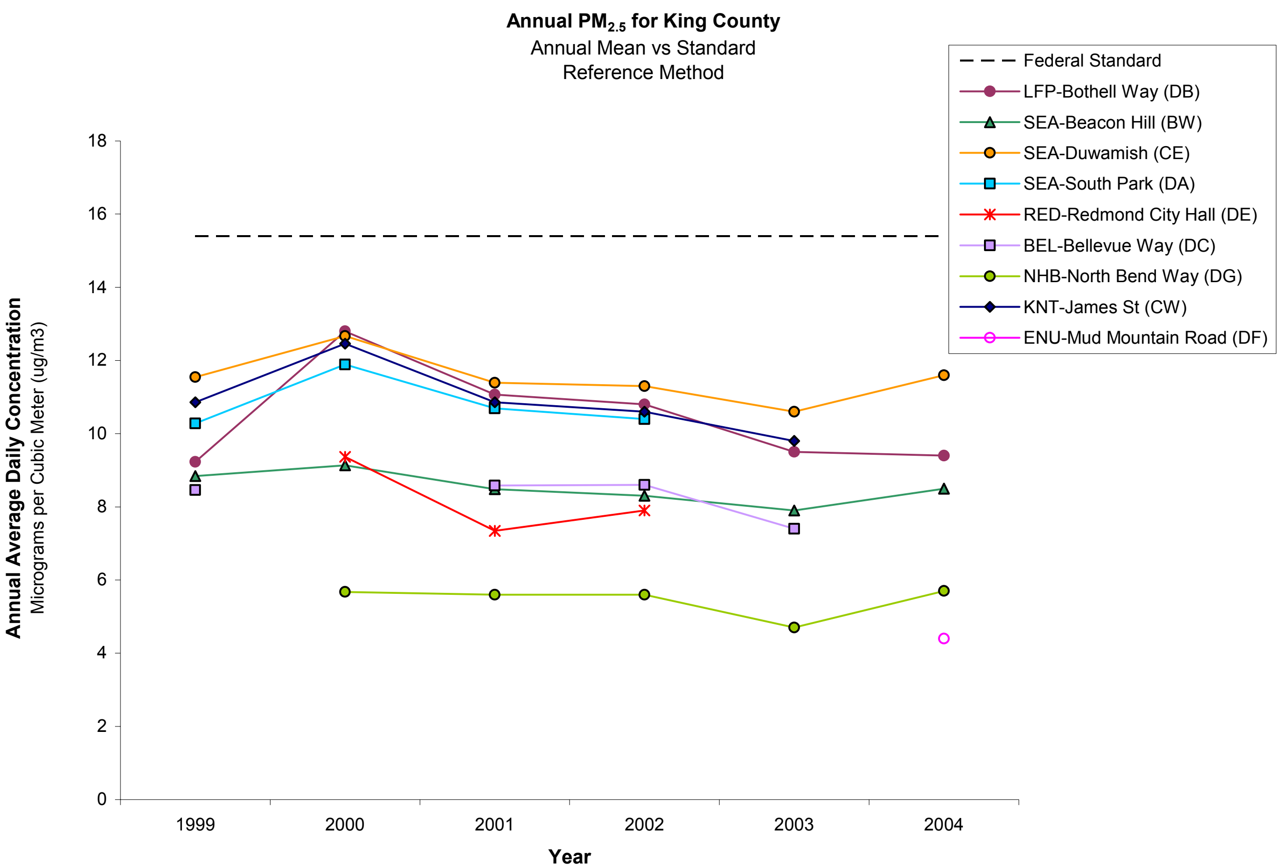
Note: Concentrations for Seattle Queen Anne (AQ), Seattle Olive Way (AZ), and Redmond City Hall (DE) measured with continuous methods (nephelometer)

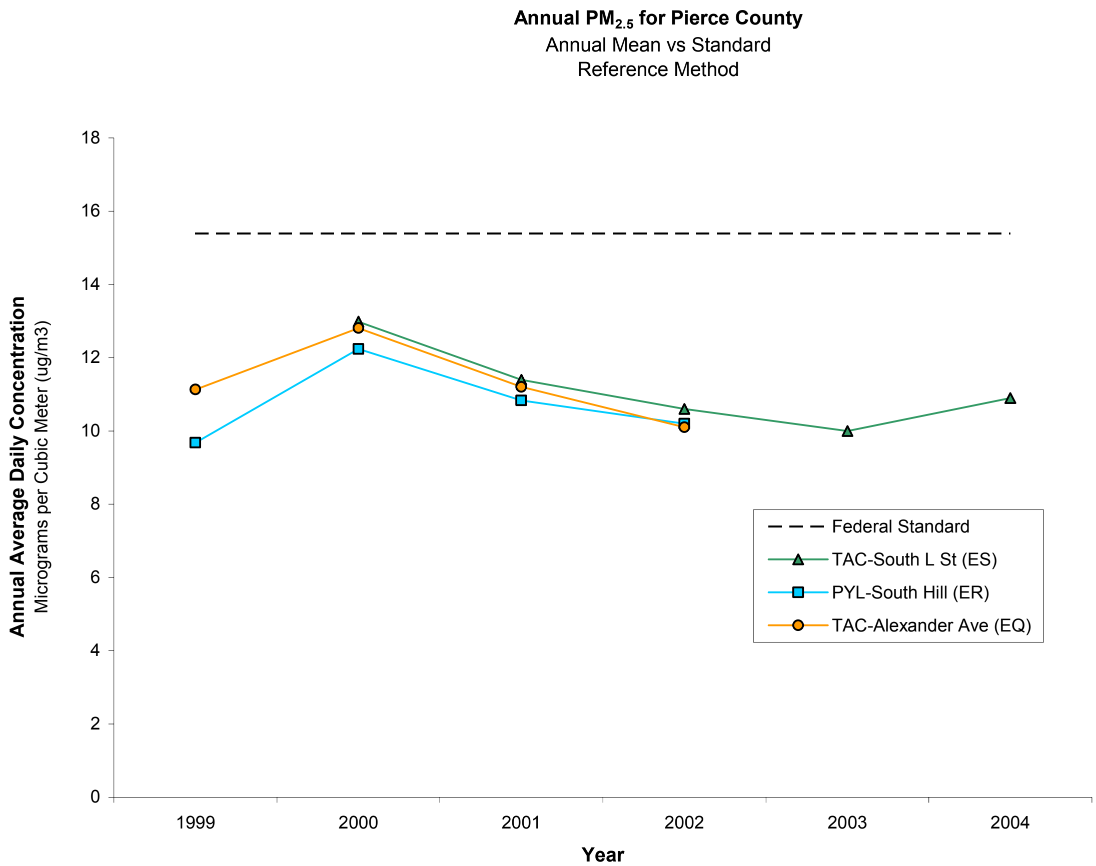


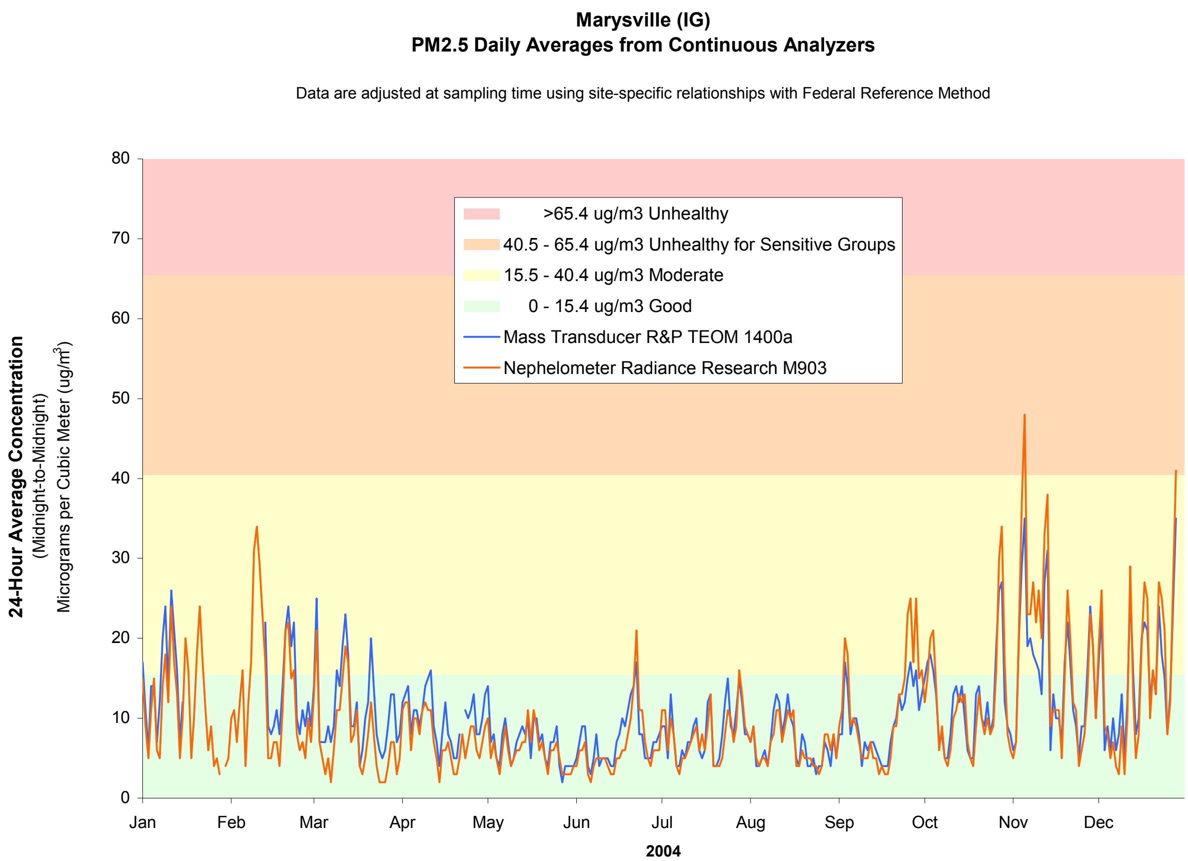
Note: 2003 and 2004 values for Tacoma Alexander (EQ) and Puyallup South Hill (ER) measured with continuous nephelometers


Daily $PM_{2.5}$ for Kitsap County
Daily 98th Percentile vs Standard
Continuous Method- BAM
98th Percentile of Daily Concentrations
Micrograms per Cubic Meter (ug/m3)
70
60
50
40
30
20
10
0
1999
2000
2001
2002
2003
2004
Year
Federal Standard
Health Goal
Bremerton Meadowdale (QE)
Silverdale (QG)


Annual PM2.5 for Snohomish County
Annual Mean vs Standard
Reference Method
Annual Average Daily Concentration
Micrograms per Cubic Meter (ug/m3)
18
16
14
12
10
8
6
4
2
0
1999
2000
2001
2002
2003
2004
Year
Federal Standard
MRV-Junior High School (IG)
LYN-212th St (II)

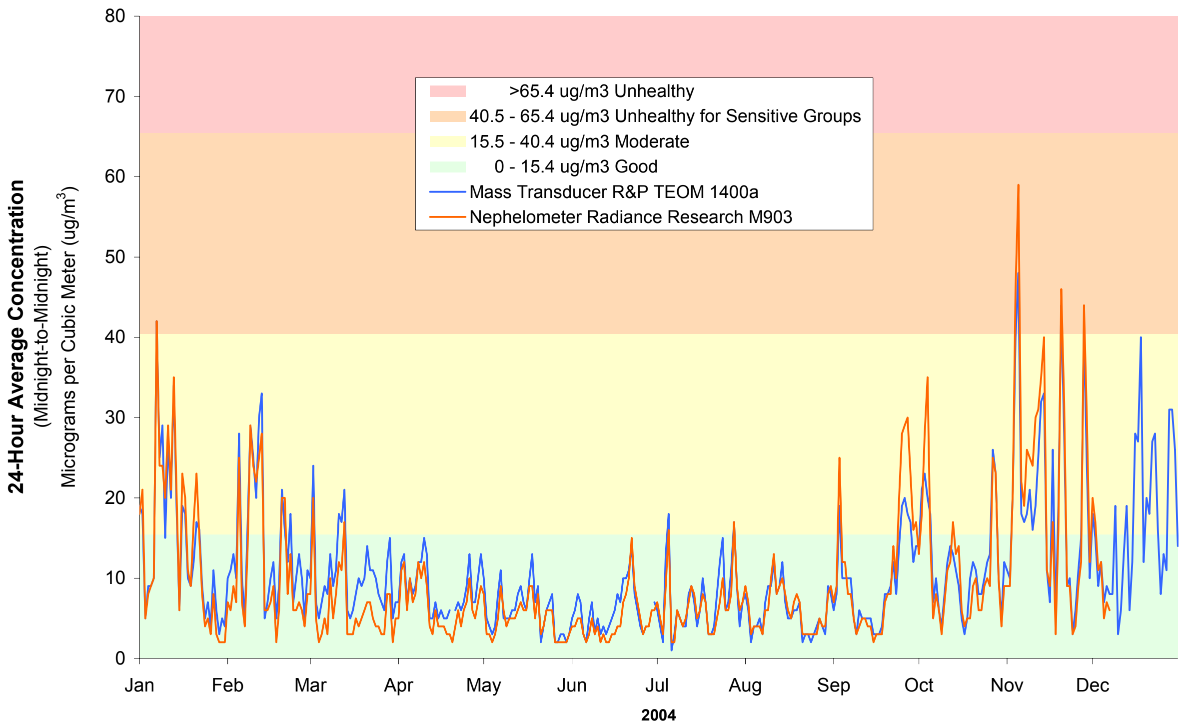

Annual $PM_{2.5}$ for King County
Annual Mean vs Standard
Reference Method
Federal Standard
LFP-Bothell Way (DB)
SEA-Beacon Hill (BW)
SEA-Duwamish (CE)
SEA-South Park (DA)
RED-Redmond City Hall (DE)
BEL-Bellevue Way (DC)
NHB-North Bend Way (DG)
KNT-James St (CW)
ENU-Mud Mountain Road (DF)
Annual Average Daily Concentration
Micrograms per Cubic Meter (ug/m3)
0
2
4
6
8
10
12
14
16
18
1999
2000
2001
2002
2003
2004
Year

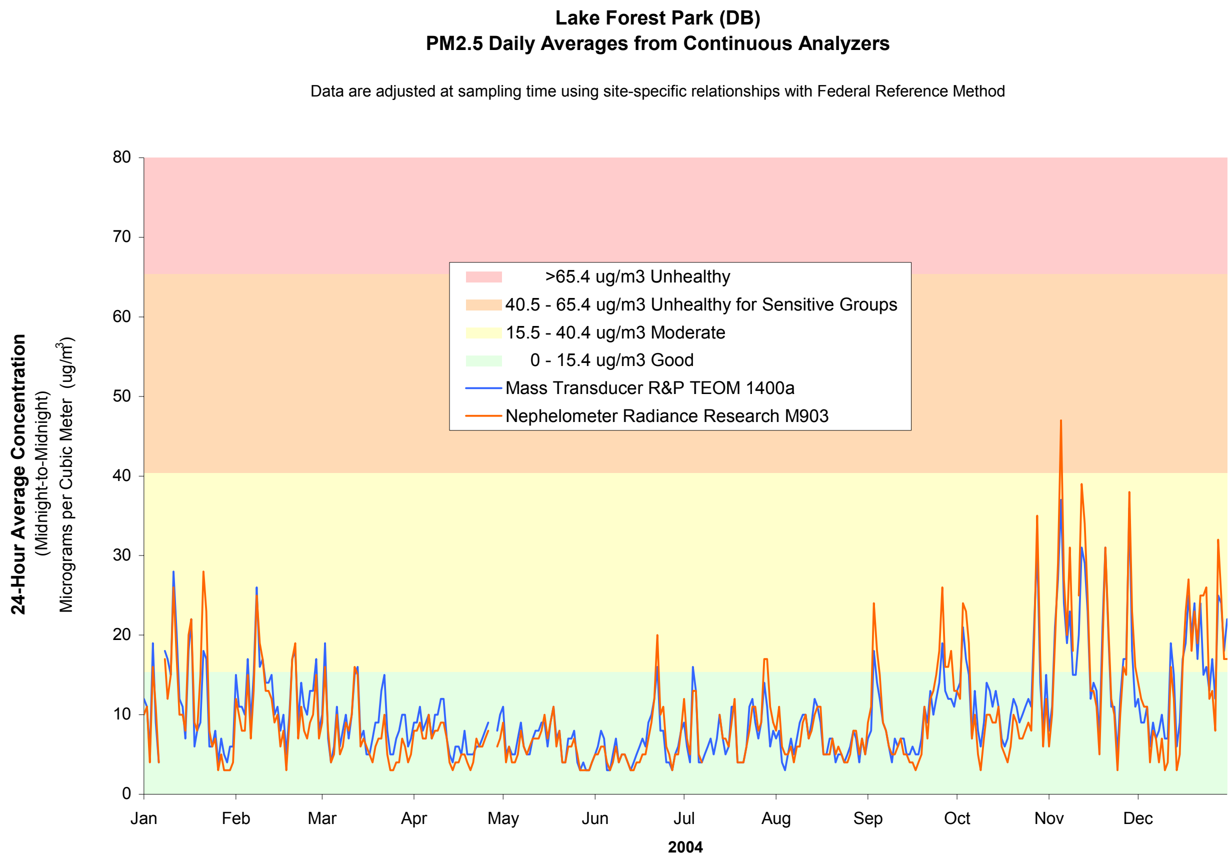

Annual PM2.5 for Pierce County
Annual Mean vs Standard
Reference Method
Annual Average Daily Concentration
Micrograms per Cubic Meter (ug/m3)
18
16
14
12
10
8
6
4
2
0
1999
2000
2001
2002
2003
2004
Year
Federal Standard
TAC-South L St (ES)
PYL-South Hill (ER)
TAC-Alexander Ave (EQ)

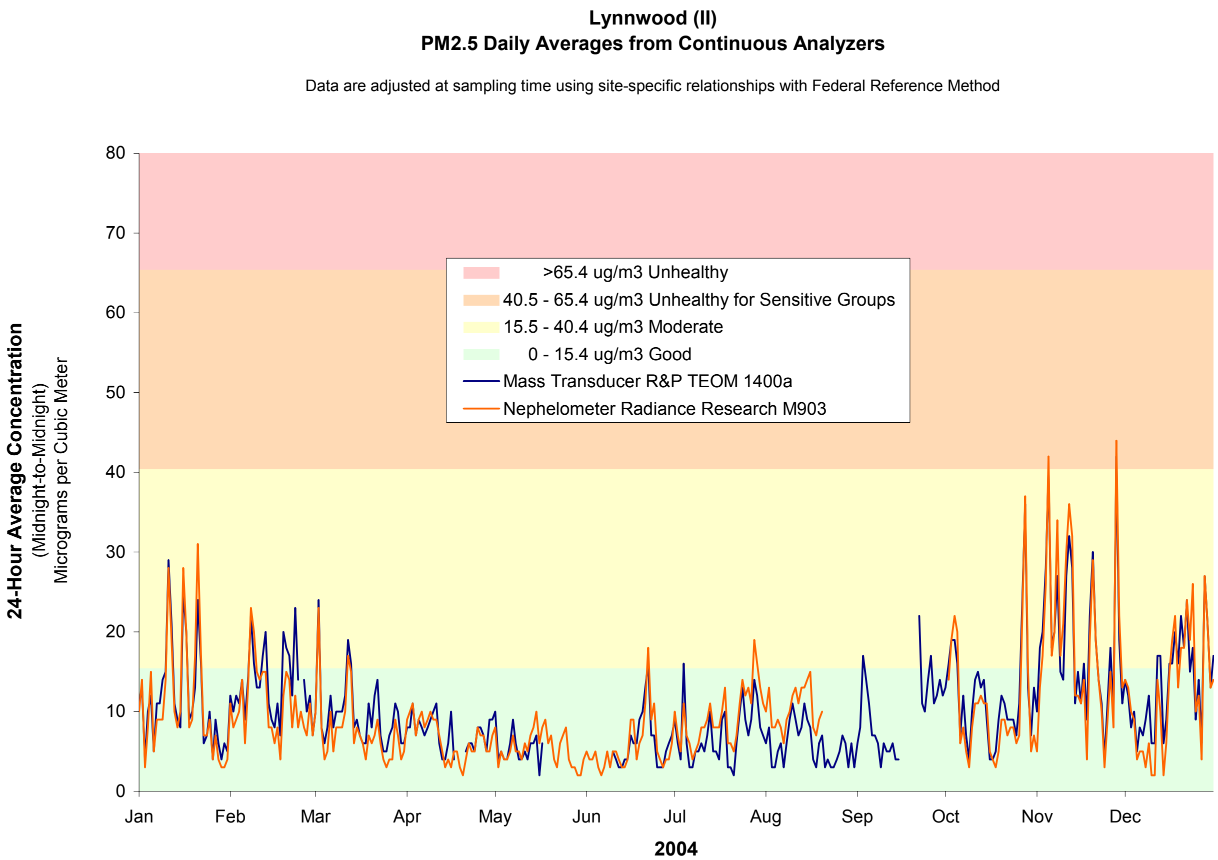

Marysville (IG)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004

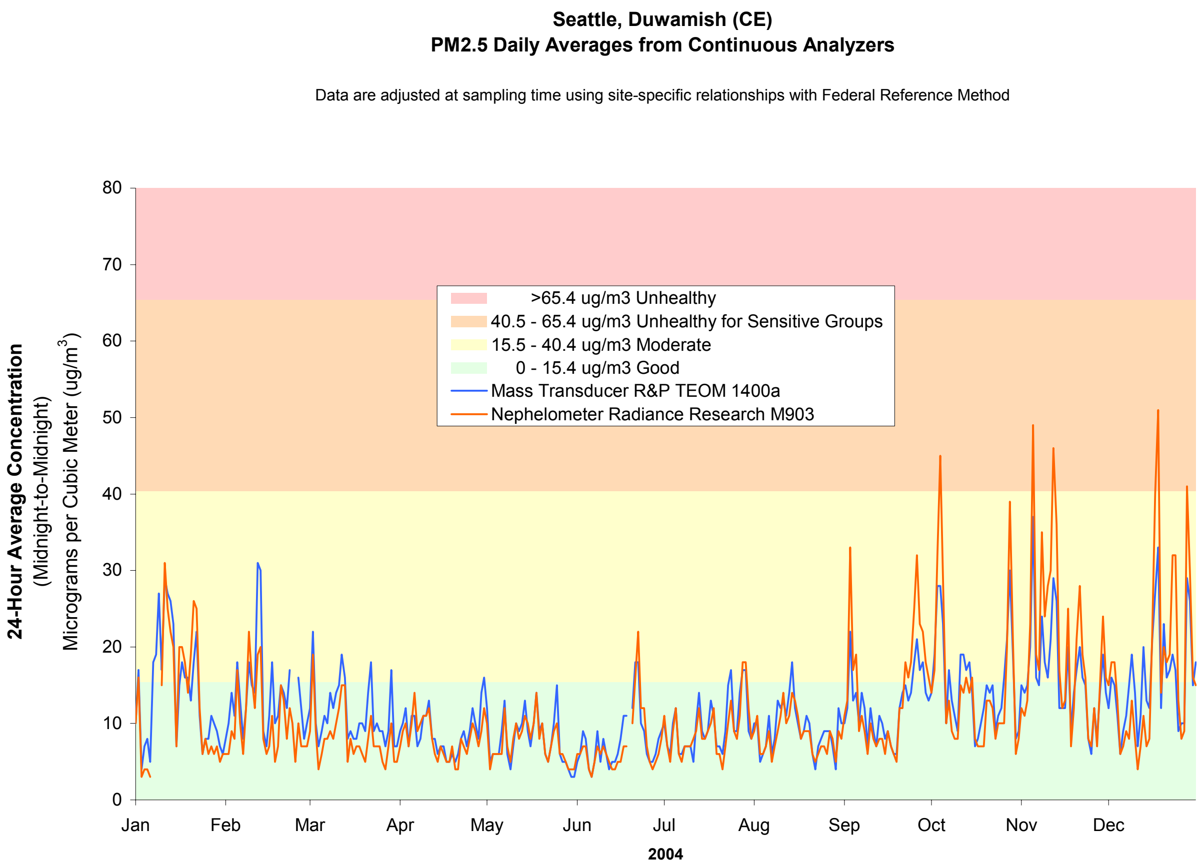
Tacoma, South L Street (ES)
PM2.5 Daily Averages from Continuous Analyzers

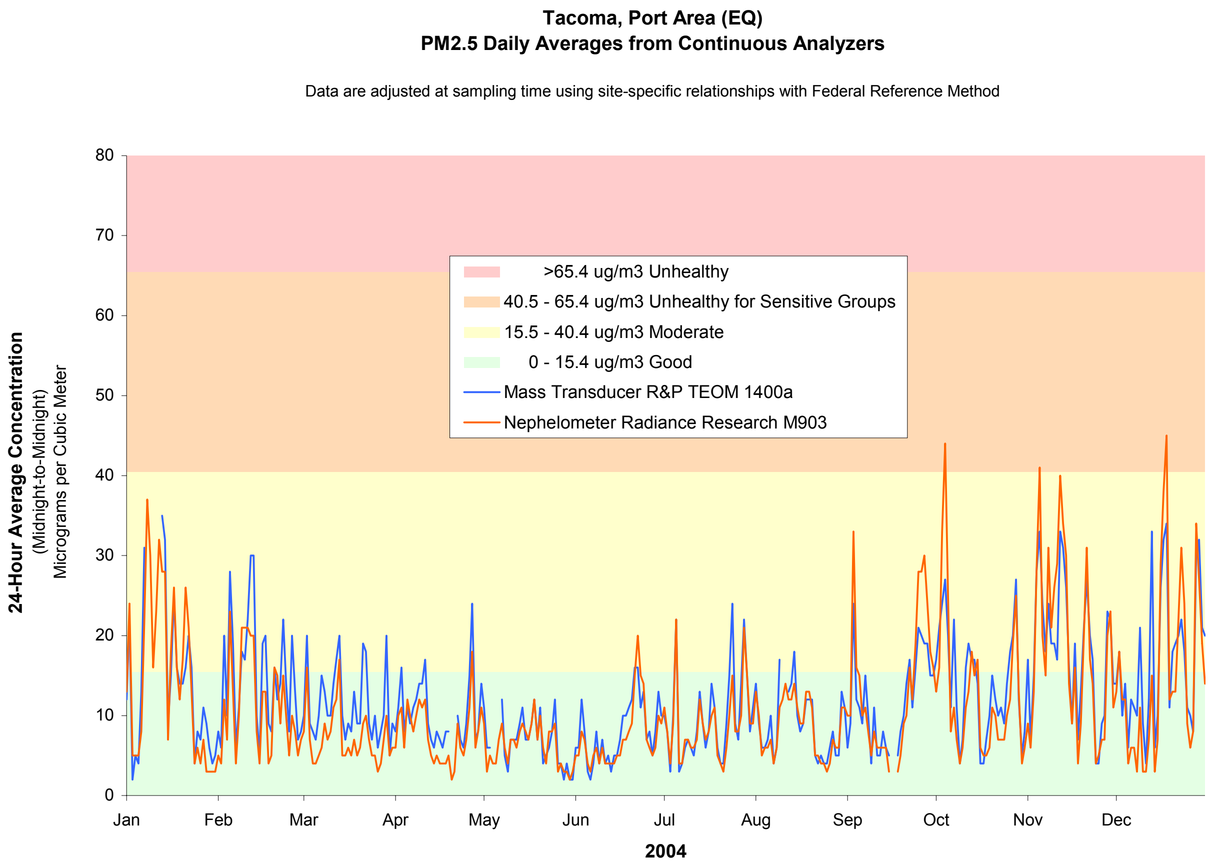
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method

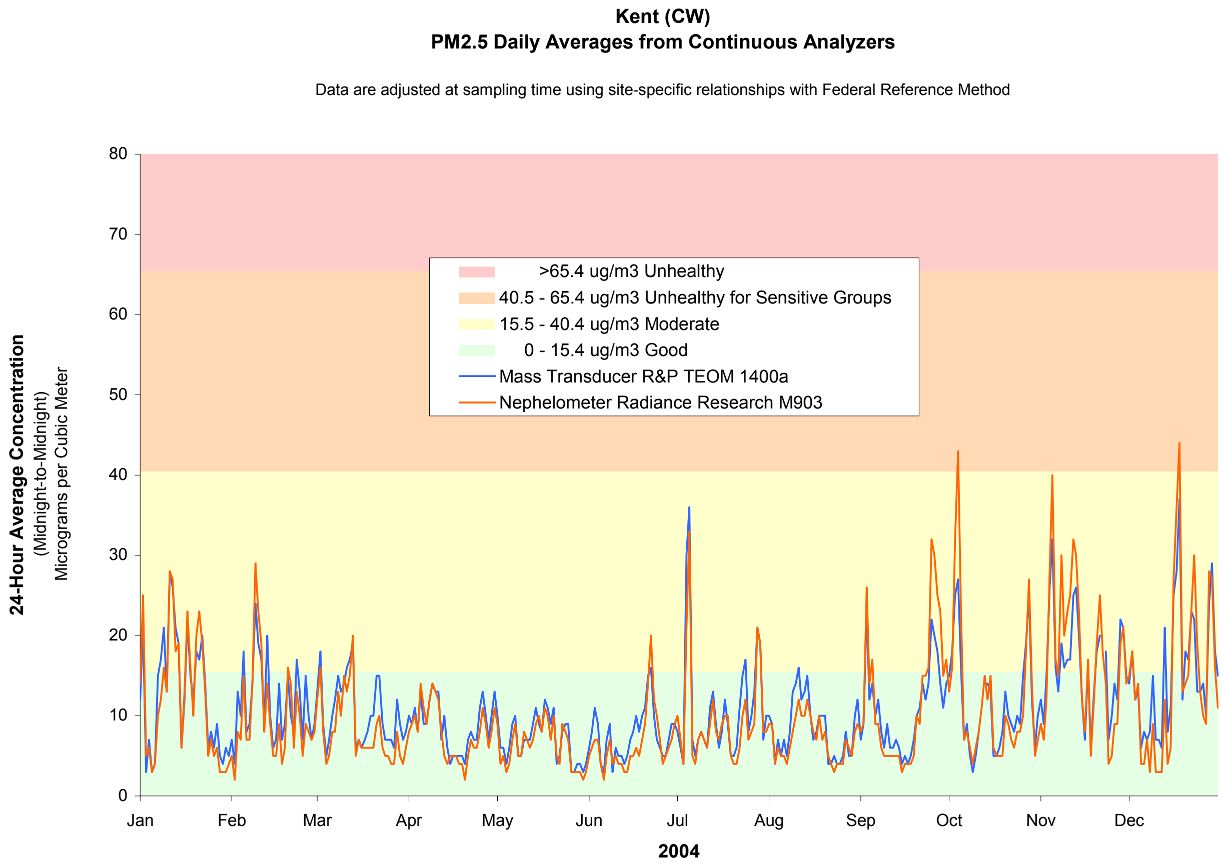



Lake Forest Park (DB)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004


Lynnwood (II)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004

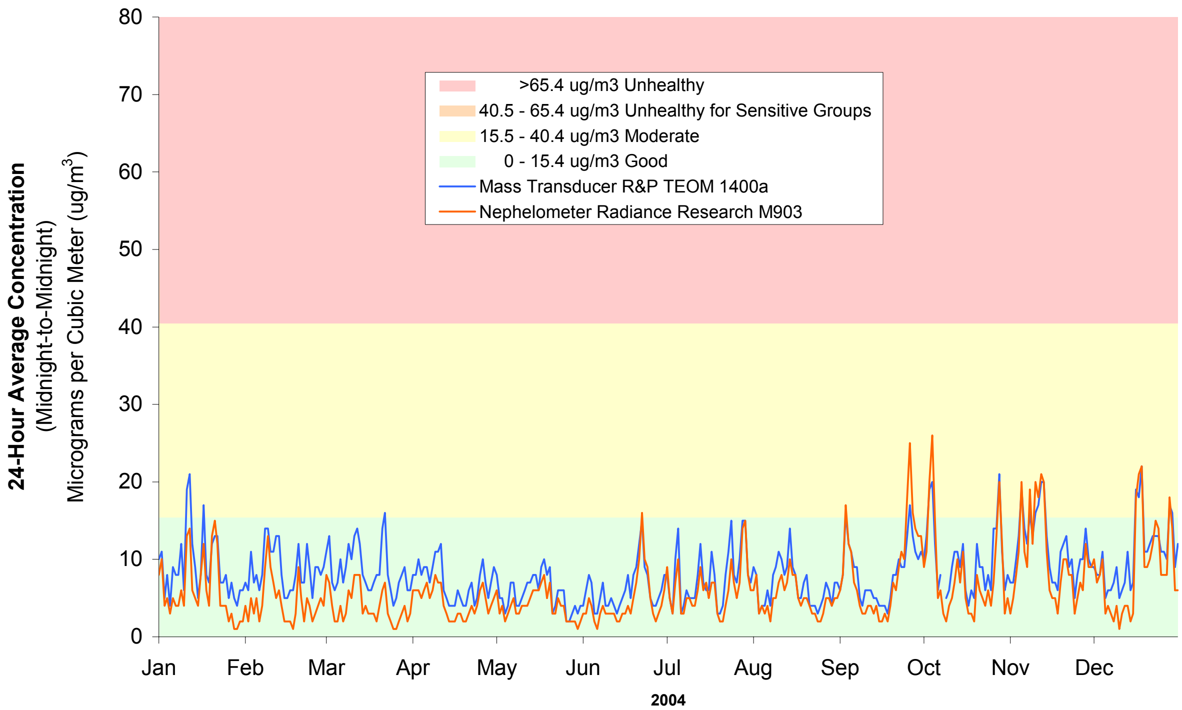

Seattle, Duwamish (CE)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004


Tacoma, Port Area (EQ)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004

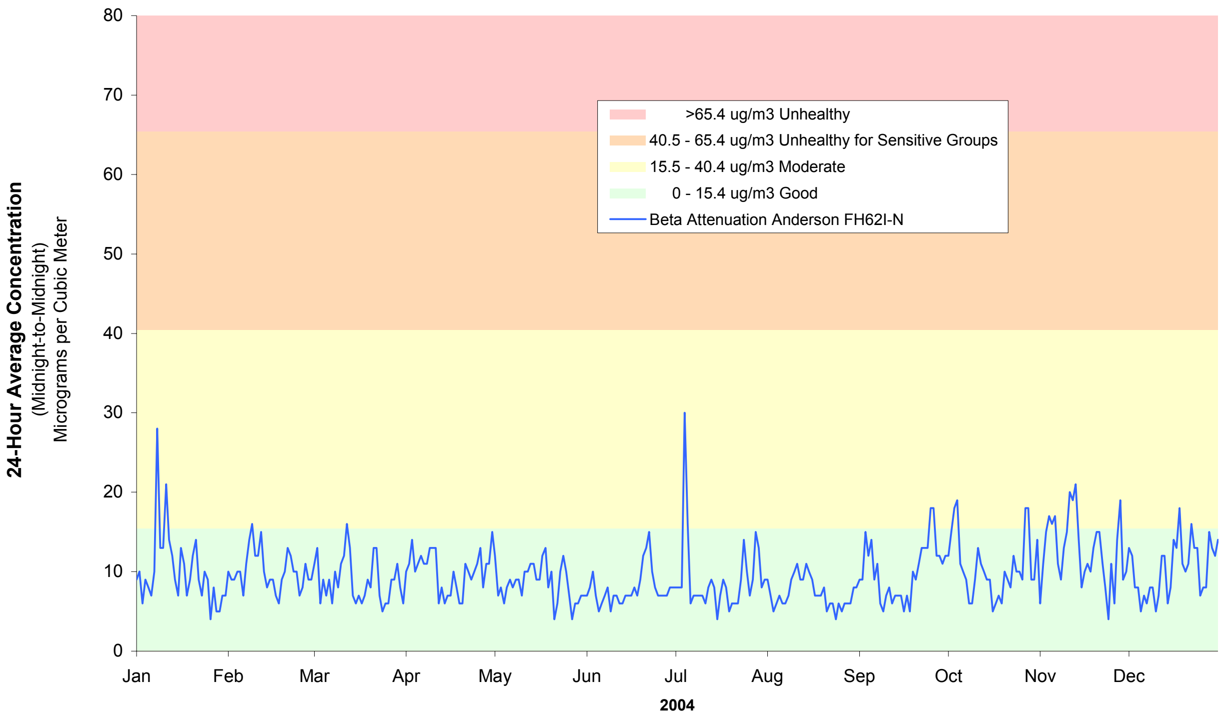

Kent (CW)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004

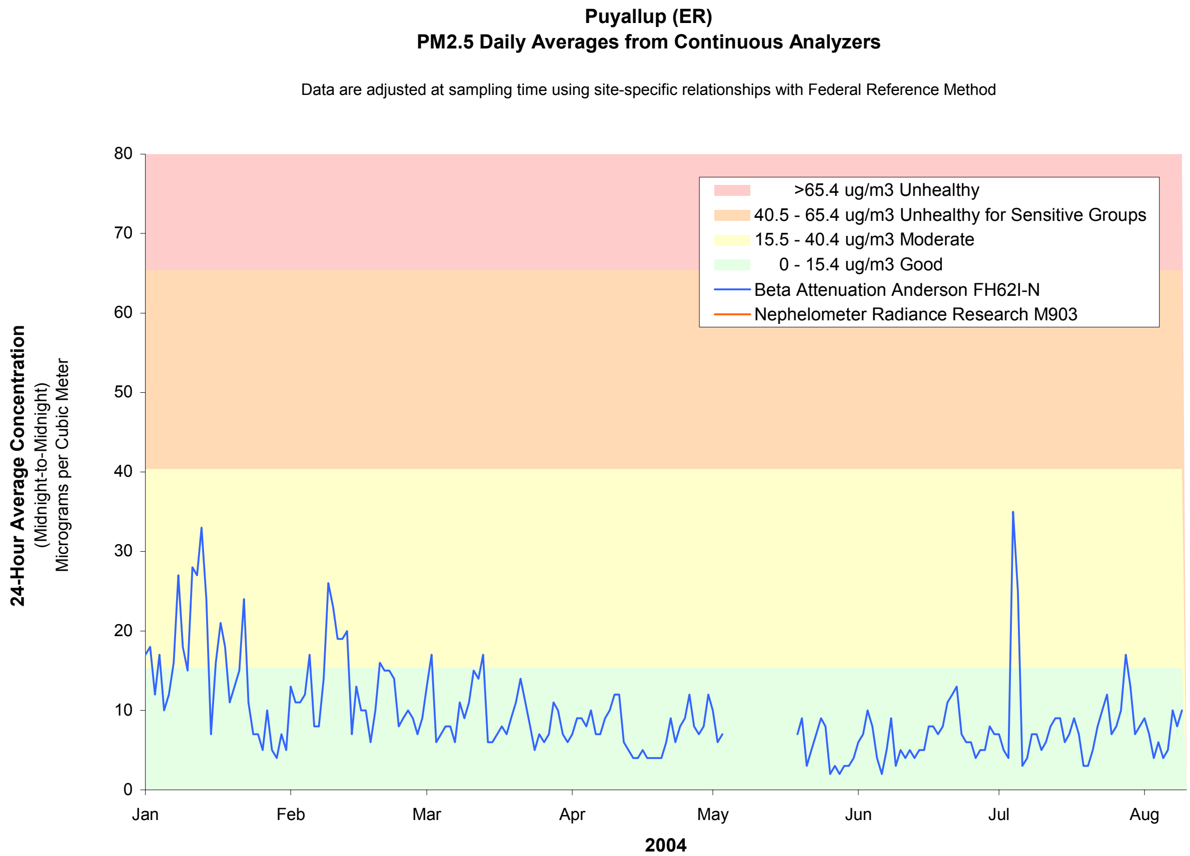
Bellevue, 143rd Ave NE (CZ)
PM2.5 Daily Averages from Continuous Analyzers

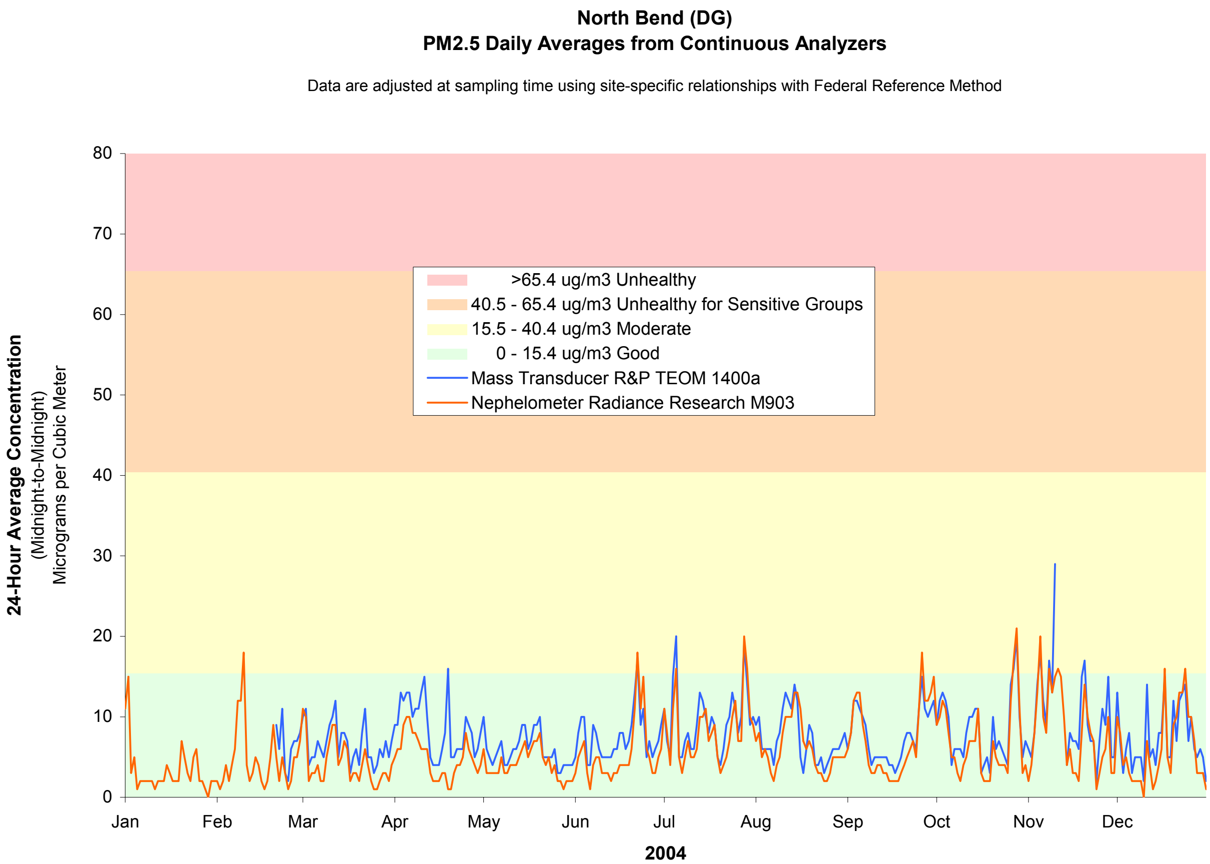
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method



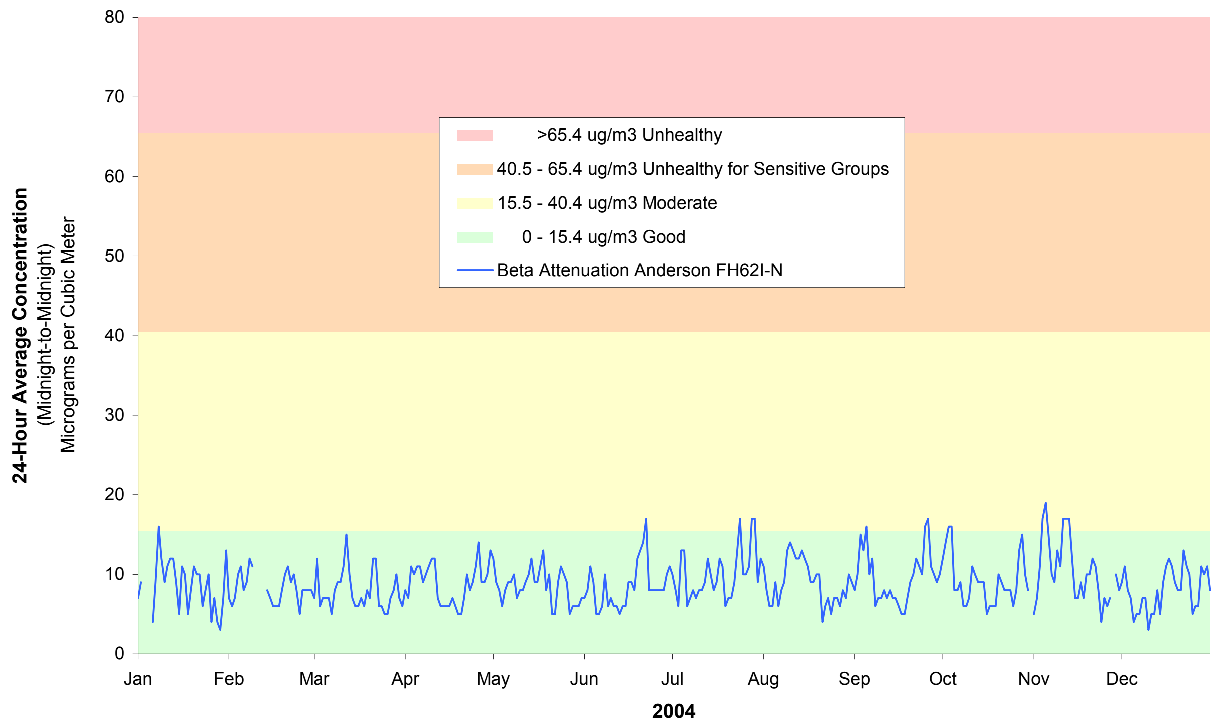
Bremerton, Meadowdale (QE)
PM2.5 Daily Averages from Continuous Analyzers




Puyallup (ER)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Beta Attenuation Anderson FH62I-N
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
2004


North Bend (DG)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
0
10
20
30
40
50
60
70
80
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004

Silverdale (QG)
PM2.5 Daily Averages from Continuous Analyzers



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 nitrous oxides (NO_x). 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. Ozone levels are highly affected by weather. The Agency monitors ozone from May through September, as this is the time period of concern for high ozone levels in the Pacific Northwest.

People frequently hear of ozone in the upper atmosphere. In this context ozone is considered beneficial because it 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. Ozone has also been linked to immune system effects.[36] People with respiratory conditions should limit outdoor exertion if ozone levels are high. 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.[37]

The majority of monitoring stations measuring ozone are located in rural regions of the Puget Sound, 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. Highest ozone concentrations are measured in areas such as North Bend and Enumclaw.

Graphs presented on the following pages show trends in ozone levels in the Puget Sound airshed, reflecting both the AQI and the NAAQS standards. The graph on page 71 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 AQI breakpoints for ozone, which is typically based on the 8-hour average. The graph on page 72 shows the trend of ozone over the summer for the last seven years. Levels have occasionally reached the "unhealthy for sensitive groups" zone in recent years.

[36] EPA AirNow Smog Health Effects. http://www.epa.gov/airnow/health/smog1.html#3.

[37] EPA Health and Environmental Effects of Ground Level Ozone. http://www.epa.gov/ttn/oarpg/naaqsfin/o3health.html.

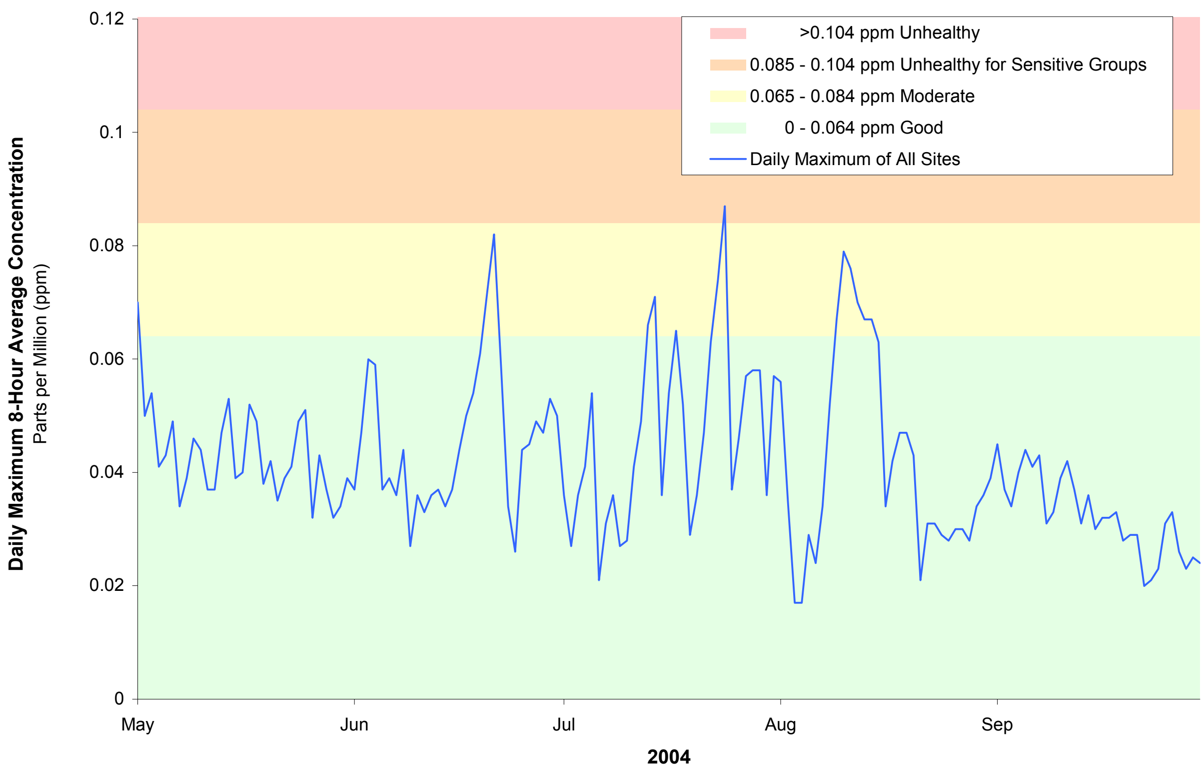
The graph on page 73 plots data for each monitoring station against the federal standard, and shows that the Puget Sound area has fallen below the standard since 1993. This means the 3-year average of the 4th-highest 8-hour concentration has not violated the NAAQS standard of 0.084 ppm since 1992. The ozone standard is defined such that 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 4th-highest concentrations. The year on the x-axis represents the last year averaged. For example, concentrations shown for 2004 are an average of 2002, 2003, and 2004 concentrations. The table on page A-11 of the Appendix shows that the 8-hour standard of 0.084 ppm was exceeded once in 2004: at Enumclaw and North Bend monitoring sites (0.087 ppm on July 24th).

While this graph clearly shows that the Puget Sound region has not violated the standard in over ten years, ozone levels have not decreased as significantly as other criteria air pollutants in our airshed.

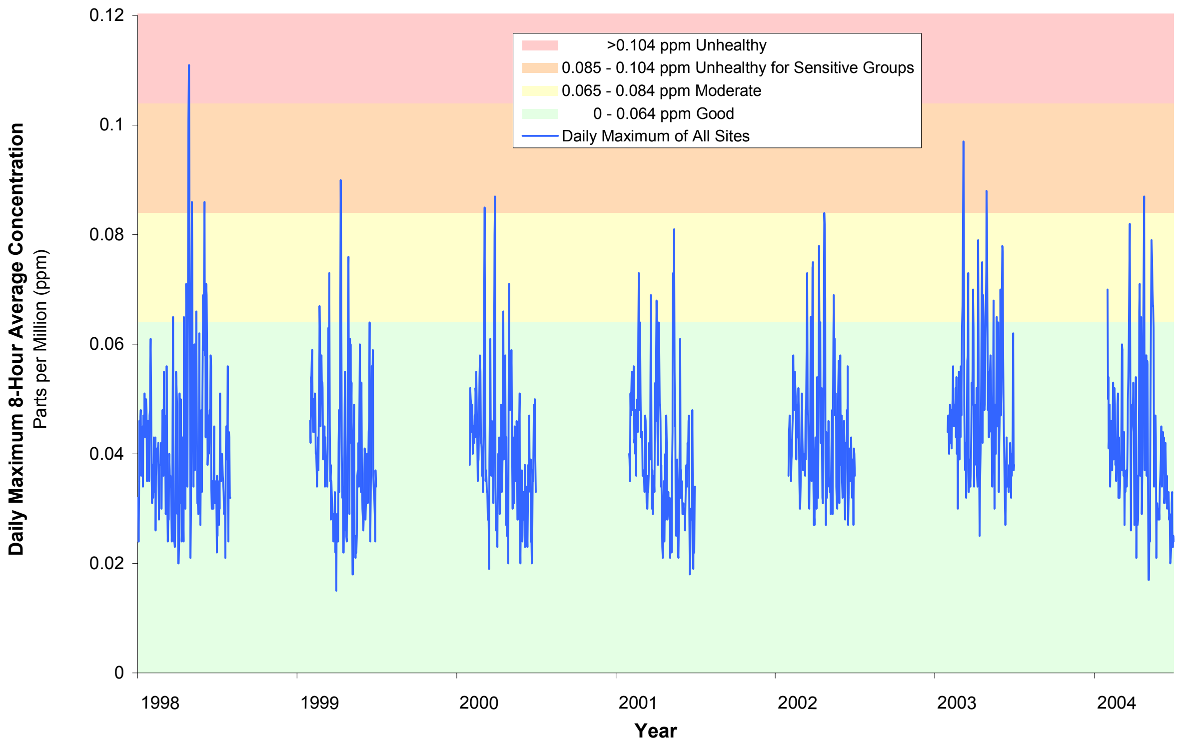
The 1-hour standard of 0.12 ppm was not exceeded in 2004 at any site during measurements, as seen in the table on page A-12 of the Appendix. The EPA does not believe that the 1-hour standard is as meaningful as the 8-hour standard to protect against adverse health effects. The 1-hour standard will be phased out in the Puget Sound area in June 2005.

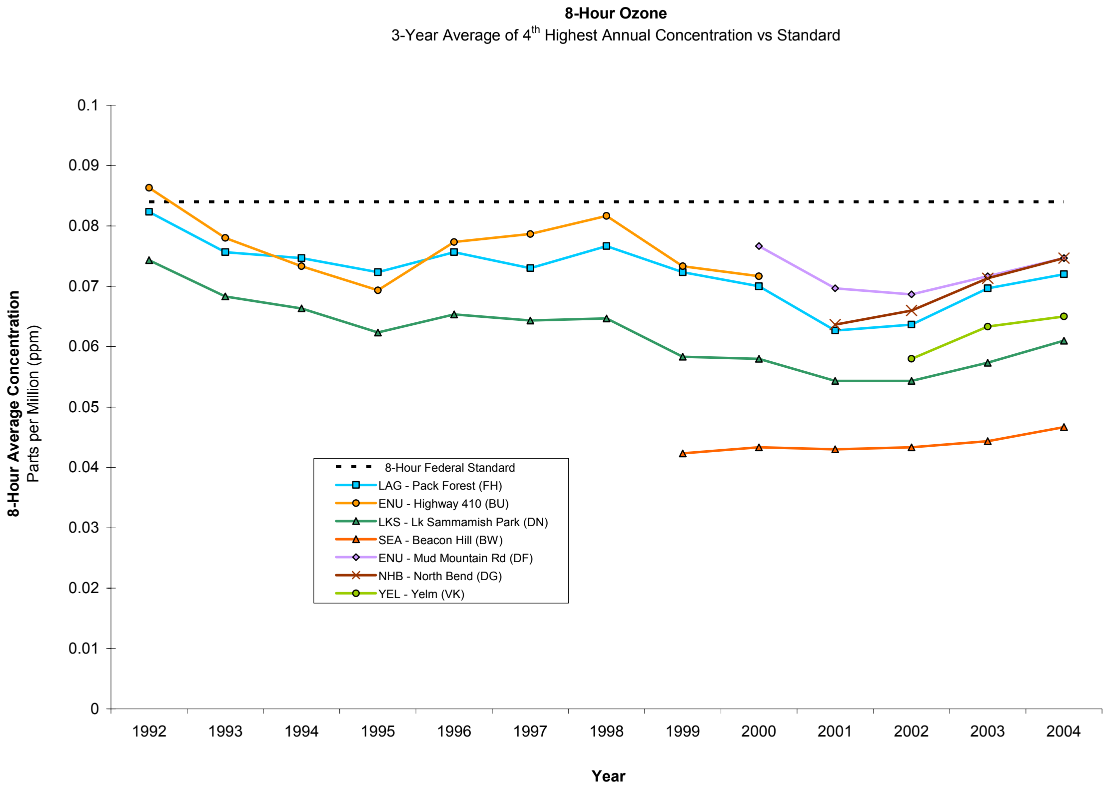
For additional information on ozone, visit www.epa.gov/air/urbanair/ozone/index.html. There is also additional information on ozone in question/answer format in the definitions section of this document.

Ozone (O_3) in Puget Sound Region
Daily Maximum 8-Hour Concentration



Ozone (O_3) in Puget Sound Region
for the months May through September
Daily Maximum 8-Hour Concentration




8-Hour Ozone
3-Year Average of 4th Highest Annual Concentration vs Standard
8-Hour Average Concentration
Parts per Million (ppm)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
8-Hour Federal Standard
LAG - Pack Forest (FH)
ENU - Highway 410 (BU)
LKS - Lk Sammamish Park (DN)
SEA - Beacon Hill (BW)
ENU - Mud Mountain Rd (DF)
NHB - North Bend (DG)
YEL - Yelm (VK)

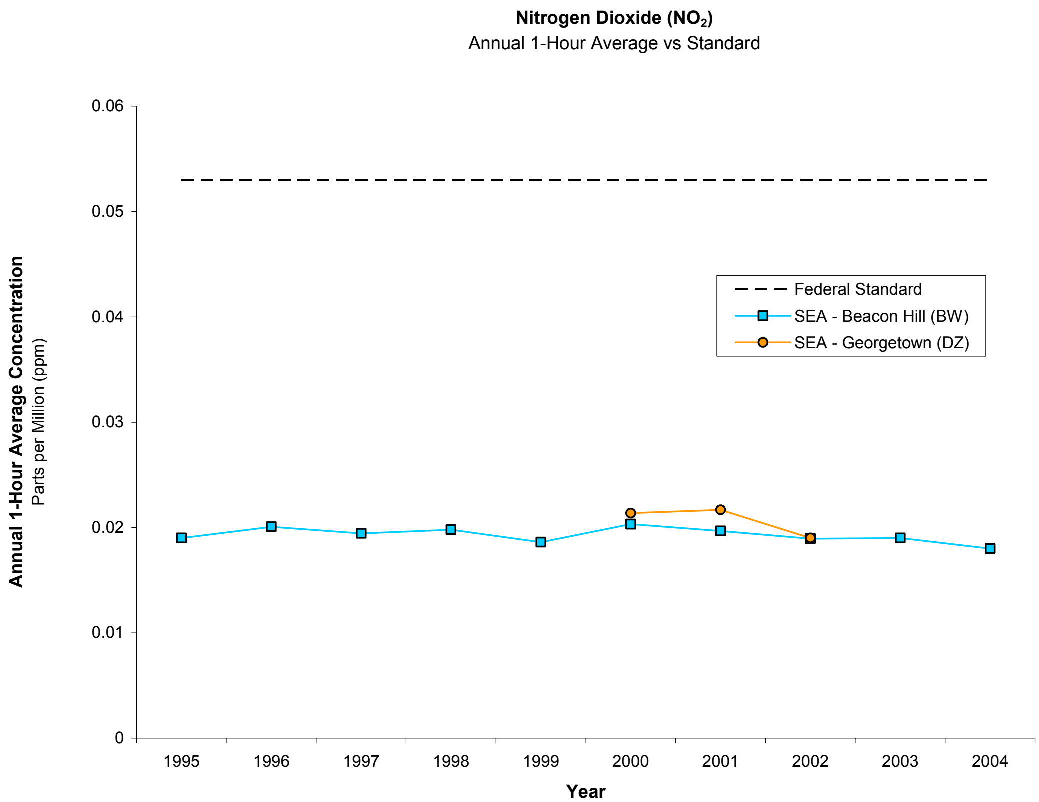
Nitrogen Dioxide

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. The term "NO_X", which is frequently used, refers to both NO and NO_2. NO_2 will react with VOCs and can result in the formation of ozone. 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. NO_2 pollution is greatest in cold weather.

NO_2 can cause respiratory symptoms such as coughing, wheezing, and shortness of breath in people with respiratory diseases such as asthma. Long-term exposure can lead to respiratory infections.

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

The Washington State Department of Ecology maintains one monitoring site for nitrogen dioxide at the Beacon Hill monitoring site. The annual average for each year has consistently been less than half of the NAAQS standard, as shown in the graph on page 75 and in data on page A-13 of the Appendix. The maximum 1-hour average of NO_2 measured in 2004 was 0.073 ppm on February 13th. Visit www.epa.gov/air/urbanair/nox/index.html. for additional information on NO_2.


Nitrogen Dioxide (NO_2)
Annual 1-Hour Average vs Standard
Annual 1-Hour Average Concentration
Parts per Million (ppm)
0.06
0.05
0.04
0.03
0.02
0.01
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Federal Standard
SEA - Beacon Hill (BW)
SEA - Georgetown (DZ)

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. The majority of CO comes from vehicle exhaust. 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.

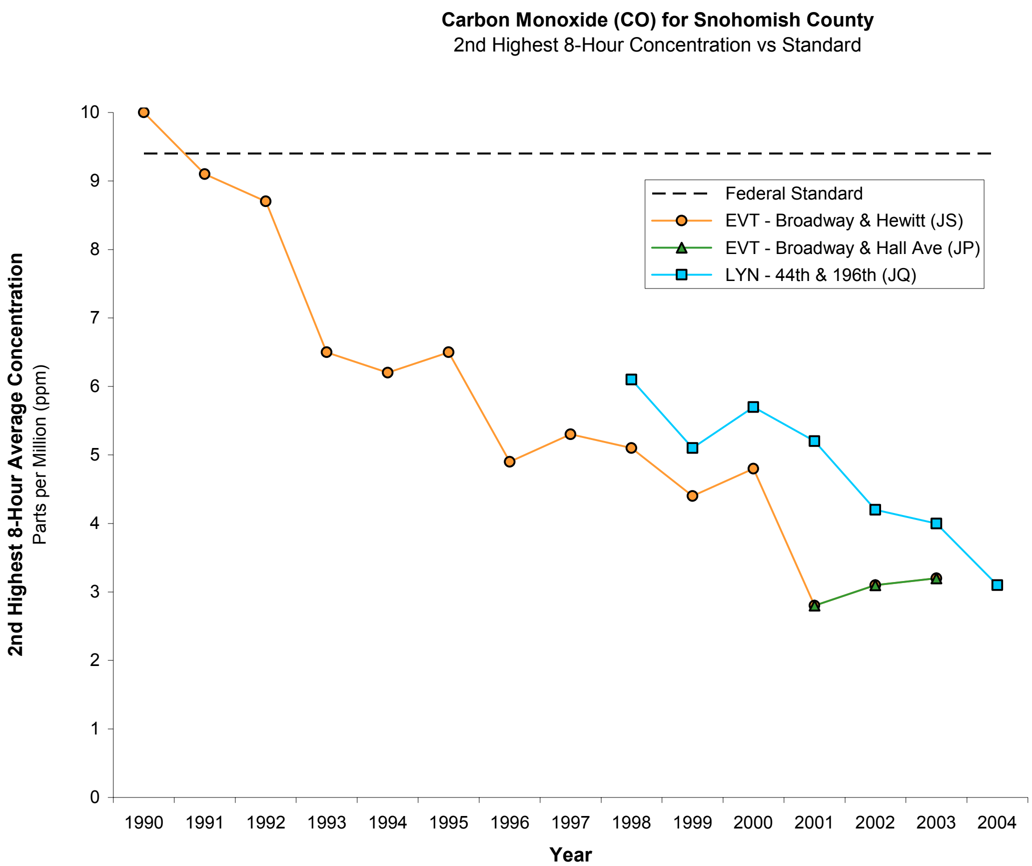
The Washington State Department of Ecology conducts all CO monitoring. CO monitoring stations are located in areas with heavy traffic congestion. These include central business areas, roadsides, and shopping malls. CO levels have reduced significantly in the last fifteen years in the Puget Sound area, primarily due to cleaner car technology.

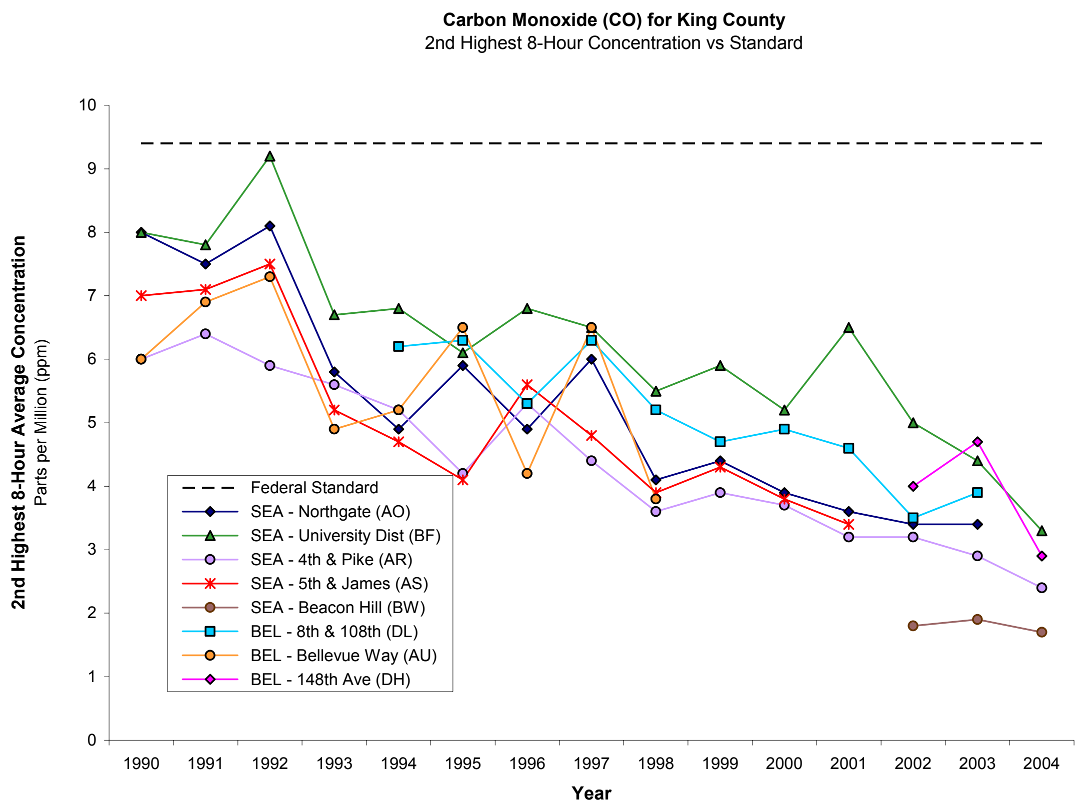
The following graphs show the second highest 8-hour concentrations versus the NAAQS standard for Snohomish, King, and Pierce counties. There are no CO monitoring stations in Kitsap County. The second-highest concentration is displayed on these graphs because, under the federal standard, the second highest 8-hour average is compared to the standard. These county-by-county graphs confirm the general downward trend that CO has taken from the early 1990s to present. EPA designated the Puget Sound region as a CO attainment area in 1996.

The maximum 8-hour concentration for CO in 2004 was 5 parts per million (ppm) on January 7th, well below the 8-hour standard of 9.4 ppm. These data are provided on page A-14 of the Appendix**.**

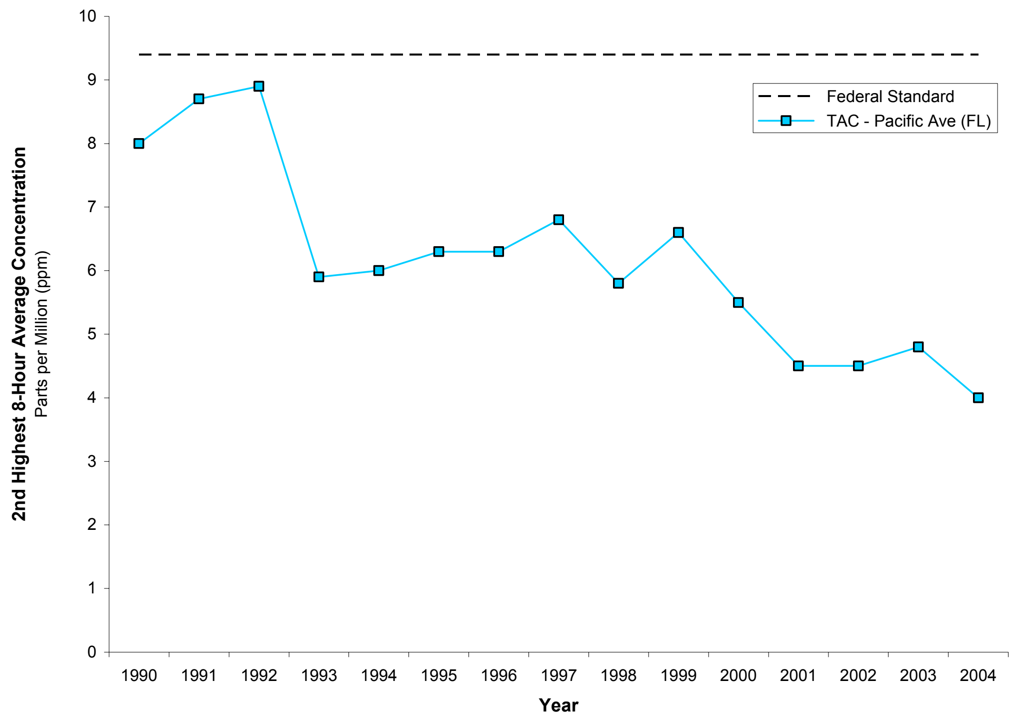
The NAAQS also includes a 1-hour standard for CO of 35 ppm, which cannot be exceeded more than once a year. Measured 1-hour concentrations in the Puget Sound area are historically much lower than the 35 ppm standard, and therefore 1-hour CO trends were not graphed. The maximum and second-highest measured 1-hour CO in 2004 are 7 and 6.4 ppm, both on January 7th. Additional 1-hour average CO data are provided in the Appendix on page A-14.

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.


Carbon Monoxide (CO) for Snohomish County
2nd Highest 8-Hour Concentration vs Standard
2nd Highest 8-Hour Average Concentration
Parts per Million (ppm)
Federal Standard
EVT - Broadway & Hewitt (JS)
EVT - Broadway & Hall Ave (JP)
LYN - 44th & 196th (JQ)
0
1
2
3
4
5
6
7
8
9
10
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year


Carbon Monoxide (CO) for King County
2nd Highest 8-Hour Concentration vs Standard
2nd Highest 8-Hour Average Concentration
Parts per Million (ppm)
Year
Federal Standard
SEA - Northgate (AO)
SEA - University Dist (BF)
SEA - 4th & Pike (AR)
SEA - 5th & James (AS)
SEA - Beacon Hill (BW)
BEL - 8th & 108th (DL)
BEL - Bellevue Way (AU)
BEL - 148th Ave (DH)
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

Carbon Monoxide (CO) for PIerce County
2nd Highest 8-Hour Concentration vs Standard



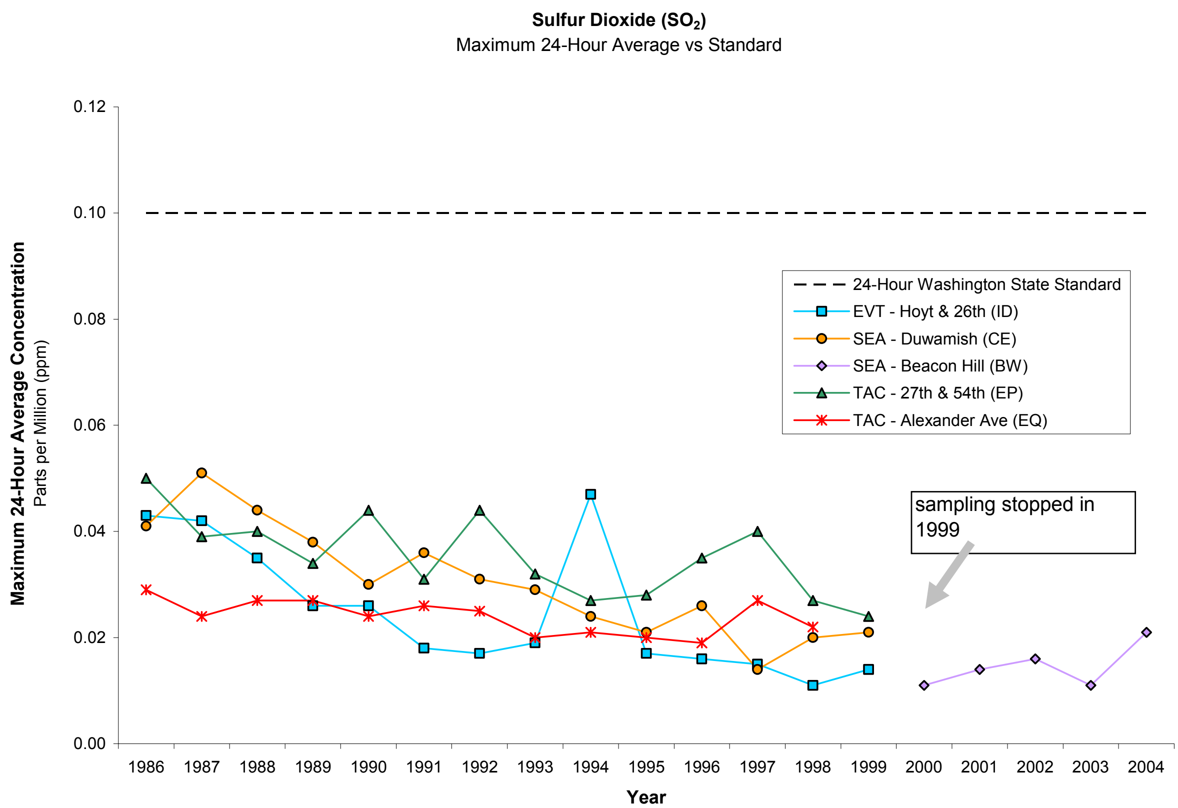
Sulfur Dioxide

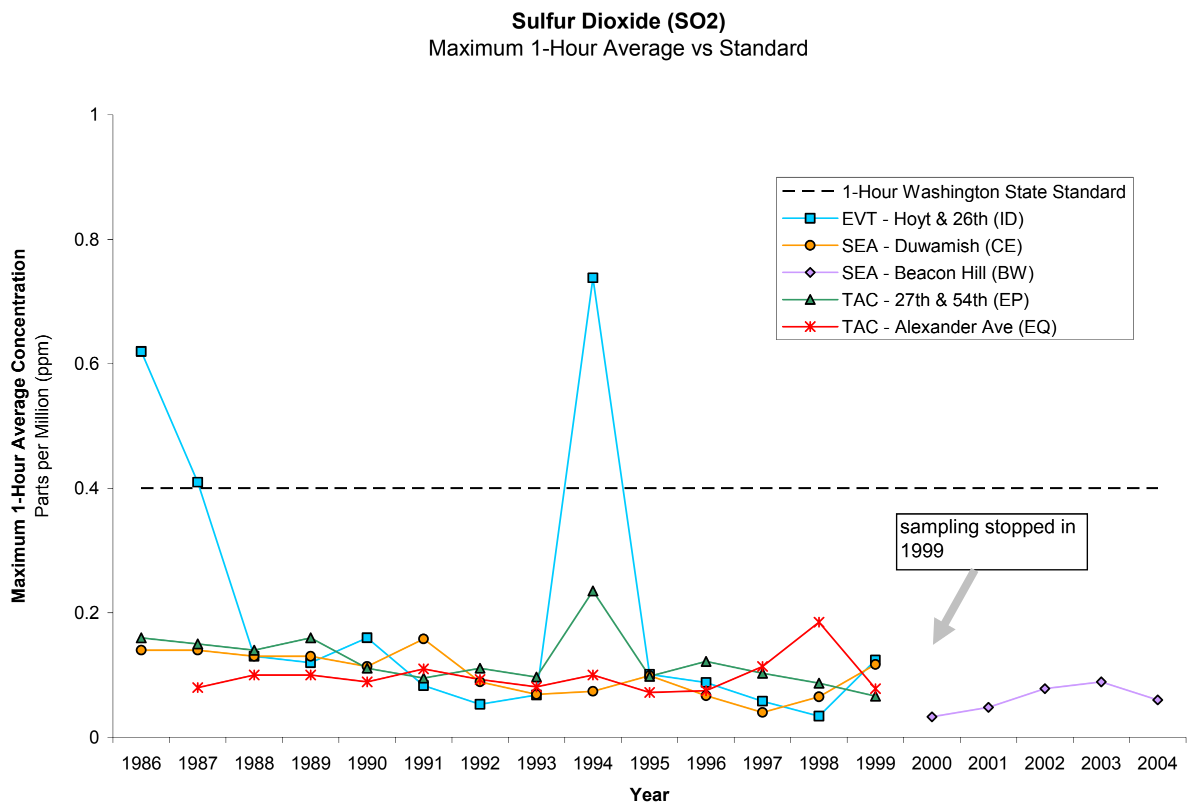
Sulfur dioxide (SO_2) is a colorless, reactive gas produced by burning fuels containing sulfur, such as coal and oil, and by industrial processes. Historically, the greatest sources of SO_2 were industrial facilities that derived their products from raw materials such as metallic ore, coal, and crude 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 craft also 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.

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 several years. 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 this decrease. The monitoring sites for SO_2 were historically sited in or near these industrial areas. The Washington State Department of Ecology currently monitors for SO_2 at the Beacon Hill site. This monitoring started in May 2000.

The maximum measured SO_2 concentrations in 2004 were significantly below all federal and regional standards. The graphs below show the maximum 24-hour and 1-hour concentrations, respectively, at individual monitoring sites. The maximum 24-hour and 1-hour averages were 0.021 ppm (measured September 26, 2004) and 0.060 ppm (measured October 3, 2004), respectively. Additional SO_2 data from the Beacon Hill site are located on page A-15 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.


Sulfur Dioxide (SO_2)
Maximum 24-Hour Average vs Standard
Maximum 24-Hour Average Concentration
Parts per Million (ppm)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
24-Hour Washington State Standard
EVT - Hoyt & 26th (ID)
SEA - Duwamish (CE)
SEA - Beacon Hill (BW)
TAC - 27th & 54th (EP)
TAC - Alexander Ave (EQ)
sampling stopped in 1999
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year


Sulfur Dioxide (SO2)
Maximum 1-Hour Average vs Standard
Maximum 1-Hour Average Concentration
Parts per Million (ppm)
1
0.8
0.6
0.4
0.2
0
1-Hour Washington State Standard
EVT - Hoyt & 26th (ID)
SEA - Duwamish (CE)
SEA - Beacon Hill (BW)
TAC - 27th & 54th (EP)
TAC - Alexander Ave (EQ)
sampling stopped in 1999
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

Lead

Lead is a highly toxic metal that was used for many years in household products, 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 lead emissions.

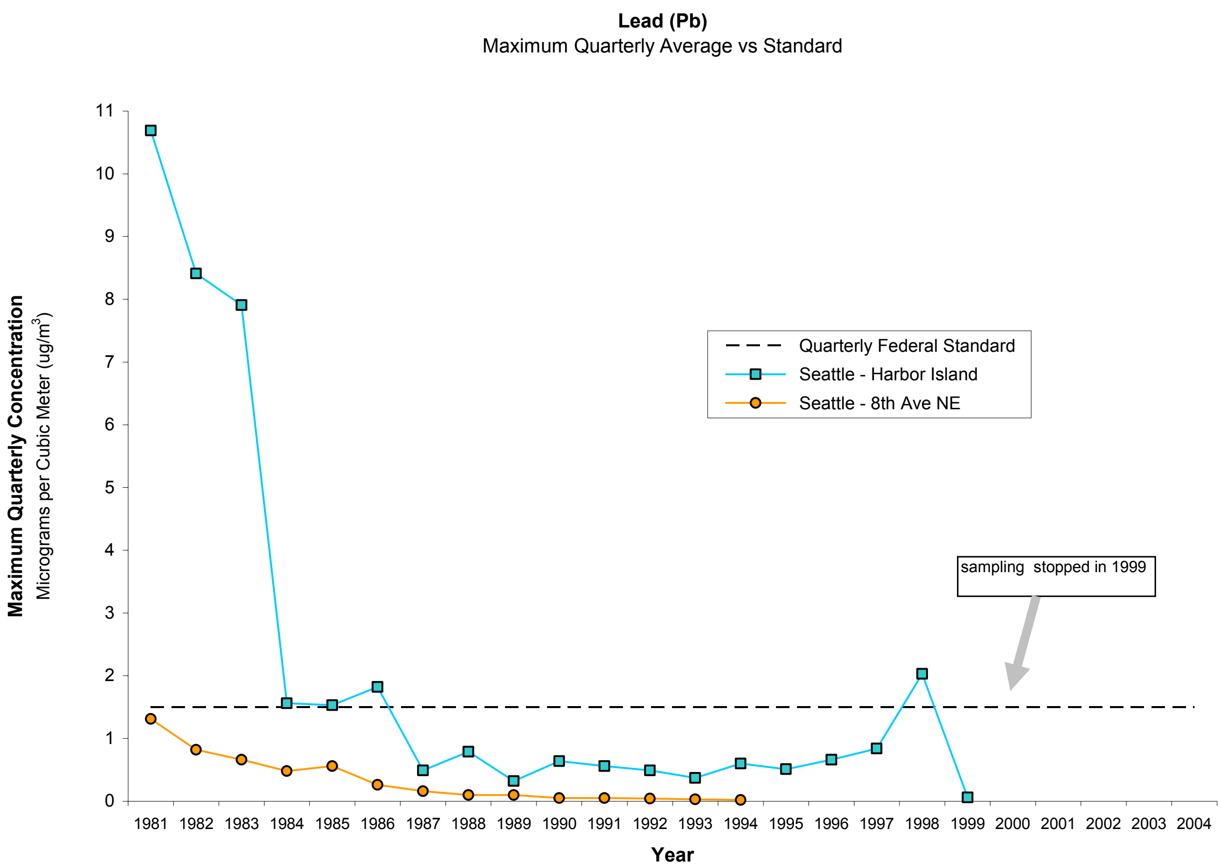
People, animals, and fish are mainly exposed to lead by breathing and ingesting it in food, water, soil, or dust. Lead accumulates in the blood, bones, muscles, and fat. Infants and young children are especially sensitive to even low levels of lead. Lead can have health effects ranging from behavioral 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. Refer to the EPA website www.epa.gov/ttnatw01/hlthef/lead.html for ways to limit your exposure to these lead sources.

Lead has not been monitored in the Puget Sound area since 1999.[38] Since the phase-out of lead in fuel and the closure of the Harbor Island lead smelter, airborne lead is no longer a public health concern in the region. The graph on page 84 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.

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

[38] 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, lead is still monitored as a PM_{10} air toxic at Beacon Hill. Also, the lead fraction of $PM_{2.5}$ is measured at speciation monitors.


Lead (Pb)
Maximum Quarterly Average vs Standard
Maximum Quarterly Concentration
Micrograms per Cubic Meter (ug/m3)
11
10
9
8
7
6
5
4
3
2
1
0
1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
Year
Quarterly Federal Standard
Seattle - Harbor Island
Seattle - 8th Ave NE
sampling stopped in 1999

Visibility

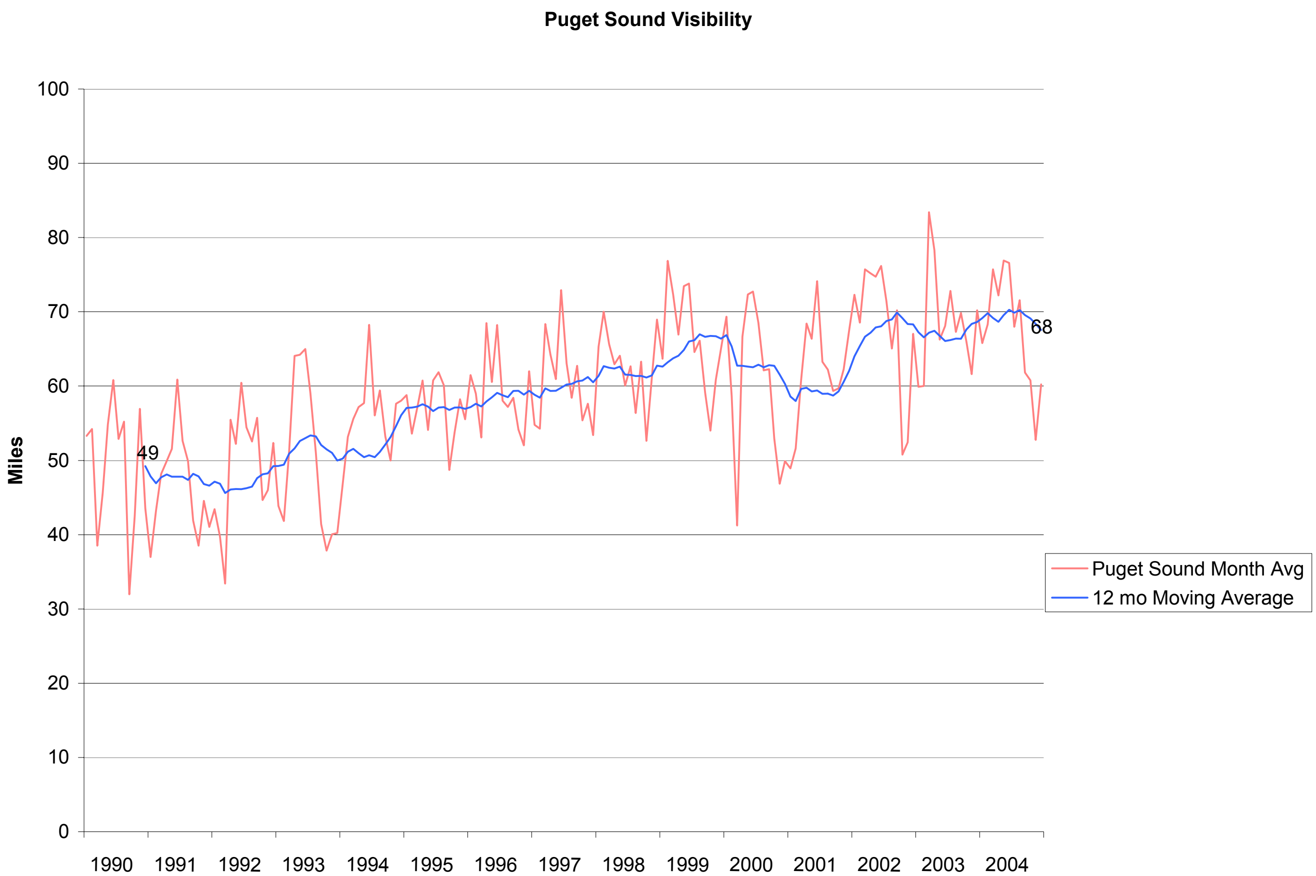
There are no federal or state standards established for visibility. This parameter is presented (without comparison to a standard) as an easily-understood indicator of air quality. Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance—usually 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 you have, the shorter your visual range will be. 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.

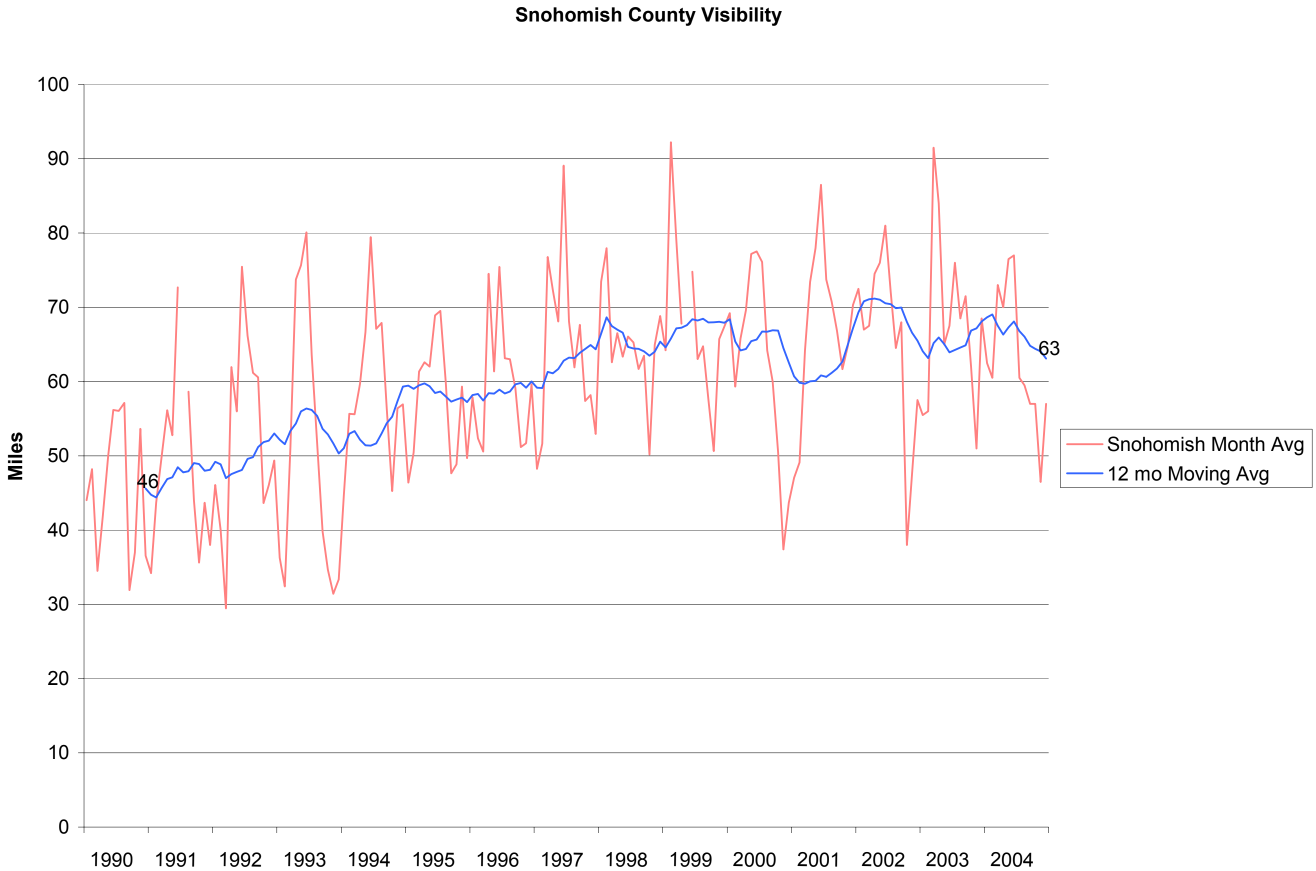
Reduced visibility is caused by weather such as clouds, fog, and rain, and air pollution, including fine particles and gases. The major pollution contributor to reduced visual range is fine particulate matter ($PM_{2.5}$), which is transported aloft and may remain suspended for a week or longer. Fine 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. $PM_{2.5}$ also presents some of the most serious health hazards to the public, so you can roughly assume that the worse the visibility due to particulate matter, the unhealthier the air is to breathe.

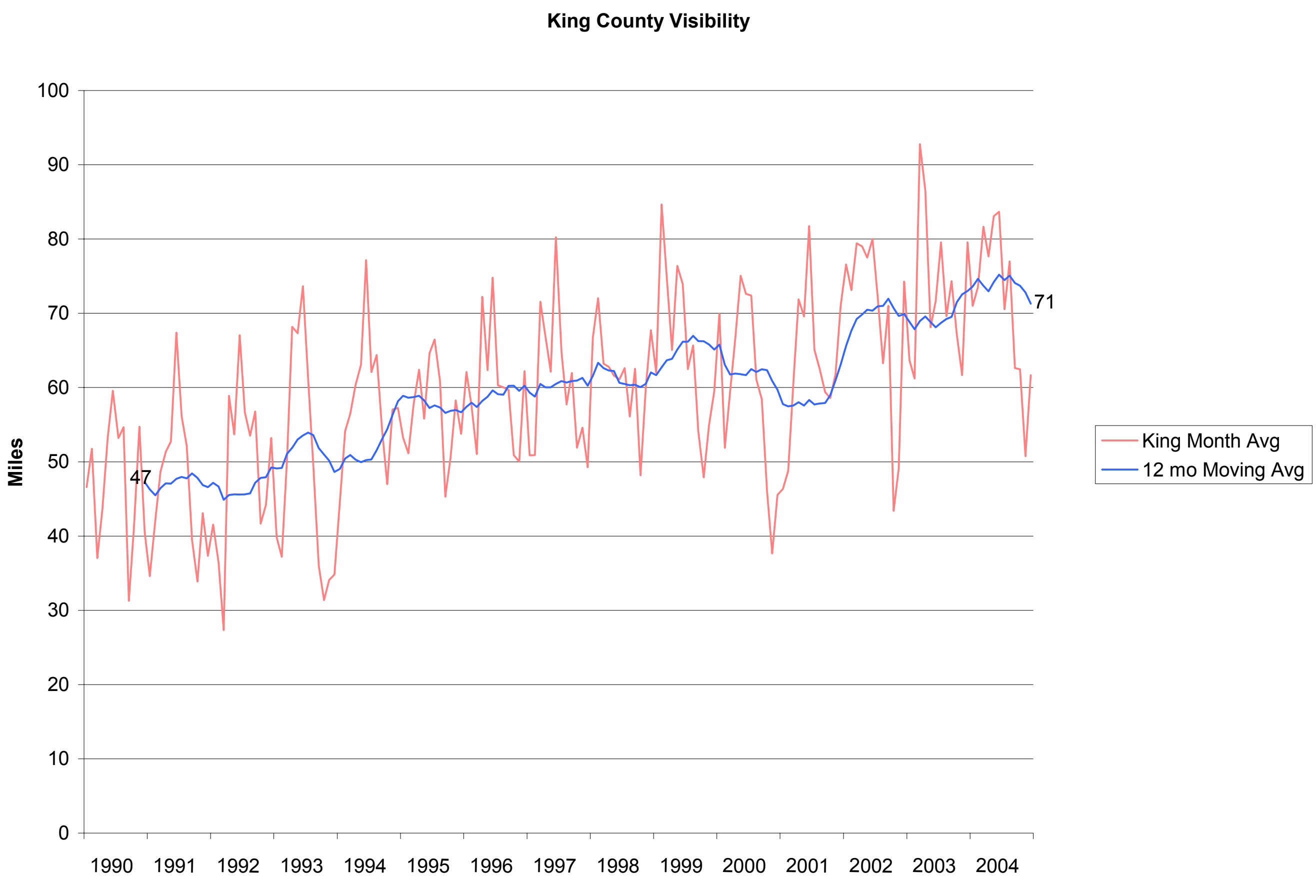
Graphs on the following pages show visibility for the overall Puget Sound area, as well as Snohomish, King, and Pierce counties. Visibility on these graphs, in units of miles, is determined by nephelometer monitoring. The nephelometer measures light scattering due to particulate matter, and then converts 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. Data from nephelometers are shown on pages A-8 and A-9 of the Appendix.

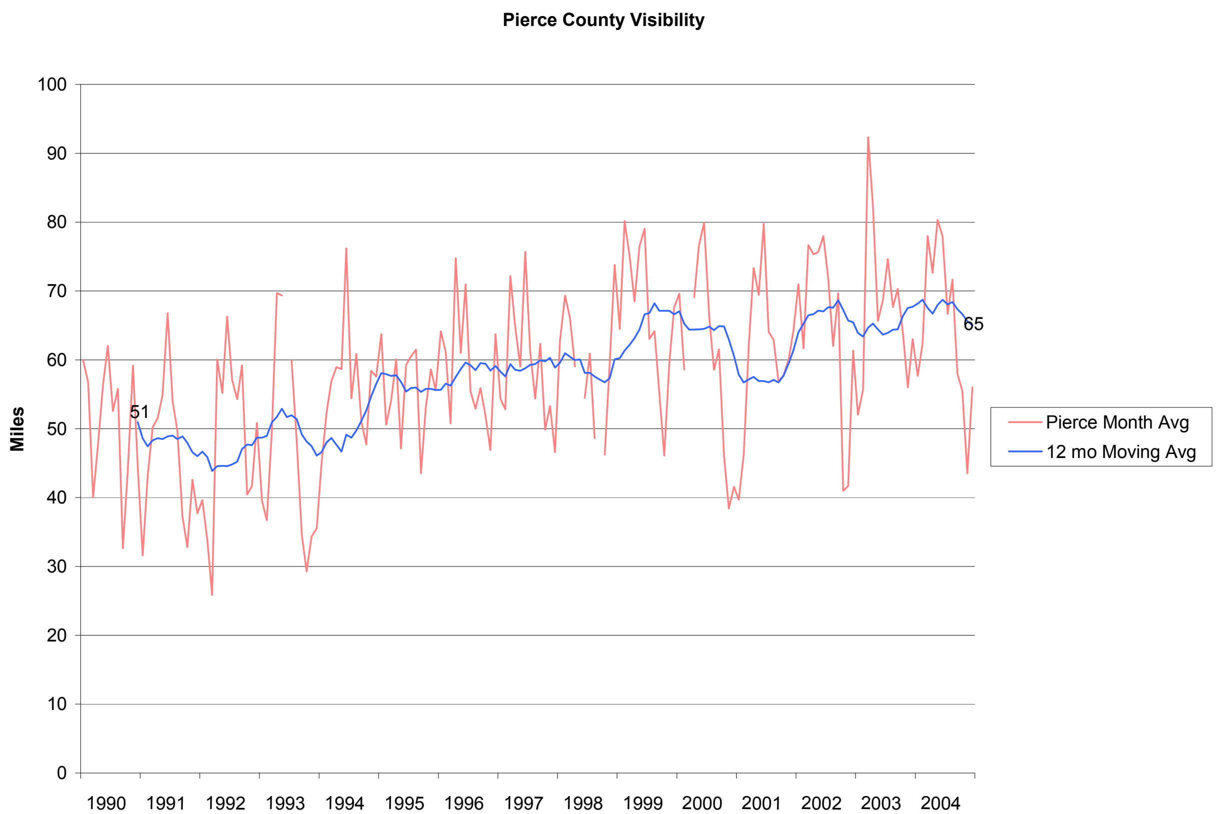
The red line on the graphs represents the monthly average visibility; it is apparent that there are large fluctuations, which correspond to the highest levels of visibility in the summer months and the lowest levels in the winter. The blue line shows a 12-month moving average, which incorporates the 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 14-year period from December 1990 through December 2004, the 12-month moving average of visual range increased from 49 miles to 68 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.


Puget Sound Visibility
Miles
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
49
68
Puget Sound Month Avg
12 mo Moving Average


Snohomish County Visibility
Miles
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
46
63
Snohomish Month Avg
12 mo Moving Avg


King County Visibility
100
90
80
70
60
50
40
30
20
10
0
Miles
47
71
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
King Month Avg
12 mo Moving Avg


Pierce County Visibility
100
90
80
70
60
50
40
30
20
10
0
Miles
51
65
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Pierce Month Avg
12 mo Moving Avg

Air Toxics

The Washington State Department of Ecology monitored 17 air toxics in 2004 at the Beacon Hill site, including seven PM_{10} metals. Monitoring was conducted every six days. This section presents a relative ranking of these toxics, based on potential cancer risks, as well as graphs for toxics using five years of monitoring data. Graphs are not presented for PM_{10} metals because they have two years of data, 2003 and 2004. A short description of health effects associated with each air toxic and local sources are also provided.

A comprehensive, cumulative risk evaluation is beyond the scope of this summary report. For more information, consult the 2003 Puget Sound Air Toxics Evaluation.[39]

Air toxics statistical summaries are provided on page A-16 of the Appendix.

Relative Ranking

The table on page 91 ranks 2004 air toxics according to mean potential cancer risk per million. Metals are listed with an (M) designation. Two air toxics monitored in 2004, vinyl chloride and 1,2-dichloropropane, are not listed in the table because they were never detected at measurable levels.

Potential cancer risk estimates are shown here to provide a meaningful basis of comparison between pollutants. 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 toxicity.[40] Unit risk factors for air toxics in the table below are listed on page A-17 of the Appendix.

Mean risks are presented in this table, and are based on average concentrations. Upper bound risks based on 95th percentile concentrations are included on page A-18 of the Appendix.[41] It is important to note that many air toxics also have non-cancer health effects. These non-cancer effects are not quantitatively reported here. Again, potential cancer risk estimates are shown here as a basis of comparison.

---

[39] Puget Sound Final Air Toxics Evaluation. 2003.

[40] Potential cancer risks are based on URFs, which are based on an assumed 70-year exposure inhalation.

[41] Upper bound estimates are often protectively used in health evaluations. Use of upper bounds is intended to account for populations that may be exposed to air toxics at concentrations greater than a mean statistic.

2004 Beacon Hill Potential Cancer Risk Estimates, per 1,000,000

AIR TOXIC	MEAN RISK
Formaldehyde	13.9
Benzene	9.9
Carbon Tetrachloride	9.8
Chromium (M)[42]	6.0
Chloroform	5.3
Arsenic (M)	4.5
1,3-Butadiene	3.8
Acetaldehyde	3.2
Nickel (M)	1.4
Tetrachloroethylene	1.0
Trichloroethylene	0.3
Cadmium (M)	0.3
Lead (M)	0.1
Beryllium (M)	0.004
Manganese (M)	na[43]

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 above table. No direct monitoring method currently exists for these toxics.[44] Acrolein is another air toxic that presents potential health risk in the Puget Sound area, in the form of respiratory irritation.[45] Acrolein is not listed in the table because no sufficient ambient monitoring method currently exists.

[42] Chromium estimated risks are based on EPA's assumption that 34% of total chromium is hexavalent, the most toxic form. EPA 1996 National Air Toxic Assessment.
[43] Manganese is not associated with cancer, so it has no potential risk estimate. Manganese is associated with nervous system effects. http://www.epa.gov/ttn/atw/hlthef/manganes.html
[44] A brief description of source apportionment modeling used to estimate concentrations of these air toxics is included in the $PM_{2.5}$ section of this report.
[45] Acrolein health effects estimate is based on modeling. US EPA National Air Toxics Assessment.

Air toxics concentrations, risk estimates, and rankings in 2004 are similar to those in the 2003 Air Toxics Evaluation.[46]

Air Toxics Graphs

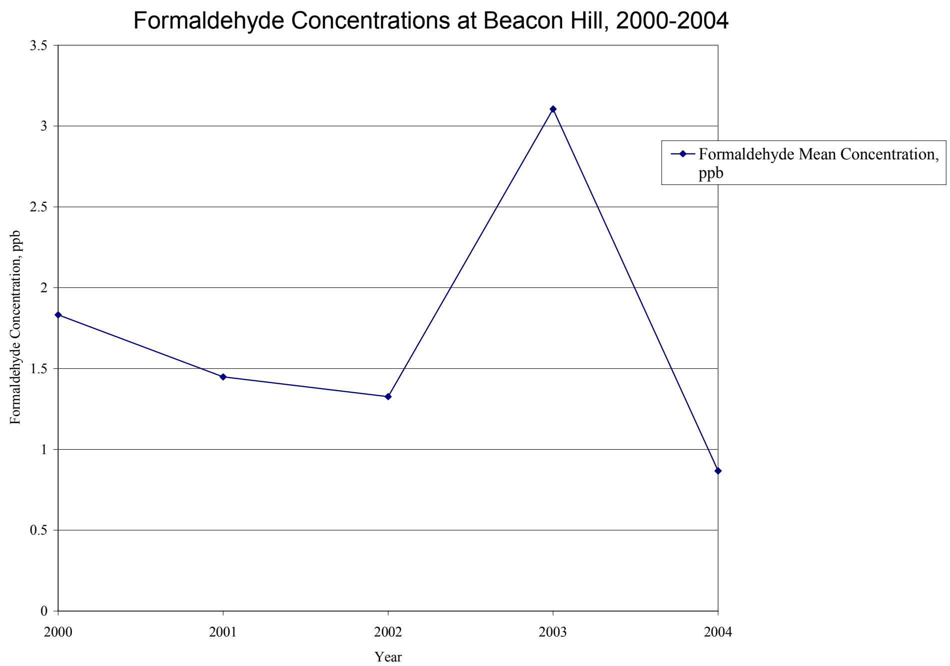
Annual mean concentrations are shown on the following pages for air toxics collected from 2000 to 2004 at Beacon Hill. Although a five-year period is likely too short to characterize trends, the data show that air toxics concentrations are relatively stable in the Puget Sound area. Graphs are not presented for PM_{10} metals because the metals data represent only two years, 2003 and 2004. The graphs below do not contain lines for federal standards, as no federal ambient air concentration standards exist for air toxics.

[46] The 2003 Puget Sound Air Toxics Evaluation is based on 2001 monitoring.

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 formaldehyde include automobiles, trucks, wood burning and other combustion, and plywood off-gassing. Its estimated mean cancer potential risk in 2004 was 13.9 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.[48] It is unlikely that there was a regional increase of formaldehyde during this time.



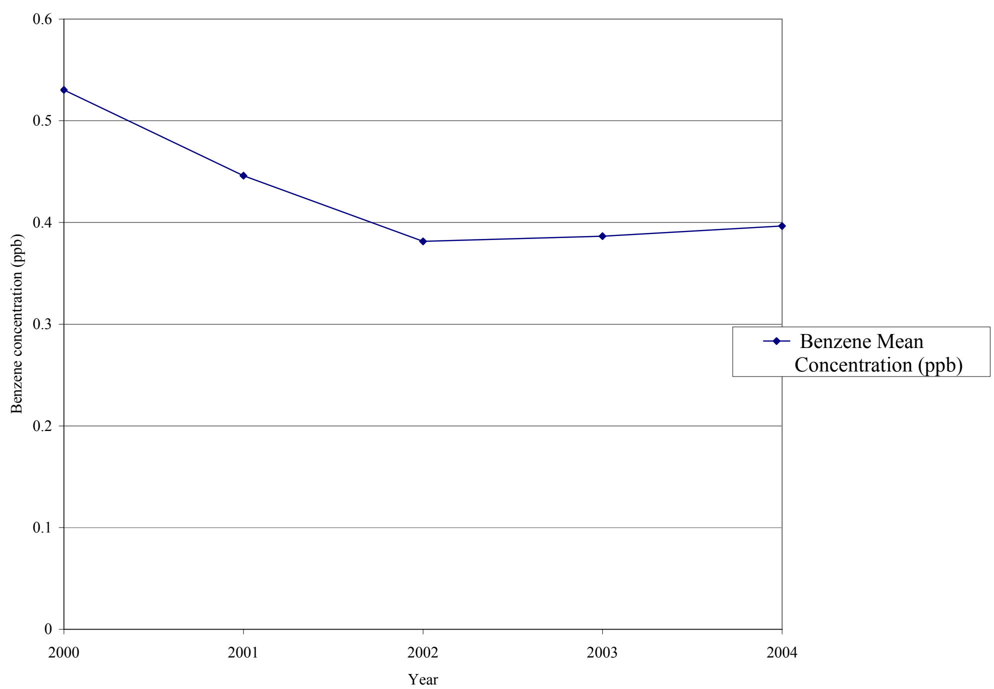
[47] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/formalde.html.

[48] A possible source of formaldehyde could include solvents that are sometimes used in research projects. The academic community occasionally uses the Beacon Hill reservoir for its research. It's not known at this time if this is what caused a significant increase in concentrations.

Benzene

The EPA lists benzene as a known human carcinogen. Benzene inhalation is also linked with blood, immune, and nervous system disorders.[49] This air toxic comes from a variety of sources, including car/truck exhaust, wood burning, evaporation of industrial solvents, and other combustion. Its estimated mean cancer risk in 2004 was 9.9 in a million.

Benzene Concentrations at Beacon Hill, 2000 - 2004

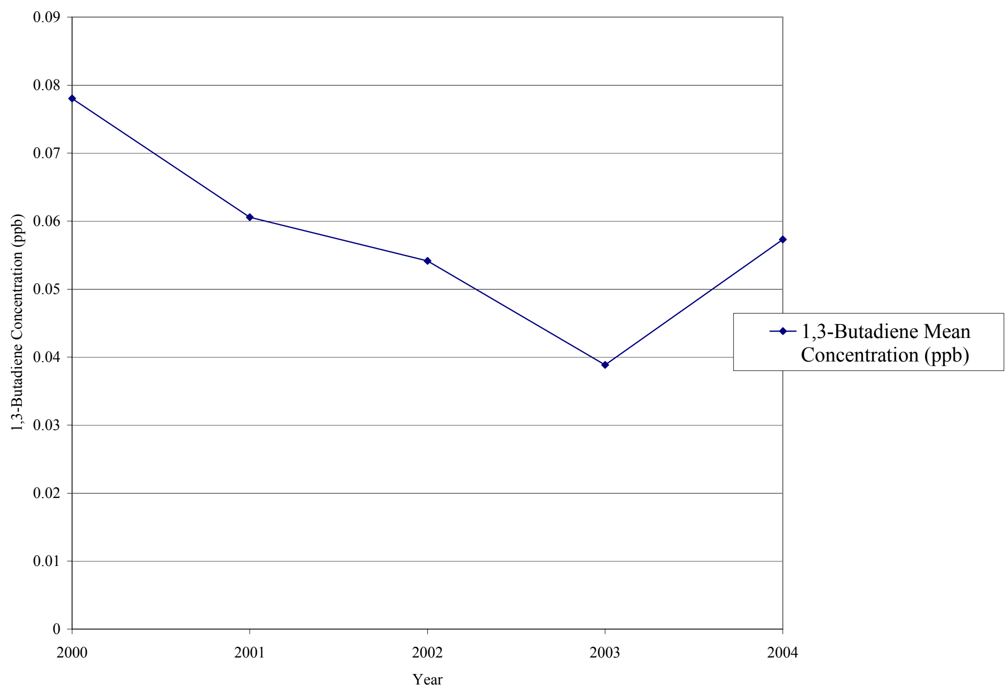


49 EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/benzene.html

1,3-Butadiene

The EPA lists 1,3-butadiene as a probable human carcinogen. 1,3-Butadiene inhalation is also associated with neurological effects.[50] Primary sources of 1,3-butadiene include cars, trucks, buses, and wood burning. Its mean 2004 potential cancer risk was 3.8 in a million.

1,3-Butadiene Concentrations at Beacon Hill, 2000 -2004

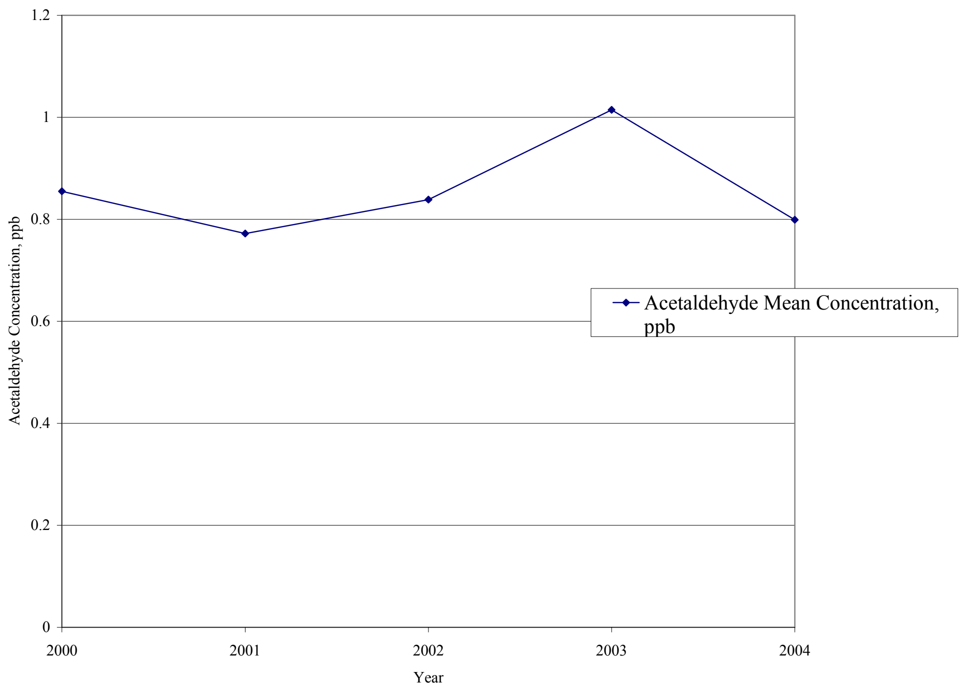


[50] EPA Hazard Summary. http://www.epa.gov/ttnatw01/hlthef/butadien.html.

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.[51] Main sources of acetaldehyde include wood burning and car/truck exhaust. Its mean 2004 potential cancer risk was 3.2 in a million.

Acetaldehyde Concentrations at Beacon Hill, 2000-2004

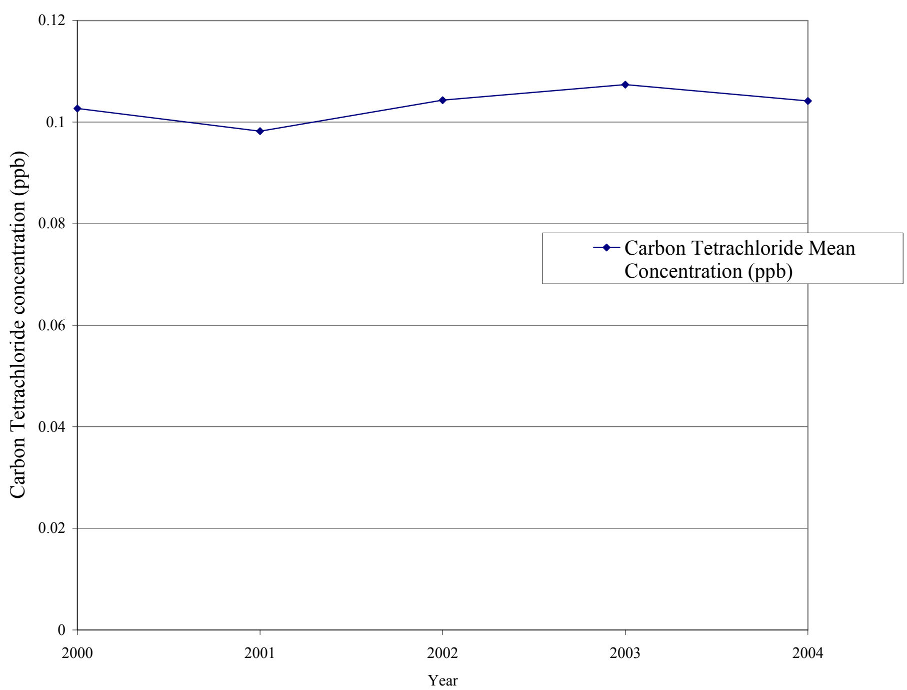


[51] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/acetalde.html.

Carbon Tetrachloride

The EPA lists carbon tetrachloride as a probable human carcinogen. Carbon tetrachloride inhalation is also associated with liver and kidney damage.[52] Carbon tetrachloride was widely used as a solvent for both industry and consumer users, and was banned for 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. Its 2004 mean potential cancer risk was 9.8 in a million.

Carbon Tetrachloride Concentrations at Beacon Hill, 2000 - 2004

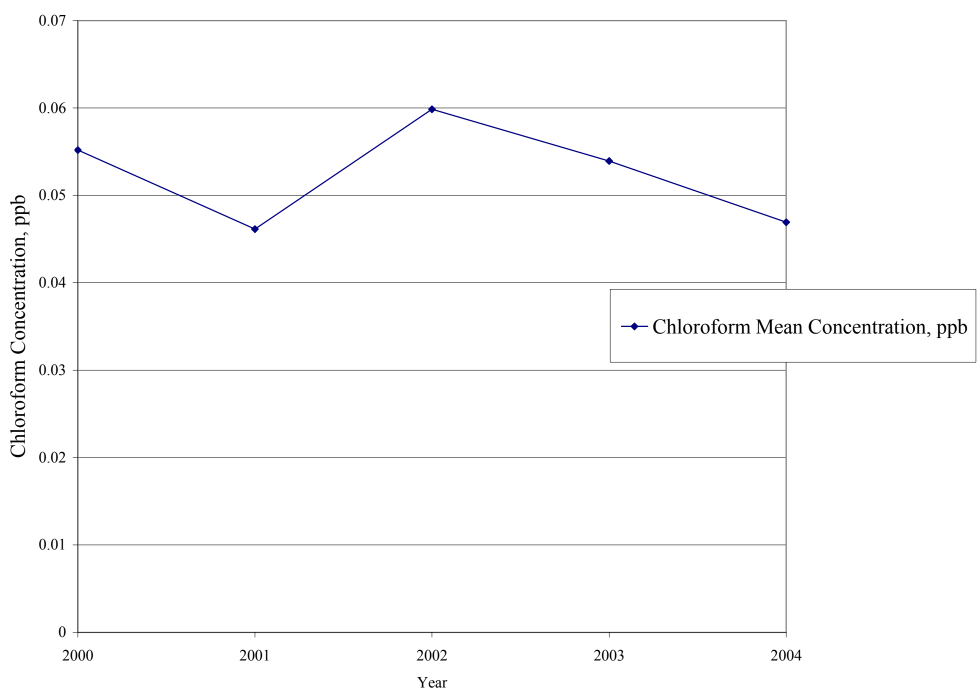


[52] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/carbonte.html.

Chloroform

The EPA lists chloroform as a probable human carcinogen. Chloroform inhalation is also associated with central nervous system effects and liver damage.[53] 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. Its 2004 mean potential cancer risk at Beacon Hill was 5.3 in a million.

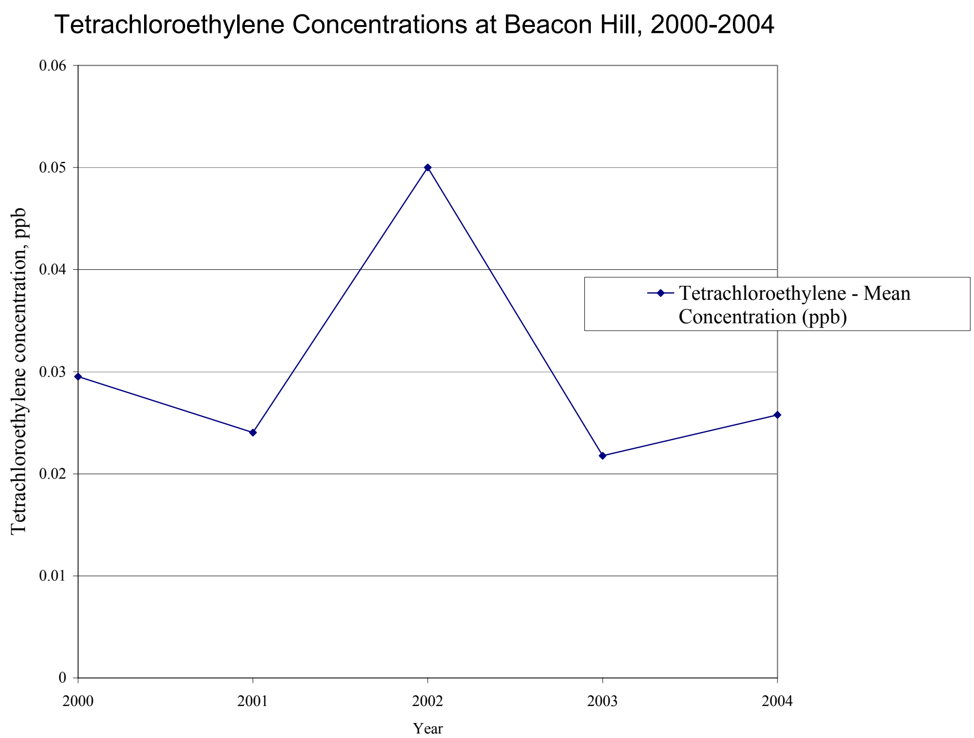
Chloroform Concentrations at Beacon Hill, 2000 - 2004



[53] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/chlorofo.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.[54] Dry cleaners are the main source of tetrachloroethylene. The Agency has required local dry cleaners to adopt closed systems and perform regular inspection and maintenance to limit the amount of tetrachloroethylene released to the environment. Its 2004 mean potential cancer risk was 1.0 in a million.

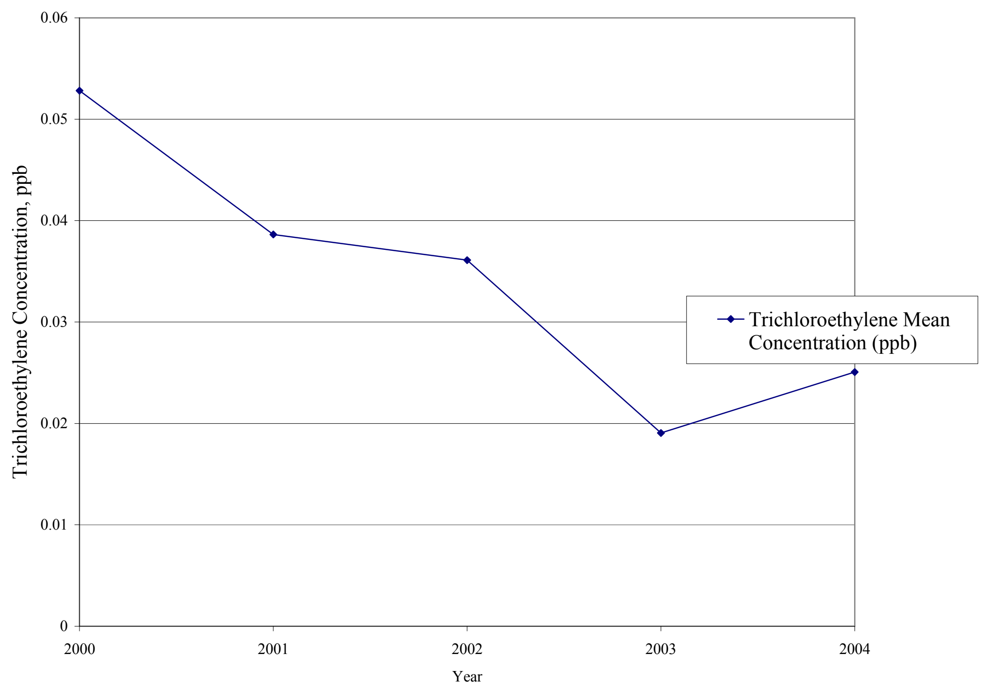


[54] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/tet-ethy.html, Tetrachloroethylene fact sheet http://www.weblakes.com/toxic/TETRACHLOROETHYLENE.HTML.

Trichloroethylene

EPA lists trichloroethylene as a probable/possible human carcinogen.[55] Trichloroethylene is also associated with central nervous system effects.[56] Local sources of trichloroethylene include solvents used for degreasing and surface coating operations. Trichloroethylene's 2004 mean potential cancer risk estimate was 0.3 in a million.

Trichloroethylene Concentrations at Beacon Hill, 2000 - 2004



[55] EPA National Air Toxic Assessment. http://www.epa.gov/ttn/atw/nata/nettables.pdf.

[56] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/tri-ethy.html.

Metals

The table on page 91 includes potential cancer risks for seven PM_{10} metals monitored at Beacon Hill. Chromium, arsenic, and nickel posed the greatest potential cancer risks. Health effects from exposure to these and other monitored metals are listed below, along with local sources.

Chromium

Chromium is listed with the highest potential cancer risk of the metals, with a 2004 mean potential cancer risk estimate of 6.0 in a million at Beacon Hill. It is important to note that the potential cancer estimate shown is based on hexavalent chromium, the most toxic type of chromium. The monitor at Beacon Hill measures total chromium, including hexavalent and other less-toxic states such as trivalent chromium. Chromium risk estimates are based on EPA's assumption that roughly one third of chromium present is hexavalent.[57]

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.[58] Sources of chromium include chrome electroplaters, as well as combustion of distillate oil, and combustion of gasoline and diesel fuels (car, truck, and bus exhaust).

Arsenic

The EPA lists arsenic as a known human carcinogen. Exposure to arsenic is also associated with skin irritation, and liver and kidney damage.[59] Arsenic is used mainly to treat wood, and combustion of distillate oil is also a source of arsenic in the Puget Sound area. Puget Sound monitoring sites with significant wood burning show higher arsenic levels. It's possible that people are burning wood treated with CCA (chromated copper arsenate), which can also release arsenic into the air. Arsenic's 2004 mean potential cancer risk estimate at Beacon Hill was 4.5 in a million.

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[57] EPA National Air Toxics Assessment. http://www.epa.gov/ttn/atw/nata/gloss1.html.

[58] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/chromium.html.

[59] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/arsenic.html.

Nickel

The EPA lists nickel as a known human carcinogen.[60] Nickel is also associated with dermatitis and respiratory effects.[61] Combustion of gasoline and diesel fuels (car, truck, and bus exhaust) is the main source of nickel in the Puget Sound area. Nickel's 2004 mean potential cancer risk estimate at Beacon Hill was 1.4 in a million.

Cadmium

The EPA lists cadmium as a probable human carcinogen. Cadmium exposures are also associated with kidney damage.[62] Combustion of distillate oil is a main source of cadmium in the Puget Sound area. Cadmium's 2004 mean potential cancer risk estimate at Beacon Hill was 0.3 in a million.

Lead

The EPA lists lead as a probably human carcinogen. Lead is associated primarily with central nervous system effects, and is also associated with reproductive and digestive effects. 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 2004 mean potential cancer risk estimate at Beacon Hill was 0.1 in a million.

Beryllium

EPA has classified beryllium as a probable human carcinogen. Beryllium exposures are also associated with lung inflammation and immunological effects.[63] Beryllium sources include combustion of coal and fuel oil that contain beryllium, and tobacco smoke. Beryllium levels are

[60] IRIS Summary. http://www.epa.gov/iris/subst/0273.htm.

[61] EPA Hazard Summary. http://www.epa.gov/iris/subst/0273.htm.

[62] EPA Hazard Summary. http://www.epa.gov/ttn/atw/hlthef/cadmium.html.

[63] EPA hazard summary. http://www.epa.gov/ttn/atw/hlthef/berylliu.html.

extremely low in the Puget Sound area, where there are no known sources. Beryllium's 2004 mean potential cancer risk estimate was 0.004 in a million.

Manganese

EPA lists manganese as "not classifiable" for cancer. Manganese exposures are primarily associated with central nervous system effects.[64] Manganese is naturally-occurring and is usually present in air in small amounts. Additional local sources include steel foundries and blasting of metal parts. Manganese levels are extremely low in ambient air the Puget Sound area, well below levels indicating significant risk.[65]

[64] EPA National Air Toxics Assessment. http://www.epa.gov/ttnatw01/hlthef/manganes.html.

[65] Manganese risk is based on the reference concentration of 0.05 ug/m^3 for non-cancer health effects. The manganese 2004 upper bound concentration was 0.02 ug/m^3.

Definitions

General Definitions

Calculation and Breakpoints for the Air Quality Index (AQI)

Breakpoints for Criteria Pollutants							AQI Categories	
O_3 (ppm) 8-hour	**O_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	Hazardous

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 detailed information about the AQI and the pollutants it measures, go to 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/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

A wood stove that has been certified by EPA. Certified wood stoves emit significantly less pollution than non-certified stoves and are identified by an EPA certification plate. A wood stove cannot be retrofitted to become certified but rather is manufactured to meet EPA particulate emission standards. Visit www.pscleanair.org/burning/indoor/index.shtml#facts to learn more about certified wood stoves.

Criteria Air Pollutant (CAP)

The Clean Air Act of 1970 defined six *criteria pollutants* and established ambient concentrations to protect public health. EPA periodically has revised the original concentration limits and methods of measurement, most recently in 1997.

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. 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.

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

A wood stove that is not certified by the EPA. These wood stoves emit twice as much pollution as certified wood stoves.

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, 1998.

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). The major pollution contributor is fine particulate matter ($PM_{2.5}$) emissions, which are 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. $PM_{2.5}$ also presents some of the most serious health hazards to the public, so you can roughly assume that the worse the visibility, the unhealthier the air is to breathe.

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.

  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 and is marginally within the Federal standards.

- **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 the map on page 20 of the Puget Sound measuring locations. 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. The Agency considers $PM_{2.5}$ one of the major air pollution concerns affecting our community.

- **How is it caused?**
  – $PM_{2.5}$ comes from all types of combustion, including cars, diesel trucks, power plants, and wood burning, and from some industrial processes. 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?**
  Any time.

- **Who is affected?**
  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 have serious health 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.
  – 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, both $PM_{2.5}$ and PM_{10} are monitored throughout the Puget Sound. The majority of PM 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 worst 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.

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.

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?**
  Because NO_2 is not a major concern of the Puget Sound region, it is measured at only one location, Beacon Hill. The Washington State Department of Ecology conducts all NO_2 monitoring.

Pollution Sources

Anthropogenic Emissions

Any emissions released as a result of human activity.

Area Sources

Countywide categories of pollution sources, in which each individual source emits pollutants below the thresholds for a point source facility.

Biogenics

Natural sources such as trees, plants, grass, crops, and soils. The worldwide emission rate of these natural hydrocarbons has been estimated to exceed that of non-methane hydrocarbons originating from human sources. Isoprene, one of the major constituents of biogenic emissions, is very photoreactive, and would seem to make biogenic VOC a contributor in the formation of ozone. The study of hydrocarbon emissions from plants is therefore of key importance to our understanding of the global effects of naturally produced 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.

Non-road Mobile Sources

Farm vehicles, on-site construction/industrial vehicles, logging equipment, small marine craft, aircraft, trains, ocean-going ships, tugs and ferries, 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 a any single HAP or 6 tons per year of facility total HAP.

Registered Facility

The total of all pollutant-emitting activities located on adjacent or contiguous properties owned or operated by one person or corporate entity. It includes all of the pollutant-emitting buildings, processes, structures, equipment, control apparatuses, and storage areas at a facility. The annual fees for large and small registered emission sources are based on Regulation I, 5.07(c)(1) and 5.07(c)(2), respectively.

Stationary Area Sources

Also called area sources. 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.

110 Union Street, Suite 500
Seattle, Washington 98101

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

2004
Air Quality Data Summary Appendix

July 2005

Working Together for Clean Air

Air Quality Index
1980 - 2004

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	279	84	3	0	0	365	1			3	0		116	Nov 5	PM
Totals	6906	2141	24	20	0	4361	4461	236	33	25	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.

Air Quality Index
1980 - 2004

King County

	Days in Each Air Quality Category					Pollutant Determining the AQI: All Days				Pollutant Determining the AQI: Unhealthy Days			Highest Value		
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	257	103	6	0	0	279	2		85	5	0	1	132	Dec 18	PM
Totals	5285	3704	31	106	6	3714	4718	61	639	46	83	14			

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 - 2004

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 8	PM
2004	246	112	8	0	0	257	17		92	8	0		137	Nov 5	PM
Totals	5771	3218	52	86	5	6148	2116	293	383	72	66	5			

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 - 2004

Kitsap 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
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
Totals	4415	299	0	1	0	4163	552	0	0	1	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.

PARTICULATE MATTER (PM_{10}) - Continuous

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

2004

Location	Method	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	99th Percentile	Max Value
17171 Bothell Way NE, Lake Forest Park	B	360	16.1	11.4	13.3	16.0	14.2	34	41
Duwamish, 4752 E Marginal Way S, Seattle	T	362	28.2	21.9	23.8	29.2	25.8	62	104
James St & Central Ave, Kent	T	366	17.7	15.3	18.5	19.7	17.8	39	45
Port of Tacoma, 2301 Alexander Ave, Tacoma	B	362	26.2	23.0	23.8	20.2	23.3	66	196

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 adjusted using seasonal site-specific relationships with Federal Reference Method samplers.

Summary of Maximum Observed Concentrations and Values >60

Location	Method	Jan 13 Tue	Feb 12 Thu	Feb 13 Fri	Mar 18 Thu	Apr 27 Tue	Jul 5 Mon	Nov 5 Fri
17171 Bothell Way NE, Lake Forest Park	B					--		41
Duwamish, 4752 E Marginal Way S, Seattle	T	62	104	72				64
James St & Central Ave, Kent	T						45	
Port of Tacoma, 2301 Alexander Ave, Tacoma	B		77	66	68	196		

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Method	Good	Moderate	Unhealthy for Sensitive Groups
17171 Bothell Way NE, Lake Forest Park	B	360	0	0
Duwamish, 4752 E Marginal Way S, Seattle	T	358	4	0
James St & Central Ave, Kent	T	366	0	0
Port of Tacoma, 2301 Alexander Ave, Tacoma	B	358	3	1

PARTICULATE MATTER ($PM_{2.5}$)

Micrograms per Cubic Meter

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

2004

Location	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	98th Percentile	Max Value
Marysville JHS, 1605 7th St, Marysville	119	10.1	7.3	7.8	15.0	10.0	28	44
17171 Bothell Way NE, Lake Forest Park	113	9.8	6.2	6.6	14.5	9.4	25	41
Duwamish, 4752 E Marginal Way S, Seattle	129	11.5	8.3	10.0	17.0	11.6	29	43
Beacon Hill, 15th S & Charlestown, Seattle	356	7.6	6.5	8.4	11.5	8.5	26	33
42404 SE North Bend Way, North Bend	55	4.3	4.9	5.8	7.3	5.7	17	20
7802 South L St, Tacoma	115	11.6	6.0	8.0	17.9	10.9	44	57
30525 SE Mud Mountain Road, Enumclaw	57	3.2	4.4	6.6	3.4	4.4	12	13

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	Method	Jan 7 Wed	Sep 30 Thu	Nov 5 Fri	Nov 20 Sat	Dec 18 Sat
Marysville JHS, 1605 7th St Marysville				44		--
17171 Bothell Way NE, Lake Forest Park		--		41		--
Duwamish, 4752 E Marginal Way, Seattle				43		--
Beacon Hill, 15th S & Charlestown						33
42404 SE North Bend Way, North Bend		--		20	--	--
7802 South L St, Tacoma		44		57	51	--
30525 SE Mud Mountain Road, Enumclaw		--	13		--	--

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Good	Moderate	Unhealthy for Sensitive Groups
Marysville JHS, 1605 7th St, Marysville	103	15	1
17171 Bothell Way NE, Lake Forest Park	94	18	1
Duwamish, 4752 E Marginal Way S, Seattle	91	37	1
Beacon Hill, 15th S & Charlestown, Seattle	322	34	0
42404 SE North Bend Way, North Bend	52	3	0
7802 South L St, Tacoma	89	23	3
30525 SE Mud Mountain Road, Enumclaw	57	0	0

PARTICULATE MATTER ($PM_{2.5}$) - Continuous

Micrograms per Cubic Meter

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

2004

Location	Method	Number of Values	Quarterly Arithmetic Averages				Year Arith Mean	98th Percentile	Max Value
			1st	2nd	3rd	4th			
Marysville JHS, 1605 7th St, Marysville	T	334		8.0	8.2	14.1	10.5	26	35
6120 212th St SW, Lynnwood	T	333	11.5		7.3	14.8	10.3	28	42
17171 Bothell Way NE, Lake Forest Park	T	363	10.9	6.7	7.9	15.1	10.2	27	37
Duwamish, 4752 E Marginal Way S, Seattle	T	363	13.0	8.2	10.4	15.9	11.9	29	37
601 143rd Ave NE, Bellevue	T	365	8.8	6.3	7.5	10.7	8.3	19	22
*42404 SE North Bend Way, North Bend	T	312		7.3	8.1	8.5	7.8	17	29
James St & Central Ave, Kent	T	364	11.6	7.8	10.0	14.5	11.0	27	37
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	352	13.2	8.4	10.1	16.3	12.1	32	35
7802 South L St, Tacoma	T	363	12.9	6.8	7.4	16.0	10.8	33	48
South Hill, 9616 128th St E, Puyallup	B	207	12.3	6.7	8.4		9.5	27	35
*Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	B	366	9.7	8.8	8.8	11.2	9.6	19	30
*10955 Silverdale Way NW, Silverdale	B	358	8.3	8.6	9.5	9.2	8.9	17	19

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 adjusted using seasonal site-specific relationships with Federal Reference Method samplers except those marked with an asterisk.

Summary of Maximum Observed Concentrations and Values >40

Location	Method	Jan 7 Wed	Jan 13 Tue	Jul 4 Sun	Nov 5 Fri	Nov 10 Wed	Nov 20 Sat	Nov 28 Sun	Dec 18 Sat	Dec 28 Tue
Marysville JHS, 1605 7th St, Marysville	T				35					35
6120 212th St SW, Lynnwood	T							42		
17171 Bothell Way NE, Lake Forest Park	T		--		37					
Duwamish, 4752 E Marginal Way S, Seattle	T				37					
601 143rd Ave NE, Bellevue	T								22	
*42404 SE North Bend Way, North Bend	T	--	--			29				
James St & Central Ave, Kent	T								37	
Port of Tacoma, 2301 Alexander Ave, Tacoma	T		35							
7802 South L St, Tacoma	T	42			48		44	41		
South Hill, 9616 128th St E, Puyallup	B			35	--	--	--	--	--	--
*Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	B			30						
*10955 Silverdale Way NW, Silverdale	B				19			--		

-- 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	278	56	0	
6120 212th St SW, Lynnwood	T	275	57	1	
17171 Bothell Way NE, Lake Forest Park	T	306	57	0	
Duwamish, 4752 E Marginal Way S, Seattle	T	284	79	0	
601 143rd Ave NE, Bellevue	T	345	20	0	
*42404 SE North Bend Way, North Bend	T	302	10	0	
James St & Central Ave, Kent	T	298	66	0	
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	259	93	0	
7802 South L St, Tacoma	T	291	68	4	
South Hill, 9616 128th St E, Puyallup	B	181	26	0	
*Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	B	345	21	0	
*10955 Silverdale Way NW, Silverdale	B	343	15	0	

PARTICULATE MATTER ($PM_{2.5}$) - Continuous

Micrograms per Cubic Meter

Sampling Method: Equivalent - Radiance Research M903 Nephelometer

2004

Location	Number of Values	Quarterly Arithmetic Averages				Year Arith Mean	98th Percentile	Max Value
		1st	2nd	3rd	4th			
Marysville JHS, 1605 7th St, Marysville	362	10.6	6.7	8.4	15.0	10.1	31	48
6120 212th St SW, Lynnwood	324	9.9	5.9		13.9	9.9	31	44
17171 Bothell Way NE, Lake Forest Park	357	9.8	6.1	8.7	15.1	10.0	31	47
Queen Anne Hill, Seattle	345	7.0	5.7	7.9	10.5	7.8	26	36
Olive & Boren, Seattle	365	8.7	6.7	9.8	13.8	9.8	33	44
Beacon Hill, 15th S & Charlestown, Seattle	362	7.6	6.9	9.2	11.2	8.7	18	28
Duwamish, 4752 E Marginal Way S, Seattle	362	10.4	7.6	10.4	17.3	11.5	36	51
South Park, 8025 10th Ave S, Seattle	359	10.5	6.4	8.9	17.2	10.8	37	56
City Hall, 15670 NE 85th, Redmond	358	5.9	4.6	6.8	10.6	7.0	23	34
601 143rd Ave NE,, Bellevue	366	4.9	4.3	6.5	8.8	6.1	20	26
305 Bellevue Way NE, Bellevue	365	7.1	5.4	7.2	11.1	7.7	24	30
42404 SE North Bend Way, North Bend	366	4.0	4.8	7.1	7.0	5.7	16	21
James St & Central Ave, Kent	366	10.2	6.9	9.5	14.6	10.3	32	44
Port of Tacoma, 2301 Alexander Ave, Tacoma	364	11.2	7.1	10.1	15.4	10.9	34	45
7802 South L St, Tacoma	342	10.8	5.5	7.8		9.6	35	59
South Hill, 9616 128th St E, Puyallup	221	10.7	5.6	7.5		8.0	28	33

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 7 Wed	Jan 13 Tue	Oct 1 Fri	Oct 3 Sun	Oct 4 Mon	Oct 28 Thu	Nov 4 Thu	Nov 5 Fri	Nov 12 Fri	Nov 20 Sat	Nov 28 Sun	Dec 17 Fri	Dec 18 Sat	Dec 28 Tue
Marysville JHS, 1605 7th St, Marysville								48						41
6120 212th St SW, Lynnwood			--					42			44			
17171 Bothell Way NE, Lake Forest Park	--							47						
Queen Anne Hill, Seattle									36				--	
Olive & Boren, Seattle					44									
Beacon Hill, 15th S & Charlestown, Seattle					28								28	
Duwamish, 4752 E Marginal Way S, Seattle					45			49	46				51	41
South Park, 8025 10th Ave S, Seattle					48			47	45			43	56	41
City Hall, 15670 NE 85th, Redmond														34
601 143rd Ave NE,, Bellevue					26									
305 Bellevue Way NE, Bellevue					30								30	
42404 SE North Bend Way, North Bend						21								
James St & Central Ave, Kent					43								44	
Port of Tacoma, 2301 Alexander Ave, Tacoma					44			41					45	
7802 South L St, Tacoma	42						46	59		46	44	--	--	--
South Hill, 9616 128th St E, Puyallup		33	--	--	--	--	--	--	--	--	--	--	--	--

-- Indicates no sample on specified day

PARTICULATE MATTER ($PM_{2.5}$) - Continuous

Micrograms per Cubic Meter

Air Quality Index Summary

Location	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Marysville JHS, 1605 7th St, Marysville	299	61	2	
6120 212th St SW, Lynnwood	280	42	2	
17171 Bothell Way NE, Lake Forest Park	294	62	1	
Queen Anne Hill, Seattle	316	29	0	
Olive & Boren, Seattle	318	45	2	
Beacon Hill, 15th S & Charlestown, Seattle	330	31	0	
Duwamish, 4752 E Marginal Way S, Seattle	289	68	5	
South Park, 8025 10th Ave S, Seattle	287	66	6	
City Hall, 15670 NE 85th, Redmond	335	23	0	
601 143rd Ave NE,, Bellevue	348	18	0	
305 Bellevue Way NE, Bellevue	334	31	0	
42404 SE North Bend Way, North Bend	353	13	0	
James St & Central Ave, Kent	304	60	2	
Port of Tacoma, 2301 Alexander Ave, Tacoma	292	69	3	
7802 South L St, Tacoma	282	55	5	
South Hill, 9616 128th St E, Puyallup	194	27	0	

Particulate Matter ($PM_{2.5}$) - Black Carbon

Micrograms per Cubic Meter

Sampling Method: Light Absorption by Aethalometer

2004

Location	Number of Values	Quarterly Arithmetic Averages				Annual Mean	Max Value
		1st	2nd	3rd	4th		
17171 Bothell Way NE, Lake Forest Park	297	1.9	0.8	1.0	2.1	1.5	6.2
Olive & Boren, Seattle	344	1.9	1.3	1.8	2.5	1.9	6.0
Beacon Hill, 15th S & Charlestown, Seattle	341	1.2	0.7	1.3	1.6	1.2	4.8
Duwamish, 4752 E Marginal Way S, Seattle	291	2.5	1.4	1.7		2.0	7.7
7802 South L St, Tacoma	261	1.6			2.2		7.7

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

Location	Jan 9 Fri	Jan 13 Tue	Feb 12 Thu	Nov 5 Fri
17171 Bothell Way NE, Lake Forest Park				6.2
Olive & Boren, Seattle		--	--	6.0
Beacon Hill, 15th S & Charlestown, Seattle				4.8
Duwamish, 4752 E Marginal Way S, Seattle	7.7	7.7	7.7	
7802 South L St, Tacoma				7.7

-- Indicates no sample on specified day

OZONE

(Parts per Million)
2004

Location / Continuous Sampling Period(s)	2004 Six Highest Daily 8-Hour Concentrations			4^{th} Highest Daily 8-Hour Concentration			3-Year Average of 4^{th} Highest 8-Hour Concentration
	Value	Date	End Time	2002	2003	2004	2002 - 2004
Beacon Hill, 15th S & Charlestown	.059	1 May	1800				
Seattle, Wa	.054	19 Jun	2000				
1 May-30 Sep	.052	20 Jun	2000				
	.048	21 Jun	2000	.042	.050	.048	.047
	.048	13 Jul	1900				
	.047	4 Jun	1900				
20050 SE 56^{th}	.080	24 Jul	1800				
Lake Sammamish State Park, Wa	.064	21 Jun	1900				
1 May-30 Sep	.063	20 Jun	1700				
	.063	23 Jul	1800	.054	.066	.063	.061
	.060	11 Aug	2000				
	.058	10 Aug	1900				
42404 SE North Bend Way,	.087	24 Jul	1900				
North Bend, Wa	.079	10 Aug	1900				
1 May-30 Sep	.076	21 Jun	1900				
	.076	11 Aug	2000	.069	.079	.076	.075
	.070	1 May	1900				
	.067	12 Aug	2000				
30525 SE Mud Mountain Road,	.087	24 Jul	1800				
Enumclaw, Wa	.082	21 Jun	2000				
1 May-30 Sep	.074	23 Jul	1900				
	.074	11 Aug	1900	.070	.080	.074	.075
	.072	20 Jun	2000				
	.071	10 Aug	1900				
Charles L Pack Forest	.078	24 Jul	1700				
La Grande, Wa	.075	21 Jun	2000				
1 May-30 Sep	.071	14 Jul	2000				
	.071	23 Jul	1900	.068	.077	.071	.072
	.071	11 Aug	1900				
	.070	12 Aug	1900				
71 E Campus Dr,	.063	11 Aug	2000				
Belfair, Wa	.061	19 Jun	1800				
1 May-30 Sep	.059	9 Aug	1900				
	.057	17 Jul	2000	.062	.061	.057	.060
	.055	21 Jun	1800				
	.055	23 Jul	1900				
709 Mill Road SE,	.069	21 Jun	1900				
Yelm, Wa	.067	24 Jul	1700				
1 May-30 Sep	.065	11 Aug	2000				
	.065	14 Aug	1900	.058	.072	.065	.065
	.061	1 May	2000				
	.061	14 Jul	2000				

Notes

(1) All ozone stations 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.

OZONE

(Parts per Million)
2004

Location / Continuous Sampling Period(s)	Six Highest Daily Maximum 1 Hour Averages			Estimated No. of Days Daily Maximum 1 Hour Average Exceeded .12 ppm			No. of Days Daily Maximum 1 Hour Average Expected to Exceed .12 ppm
	Value	Date	End Time	2002	2003	2004	
Beacon Hill, 15th S & Charlestown	.064	1 May	1300	0.0	0.0	0.0	0.0
Seattle, Wa	.063	19 Jun	1500				
1 May-30 Sep	.062	13 Jul	1500				
	.060	4 Jun	1700				
	.059	21 Jun	1500				
	.058	10 Aug	1600				
20050 SE 56th	.085	21 Jun	1600	0.0	0.0	0.0	0.0
Lake Sammamish State Park, Wa	.085	24 Jul	1300				
1 May-30 Sep	.081	11 Aug	1600				
	.076	10 Aug	1800				
	.075	20 Jun	1600				
	.074	23 Jul	1400				
42404 SE North Bend Way,	.104	24 Jul	1500	0.0	0.0	0.0	0.0
North Bend	.093	10 Aug	1800				
1 May-30 Sep	.092	21 Jun	1600				
	.088	11 Aug	1700				
	.080	20 Jun	1700				
	.079	13 Jul	1800				
30525 SE Mud Mountain Road,	.112	24 Jul	1400	0.0	0.0	0.0	0.0
Enumclaw	.094	21 Jun	1600				
1 May-30 Sep	.090	23 Jul	1600				
	.088	11 Aug	1800				
	.084	20 Jun	1700				
	.079	10 Aug	1600				
Charles L Pack Forest	.089	24 Jul	1400	0.0	0.0	0.0	0.0
La Grande, Wa	.088	21 Jun	1600				
1 May-30 Sep	.087	11 Aug	1700				
	.085	14 Jul	1700				
	.075	20 Jun	1700				
	.075	23 Jul	1600				
71 E Campus Dr,	.072	11 Aug	1700	0.0	0.0	0.0	0.0
Belfair, Wa	.065	19 Jun	1800				
1 May-30 Sep	.065	24 Jul	1400				
	.065	9 Aug	1700				
	.063	17 Jul	1900				
	.062	21 Jun	1600				
709 Mill Road SE,	.080	21 Jun	1700	0.0	0.0	0.0	0.0
Yelm, Wa	.078	14 Jul	1600				
1 May-30 Sep	.075	11 Aug	1700				
	.074	24 Jul	1200				
	.070	14 Aug	1800				
	.068	17 Jul	1800				

Notes
(1) All ozone stations 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.

NITROGEN DIOXIDE
(Parts per Million)
2004

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	.018	.022 .018	.019 .017	.020 .019	.014 .020	.014 .019	.016	7968	.018

Maximum and Second Highest Concentrations

Location / Continuous Sampling Periods(s)	1 Hour Average		
	Value	Date	End Time
Beacon Hill, 15th S & Charlestown, Seattle 1 Jan-31 Dec	.073 .068	13 Feb 30 Apr	1100 2100

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)
2004

Location / Continuous Sampling Period(s)	Six Highest Concentrations: 1 Hour Average Value	Date	End Time	8 Hour Average Value	Date	End Time	Number of 8 Hour Averages Exceeding 9 ppm	Number of Days 8 Hour Average Exceeded 9 ppm
44th Ave W & 196th St SW	5.1	12 Feb	0800	3.4	8 Feb	0100	0	0
Lynnwood	4.7	12 Feb	0900	3.1	21 Jan	2300		
1 Jan-3 May	4.4	21 Jan	1900	2.9	16 Jan	2300		
	4.4	7 Feb	2300	2.8	12 Feb	1000		
	4.4	11 Feb	0900	2.7	19 Feb	2300		
	4.2	12 Jan	0900	2.7	25 Feb	1400		
2421 148th Ave NE	4.8	5 Nov	2000	3.2	11 Jan	2400	0	0
Bellevue	4.7	21 Jan	1900	2.9	20 Dec	2300		
1 Jan-31 Dec	4.6	13 Feb	0800	2.9	21 Jan	2300		
	4.4	12 Feb	0900	2.8	4 Nov	2300		
	4.4	20 Dec	2200	2.8	18 Dec	2400		
	4.3	11 Jan	2300	2.7	9 Jan	1600		
University District, 1307 NE 45th St	4.9	12 Feb	1800	3.4	13 Jan	2300	0	0
Seattle	4.2	13 Jan	1900	3.3	12 Feb	2300		
1 Jan-31 Dec	4.0	3 Oct	0200	3.3	8 Nov	0200		
	3.9	21 Jan	2200	2.9	3 Oct	0200		
	3.9	12 Feb	0800	2.9	12 Nov	1900		
	3.9	3 Oct	2400	2.8	5 Nov	2200		
1424 4th Ave	3.6	13 Jan	1900	2.5	18 Dec	2200	0	0
Seattle	3.5	11 Feb	2300	2.4	12 Feb	0400		
1 Jan-31 Dec	3.4	16 Sep	1900	2.3	28 Dec	2300		
	3.2	11 Feb	2200	2.2	13 Jan	2300		
	3.1	29 Mar	0800	2.1	31 Dec	1900		
	3.0	13 Jan	2000	2.1	13 Feb	1000		
Beacon Hill, 15th S and Charlestown	2.7	12 Feb	1000	1.8	29 Dec	0100	0	0
Seattle	2.6	13 Feb	1100	1.7	11 Jan	1500		
1 Jan- 31 Dec	2.0	11 Jan	1400	1.7	18 Dec	1500		
	2.0	18 Dec	1200	1.6	22 Jan	0100		
	2.0	28 Dec	1800	1.6	12 Feb	1500		
	2.0	28 Dec	2300	1.5	19 Dec	0200		
1101 Pacific Ave	7.0	7 Jan	1800	5.0	7 Jan	2300	0	0
Tacoma	6.4	7 Jan	1700	4.0	8 Jan	1500		
1 Jan-31 Dec	5.8	7 Jan	1900	4.0	8 Jan	2400		
	5.5	8 Jan	1800	3.7	9 Jan	1400		
	5.3	12 Feb	1900	3.3	6 Nov	0100		
	4.9	8 Jan	1100	3.3	13 Feb	0100		

Notes
(1) All carbon monoxide stations 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)
2004

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	.002	.002 .004	.002 .004	.002 .004	.002 .004	.002 .003	.003	8584	.003

Maximum and Second Highest Concentrations for Various Averaging Periods

Location / Continuous Sampling Periods(s)	1 Hour Average			3 Hour Average			24 Hour Average		
	Value	Date	End Time	Value	Date	End Time	Value	Date	End Time
Beacon Hill, 15th S & Charlestown, Seattle 1 Jan-31 Dec	.060 .056	3 Oct 25 Sep	1200 2300	.054 .045	22 Nov 25 Sep	1400 2400	.021 .017	26 Sep 3 Oct	1100 1400

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.

Air Toxics
2004 Beacon Hill Statistical Summaries
Concentrations in parts per billion by volume (ppbv)

Statistic	Benzene	1,3-Butadiene	Carbon Tetrachloride	Chloroform	Perc	Trichloroethylene	Acetaldehyde	Formaldehyde
Count	60	60	60	60	60	60	59	59
Non detects	1	1	1	1	1	1	1	1
Median	0.30	0.04	0.10	0.04	0.02	0.02	0.74	0.78
Mean	0.40	0.06	0.10	0.05	0.03	0.03	0.80	0.87
95th Percentile	0.86	0.13	0.12	0.11	0.07	0.07	1.30	1.60
Maximum	1.17	0.21	0.12	0.12	0.11	0.09	1.64	2.03

Carbon Tet = carbon tetrachloride,
Perc = tetrachloroethylene
Count is the number of days with data collected, and does not include non-detects.
All non-detects occurred on 12/20/2004, and were likely due to equipment failure. This date was not included in statistics or risk estimates.
All air toxics received from Department of Ecology John Williamson.
All 61 counts for Vinyl chloride and 1,2-dichloropropane were non-detect.

Statistical Summaries for 2004 Beacon Hill Air Toxics Metals
Concentrations in nanograms per cubic meter (ng/m^3)

Statistic	Arsenic	Beryllium	Cadmium	Chromium	Lead	Manganese	Nickel
Count	59	59	59	59	59	59	59
Non detects	2	2	2	2	2	2	2
Median	0.83	0.00	0.11	1.21	4.41	6.48	2.05
Mean	1.05	0.00	0.16	1.48	5.77	8.26	3.01
95%tile	2.76	0.006	0.43	3.98	12.97	21.29	7.42
Max	3.60	0.007	0.84	11.53	34.09	38.21	23.54

Count is the number of days with data collected, and does not include non-detects.
All non-detects occurred on 8/30/2004 and 5/20/2004, and were likely due to equipment failure. These dates not included in statistics or risk estimates.

2004 Air Toxics Unit Risk Factors

AIR TOXIC	UNIT RISK FACTOR RISK/µg/m^3	CANCER RATING[1]	SOURCE
Formaldehyde	1.3E-05	B1	IRIS[2]
Benzene	7.8E-06	A	IRIS
Carbon Tetrachloride	1.5E-05	B2	IRIS
Chromium (Hexavalent) (M)	1.2E-02	A	IRIS
Chloroform	2.3E-05	B2	IRIS
Arsenic (M)	4.3E-03	A	IRIS
1,3-Butadiene	3E-05	A	EPA NATA[3], IRIS
Acetaldehyde	2.2E-06	B2	IRIS
Nickel (Subsulfide) (M)	4.8E-04	A	IRIS
Tetrachloroethylene	5.6E-06	B2	CAL EPA, EPA NATA
Trichloroethylene	2E-06	B2	CAL EPA[4], EPA NATA
Cadmium (M)	1.8E-03	B1	IRIS
Lead (M)	1.2E-05	B2	CAL EPA, EPA NATA
Beryllium (M)	2.4E-03	B1	IRIS

[1] Ratings per 1986 EPA guidelines.

[2] Integrated Risk Information System. EPA. http://www.epa.gov/iris/.

[3] National Air Toxics Assessment. 1996. EPA. http://www.epa.gov/ttn/atw/nata/nettables.pdf.

[4] California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. http://www.arb.ca.gov/toxics/healthval/healthval.htm.

2004 Beacon Hill Potential Cancer Risk Estimates, per 1,000,000

Upper Bound – 95th Percentile

AIR TOXIC	UPPER-BOUND POTENTIAL RISK (95TH PERCENTILE)
Formaldehyde	25.5
Benzene	21.4
Carbon Tetrachloride	11.3
Chromium (M)[5]	19.5
Chloroform	12.7
Arsenic (M)	12.3
1,3-Butadiene	8.6
Acetaldehyde	5.2
Nickel (M)	4.4
Tetrachloroethylene	2.7
Trichloroethylene	0.8
Cadmium (M)	1.2
Lead (M)	0.2
Beryllium (M)	0.015
Manganese (M)	na

[5] Chromium estimated risks are based on EPA's assumption that 34% of total chromium is hexavalent, the most toxic form. EPA 1996 National Air Toxic Assessment.