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Puget Sound Clean Air Agency

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2006
Air Quality Data Summary

August 2007

Working Together for Clean Air

Table of Contents

Table of Contents i
List of Figures ii
List of Maps iii
List of Tables iii
Appendix – Data Tables iv
Introduction 1
Executive Summary for 2006 3
Air Quality Index 7
Monitoring Network 13
Impaired Air Quality—Burn Bans and Smog Watch 21
Regional Emissions Inventory 25
Air Quality Standards and Health Goals 28
Particulate Matter (10 micrometers in diameter) 31
Particulate Matter (2.5 micrometers in diameter) 36
Particulate Matter - $PM_{2.5}$ Special Monitoring Project 62
Particular Matter - $PM_{2.5}$ Speciation and Aethalometers 65
Ozone 71
Nitrogen Dioxide 77
Carbon Monoxide 79
Sulfur Dioxide 83
Lead 86
Visibility 88
Air Toxics 94
Definitions 96

List of Figures

Figure 1: Number of Days Air Quality Was Rated As "Good" per AQI 8
Figure 2: Air Quality for Snohomish County.. 9
Figure 3: Air Quality for King County 10
Figure 4: Air Quality for Pierce County.. 11
Figure 5: Air Quality for Kitsap County 12
Figure 6: $PM_{2.5}$ Levels Following December Windstorm... 22
Figure 7: Number of Days with Indoor Burning Bans in Puget Sound Region............................... 22
Figure 8: June 24th-28th Smog Watch.. 24
Figure 9: July 20th-24th Smog Watch.. 24
Figure 10: Daily PM_{10} for Snohomish County 32
Figure 11: Daily PM_{10} for King County.. 33
Figure 12: Daily PM_{10} for Pierce County 34
Figure 13: Daily PM_{10} for Kitsap County... 35
Figure 14: Daily $PM_{2.5}$ for Snohomish County.. 39
Figure 15: Daily $PM_{2.5}$ for King County 40
Figure 16: Daily $PM_{2.5}$ for Pierce County... 41
Figure 17: Daily $PM_{2.5}$ for Kitsap County 42
Figure 18: Days Exceeding the $PM_{2.5}$ Health Goal, 2000 - 2006.. 43
Figure 19: Annual $PM_{2.5}$ for Snohomish County 44
Figure 20: Annual $PM_{2.5}$ for King County 45
Figure 21: Annual $PM_{2.5}$ for Pierce County 46
Figure 22: Annual $PM_{2.5}$ for Kitsap County 47
Figure 23: Darrington (JO) $PM_{2.5}$ Daily Averages from Continuous Analyzers 49
Figure 24: Marysville (IG) $PM_{2.5}$ Daily Averages from Continuous Analyzers.............................. 50
Figure 25: Tacoma, South L Street (ES) $PM_{2.5}$ Daily Averages from Continuous Analyzers........ 51
Figure 26: Lake Forest Park (DB) $PM_{2.5}$ Daily Averages from Continuous Analyzers................. 52
Figure 27: Lynwood (II) $PM_{2.5}$ Daily Averages from Continuous Analyzers.................................. 53
Figure 28: Seattle, Duwamish (CE) $PM_{2.5}$ Daily Averages from Continuous Analyzers 54
Figure 29: Tacoma, Port Area (EQ) $PM_{2.5}$ Daily Averages from Continuous Analyzers 55
Figure 30: Kent (CW) $PM_{2.5}$ Daily Averages from Continuous Analyzers 56
Figure 31: Bellevue, 305 Bellevue Way NE (DC) $PM_{2.5}$ Daily Averages from Continuous Analyzers 57
Figure 32: Puyallup (ER) $PM_{2.5}$ Daily Averages from Continuous Analyzers............................... 58
Figure 33: Bremerton, Meadowdale (QE) $PM_{2.5}$ Daily Averages from Continuous Analyzers 59
Figure 34: North Bend (DG) $PM_{2.5}$ Daily Averages from Continuous Analyzers........................... 60
Figure 35: Silverdale (QG) $PM_{2.5}$ Daily Averages from Continuous Analyzers 61
Figure 36: Daily $PM_{2.5}$ Concentrations for South Tacoma Monitoring Project 64
Figure 37: Tacoma South L Smoke Site, $PM_{2.5}$ Speciation Data 2006... 67
Figure 38: Duwamish Industrial Mix Site, $PM_{2.5}$ Speciation Data 2006.. 68
Figure 39: Olive Street Freeway (On-road Mobile) $PM_{2.5}$ Site Speciation Data 2006..................... 69
Figure 40: 8-Hour Ozone, 3 Year Average of 4th Highes Annual Concentration 1993-2006.......... 74
Figure 41: Ozone in Puget Sound Region, 8-hour Concentration May-September 2006 75
Figure 42: Ozone in Puget Sound Region, 8-hour Concentration May-September 1998-2006...... 76

Figure 43: Nitrogen Dioxide (NO_2) Annual 1-Hour Average vs. Standard....................................... 78
Figure 44: Carbon Monoxide (CO) for Snohomish County 80
Figure 45: Carbon Monoxide (CO) for King County.. 81
Figure 46: Carbon Monoxide (CO) for Pierce County... 82
Figure 47: Sulfur Dioxide (SO_2) Maximum 24-Hour Average vs. Standard 84
Figure 48: Sulfur Dioxide (SO_2) Maximum 1-Hour Average vs. Standard 85
Figure 49: Lead (Pb) Maximum Quarterly Average vs. Standard 87
Figure 50: Puget Sound Visibility 1990-2006 89
Figure 51: Snohomish County Visibility 1990-2006 90
Figure 52: King County Visibility 1990-2006... 91
Figure 53: Pierce County Visibility 1990-2006.. 92
Figure 54: Kitsap County Visibility 1990-2006 93

List of Maps

Map 1: Active Air Monitoring Sites for 2006..19
Map 2: The 98th Percentile Daily $PM_{2.5}$ Concentrations for 2006 38
Map 3: Location of Monitors in the 2006 Special Monitoring Project 63
Map 4: Ozone 3 year Average of 4th Highest Value for 2006..72

List of Tables

Table 1: AQI Ratings for 2006...4
Table 2: Air Quality Monitoring Network 15
Table 3: Monitoring Methods Used from 1999 to 2005 in Puget Sound Airshed 20
Table 4: Puget Sound Region 2004 Estimated Criteria Air Pollutant Emission Inventory 27
Table 5: Puget Sound Region Air Quality Standards for Criteria Pollutants 29
Table 6: Comparison of Relevant Daily $PM_{2.5}$ Standards and Goals..37
Table 7: 2005 Beacon Hill Potential Cancer Risk Estimates per 1,000,000.......................................95
Table 8: Calculation and Breakpoints for the Air Quality Index (AQI) 96

Appendix – Data Tables

Air Quality Index Snohomish County (1980-2006) **A-1**
Air Quality Index King County (1980-2006) **A-2**
Air Quality Index Pierce County (1980-2006) **A-3**
Air Quality Index Kitsap County (1990-2006) **A-4**
Burn Bans 1988-2006 .... **A-5**
Particulate Matter (PM_{10}) – Continuous **A-6**
Particulate Matter ($PM_{2.5}$) **A-7**
Particulate Matter ($PM_{2.5}$) – Continuous (Tef-coat Glass Fiber) **A-8**
Particulate Matter ($PM_{2.5}$) – Continuous (Nephelometer) **A-9**
$PM_{2.5}$ Speciation Analytes Monitored in 2006 .... **A-10**
$PM_{2.5}$ Black Carbon **A-12**
Ozone (8-hour concentration) **A-13**
Ozone (1-hour average) **A-14**
Nitrogen Dioxide **A-15**
Carbon Monoxide **A-16**
Sulfur Dioxide **A-17**
Air Toxics 2005 Beacon Hill Statistical Summaries **A-18**
Statistical Summaries for 2005 Beacon Hill Air Toxics PM_{10} Metals **A-18**
2005 Air Toxics Unit Risk Factors **A-19**
2005 Beacon Hill Potential Cancer Risk Estimates, per 1,000,000, Upper Bound **A-20**

The 2006 Air Quality Data Summary is available
for viewing or download on the internet at:

www.pscleanair.org/

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

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

Introduction

Background

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

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

Beginning in 2004, the Agency added additional information on air toxics to the Air Quality Summary. Air toxics are pollutants beyond the six criteria air pollutants and are broadly defined by the Agency as a category that covers over 400 air pollutants. These pollutants are associated with a broad range of adverse health effects, including cancer. We continue to summarize local air toxics data in this year's report to more comprehensively report on the area's air quality.[1] In recent years, we have added additional fine particulate matter monitoring information and more graphics (maps displaying concentrations), in an effort to continually improve this report.

The Puget Sound Clean Air Agency and Washington State Department of Ecology work together to monitor air quality within the Puget Sound region.[2] Real-time air monitoring data are available for some pollutants on the Internet at http://www.pscleanair.org/airq/aqi.aspx and https://fortress.wa.gov/ecy/aqp/Public/aqn.shtml. 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. If you would like to sign up for our monthly electronic news letter, Clean Air Newsline, you can do so by going to www.pscleanair.org/news/agencynews.aspx and selecting Clean Air Newsline. Clean Air Newsline is a monthly electronic newsletter to provide air quality information to the residents of King, Kitsap, Pierce and Snohomish counties. Subscribers receive the latest on air quality news, trends and projects that affect our local communities and the air we breathe. It is also used to send timely and important messages about burn bans, Smog Watches and early calls to action when air quality deteriorates.

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.

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[1] Due to the relocation of the State Department of Ecology's air toxic monitoring site in 2006 and the resulting incomplete dataset, 2005 air toxics results are presented in this data summary.
[2] 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 immediately following the executive summary. Information on the Agency-issued burn bans and smog watches and a local emissions inventory are then presented.

The primary focus of this report is to present information on criteria air pollutants. Graphs, statistical summaries, and health effects information are provided for each pollutant. Comparisons to ambient air quality standards and health goals are also provided. A presentation of visibility based on fine particulate measurement is also included.

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

Executive Summary for 2006

The Agency, along with partners, continued to monitor the region's air quality in 2006. Over the last decade, many criteria air pollutant concentrations have fallen well below levels of concern in our jurisdiction. Levels of carbon monoxide, a pollutant that the region was formerly in non-attainment for, have fallen to levels so low that the Washington State Department of Ecology discontinued many of the monitors in 2006, in order to focus its monitoring resources on higher priority pollutants. The same is true for criteria pollutants sulfur dioxide, lead, and nitrogen dioxide. They are no longer at levels of concern in our airshed.

While the area enjoys improving air quality, we are facing new challenges. After more than a decade of attaining all federal standards, the Agency faces non-attainment, potentially in multiple areas for $PM_{2.5}$ and ozone. This is due to a stricter fine particulate standard, and a potentially stricter ozone standard.

For fine particulate matter, concentrations at the South L Tacoma monitoring site, located in the south end of Tacoma, violate the new, stricter fine particulate matter federal standard, and will be recommended for non-attainment in December 2007. Other sites in Snohomish and King County are very close to the federal standard. The new federal standard is about 50% lower than the former standard.[3] Additionally, $PM_{2.5}$ levels at monitors in both Snohomish and King Counties are very close to the standard. The Agency will need to increase its efforts with partners to bring the South L monitor back into attainment and maintain $PM_{2.5}$ attainment status in the rest of our region. While efforts to reduce fine particulate emissions will be tailored to different areas, they will generally work towards wood smoke emissions reductions, as the highest $PM_{2.5}$ levels occur in heating months, when wood stoves and fireplaces contribute the majority of $PM_{2.5}$. Beyond federal standards, $PM_{2.5}$ levels at monitors in Snohomish, King, and Pierce County continue to exceed the Agency's local health goal of 25 $\mu g/m^3$ not to be exceeded, which is even lower than the federal standard to protect health.

In addition to fine particulate matter, ozone levels remain a concern in our region. Ozone concentrations have not dropped as significantly as its precursor pollutants, volatile organic compounds and nitrogen oxides. In 2006, peak ozone concentrations were higher than the region had seen since 1998; however, the average ozone levels have remained fairly stable over the last several years. EPA proposed a new standard for June 2006 and will likely adopt the new stricter standard in March 2008. Ozone levels in our region will potentially violate this standard. Meeting a stricter ozone standard will present another challenge for the Puget Sound region, and will require the Agency and its partners to work together closely to reduce ozone precursor emissions.

In addition to fine particulate and ozone, air toxics are also present in our airshed at levels that pose adverse health effects.[4] These health effects include but are not limited to increased cancer risk and respiratory, cardiovascular, and neurological effects.

[3] U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions - 2006- http://www.epa.gov/particles/actions.html .
[4] Puget Sound Final Air Toxics Evaluation. 2003. http://www.pscleanair.org/airq/basics/psate_final.pdf.

Many of the same sources that produce criteria and toxic air pollutants also generate greenhouse gases. The Agency continues to work with partners to reduce greenhouse gases to make the Northwest region a leader in the field.[5] Greenhouse gases are unique. Unlike the criteria pollutants and air toxics included in this summary, we do not monitor their levels in the atmosphere or present historic trends. The Agency currently focuses on local inventories and reduction strategies, and is exploring ways to present trends in future reports. For more information please refer to http://www.pscleanair.org/programs/climate/default.aspx.

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. Diesel Solutions® is an example. This award-winning program has resulted in clean air retrofits on thousands of diesel vehicles in the Puget Sound region over the past five years. Please visit our website at www.pscleanair.org for more information about these projects.

Air Quality Index (AQI)

The AQI is a nationwide reporting standard developed by the EPA for the criteria pollutants. The AQI is used to report daily air quality. The number of “good” AQI days continued to dominate regionally in the Puget Sound area in 2006. However, air quality degraded into “moderate” for approximately a quarter of the time and “unhealthy for sensitive groups” and “unhealthy” for brief periods.

Table 1 shows the AQI breakdown by percentage in each category for 2006. Pierce County registered the highest AQI value of 170 on December 17. The highest pollutant level determines the AQI. Fine particulate matter ($PM_{2.5}$) determined the AQI on December 17. $PM_{2.5}$ typically determines the AQI in the Puget Sound area on days considered unhealthy for sensitive groups.

Table 1: AQI Ratings for 2006

	AQI Rating (% of year)				
County	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Highest AQI
Snohomish	82%	16%	2%	0%	143
King	73%	24%	2%	1%	169
Pierce	78%	19%	2%	1%	170
Kitsap	93%	7%	0%	0%	105

Emissions Inventory

The Agency is in the process of completing its inventory for 2005; therefore, it is not available at the time of publication of this report. The 2004 inventory is available at http://www.pscleanair.org/news/library/reports/2005AQDSFinal.pdf. The 2004 inventory shows that

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

on-road vehicles continue to be the greatest 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 to $PM_{2.5}$ emissions.

When the 2005 inventory is available, this report will be updated with a link to it.

Impaired Air Quality -- Burn Bans and Smog Watches

The Puget Sound Clean Air Agency issues temporary bans on indoor and outdoor burning when the weather trends toward stagnant conditions, such as air inversions, trap fine particle pollution emitted from our chimneys, cars, trucks, and other activities. These burn bans are mandatory. There are two stages of the burn bans. Stage 1 prohibits burning from fireplaces and uncertified wood stoves unless it is your only adequate source of heat. Stage 2 prohibits burning in fireplaces, uncertified wood stoves, EPA certified wood stoves, and pellet stoves unless it is your only adequate source of heat. The 2005 Legislature changed the PM_{10} burn ban "trigger" to a fine particulate ($PM_{2.5}$) trigger. This new criteria enables the Agency to better protect public health by issuing burn bans more effectively.

The Agency did not issue any burn bans in 2006. In mid-December, elevated concentrations of $PM_{2.5}$ were detected, but the Agency did not call a burn ban because the elevated $PM_{2.5}$ concentrations were likely due to people using wood as their primary heat source during power outages affecting more than 1 million residents.

The Agency also may issue a Smog Watch when the Agency's meteorologists predict elevated smog levels within the next 48 hours that are expected to persist for several days. During a Smog Watch, the Agency encourages people to voluntarily take steps that will keep smog levels from rising even higher including. The Agency issued two smog watches in 2006. The first smog watch was for four days from June 24 and to June 28. The second smog watch was called July 20 and canceled July 24.

Criteria Air Pollutants and Visibility

The Puget Sound airshed is currently in attainment for carbon monoxide, ozone, and PM_{10}, and has maintenance plans in place for these pollutants.

The Puget Sound area had one violation to the National Ambient Air Quality Standards (NAAQS) in 2006. The three year average the 98th percentile of daily $PM_{2.5}$ concentrations at the South L Tacoma monitor, located at the south end of Tacoma, in Pierce County, violated the new standard of 35 $\mu g/m^3$. An area surrounding this monitor will be designated as non-attainment for $PM_{2.5}$.

In addition to the federal standard, our Board of Directors adopted a more stringent goal based on recommendations from our Particulate Matter Health Committee. The Committee conducted a systematic review of health data and recommended that a daily average of 25 $\mu g/m^3$ is protective of human health. Several areas in the region fall short of the local health goal for fine particulate matter. 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 and are very close to the Federal Standard. These are areas of concern.

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

Air Toxics

The Department of Ecology began monitoring air toxics at the Seattle Beacon Hill site in 2000. Because the Beacon Hill site was not in operation for a significant portion of the year due to the relocation of the site, there is an incomplete 2006 dataset. The Agency typically presents air toxics data as annual concentrations, so a partial dataset is not considered representative and should not be compared to concentrations from previous years. A brief summary of 2005 air toxics data and a link to the more comprehensive 2005 data summary are presented in this report.

Formaldehyde (primarily from vehicles and other combustion), presented the highest potential cancer risk from air toxics monitored in 2005. It is important to note that this ranking does not include diesel particulate matter. A comprehensive 2003 evaluation showed that diesel particulate matter presents the majority of potential air toxics cancer health risk in our area.[6] Unfortunately, there is no direct monitoring method to measure diesel particulate matter. The Agency, the Washington Department of Ecology, the University of Washington, and other partners are using various monitoring methods to characterize indicators of diesel particulate matter. These methods are described further in the $PM_{2.5}$ Speciation section of this report.[7]

[6] Puget Sound Final Air Toxics Evaluation. 2003. http://www.pscleanair.org/airq/basics/psate_final.pdf.
[7] These methods are described further in the fine particulate section of this report.

Air Quality Index

The air quality index (AQI) is reported according to a 500-point scale for five of the six major criteria air pollutants: ozone, particulate matter (both $PM_{2.5}$ and PM_{10}), carbon monoxide, nitrogen dioxide, and sulfur dioxide. The highest pollutant determines the daily ranking. For example, if an area has a carbon monoxide value of 132 on a given day and all other pollutants are below 50, the AQI for that day would be 132. The scale breaks down into six categories, listed below. Each category has a corresponding color, shown with pollution concentration breakpoints for each category, shown in Table 4 in the definitions section of this document.

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

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

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

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

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Figures 2-5 present AQI days 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. Summaries include "good", "moderate", "unhealthy for sensitive groups", and "unhealthy" days from 1980 to 2006 (from 1990 to 2006 for Kitsap).

Figure 1:

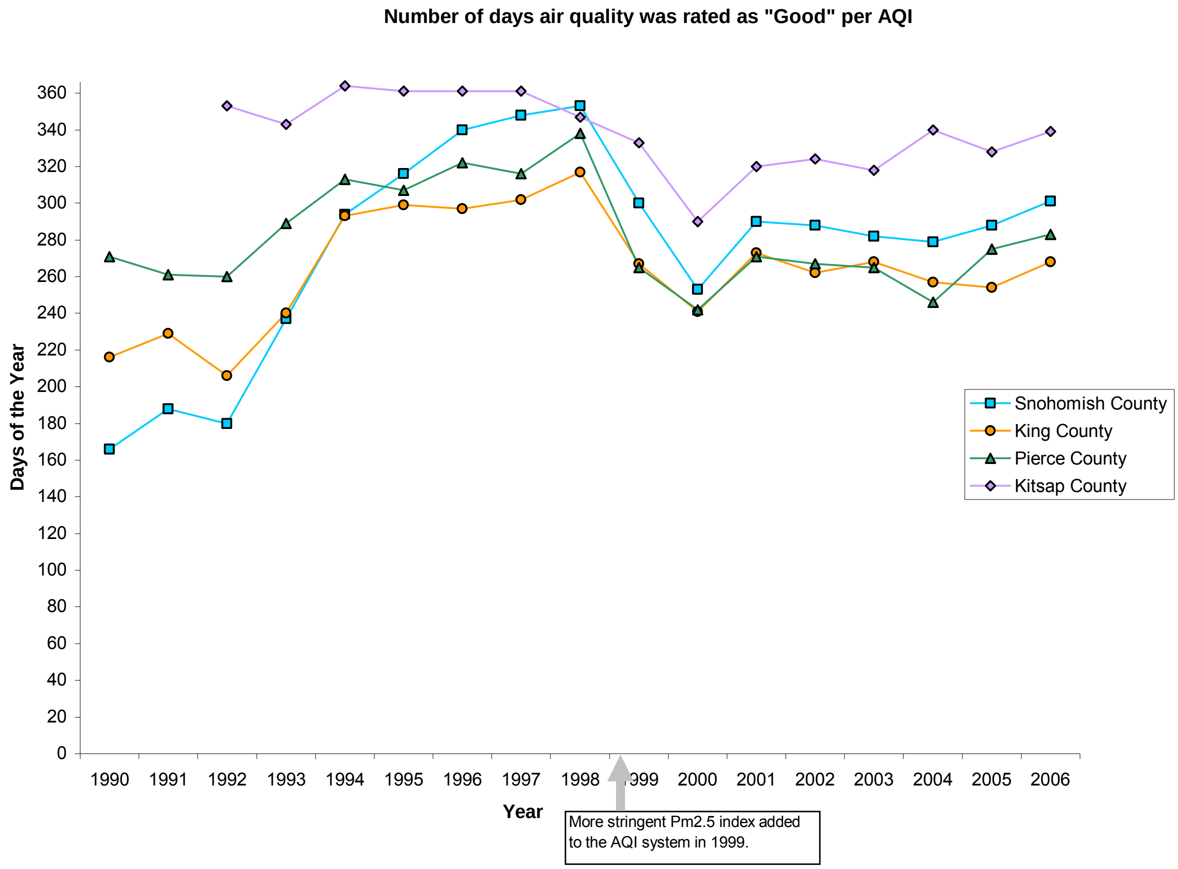


Figure 2:

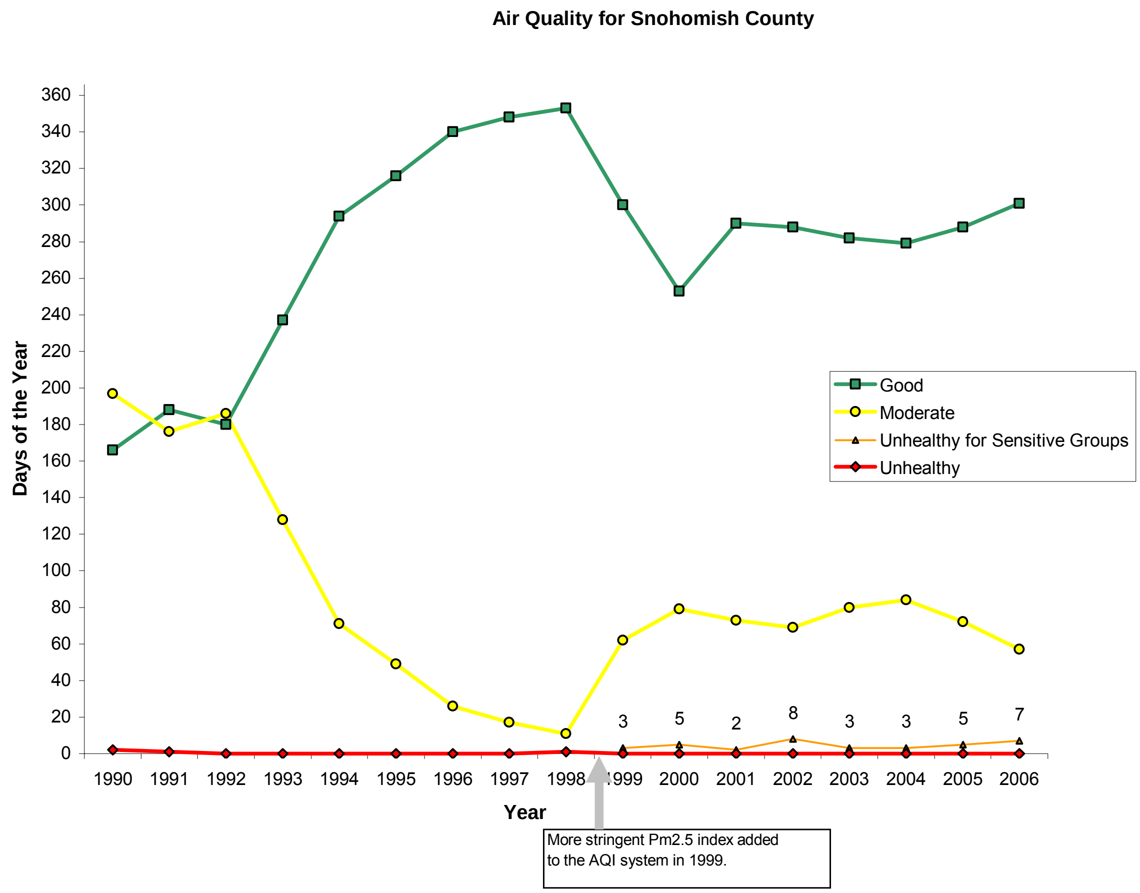

Air Quality for Snohomish County
Days of the Year
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year
3
5
2
8
3
3
5
7
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
More stringent Pm2.5 index added to the AQI system in 1999.

Figure 3:

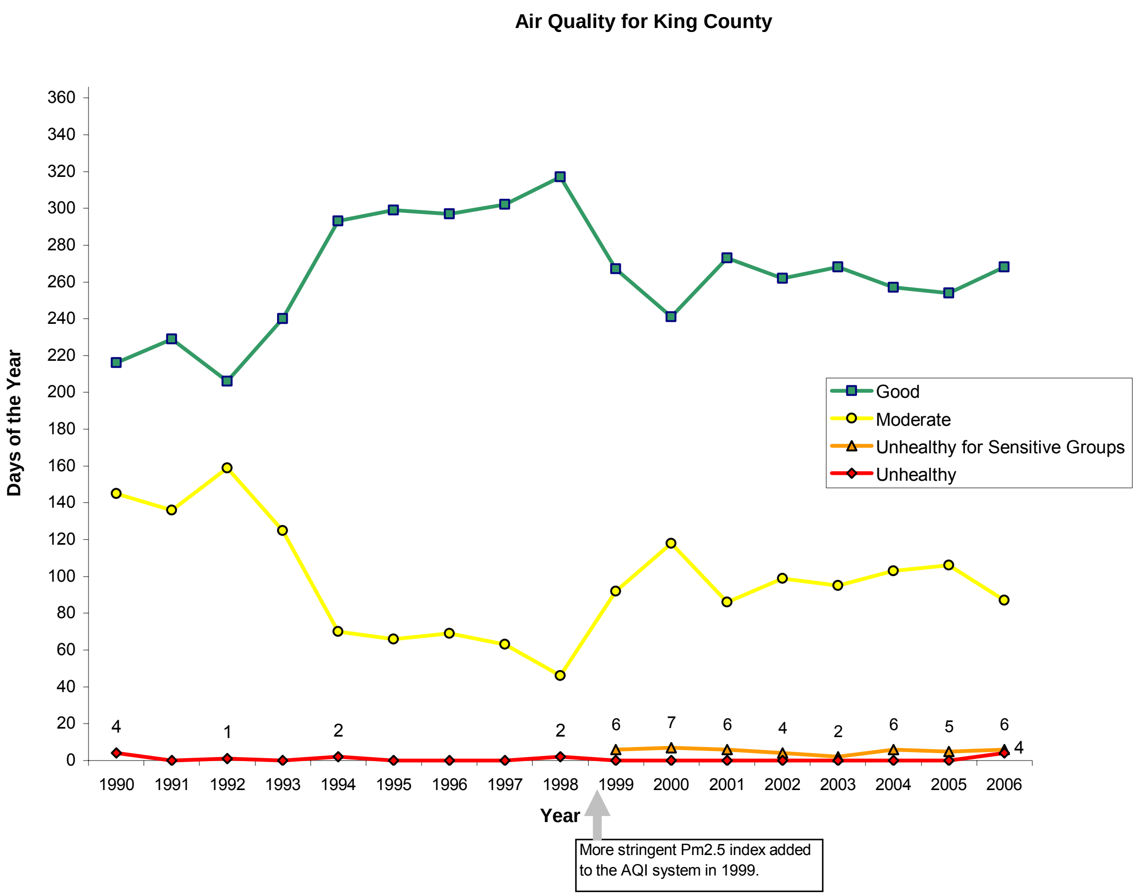

Air Quality for King County
Days of the Year
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Year
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
4 1 2 2 6 7 6 4 2 6 5 6 4
More stringent Pm2.5 index added to the AQI system in 1999.

Figure 4:

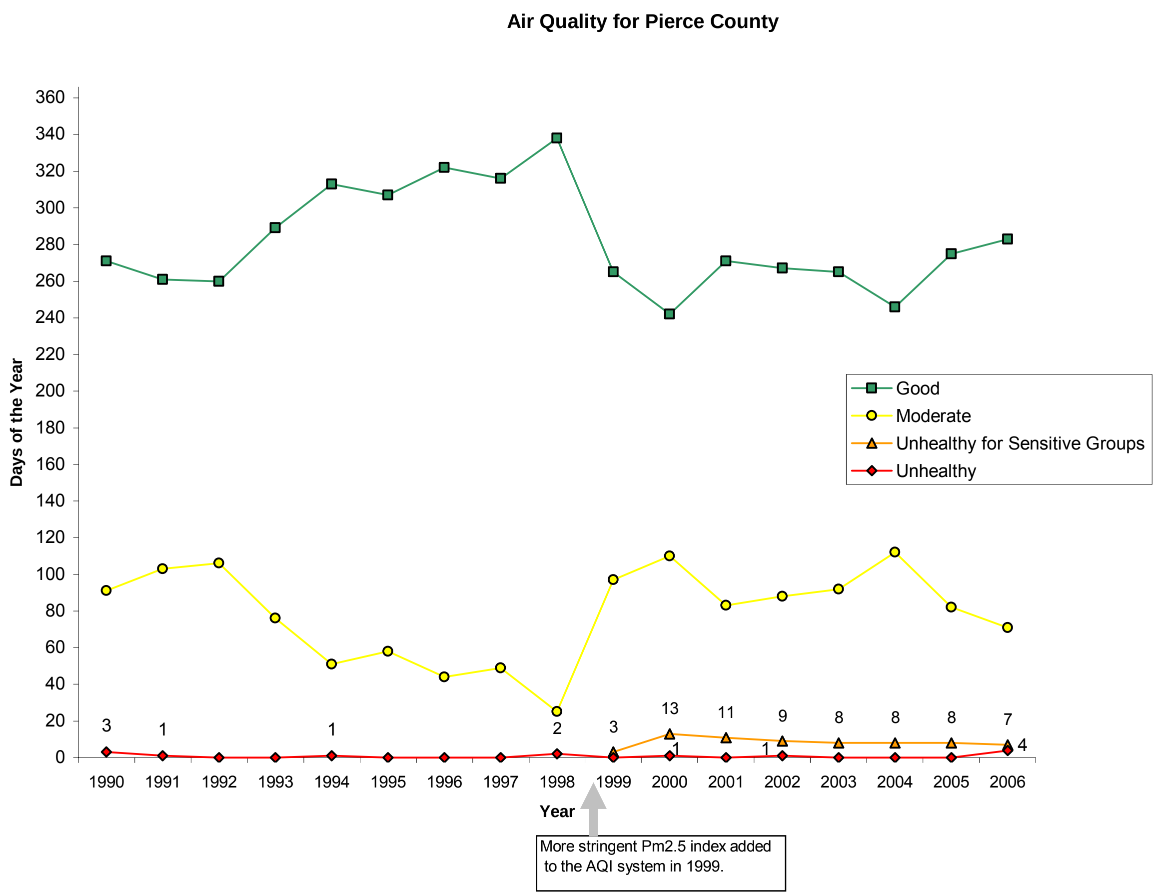
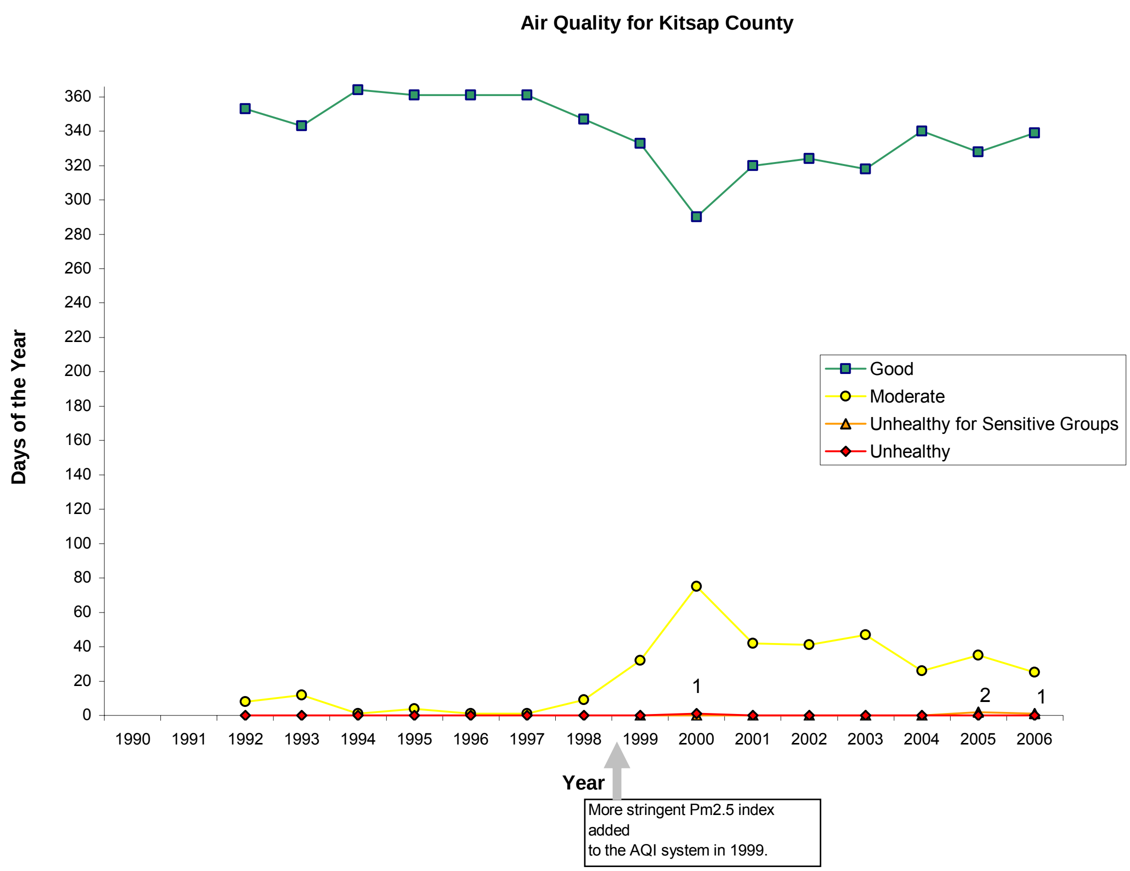

Air Quality for Pierce County
Days of the Year
Year
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
More stringent Pm2.5 index added to the AQI system in 1999.

Figure 5:


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
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Year
1
2
1
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 region's monitoring network, comprised of both meteorological and pollutant-specific equipment. Data from the network are either collected manually by field staff or sent directly to engineers and scientists through a telemetry network. The Agency is currently working with the Washington State Department of Ecology and other local air agencies to improve the efficiency of the telemetry network.

The Agency has conducted monitoring as early as 1965; however, this report will focus on post 1999 monitoring. Table 2 presents a summary of the monitoring stations and parameters monitored from 1999 through 2006. Some parameters were monitored for only part of this time frame. Shaded stations in the table are currently operating. Similarly, a filled circle denotes a pollutant that is currently monitored (in 2006). An "x" denotes a pollutant that was no longer monitored in 2006. The network changes because the Agency and the Department of Ecology regularly re-evaluate monitoring resources to measure and report on the pollutants that are most relevant to public health. Additionally, sometimes logistical issues (such as loss or gain of real estate) cause changes in the network.

Monitoring stations are located in a variety of geographic locations in the Puget Sound region. Most are located in highly populated areas. A few are located in representative rural areas. Monitors are sited according to specific EPA criteria. EPA developed siting criteria to ensure a consistent and representative picture of air quality. Map 1 on page 19 shows monitoring stations that were active in 2006.

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

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

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

Special Monitoring Projects

In addition to the network described in this section and presented on Map 1, the Agency conducted one short-term special monitoring project in 2006 to improve our understanding of the spatial distribution of $PM_{2.5}$ air quality in Tacoma.

In anticipation that the South L Tacoma site, located in the south end of Tacoma, would violate the new federal $PM_{2.5}$ standard, the Agency conducted a six month study of the South Tacoma area. For this study, four temporary monitors were operated around the South L Tacoma site from September 2006 through February 2007. These monitors were sited to determine if areas beyond the South L Tacoma site also experience elevated $PM_{2.5}$ concentrations in winter months. The report describes this project in more detail later in the $PM_{2.5}$ Special Monitoring Projects Section of this summary.

Fine Particulate Monitoring – Federal Reference Method and Continuous Methods

Fine particulate matter ($PM_{2.5}$) is measured using a variety of methods because it is the main pollutant of concern in our area. The EPA considers the federal reference method (FRM) to be the most accurate way to determine $PM_{2.5}$ concentrations.[8] 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 rapid turnaround information.

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

These methods determine fine particulate matter concentration differently:

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

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

Where possible in this report, 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." Continuous concentrations from Kitsap are not adjusted to make them "FRM-like", as there is no site-specific FRM data at the Meadowdale and Silverdale monitoring sites.

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

Table 2: Air Quality Monitoring Network

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

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

Station ID	Location	PM_{10} Ref	PM_{10} bam	PM_{10} teom	$PM_{2.5}$ ref	$PM_{2.5}$ bam	$PM_{2.5}$ teom	$PM_{2.5}$ ls	$PM_{2.5}$ bc	O_3	SO_2	NO_x	CO	b_{sp}	Wind	Temp	AT	Vsby	Location
FF⦿	5225 Tower Drive NE, northeast Tacoma														●	●			b, f
FG⦿	Mt Rainier National Park, Jackson Visitor Center									●				●					c
FH⦿	Charles L Pack Forest, La Grande									●									c, f
FL⦿	1101 Pacific Ave, Tacoma (ended Jun30, 2006)												X						a, d
ID	Hoyt Ave & 26th St, Everett (ended Feb 29, 2000)										x				x				a, e, d
IG	Marysville JHS, 1605 7th St, Marysville	X	X		●		●	●	●					●	●	●		●	b, d
IH	20935 59th Place West, Lynnwood (ended Jun 8, 1999)	X		X										X	X			X	a, d
II	6120 212th St SW, Lynnwood				●	●	●	●						●	●			●	b, d
JN⦿	5810 196th Street, Lynwood (ended Jun 30, 2006)												X						a,d
JO	Darrington High School, Darrington 1085 Fir St				●			●	●					●	●	●		●	d, f
JP⦿	2939 Broadway Ave, Everett (ended March 31, 2003)												X						a, d
JQ⦿	44th Ave W & 196th St SW, Lynnwood (ended May 3, 2004)												X						a, d
JS⦿	Broadway & Hewitt Ave, Everett (ended May 21, 2000)												X						a, d
QE	Meadowdale, 7252 Blackbird Dr NE, Bremerton	X				●		●						●	●	●		●	b, f
QF	Lions Park, 6th Ave NE & Fjord Dr, Poulsbo (ended Feb 29, 2000)														X				b, f
QG	Fire Sta #51, 10955 Silverdale Way, Silverdale (began Jun 2, 2000)					●		●						●	●	●		●	a, d
UB⦿	71 E Campus Dr, Belfair (ended September 30, 2004)									X									c

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
VK⦿	Fire Station, 709 Mill Road SE, Yelm (began May 1, 2000)									●									c. f

Monitoring Network Table Notes:

⦿	**Station operated by Washington State Department of Ecology**
VK⦿	**Shading indicates station currently functioning**
●	**Indicates parameter currently monitored**
X	**Indicates parameter previously monitored**
PM_{10} ref	**Particulate Matter 10 micrometers (reference)**
PM_{10}	**Particulate Matter 10 micrometers (beta attenuation continuous)**
PM_{10}	**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**
$PM_{2.5}$ bc	**Particulate Matter 2.5 micrometers black carbon (light**
	Location
a	**Urban Center**
b	**Suburban**
c	**Rural**
d	**Commercial**
e	**Industrial**
f	**Residential**

SO_2	**Sulfur Dioxide**
NO_x	**Nitrogen Oxide**
CO	**Carbon Monoxide**
b_{sp}	**Light scattering by atmospheric particles**
Wind	**Wind direction & speed**
Temp	**Air temperature (relative humidity also measured**
AT	**Air Toxics**
VSBY	**Visual range (light scattering by atmospheric**
PHOTO	**Visibility (camera)**
O_3	**Ozone (May through September)**

Map 1: Active Air Monitoring Network for 2006

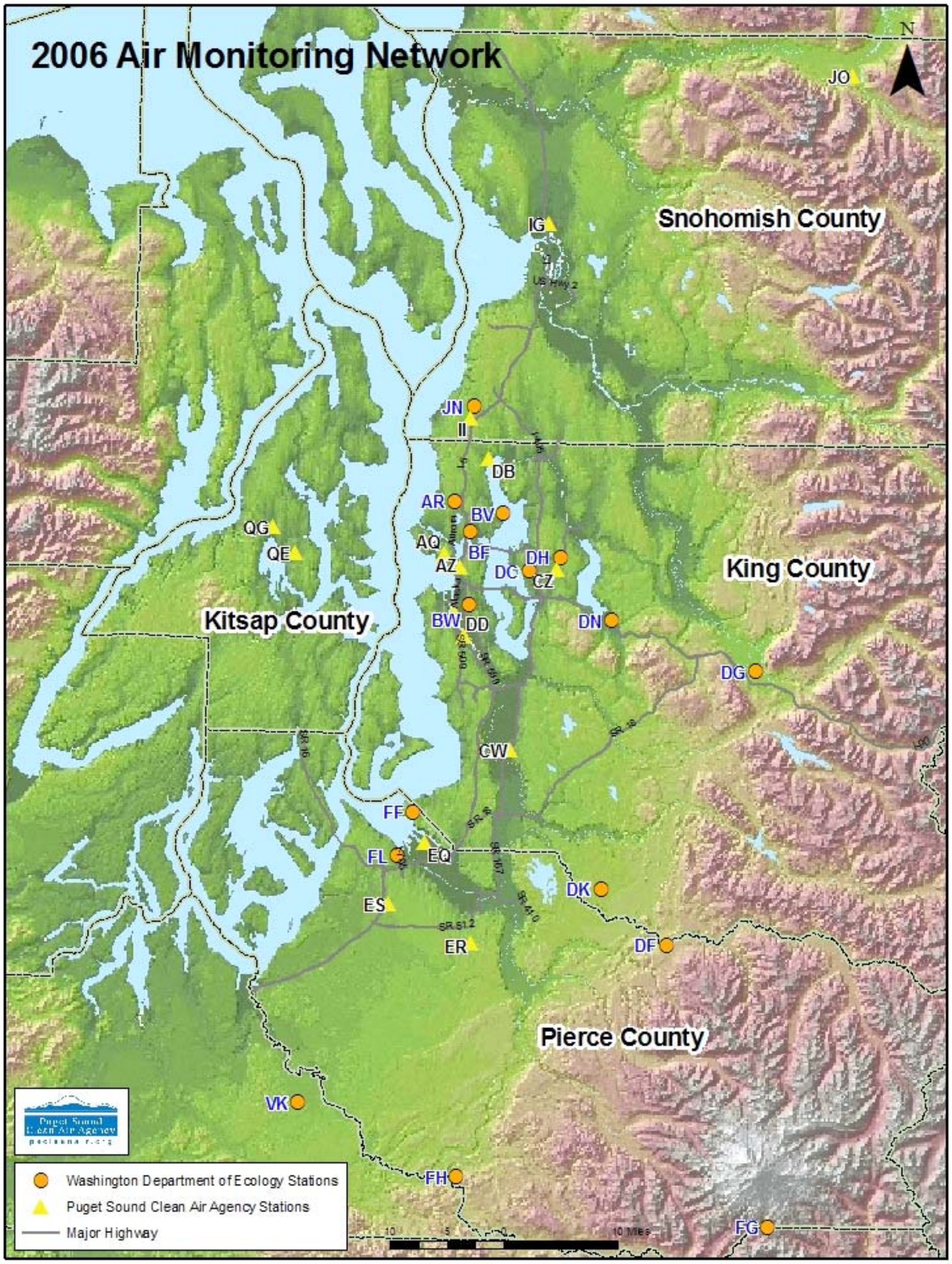


Table 3: Monitoring Methods Used from 1999 to 2006 in Puget Sound Airshed

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/ Wind Direction	RM Young 05305 Wind Monitor AQ (old method)	Miles per Hour/ Degrees
	Wind Speed/ Wind Direction	Ultrasonic (new method)	Miles per Hour/ Degrees

Impaired Air Quality—Burn Bans and Smog Watch

Burn Bans

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

There are two stages of the indoor burn bans. A first-stage burn ban may be declared by the Agency when $PM_{2.5}$ levels reach 35µg/m^3(24-hour average). 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).[9] A second-stage burn ban may be declared when $PM_{2.5}$ levels reach 60 µg/m^3 (24-hour average). For a second stage burn ban, the use of any kind of wood-burning device is prohibited unless it is the only adequate source of heat. The Agency has not issued a second-stage burn ban since 1991.

The Agency did not call any burn bans in 2006. However, in mid December of 2006 many areas experienced unhealthy levels of $PM_{2.5}$. These high concentrations of $PM_{2.5}$ were likely due to people using wood to heat their homes after a severe windstorm left many areas without electric power for several days. No burn ban was called during this time period because it was believed that the high $PM_{2.5}$ concentrations were due to people using wood heat as their only adequate heat source, which is exempt from curtailment action.

Fine particulate levels at three monitoring sites during December event are shown in Figure 6. The three sites shown in the graph are Marysville in Snohomish County, Bellevue in King County, and Tacoma South L in Pierce County. The Marysville and Tacoma South L monitoring sites typically register some of the highest fine particulate levels in the region. The Bellevue monitoring site does not typically register elevated particulate levels; but did show high particulate levels during the December event. Figure 6 shows the 24-hour average $PM_{2.5}$ concentrations, with Air Quality Index (AQI) shading. Concentrations are based on $PM_{2.5}$ nephelometer measurements. Each point represents a 24-hour average based on the 12 hours before and after. All three sites registered “moderate” levels of $PM_{2.5}$ concentrations during the December event. The Tacoma South L site reached “unhealthy” $PM_{2.5}$ concentrations on December 17.

Burn bans typically occur in November through February. Figure 7 shows the number of days when burn bans have been declared since 1988. A detailed list of these burn bans is included on page A-5 of the Appendix.

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

Figure 6:

$PM_{2.5}$ Levels Following December Windstorm

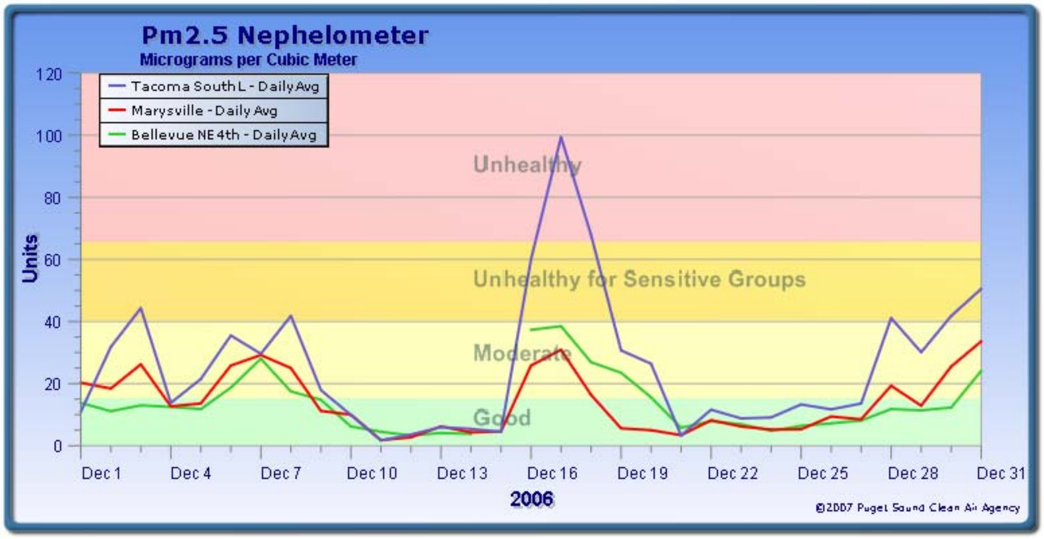
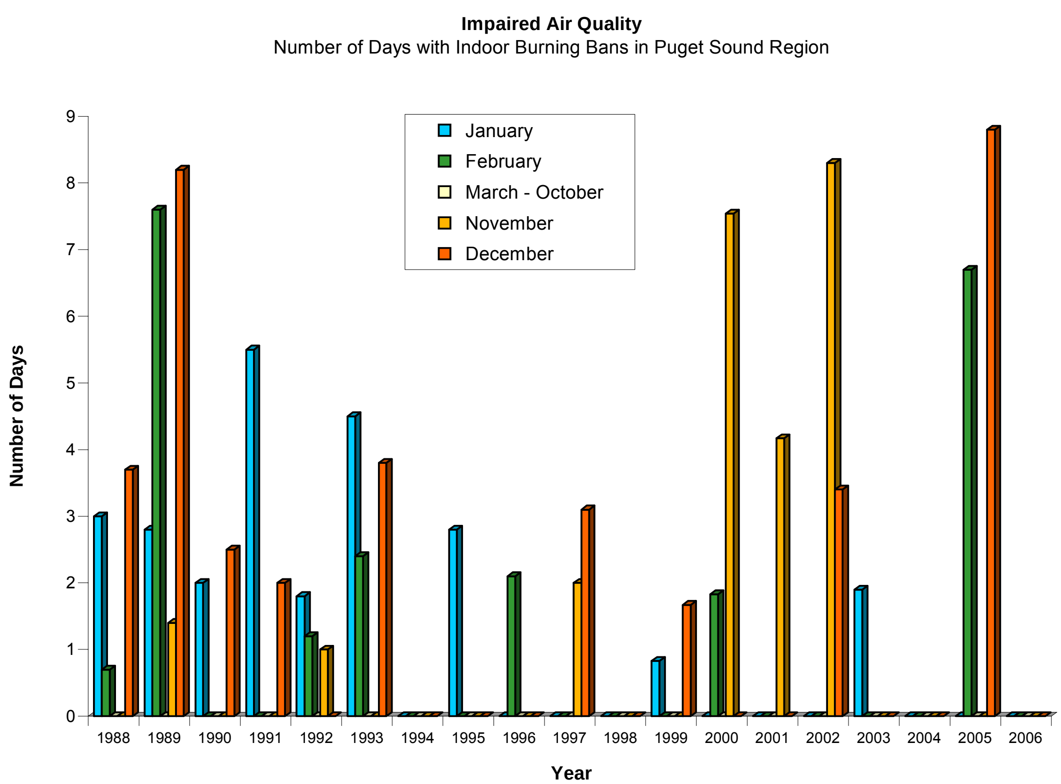


Figure 7:



Smog Watch

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

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

The Agency issued two smog watches in 2006. The first smog watch was for four days from June 24 to June 28. The second smog watch was called on July 20 and canceled July 24. The following graphs show recorded ozone concentrations during these two smog watches. Figure 8 and Figure 9 show AQI ozone levels at five different monitoring sites before, during, and after these periods. Ozone AQI levels are based on 8-hour ozone concentrations. The number “056” on these graphs is the pollutant code for ozone. The arrows on the graphs mark the beginning and end of Smog Watches. The Enumclaw and LaGrande Pack Forest monitoring sites moved into the “unhealthy for sensitive groups” AQI group during the June Smog Watch and into the “unhealthy” 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-13 of the Appendix.

Figure 8:

June 24th - June 28th Smog Watch

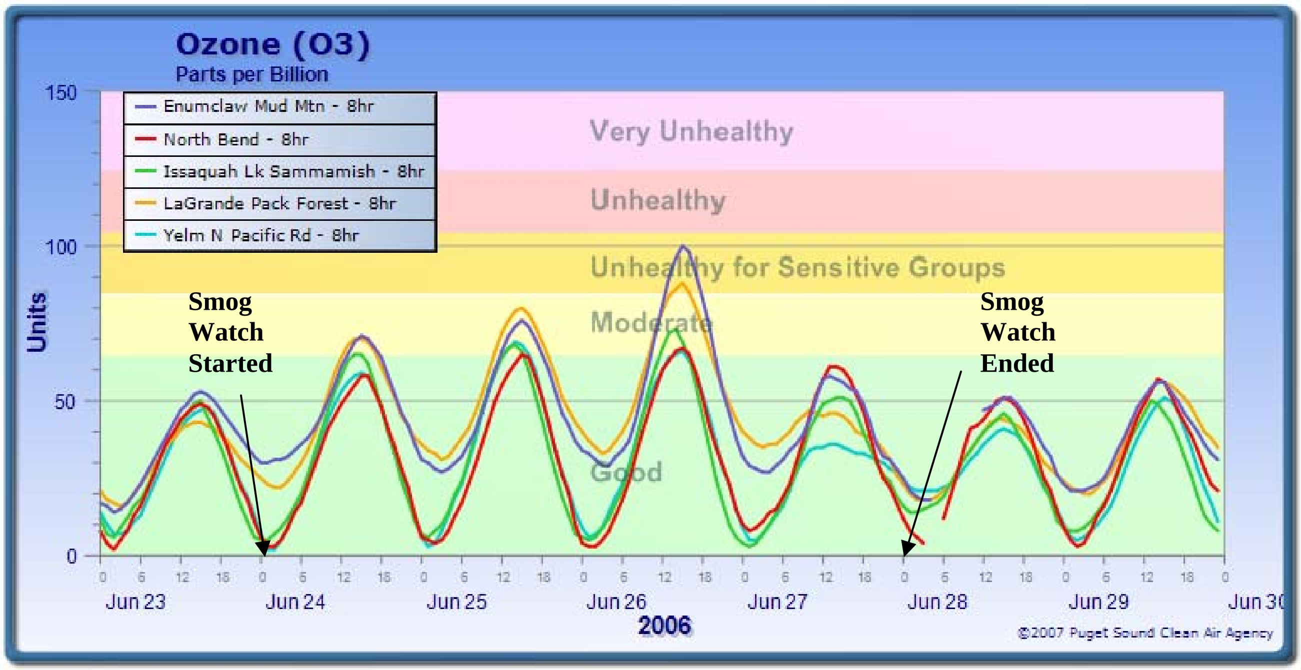
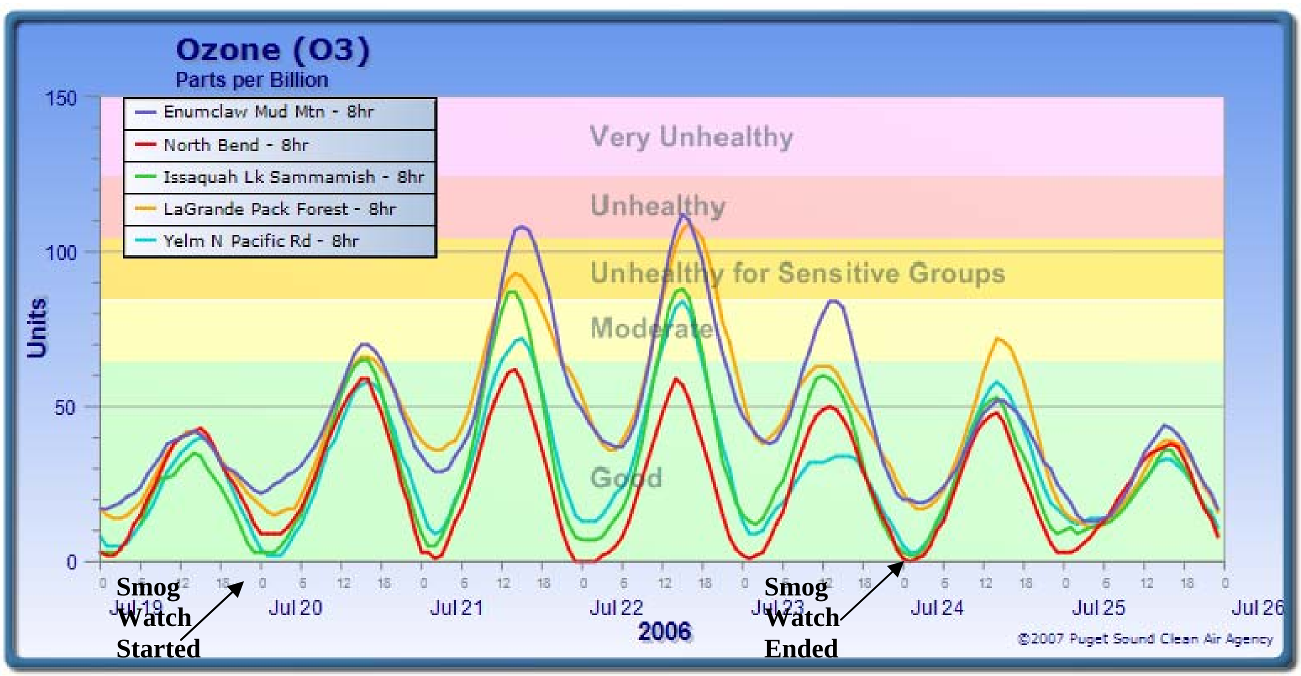


Figure 9:

July 20th - July 24th Smog Watch



Regional Emissions Inventory

Introduction

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

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 compound emissions from trees and plants and nitrous oxide emissions from soil.

1. Point Sources

   Point sources are those that many people consider when thinking of air pollution. These include large industries that emit several tons of pollution or more per year from a single location, often through a smokestack. Historically, point sources contributed a large portion of air pollutants in this area. Today, this category typically represents a very small fraction of pollutant emissions in the Puget Sound area. This large reduction is due to 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, idling reduction, 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. 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 released a comprehensive inventory of greater Puget Sound to estimate marine emissions. More information on this inventory can be found at http://www.maritimeairforum.org/emissions.shtml.

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

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

   Although area sources emit far less than point sources on an individual basis, the large numbers of these activities, often concentrated in residential neighborhoods, make them significant contributors to pollution in this region. The 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 – using cleaner alternatives for heat (natural gas, propane, heat pumps, EPA certified woodstoves); less outdoor burning - using alternatives for biomass such as chipping and composting; use of low-emission paints and solvents, and improved practices such as closed-loop dry cleaning machines.

2005 Emission Inventory

The Agency is in the process of completing its inventory for 2005. It is not available at the time of publication of this report. The 2004 inventory is available at http://www.pscleanair.org/news/library/reports/2005AQDSFinal.pdf. The 2004 criteria pollutant summary table is also presented below. A detailed description of the summary table is available in the 2005 data summary, as well as historic greenhouse gas and air toxics inventory information.

When the 2005 inventory is available, the link in this report will be updated.

Table 4: Puget Sound Region 2004 Estimated Criteria Air Pollutant Emission Inventory (thousands of tons)[10]

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**

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

Air Quality Standards and Health Goals

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

The State of Washington and the Puget Sound region have adopted these standards, and in the case of sulfur dioxide have also applied a stricter state standard. For more information, 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.[11] The air quality standards that apply to the Puget Sound airshed are summarized in Table 5.

The EPA promulgated a new, lower fine particulate standard on September 21, 2006.[12] The new daily standard of 35 $\mu g/m^3$ is more consistent with the Agency's health goal, discussed below. In addition to reducing the fine particulate daily standard, EPA has revoked the annual PM_{10} standard due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution.[13]

In addition to air quality standards, the Agency has developed an air quality health goal for daily $PM_{2.5}$ concentrations. The Agency convened a Particulate Matter Health Committee, comprised of local health professionals, who examined the fine particulate health research.[14] The Health Committee did not consider the current federal standard to be protective of human health. In 1999, the Agency adopted a health goal of 25 $\mu g/m^3$ for a daily average, more protective than the new federal standard of 35 $\mu g/m^3$. The form of this goal is "never-to-be-exceeded." The Agency did not adopt a separate health goal for the annual $PM_{2.5}$ average.

The EPA proposed a stricter 8-hour ozone standard on June 20, 2007.[15] The proposed standard would lower the current 0.08 parts per million (ppm) standard to a level ranging from 0.070 to 0.075 ppm. The

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[11] Washington Administrative Code chapters 173-470, 173-474, and 173-475
[12] U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions - 2006- http://www.epa.gov/particles/actions.html
[13] U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions - 2006- http://www.epa.gov/particles/actions.html
[14] Puget Sound Clean Air Agency. Final Report of the Puget Sound Clean Air Agency $PM_{2.5}$ Stakeholder Group. http://www.pscleanair.org/news/library/reports/pm2_5_report.pdf.
[15] 2007 Proposed Revisions to Ground-Level Ozone Standards http://www.epa.gov/air/ozonepollution/naaqsrev2007.html

EPA determined that the current standard of 0.08 is not protective of human health, and will promulgate a new standard in March 2008.[16]

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

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

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

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

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

Pollutants typically have multiple standards with different averaging times; for example, daily and annual standards. Multiple standards are created and enforced to address 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 EPA's website at http://epa.gov/air/criteria.html.

A distinction exists between "exceeding" and "violating" a standard. In most instances it is allowable for a monitoring site to exceed the standard more than once without causing a violation. This allowance is made to account for possible meteorological aberrances. For example, a carbon monoxide 8-hour

[16] EPA will accept comments in summer 2007 on a standard ranging from 0.060 ppm to the current standard of 0.08 ppm.

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 federal standards for the year 2006. Some graphs also incorporate the AQI where applicable. AQI shading is shown to aid interpretation of air quality, but does not imply whether or not standards were actually met for each pollutant; only meeting the conditions listed in the Table 5 warrant compliance. Additionally, one graph presents the number of days that our region did not meet the Agency's $PM_{2.5}$ health goal.

Particulate Matter (10 micrometers in diameter)

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

The Agency ceased monitoring PM_{10} with the federal reference method in 2003. PM_{10} is currently monitored in the Puget Sound area using continuous methods at three monitoring sites. Two are located in King County (Seattle Duwamish and Kent) and the other is located in Pierce County (Tacoma tideflats). 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; however, the Washington state burn ban trigger was changed to $PM_{2.5}$ in early 2005.

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. PM_{10} is no longer a major concern in the Puget Sound area.

On September 21, 2006 EPA revoked the annual PM_{10} standard due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution.[17]

Figures 10-18 show daily PM_{10} concentrations compared to the federal daily standard. The Standard used in the graphs is 154 $\mu g/m^3$, since 154 $\mu g/m^3$ would be rounded to 150 $\mu g/m^3$ using EPA's rounding methods. These graphs include historical reference method monitoring prior to 2004. The 2004 - 2006 values represent three-year averages calculated using continuous methods. Concentrations measured with the historical reference method are maximum daily concentrations. Concentrations measured with continuous methods are the 99th percentile of daily concentrations. The maximum daily concentrations from the reference method data demonstrate very similar values to the 99th percentile concentrations from the continuous methods and in many cases were identical. Thus this difference in statistical measure does not strongly affect the graphs.

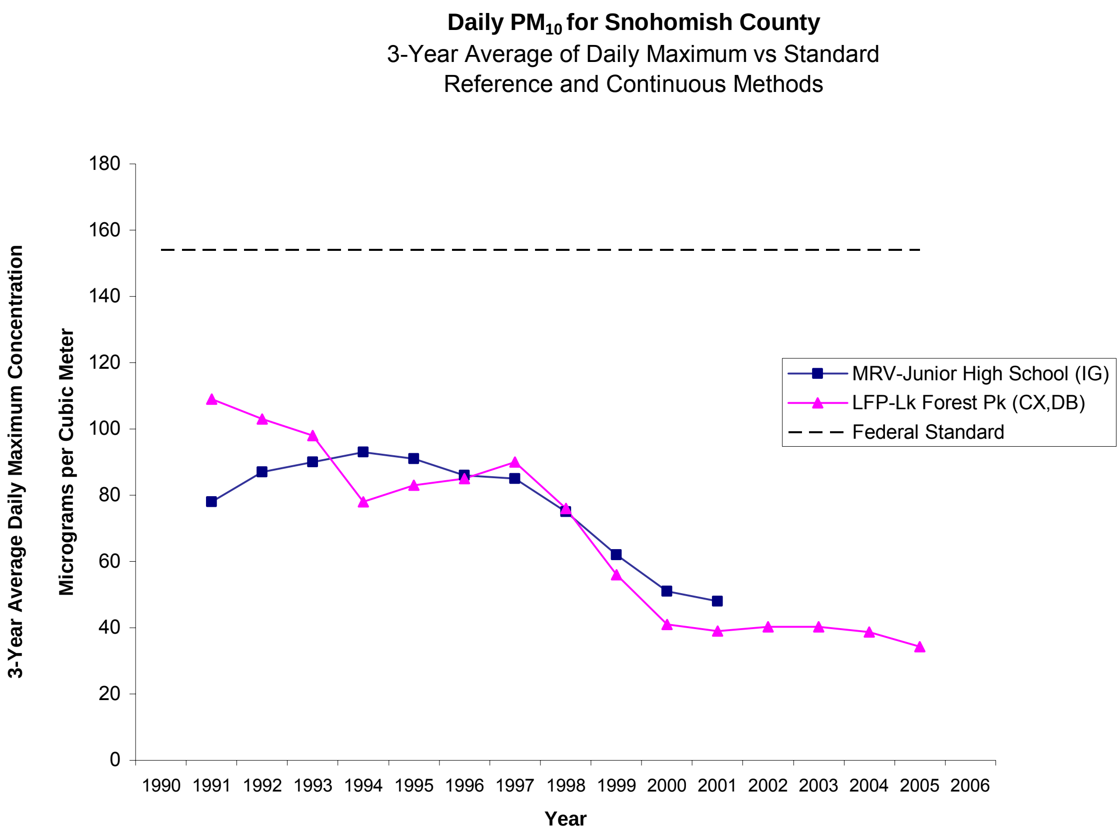
Graphs for the annual PM_{10} standard are not presented because there is no longer a federal annual standard.

A statistical summary of 2006 continuous method PM_{10} concentrations is provided on page A-6 of the Appendix. The highest daily PM_{10} concentration was 74 $\mu g/m^3$ on December 17th at the James Street & Central Avenue monitoring site in Kent, well below the federal standard.

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.

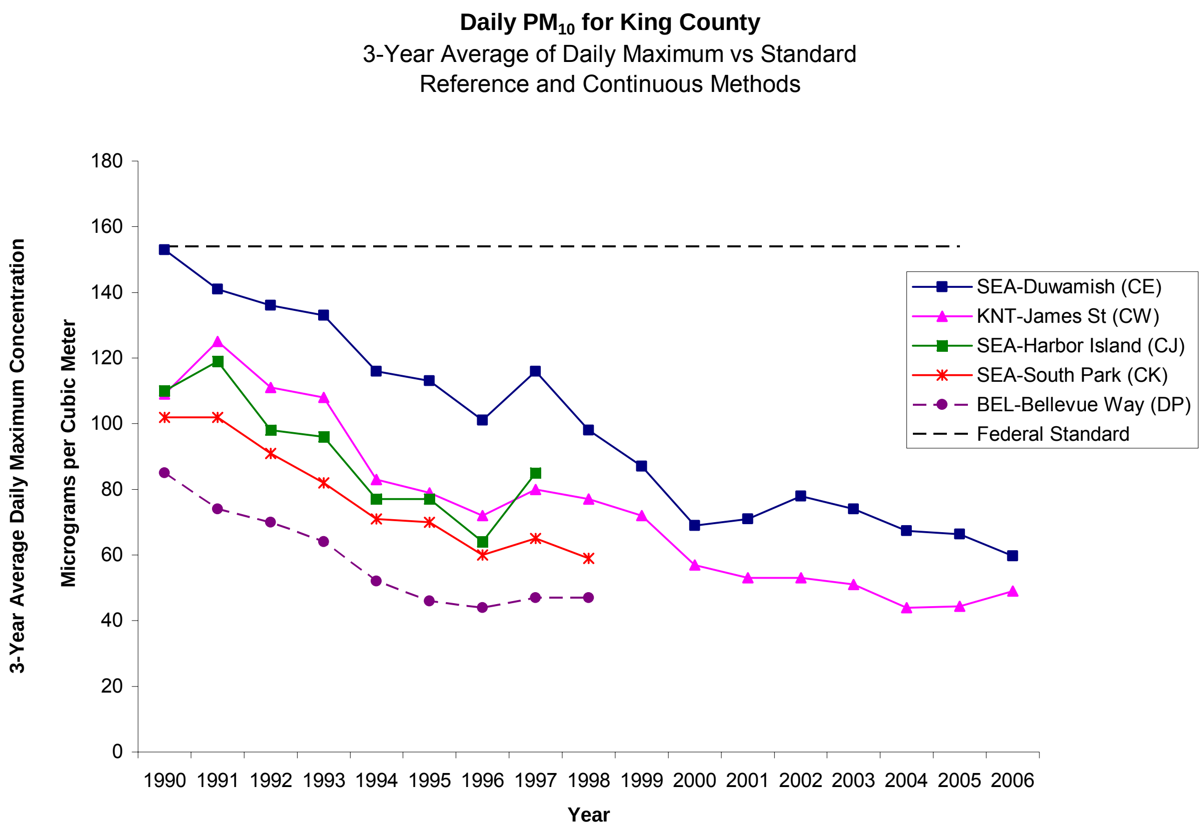
[17] U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions - 2006- http://www.epa.gov/particles/actions.html

Figure 10:



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

Figure 11:



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

Figure 12:

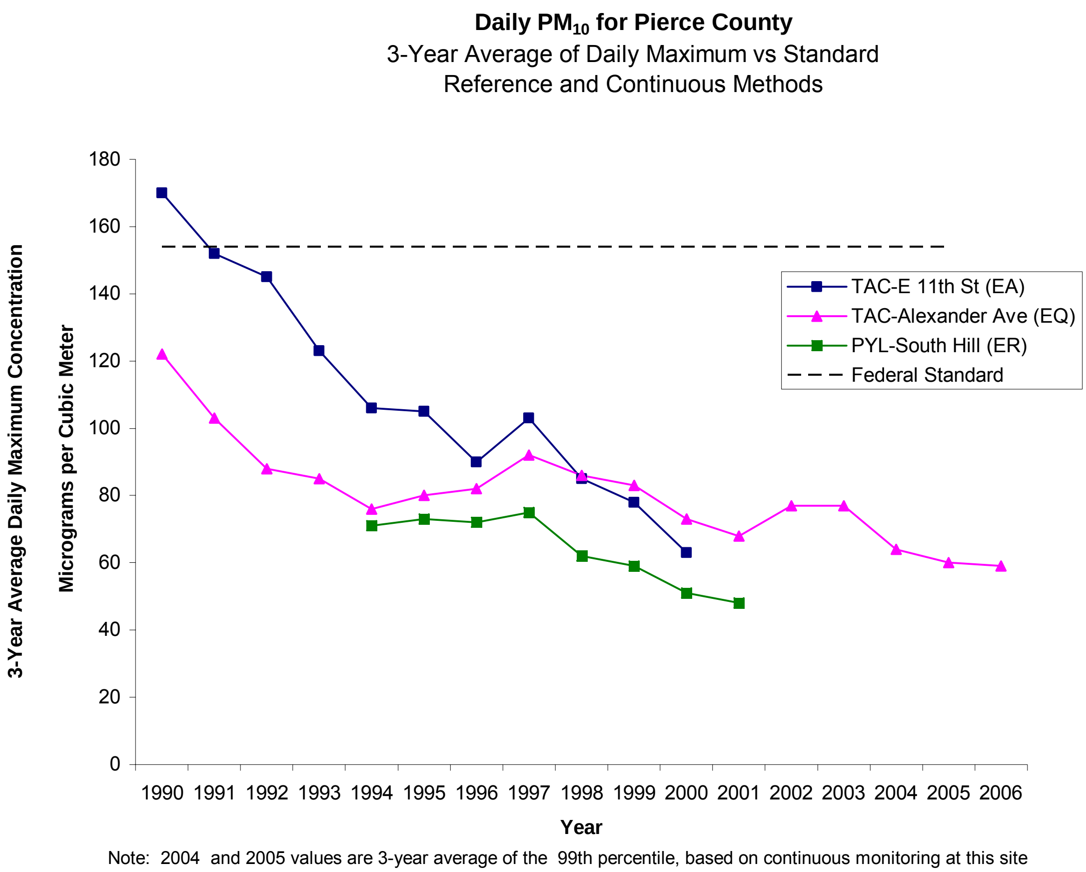
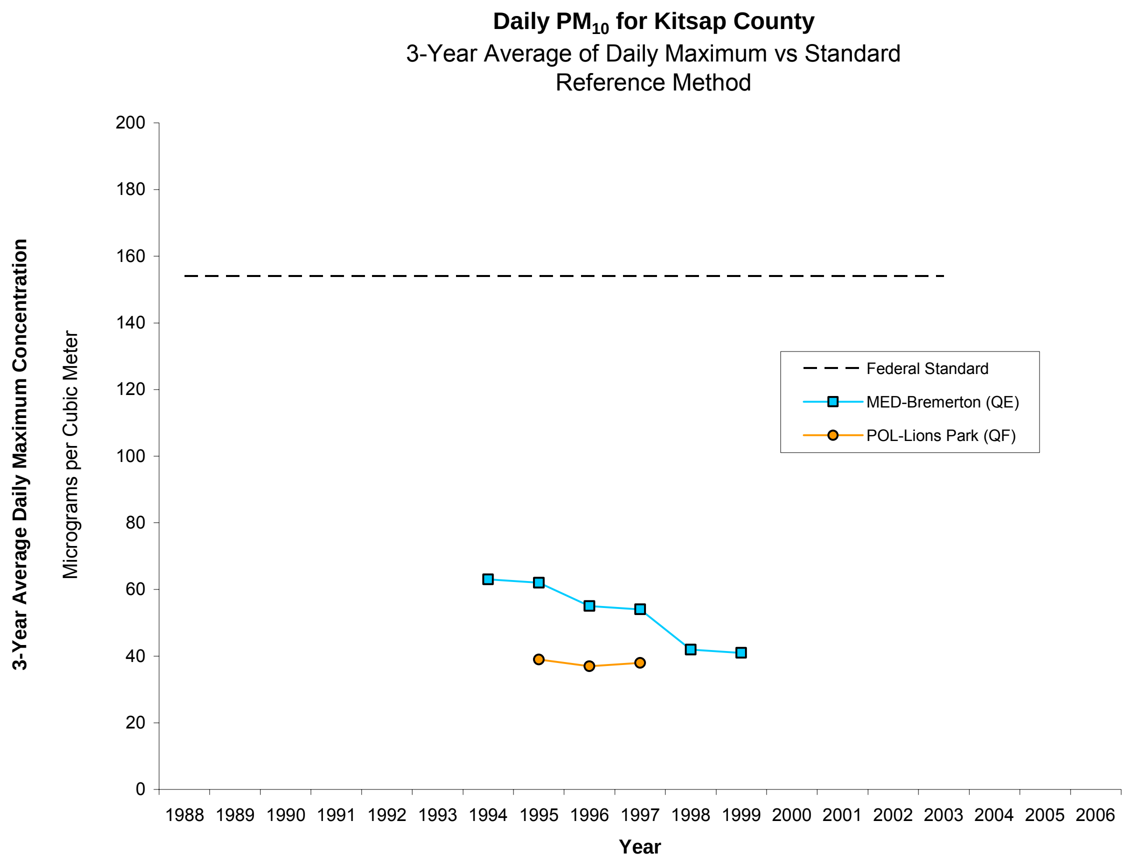

Daily PM_{10} for Pierce County
3-Year Average of Daily Maximum vs Standard
Reference and Continuous Methods
3-Year Average Daily Maximum Concentration
Micrograms per Cubic Meter
180
160
140
120
100
80
60
40
20
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Year
TAC-E 11th St (EA)
TAC-Alexander Ave (EQ)
PYL-South Hill (ER)
Federal Standard
Note: 2004 and 2005 values are 3-year average of the 99th percentile, based on continuous monitoring at this site

Figure 13:


Daily PM10 for Kitsap County
3-Year Average of Daily Maximum vs Standard
Reference Method
3-Year Average Daily Maximum Concentration
Micrograms per Cubic Meter
200
180
160
140
120
100
80
60
40
20
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Year
Federal Standard
MED-Bremerton (QE)
POL-Lions Park (QF)

Particulate Matter (2.5 micrometers in diameter)

Health Effects and Significance

Particles smaller than 2.5 micrometers in diameter are called "fine" particulate, or $PM_{2.5}$. 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 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.[18,19,20, 21] Children, older adults, and people with some illnesses are more sensitive and more likely to develop heart or lung problems associated with $PM_{2.5}$.[22,23] 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.

Daily Federal Standard and Health Goal

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

On September 21, 2006 EPA adopted a new daily standard of 35 $\mu g/m^3$, a level much closer to our health goal of 25 $\mu g/m^3$.[24] One area (Tacoma) violates the new daily standard and many areas that are currently in compliance have $PM_{2.5}$ concentrations that are close to the new daily standard.

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

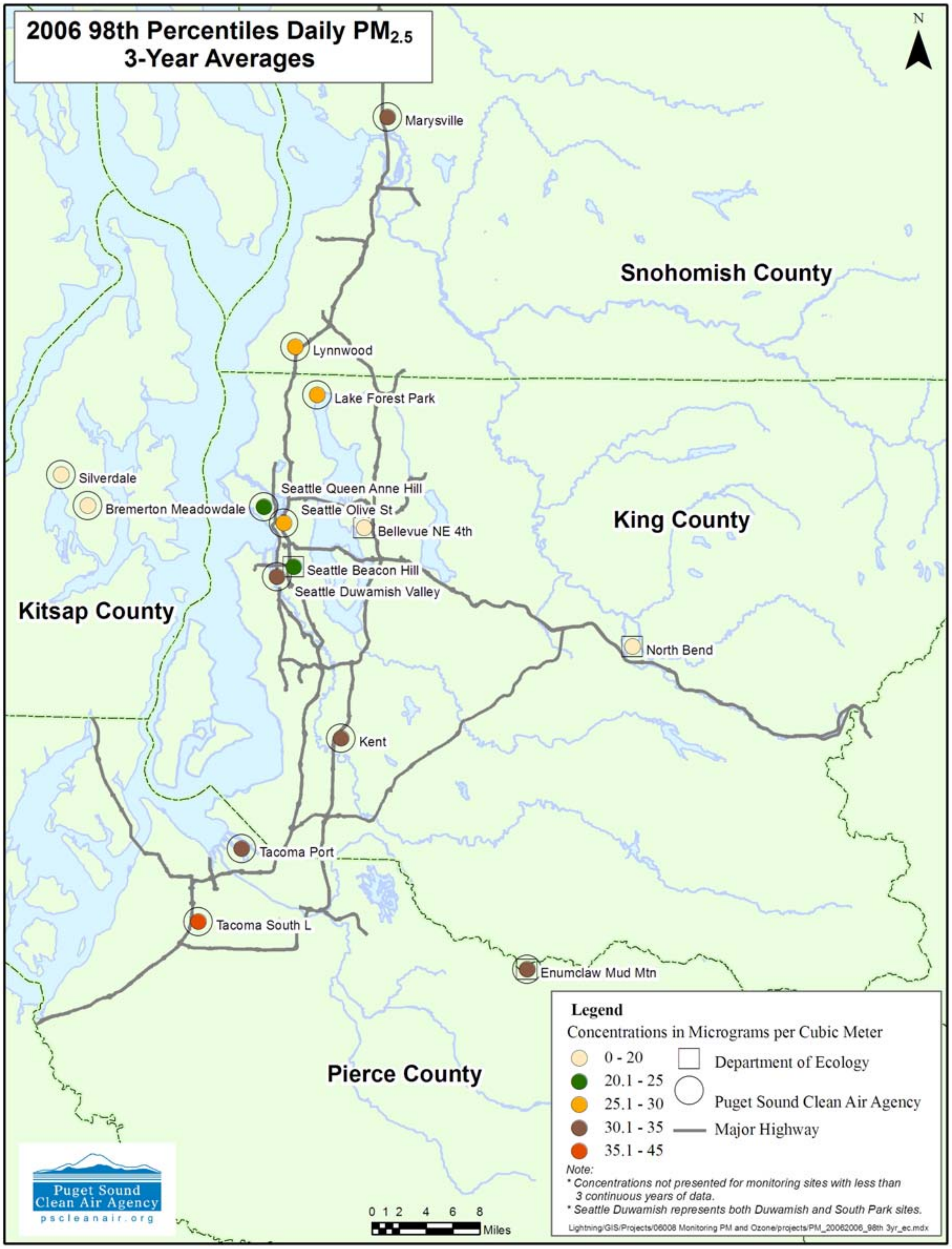
[18] **Pope et al. Lung Cancer, Cardiopulmonary Mortality, and Long–Term Exposure to Fine Particulate Air Pollution. *Journal of the American Medical Association*. 287: 1132-1141. March 6, 2002.**
[19] **Gauderman et al. The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age. *The New England Journal of Medicine.* Volume 351: 1057–1067. Number 11. September 9, 2004.**
[20] **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**
[21] **US Environmental Protection Agency (US EPA). Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. EPA-452/R-05-005. June 2005. http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20050630.pdf**
[22] **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.**
[23] **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.**
[24] **U.S. Environmental Protection Agency, Particulate Matter, PM Standard Revisions - 2006- http://www.epa.gov/particles/actions.html**

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

Standard or Goal	Level ($\mu g/m^3$)	Form
Old Daily Federal Standard	65	3-year average of 98^{th} percentile
New Daily Federal Standard	35	3-year average of 98^{th} percentile
Local Daily Health Goal	25	Never to be exceeded

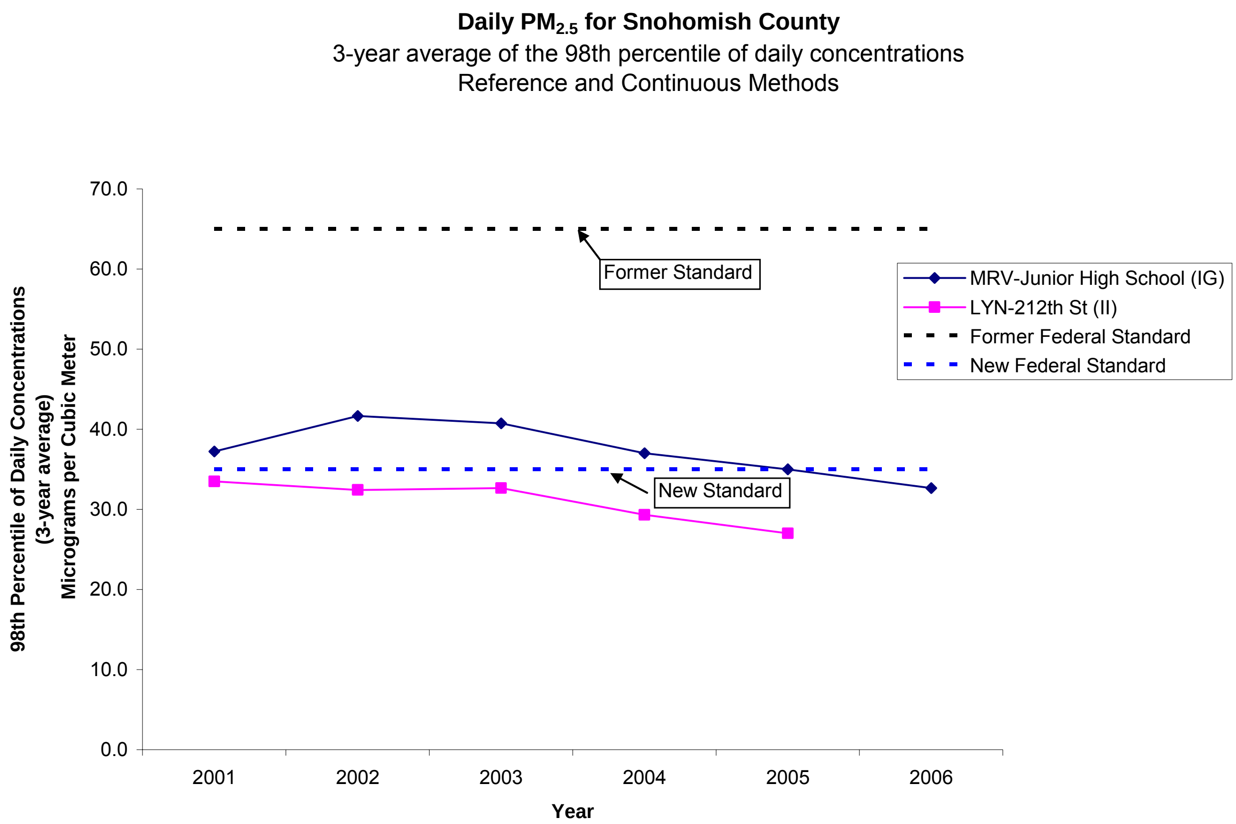
Map 2 shows the 98^{th} percentile of daily $PM_{2.5}$ concentrations. The map only includes sites with three years of monitoring data from 2004 to 2006. Map 2 shows that the Tacoma South L Site, located at the south end of Tacoma, violates the new federal standard of 35 $\mu g/m^3$. Marysville, Seattle Duwamish Valley, Port of Tacoma, and Kent are in the next highest range of concentration between 30-35 $\mu g/m^3$.

Map 2: The 98th Percentile Daily $PM_{2.5}$ Concentrations



Figures 14-17 show daily 98th percentile averages at each monitoring station in Snohomish, King, Pierce, and Kitsap counties against the current and former daily federal standards. The NAAQS 98th percentile is based on a 3-year average. Points on graphs represent averages of three consecutive years. For example, the value for 2006 is the average of the 98th percentile daily concentration for 2004, 2005, and 2006. Concentrations for Snohomish, King, and Pierce counties were measured with the FRM, except where noted.[25] Concentrations for Kitsap County were measured with continuous methods.[26] Both the new and old federal standards are shown with dashed lines. Figure 26 demonstrates that the South L Tacoma monitoring site in Pierce County violates EPA's new standard.

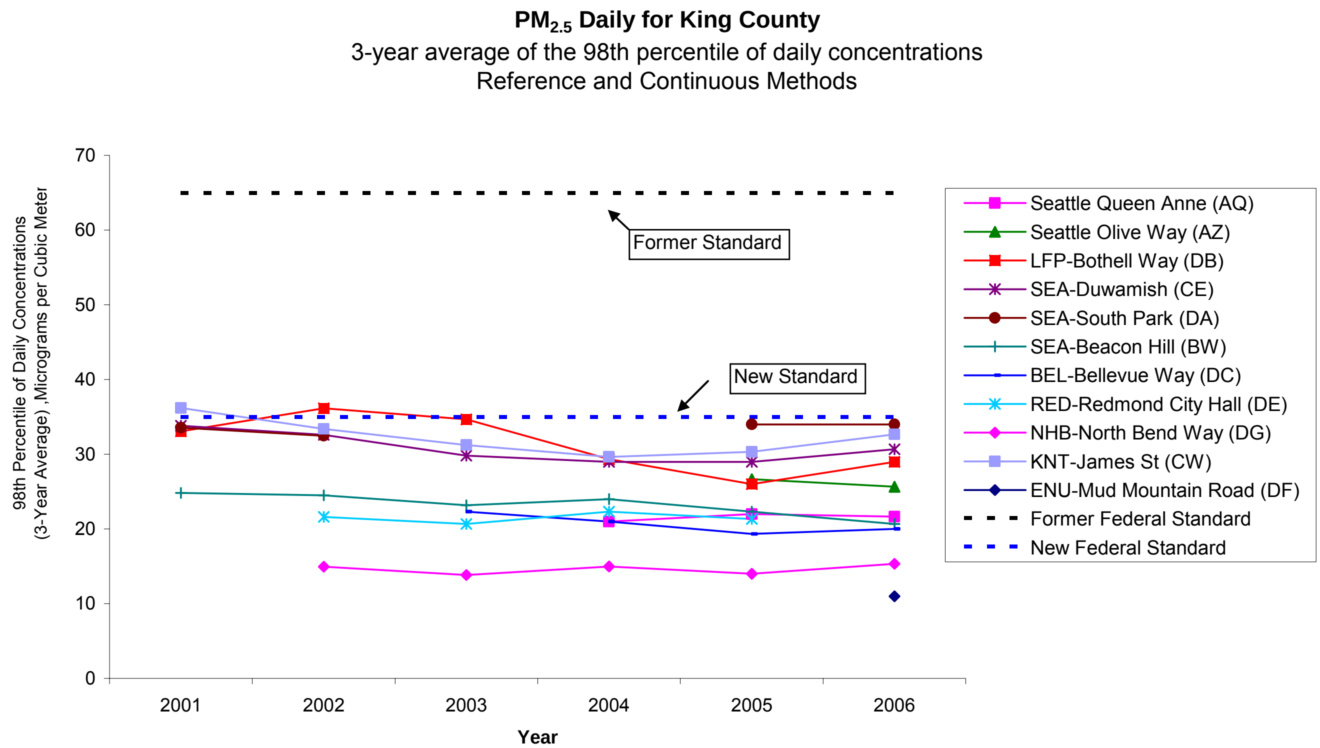
Figure 14:



Note: Marysville data are FRM from 1999-2006. Lynnwood (II) data are FRM (except 2004) from 2000-2006. 2004 value for Lynnwood (II) was measured with a nephelometer.

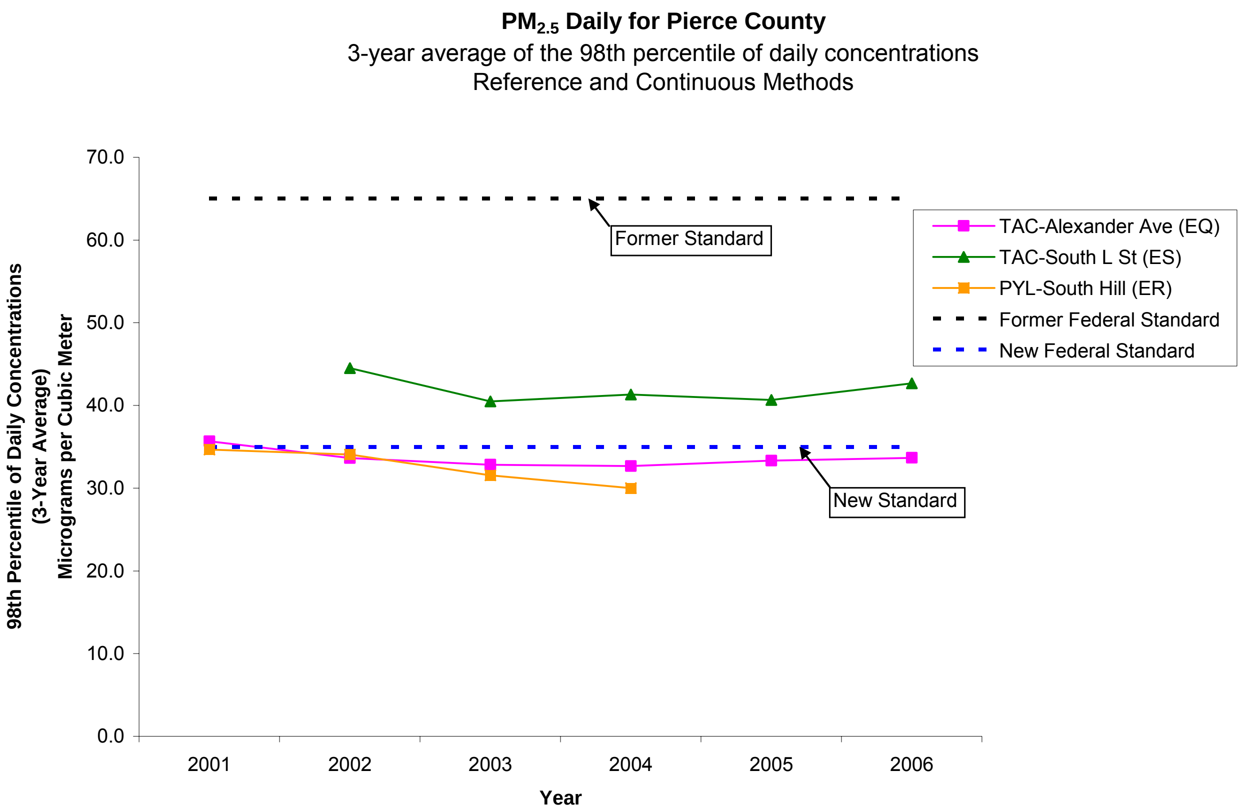
[25] Where possible, continuous method data are compared to the reference method values and calculations are made to determine the degree of difference from the reference method. The differences are then applied to the current continuous values in an attempt to make them "FRM-like."
[26] Continuous concentrations in Kitsap are not adjusted to make them "FRM-like", as there is no site-specific FRM data at the Meadowdale and Silverdale monitoring sites.

Figure 15:



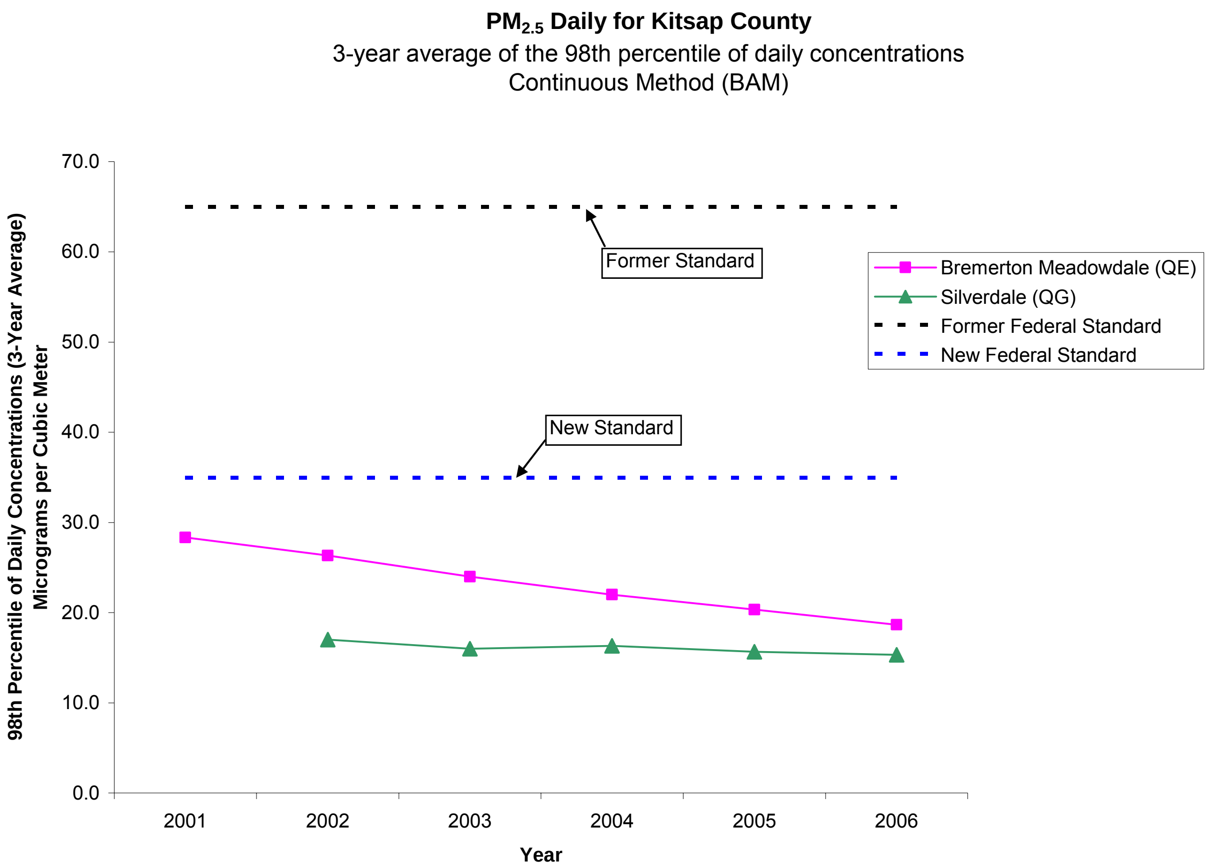
Note: Duwamish (CE), Beacon Hill (BW), and LFP (DB) data are FRM from 1999 - 2006. South Park (DA) data are FRM from 1999-2002, (3 yr avg 2004-06 was FRM in 2004, neph in 2005, 2006. Bellevue Way (DC) data are FRM from 2001-2004, neph 2005-06. Redmond (DE) data are FRM from 2000-2002, neph from 2003-2005. Queen Anne (AQ) data are neph from 2002-2006. Olive Way (AZ) data are neph from 2003-2006. North Bend (DG) data are FRM from 2000-2004, neph in 2005 and 2006. Kent (CW) data are FRM from 1999-2004, neph in 2005-2006.

Figure 16:



Note: All South L data are FRM from 2000- 2006. Alexander Avenue data are FRM from 1999- 2002 and nephelometer from 2003-2006. South Hill data are FRM from 1999-2002 and nephelemeter from 2003-2004; incomplete nephelometer data was collected from South Hill in 2005.

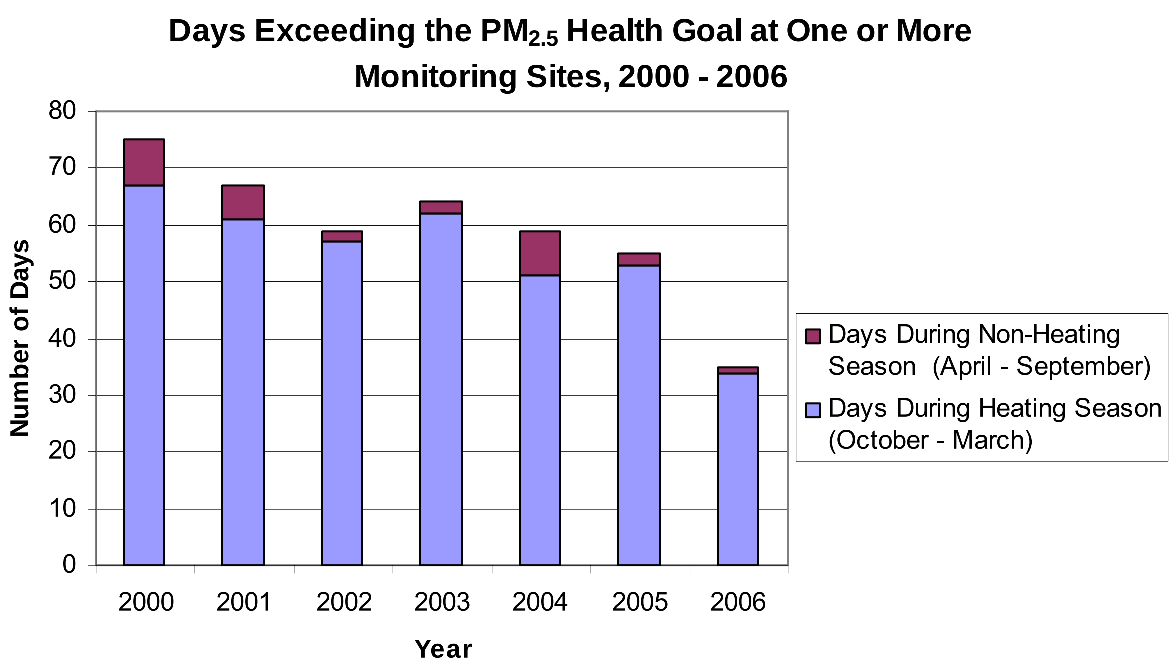
Figure 17:


PM2.5 Daily for Kitsap County
3-year average of the 98th percentile of daily concentrations
Continuous Method (BAM)
98th Percentile of Daily Concentrations (3-Year Average)
Micrograms per Cubic Meter
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Former Standard
New Standard
Bremerton Meadowdale (QE)
Silverdale (QG)
Former Federal Standard
New Federal Standard
2001
2002
2003
2004
2005
2006
Year

As described in the *Air Quality Standards and Health Goals* section, the Agency also has a daily fine particulate health goal. Many of the monitoring sites in 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. This health goal is intended to never be exceeded (unlike the federal standard that's based on the 98^{th} percentile of a 3-year average).

Figure 18 shows the number of days the health goal is exceeded annually in the region, from 2000 to 2006.[27] The shading demonstrates that our highest fine particulate days overwhelmingly take place during the winter wood heating months. While the graph indicates that we may be making slow progress reducing the number of days we exceed the health goal, it also shows that we're falling short of our goal of having zero days exceeding the health goal, especially during winter months.

Figure 18:



Includes data from all sites (in Snohomish, King, Pierce, and Kitsap counties), both daily and continuous methods. Darrington site not included, because there is less than 3 years of data.

Annual Federal Standard

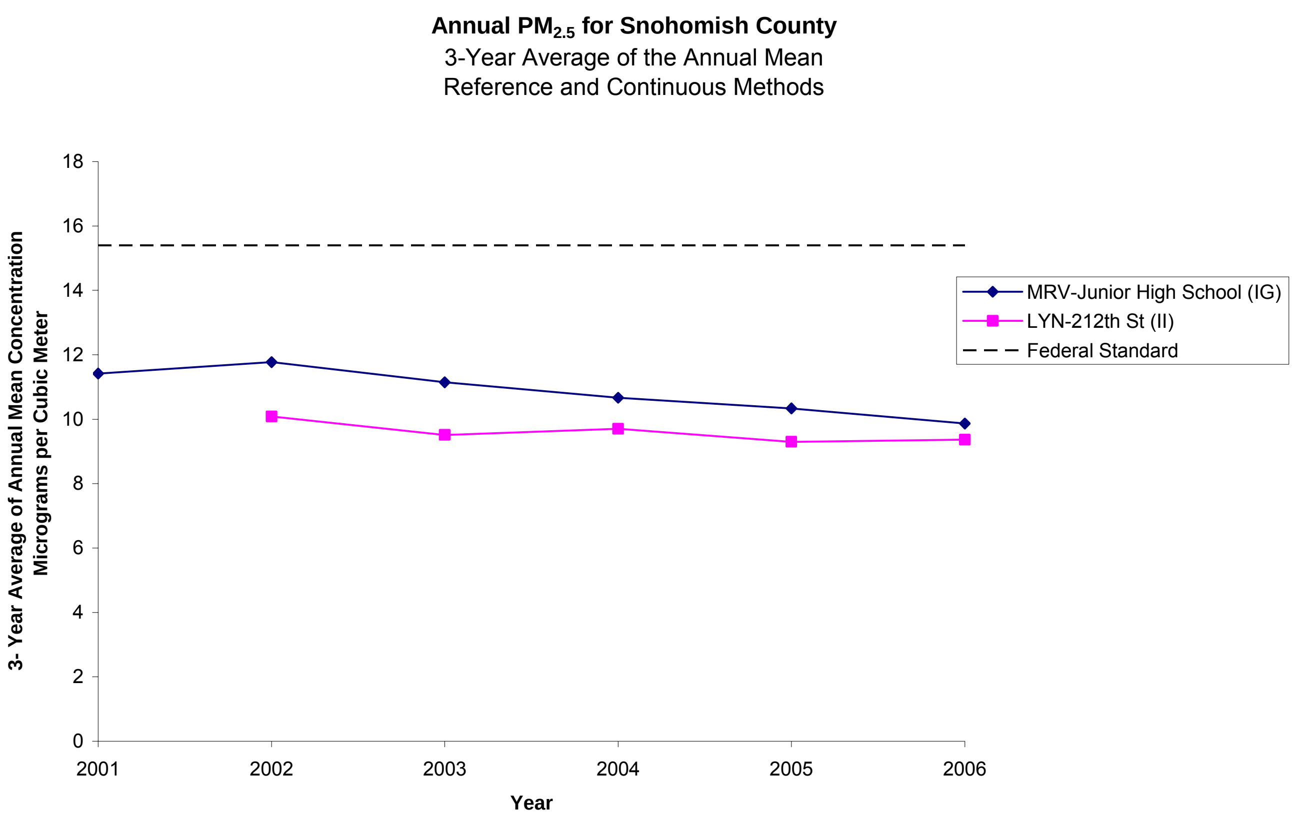
The Puget Sound airshed has been in compliance with the annual $PM_{2.5}$ standard since the EPA promulgated it in 1997. The graphs on Figures 19 through 22 show annual averages at each monitoring station for Snohomish, King, Pierce, and Kitsap counties and the federal annual standard. These graphs

[27] **The graph includes all $PM_{2.5}$ continuous and federal reference monitoring sites, but does not include the Darrington (JO) site, as it has not been operating for three full years.**

show data from both federal reference method (FRM) and continuous method monitors. The federal standard is based on a 3-year average, so each value on the graph is actually an average for three consecutive years. For example, the value for 2006 is the average of the annual averages for 2004, 2005, and 2006.

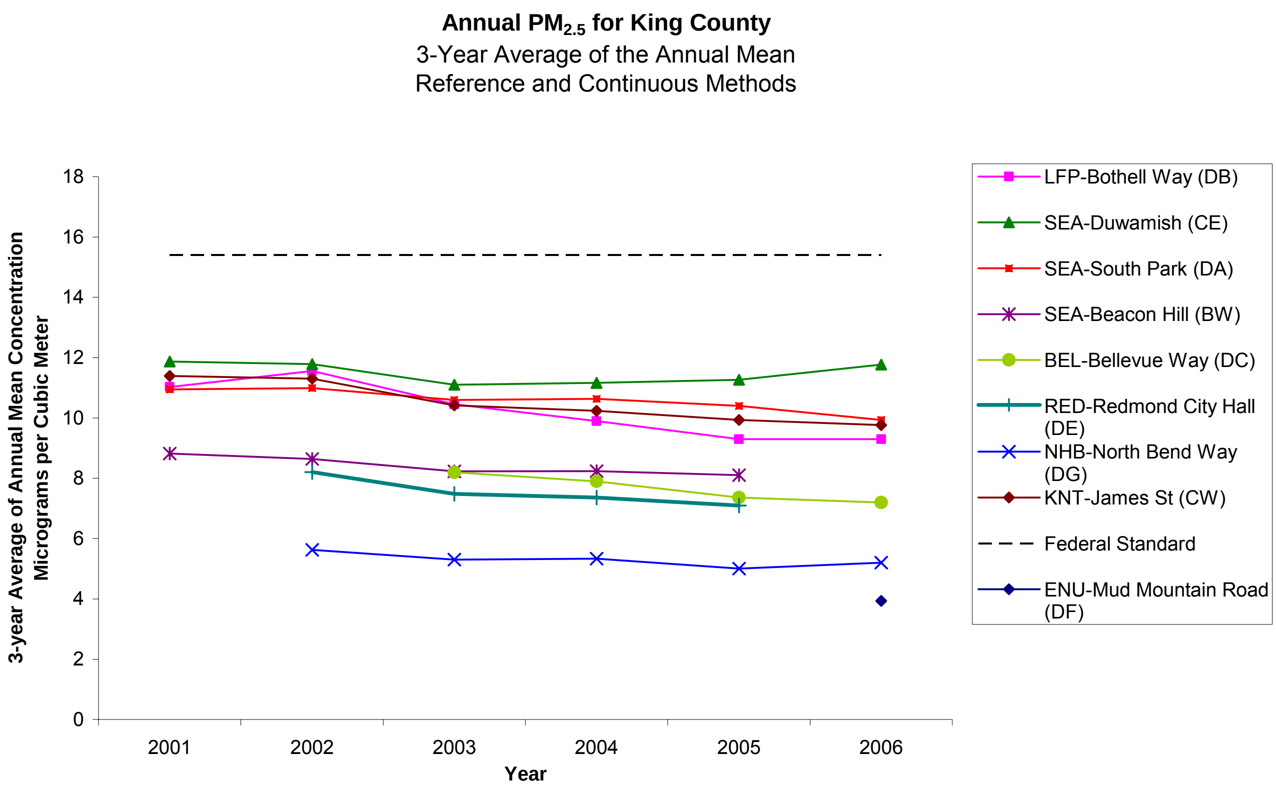
The Agency's Health Committee did not recommend an annual $PM_{2.5}$ health goal lower than the federal annual standard (15 $\mu g/m^3$).

Figure 19:



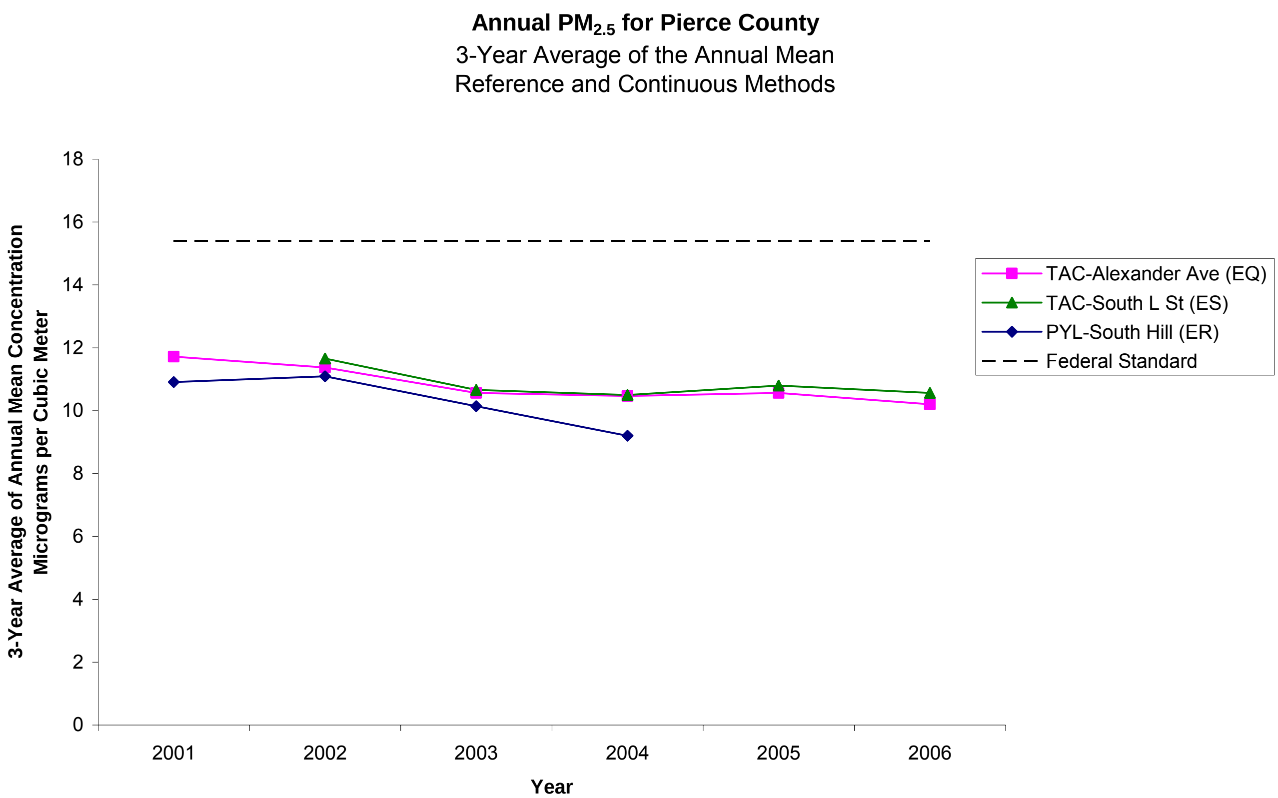
Note: Marysville (IG) data are FRM from 1999-2006. Lynnwood (II) data are FRM except 2004. The 2004 value for Lynnwood was measured with a nephelometer.

Figure 20:



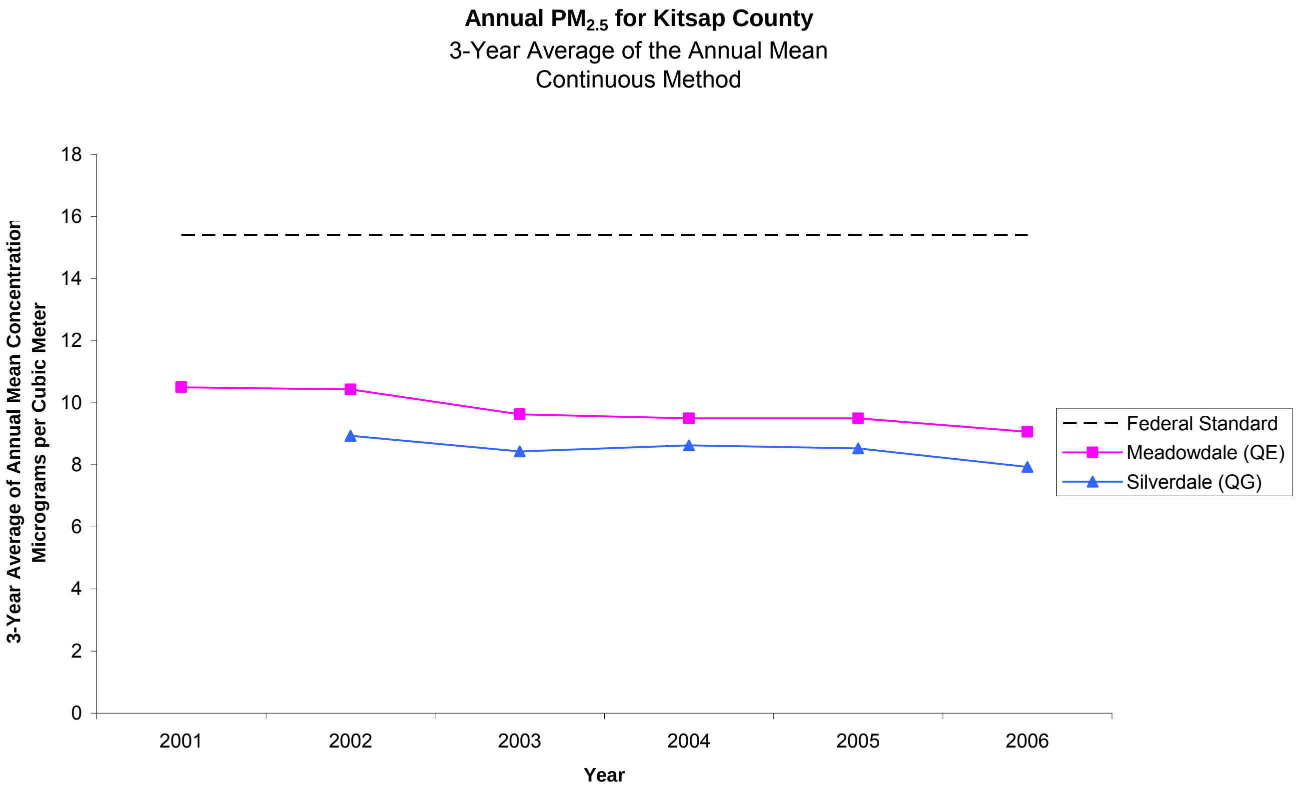
Note: Lake Forest Park (DB), Beacon Hill (BW), and Duwamish (CE) data are FRM from 1999-2006. South Park (DA) data are FRM from 1999-2002, nephelometer from 2003-2006. Redmond (DE) data are FRM from 2000-2002, nephelometer from 2003-2005. Bellevue Way (DC) data are FRM from 2001-2003, nephelometer from 2004-2006. Kent (CW) data are FRM from 1999-2003, nephelometer 2004-2006. North Bend (DG) data are FRM 2000-2004, nephelometer in 2005. Enumclaw data are FRM in 2004, nephelometer in 2005-2006.

Figure 21:



Note: South L St. (ES) data are FRM. South Hill (ER) data are FRM from 1999-2002. South Hill (ER) data 2003 and 2004 was measured with a nephelometer. Alexander Ave (EQ) data are FRM from 1999-2002. Alexander Ave (EQ) data 2003-2006 was measured with a nephelometer.

Figure 22:



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

Continuous Data and Seasonal Variability

Figures 23 through 35 show daily $PM_{2.5}$ concentrations measured at 13 sites during 2006 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 13 monitoring sites characterize different areas and these differences are reflected in the continuous data. The five 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 Darrington, Marysville, Tacoma South L, Lake Forest Park, and Lynnwood. These sites register AQI levels in the "unhealthy for sensitive groups" and "unhealthy" range occasionally in the winter months. The summer peaks at these monitoring sites (as well as others) dramatically reflect the short-term effect of 4th of July fireworks on local air quality.

The Darrington monitor, with concentrations shown on Figure 23, does not have 3 years of data, so is not represented on the Figure 14 Snohomish County graph. This monitor began as a special monitoring project, and the Agency is committed to a longterm monitoring presence there.

The Seattle Duwamish and Tacoma Port sites are industrial, with some wood smoke influence in winter months. The Kent site is both residential and commercial. These three sites typically register AQI levels in the "unhealthy for sensitive groups" range in winter months. The Tacoma Port area site and Kent site both experienced elevated levels in December following the power outage. The Duwamish monitoring site lost power/data during this time period, so it's not known what the concentrations were at this site post-windstorm.

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 therefore potentially less wood burning. The topography at the Bellevue site is also different than the Kent site as it is located at a higher elevation. Historically the seasonal graph of Bellevue reflects these differences, with very little seasonal variation and lower concentrations. During the power outage that resulted from the December 2006 storm, this site showed concentrations higher than in previous years, almost reaching the "unhealthy for sensitive groups" level.[28]

Four monitoring sites are presented that typically exhibit low concentrations and low seasonal variability. These areas have lower housing density and likely less wood smoke impact due to fewer sources. The four sites include: Puyallup, Bremerton Meadowdale, North Bend, and Silverdale.[29] In December 2006, many of these sites recorded elevated concentrations into the "moderate" and "unhealthy for sensitive groups" categories. Most of these elevated concentrations occurred during the power outage following the December wind storm.

[28]The 305 Bellevue Way monitoring site is operated by Ecology and is included in this report due because the Puget Sound Clean Air Agency's Bellevue monitoring site was not in operation for the duration of 2006.
[29] The Puyallup monitoring site is often included with this group, but had only a partial year of continuous data in fall 2005.

Statistical summaries for $PM_{2.5}$ data (both FRM and continuous monitors) are shown in tables on pages A-7 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 2006 was 99 µg/m^3, measured by nephelometer at the Tacoma South L site on December 17. 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.

Figure 23:

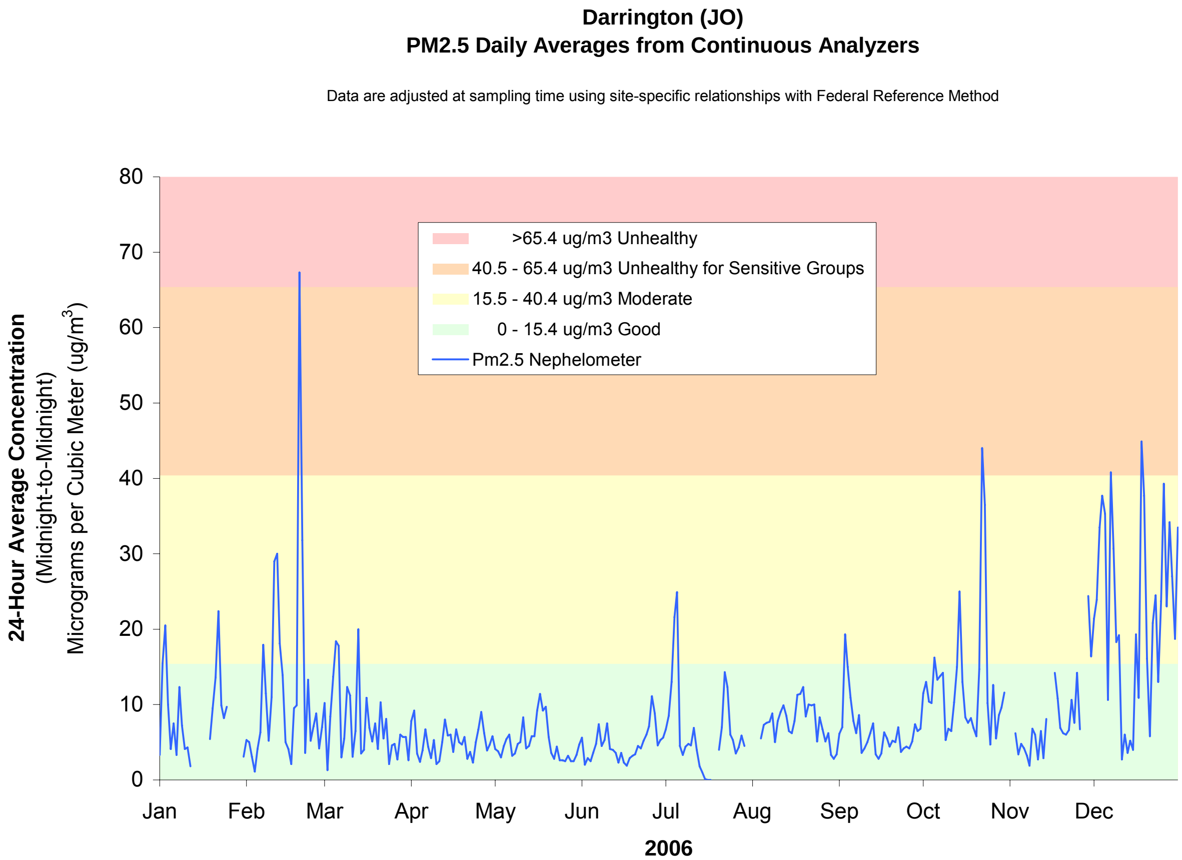


Figure 24:

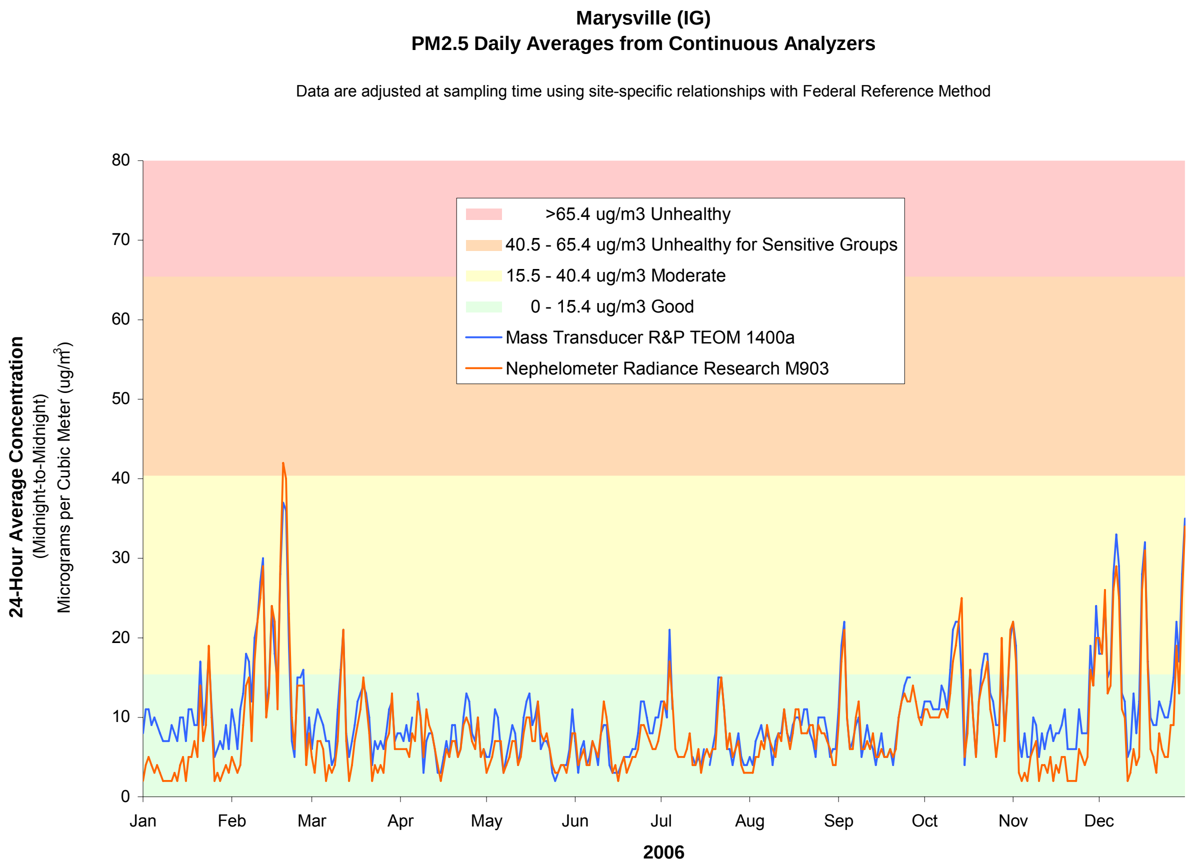

Marysville (IG)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 25:

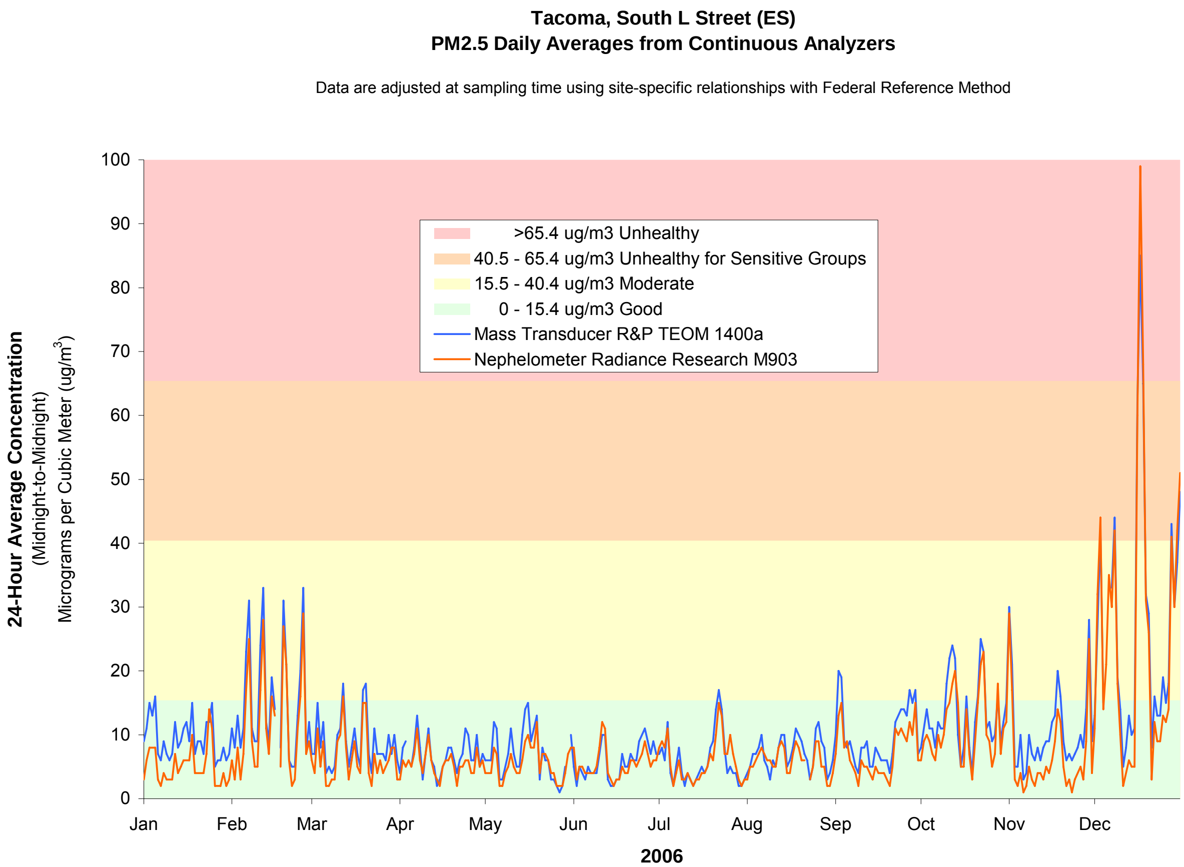
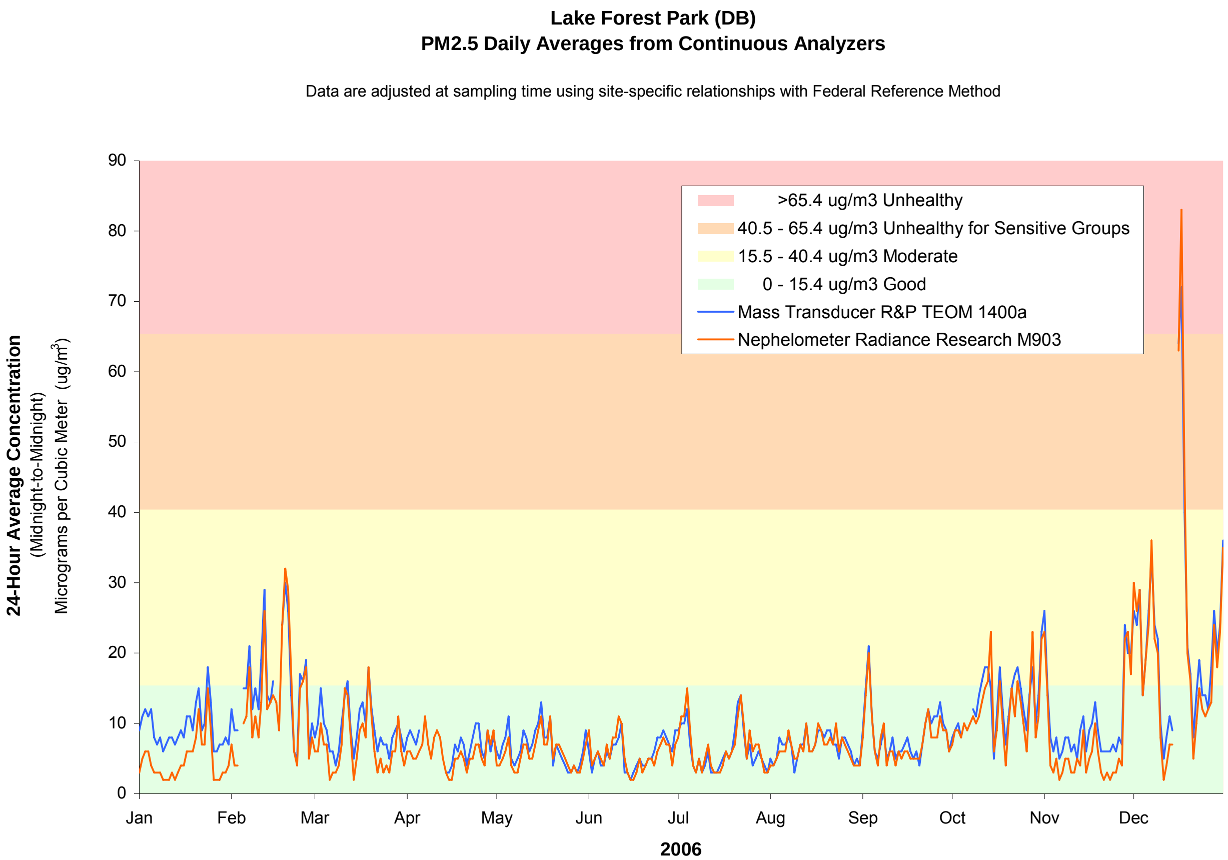
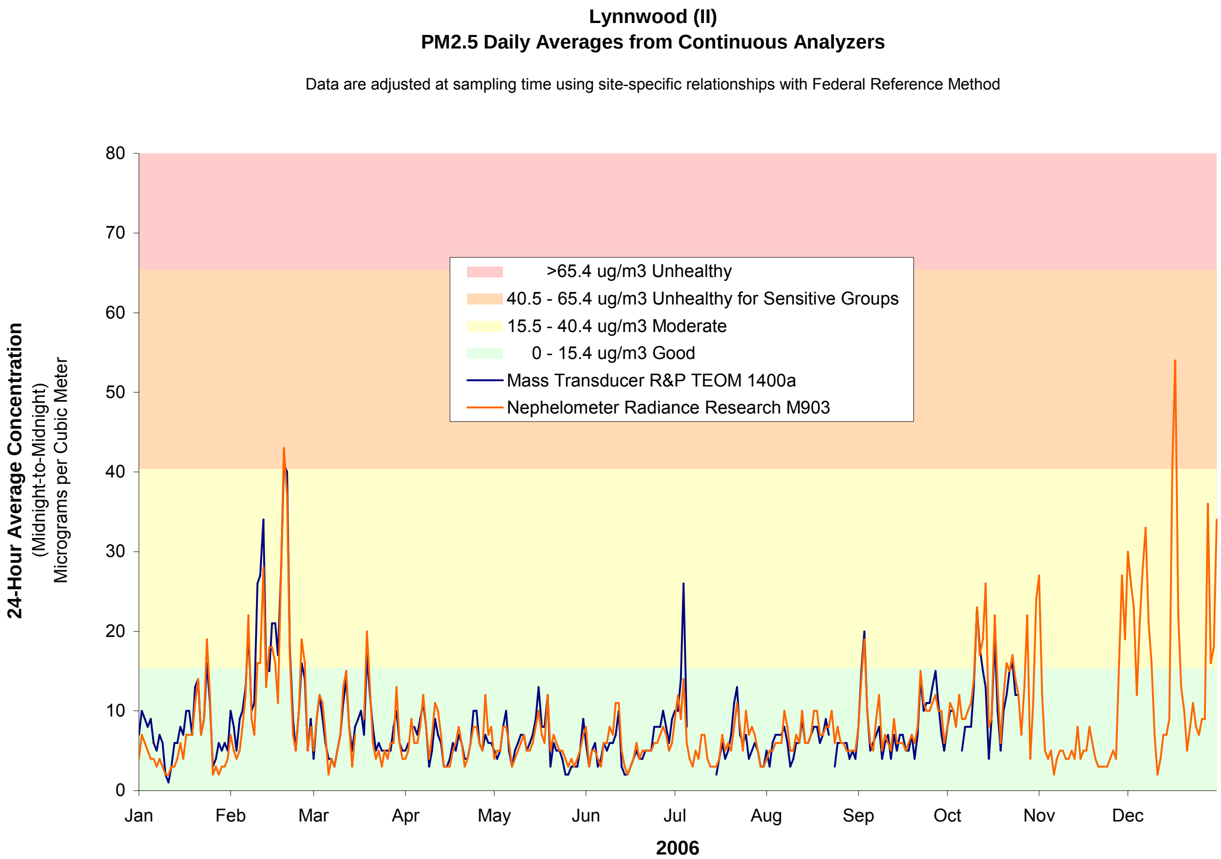

Tacoma, South L Street (ES)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 26:



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)
0
10
20
30
40
50
60
70
80
90
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 27:



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
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 28:

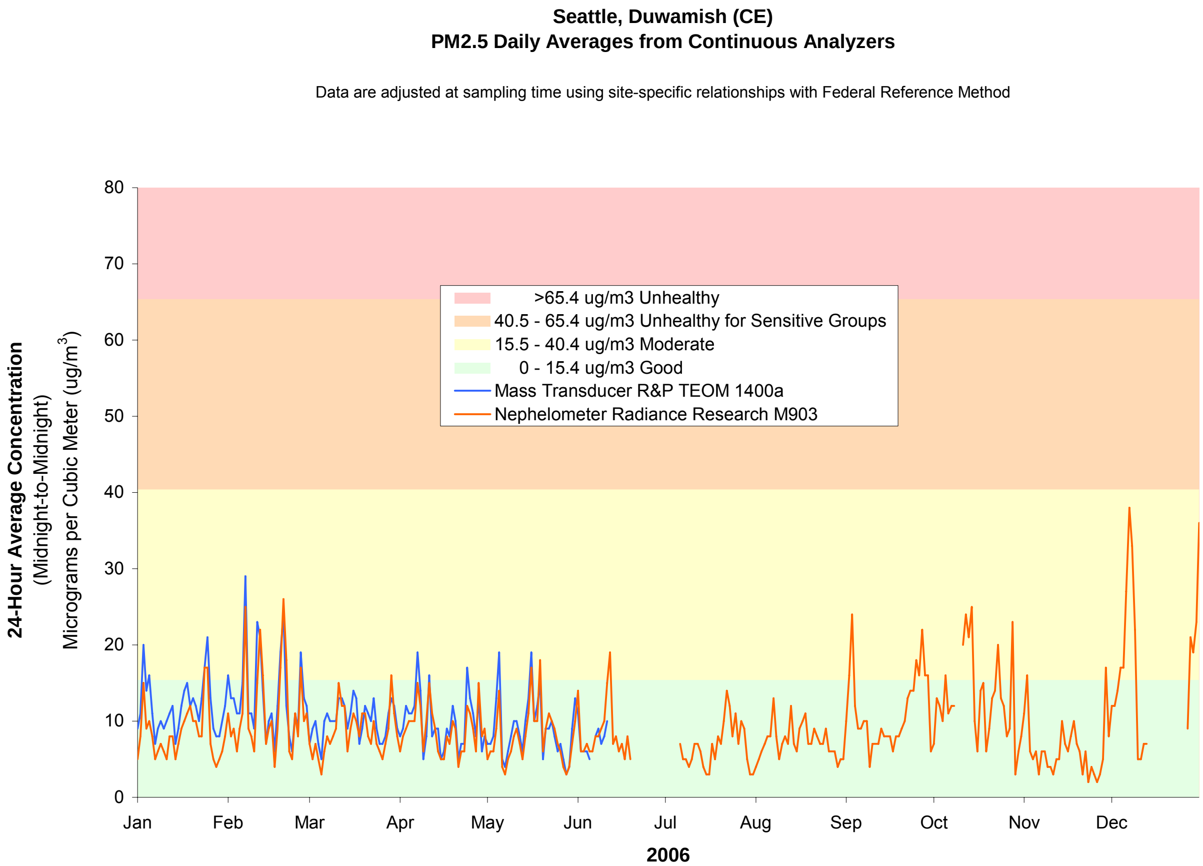

Seattle, Duwamish (CE)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 29:

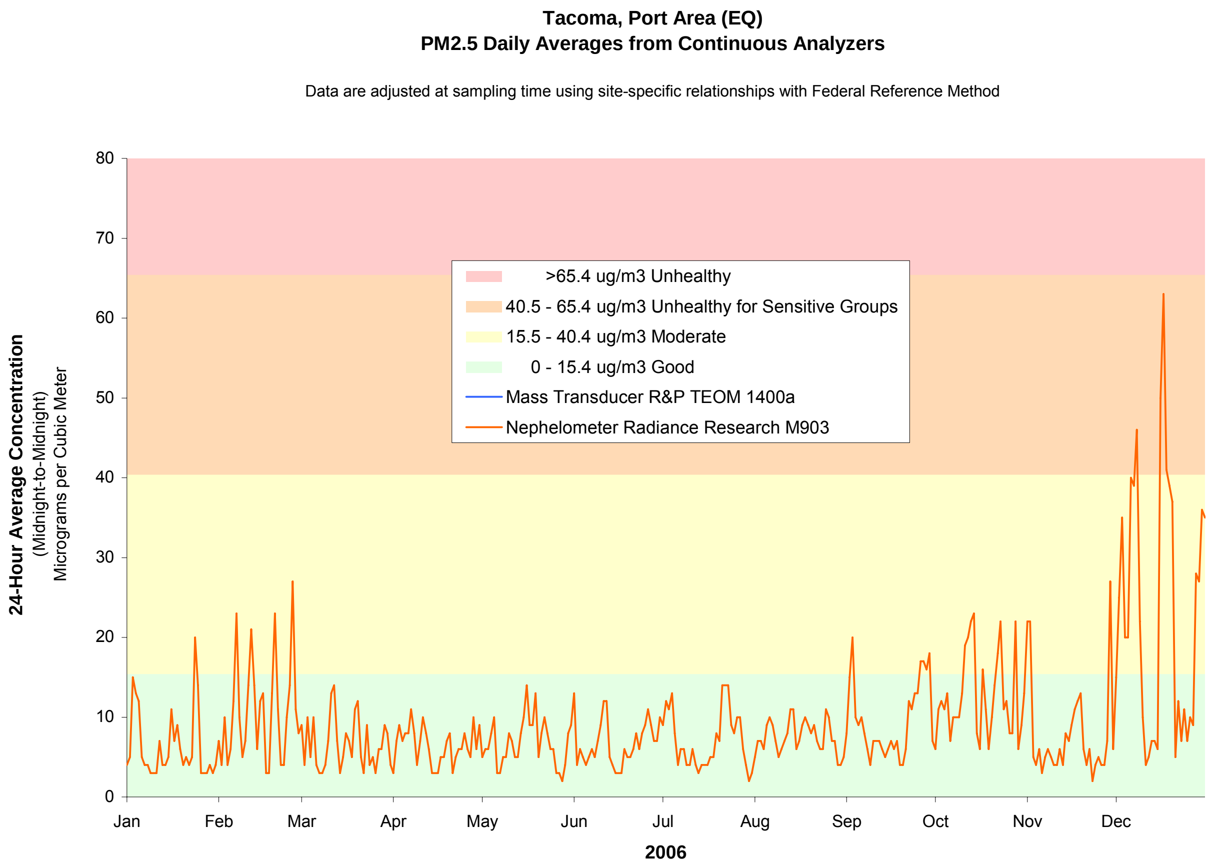

Tacoma, Port Area (EQ)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer 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
2006

Figure 30:

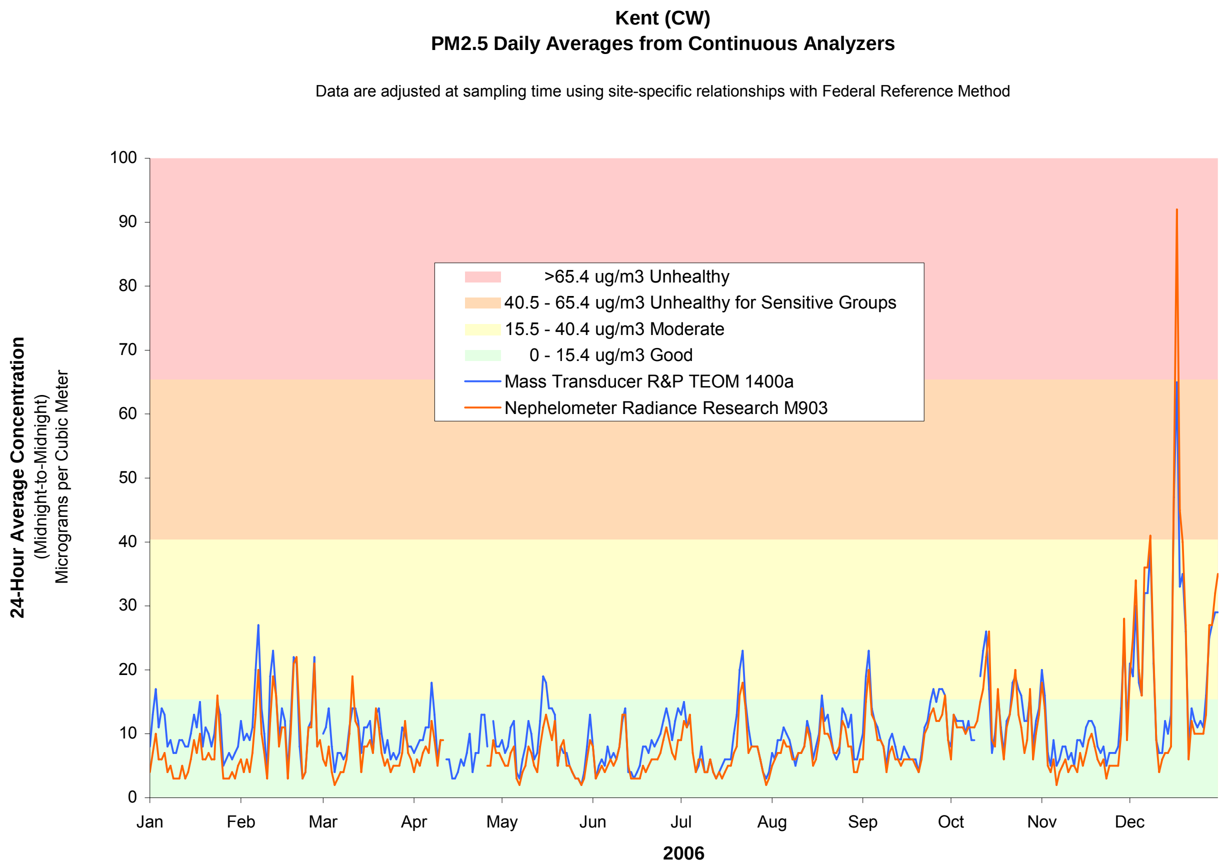

Kent (CW)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 31:

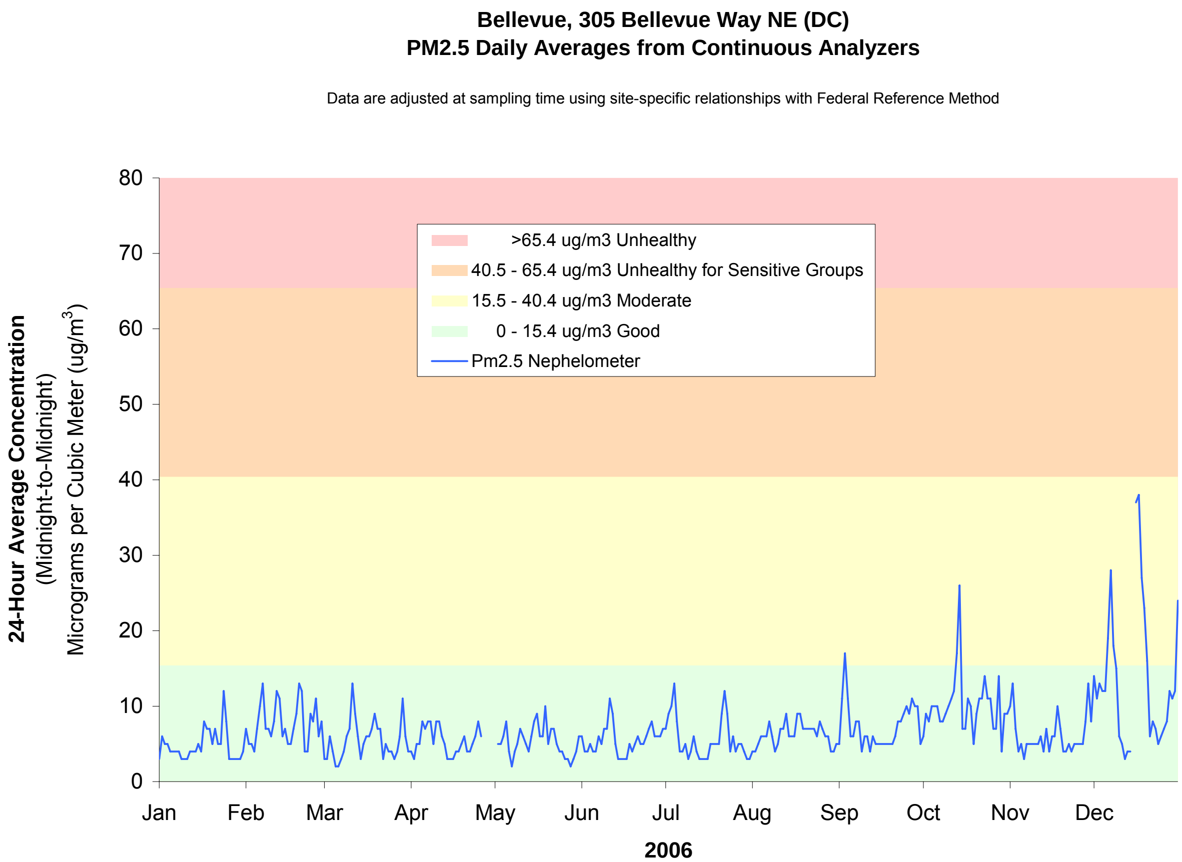

Bellevue, 305 Bellevue Way NE (DC)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Pm2.5 Nephelometer
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter (ug/m3)
0
10
20
30
40
50
60
70
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 32:

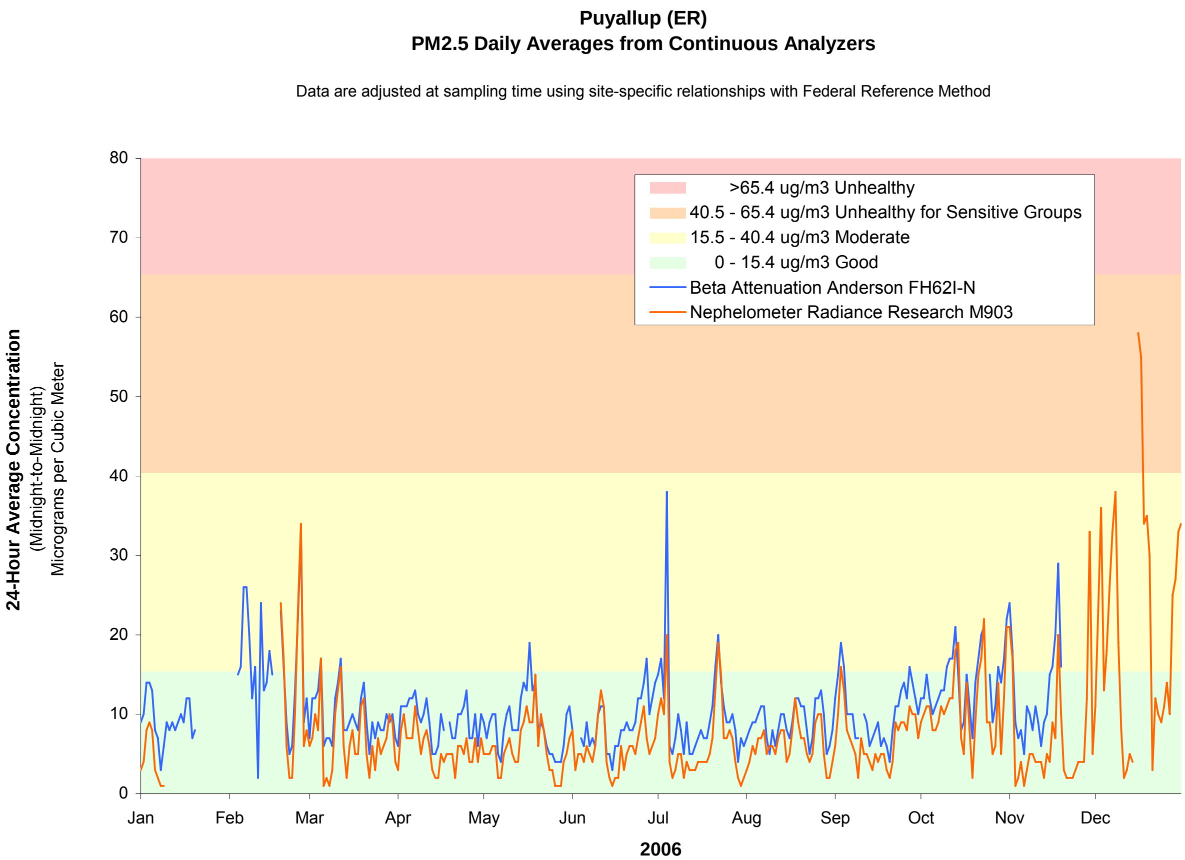

Puyallup (ER)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
80
70
60
50
40
30
20
10
0
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 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
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Figure 33:

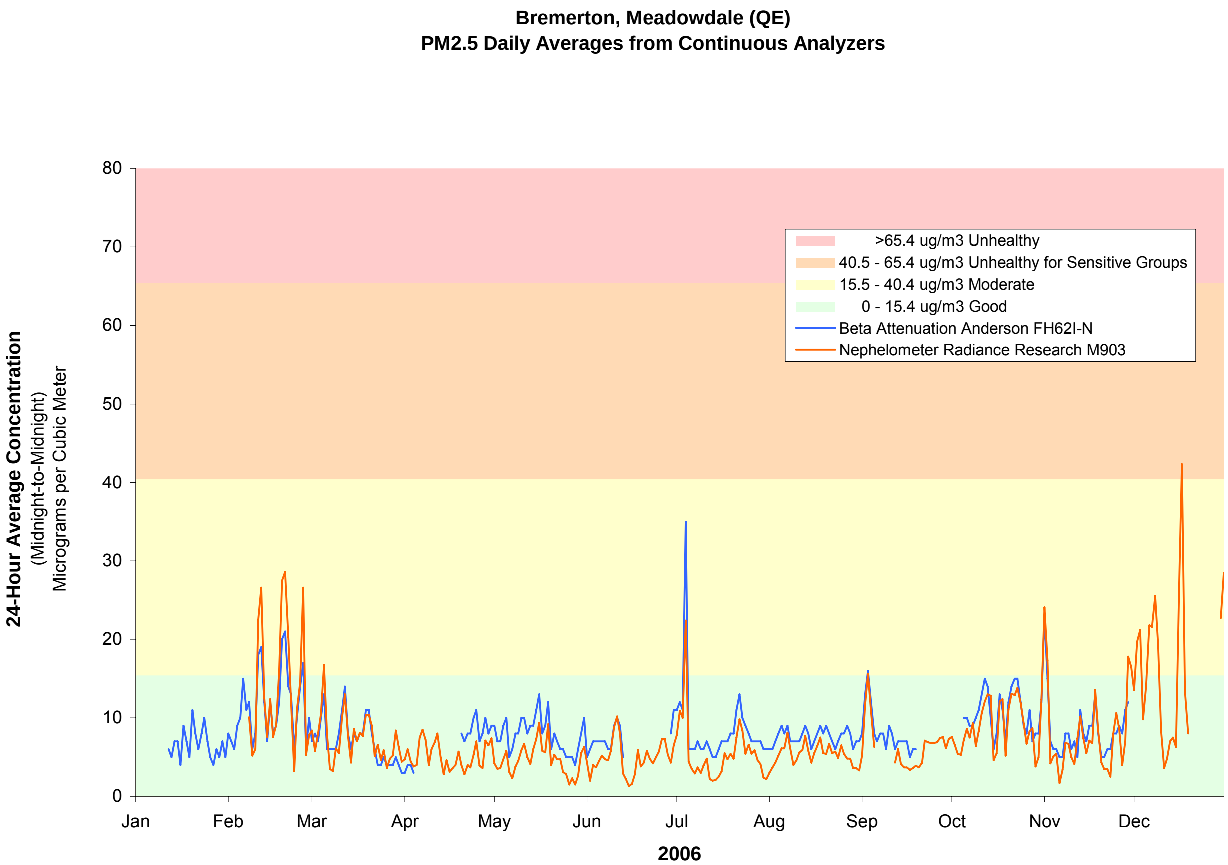

Bremerton, Meadowdale (QE)
PM2.5 Daily Averages from Continuous Analyzers
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Beta Attenuation Anderson FH62I-N
Nephelometer Radiance Research M903

Figure 34:

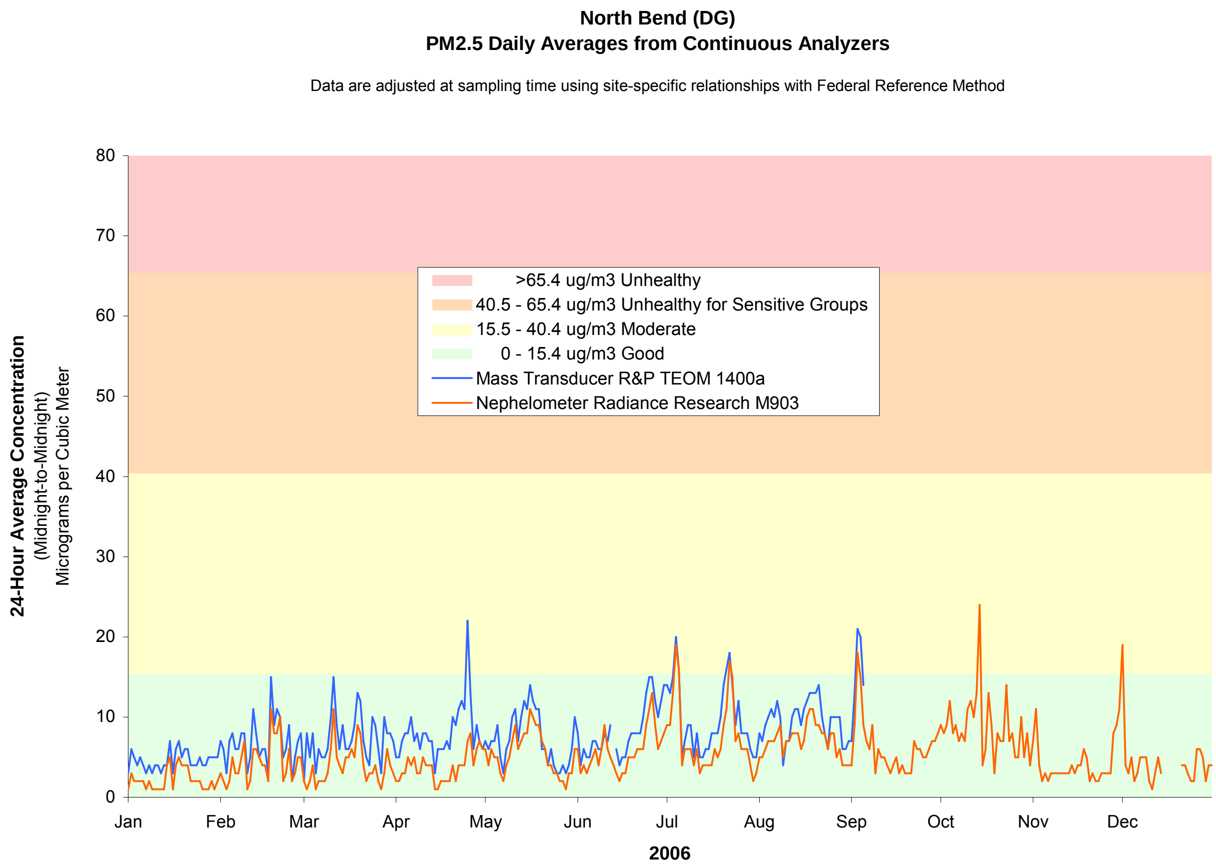
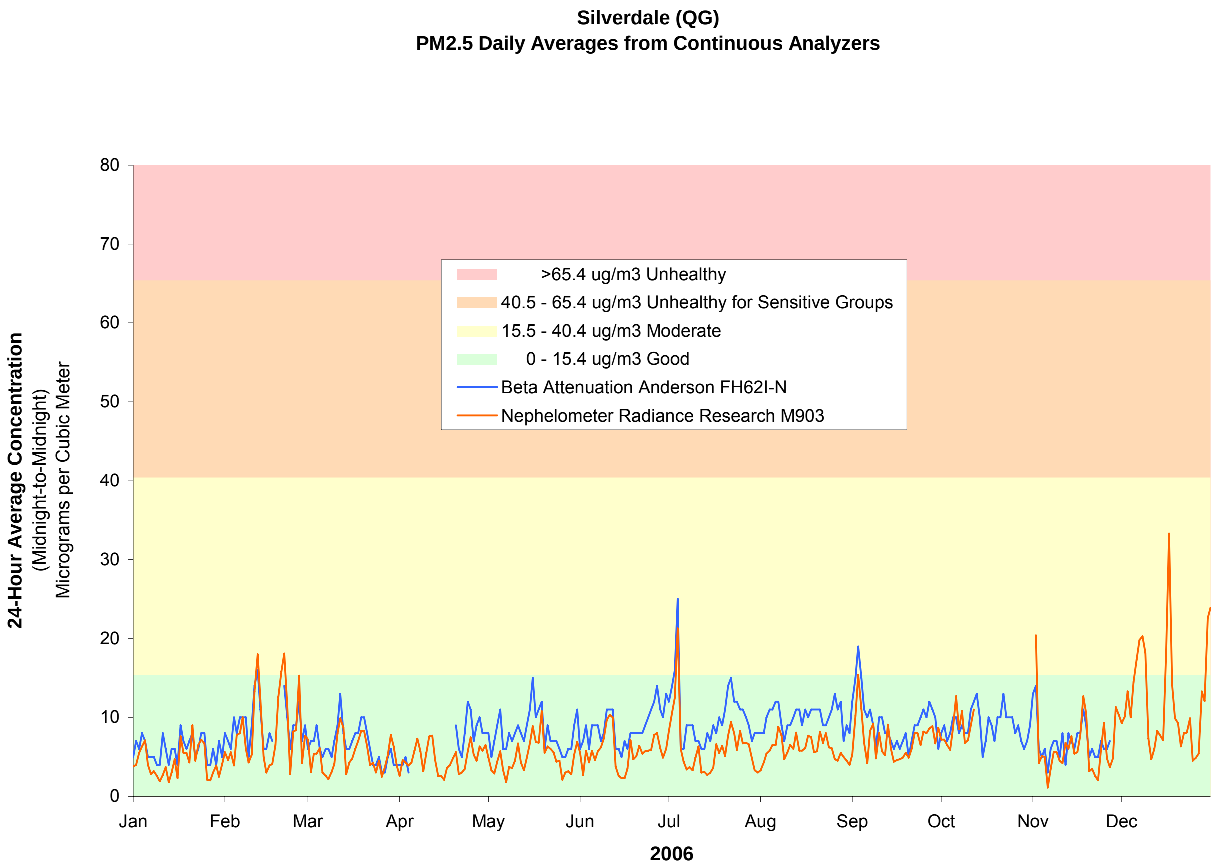

North Bend (DG)
PM2.5 Daily Averages from Continuous Analyzers
Data are adjusted at sampling time using site-specific relationships with Federal Reference Method
>65.4 ug/m3 Unhealthy
40.5 - 65.4 ug/m3 Unhealthy for Sensitive Groups
15.5 - 40.4 ug/m3 Moderate
0 - 15.4 ug/m3 Good
Mass Transducer R&P TEOM 1400a
Nephelometer Radiance Research M903
24-Hour Average Concentration
(Midnight-to-Midnight)
Micrograms per Cubic Meter
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

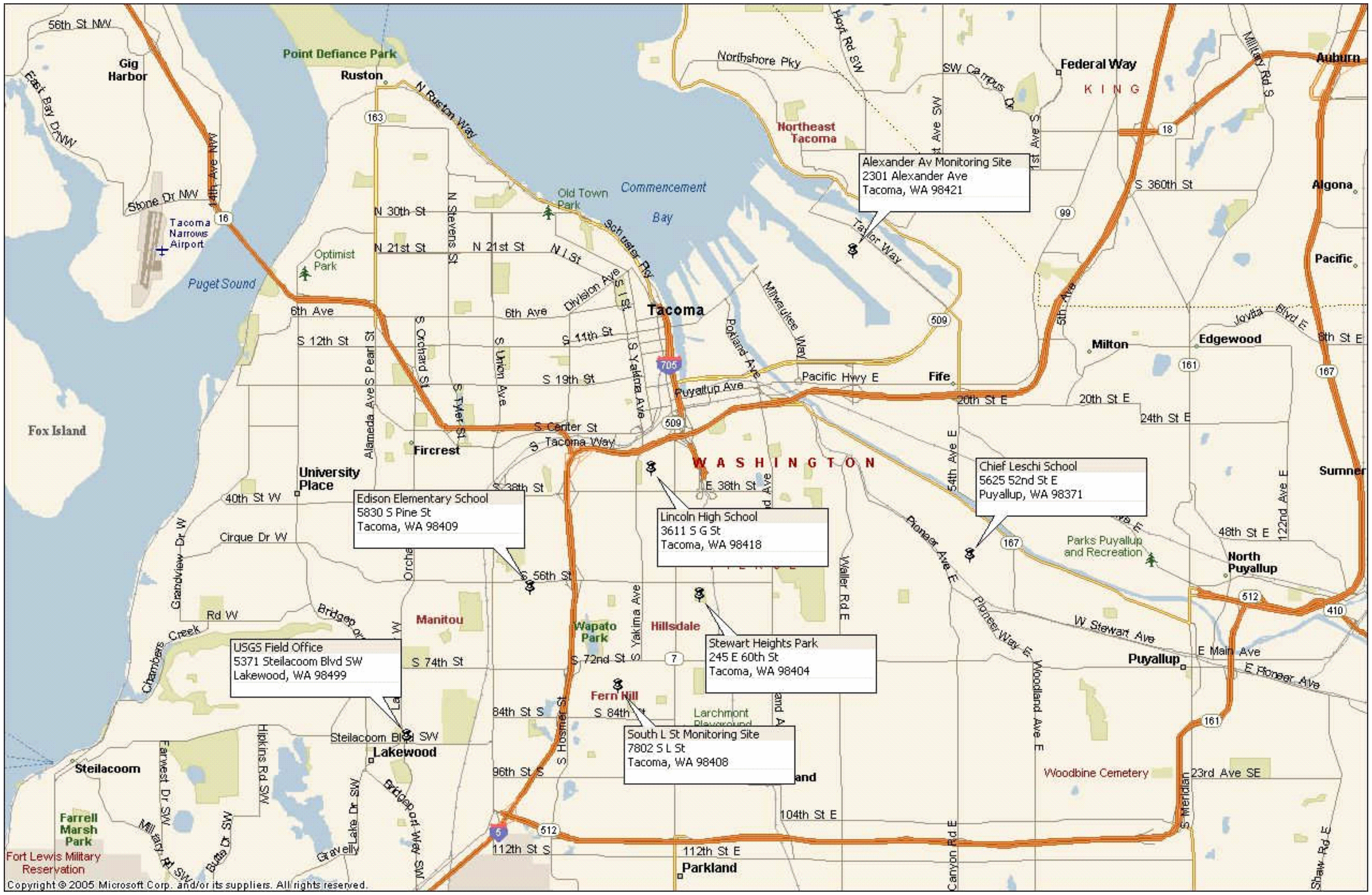
Figure 35:


Silverdale (QG)
PM2.5 Daily Averages from Continuous Analyzers
>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
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2006

Particulate Matter - $PM_{2.5}$ Special Monitoring Project

The Agency conducted one short-term special monitoring project in 2006 to improve our understanding of $PM_{2.5}$ concentrations in Tacoma. In anticipation that the South L Tacoma monitor site, located at the south end of Tacoma, would violate the new federal $PM_{2.5}$ standard, the Agency conducted a six month study of the South Tacoma area. For this study, the Agency deployed four temporary monitors around the South L Tacoma site. These temporary monitors were located at Edmonds Elementary School, Lincoln High School, USGS Field Office, and Stewart Heights Park as seen on Map 3. The study period was from September 1, 2006 to March 1, 2007. The study was conducted during this time period because elevated concentrations occur during the winter heating season.

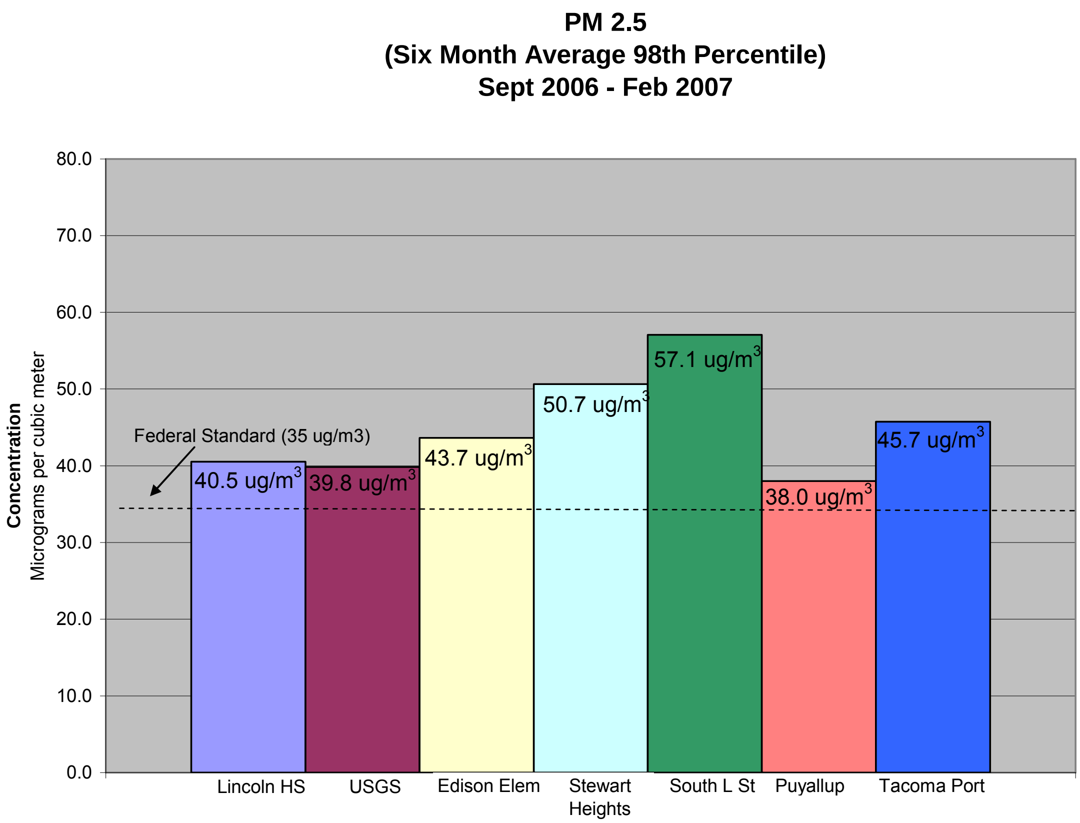
Map 3: Location of Monitors in the 2006 Special Monitoring Project



The four temporary monitors were used to help determine the extent of elevated PM2.5 concentrations in the south end area of Tacoma. The concentration results from this study include the December windstorm and the resulting power outage and period of elevated concentrations. The results, shown in Figure 36, indicate that the South L monitor measured the highest concentrations in the area. Results also informed the Agency that surrounding areas also have elevated $PM_{2.5}$ concentrations in winter months, and will inform an emissions reduction strategy broader than just the neighborhood surrounding the South L monitor.

Figure 36:

Daily Concentrations for South Tacoma Monitoring Project



While a direct comparison can not be made to the 35 $\mu g/m^3$ daily federal standard because it is based on 3 years of monitoring (not just 6 months), concentrations at all 4 temporary sites exceeded 35 $\mu g/m^3$. A direct comparison to the Agency's health goal can be made since it is never to be exceeded. All monitors showed levels that clearly exceeded the 25 $\mu g/m^3$ health goal. This temporary monitoring study provided information that will be useful as the Agency works with partners to designate a Tacoma non-attainment area. In addition, these data will help our agency to identify the most appropriate emission reduction strategies to bring the Tacoma area into attainment status for $PM_{2.5}$

Particular Matter - $PM_{2.5}$ Speciation and Aethalometers

The methods described above show the total amount of fine particulate matter, but do not tell us anything about its chemical composition. Although there are no regulatory requirements to go beyond measuring the total mass of fine particulate matter, it's important to know the chemical makeup of particulate matter in addition to its mass. The makeup of fine particulate matter can help the Agency determine potential health risks, as particulate matter from different sources have varying toxicities. Those from combustion sources, and specifically diesel combustion engines, are especially toxic. Information on fine particulate composition helped guide the Agency's commitment to reduce wood smoke and diesel particulate emissions.[30]

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

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

Speciation Monitoring and Source Apportionment

Speciation monitoring involves determining the individual fractions of metals and organics in fine particulate matter on different types of filters. These filters are weighed and analyzed to determine the makeup of fine particulate at that site. Over 60 analytes are measured at speciation monitors in the area. Analytes and annual average concentrations are shown on pages A-10 and A-11 of the Appendix. These data can then be 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 from monitoring sites to estimate how much each source is contributing at that site.

The Washington Department of Ecology conducts speciation monitoring at four monitoring sites in the Puget Sound region. These sites include:

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

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

- Seattle Olive Street – urban downtown commercial and residential area, located immediately adjacent to Interstate 5, heavy mobile source impacts (speciation samples collected every sixth day)

Speciation data from the Beacon Hill site are incomplete for 2006 due to the relocation of the site.

The Tacoma South L site is relatively new, and uses the speciation monitor that was moved from its previous location at Lake Forest Park. The Department of Ecology will be relocating the Seattle Olive Street and Duwamish monitors in 2007 and 2008, respectively to other parts of Washington State facing potential $PM_{2.5}$ non-attainment.

The Agency and the University of Washington have historically used this data to conduct source apportionment modeling. This modeling was especially useful to estimate diesel particulate matter and wood smoke particulate concentrations at Beacon Hill.[31]

Several researchers have used speciation data from these sites to better understand air quality. In addition to using speciation data for specific analytes or source apportionment modeling, the Agency uses it to qualitatively look at the makeup of fine particulate at our monitoring sites. Using a mass reconstruction equation to simplify analytes into five broad categories, we can look at seasonal differences and compare sites.[32, 33]

Figures 37-39 show simplified, major constituents of speciation data from the four speciation sites. Note that the width of each color in the graph represents the amount of matter present in the sample. For example, in all three graphs there is a larger amount of organic carbon present than nitrate.

Major constituents of fine particulate matter in our region include:

- Organic and Elemental Carbon – These are largely from combustion sources.
- Sulfate and Nitrates – These are formed in the atmosphere from sulfur and nitrogen oxides, SO_X, and NO_X. The largest sources of SO_X and NO_X in our area are on-road and non-road mobile sources (gasoline and diesel fuels). Large industrial sources also contribute substantially to SO_X (about 20%). Voluntary and regulatory programs that have started reducing the sulfur content in fuels will begin to reduce the SO_X and sulfates in our area.
- A “soil” component comprised of analytes typically associated with crustal materials – The soil fraction includes aluminum, silicon, calcium, iron, titanium, and potassium.
- It is important to note that these are not all fine particulate components, but a simplification.

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

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

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

As expected, the wood smoke site (Tacoma South L) shows more seasonal variability, with carbon concentrations substantially greater in the heating months. Interestingly, the Duwamish site also reflects this variation in December, more than in previous years. These graphs qualitatively show that a large amount of our fine particulate comes from the combustion sources (the carbon fractions). Note that the “dips” in the graph are due to missing data not to zero level $PM_{2.5}$ concentrations.

Figure 37

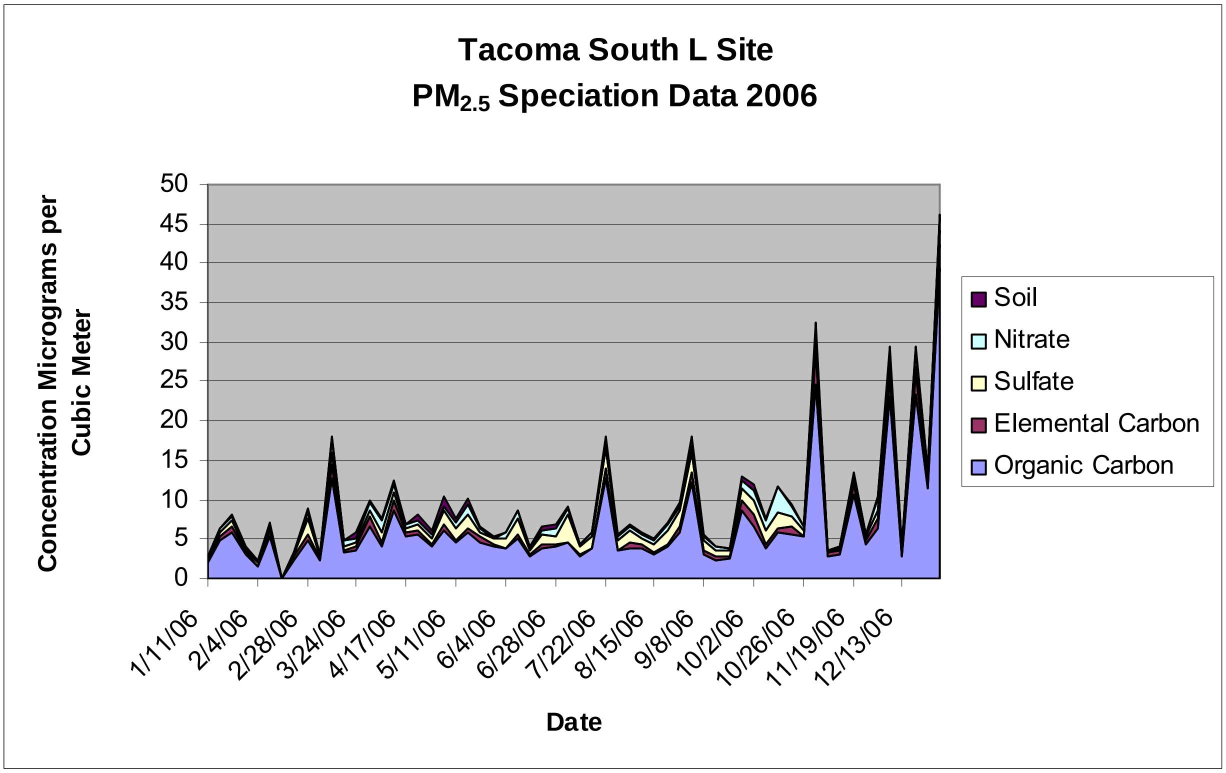


Figure 38:

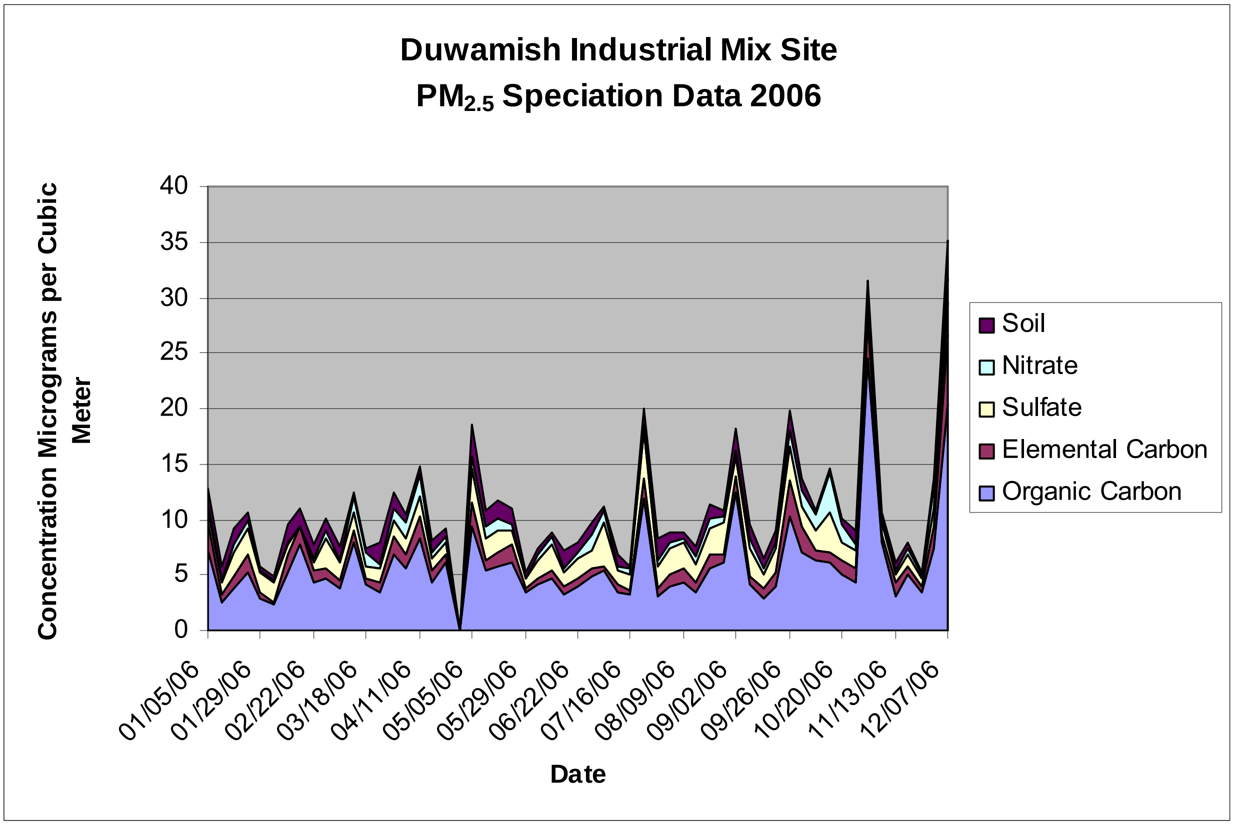
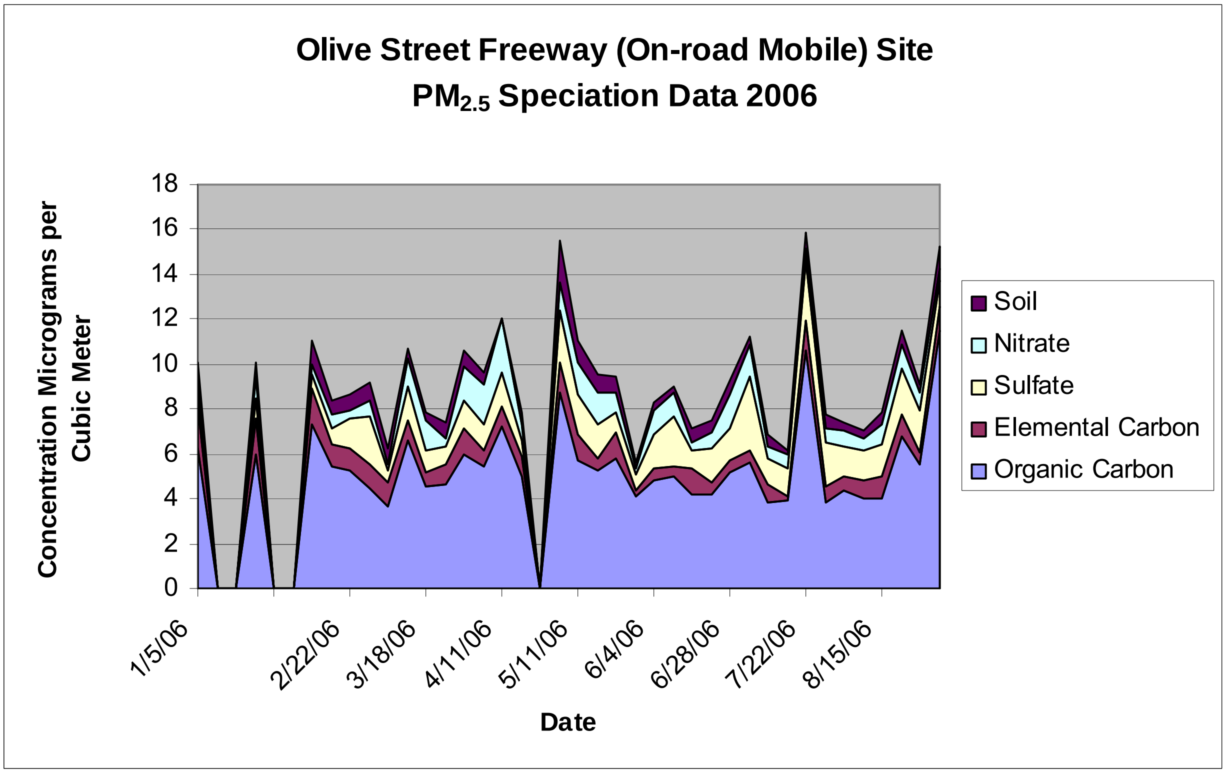

Duwamish Industrial Mix Site
PM2.5 Speciation Data 2006
Concentration Micrograms per Cubic Meter
40
35
30
25
20
15
10
5
0
01/05/06
01/29/06
02/22/06
03/18/06
04/11/06
05/05/06
05/29/06
06/22/06
07/16/06
08/09/06
09/02/06
09/26/06
10/20/06
11/13/06
12/07/06
Date
Soil
Nitrate
Sulfate
Elemental Carbon
Organic Carbon

Figure 39:


Olive Street Freeway (On-road Mobile) Site
PM2.5 Speciation Data 2006
Concentration Micrograms per Cubic Meter
18
16
14
12
10
8
6
4
2
0
1/5/06
2/22/06
3/18/06
4/11/06
5/11/06
6/4/06
6/28/06
7/22/06
8/15/06
Date
Soil
Nitrate
Sulfate
Elemental Carbon
Organic Carbon

Aethalometer Data

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

Elemental and organic carbon are related to diesel particulate, wood smoke particulate, and particulate from other combustion sources.[34] The aethalometer can provide time-resolved information. This is an especially important feature when investigating wood smoke, which has a strong variance between the evening heating hours and the rest of the day.

The Agency maintains aethalometers at monitoring sites with high particulate matter concentrations, as well as sites with speciation data, so that the different methods to measure carbon may be compared.

For more information on aethalometers, refer to our aethalometer monitoring paper at http://www.pscleanair.org/airq/Aeth-Final.pdf. Additional information on aethalometers is also included in the 2005 data summary at http://www.pscleanair.org/news/library/reports/2005AQDSFinal.pdf.

A statistical summary of aethalometer black carbon data is presented on page A-12 of the Appendix.

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

Ozone

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

People sometimes confuse upper atmosphere ozone with ground level ozone. Atmospheric ozone is 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.[35] People with respiratory conditions should limit outdoor exertion if ozone levels are high. Ozone has also been linked to immune system effects.[36] 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. Regional meteorology inhibits regular production of elevated ozone levels. These elevated ozone episodes usually occur no more than 3 to 5 days per ozone season. Highest ozone concentrations are measured in areas such as LaGrande Pack Forest and Enumclaw. As shown on Map 4, the highest ozone concentrations occur at monitors southeast of the urban area.

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

Map 4: Ozone 3 year Average of 4th Highest Value

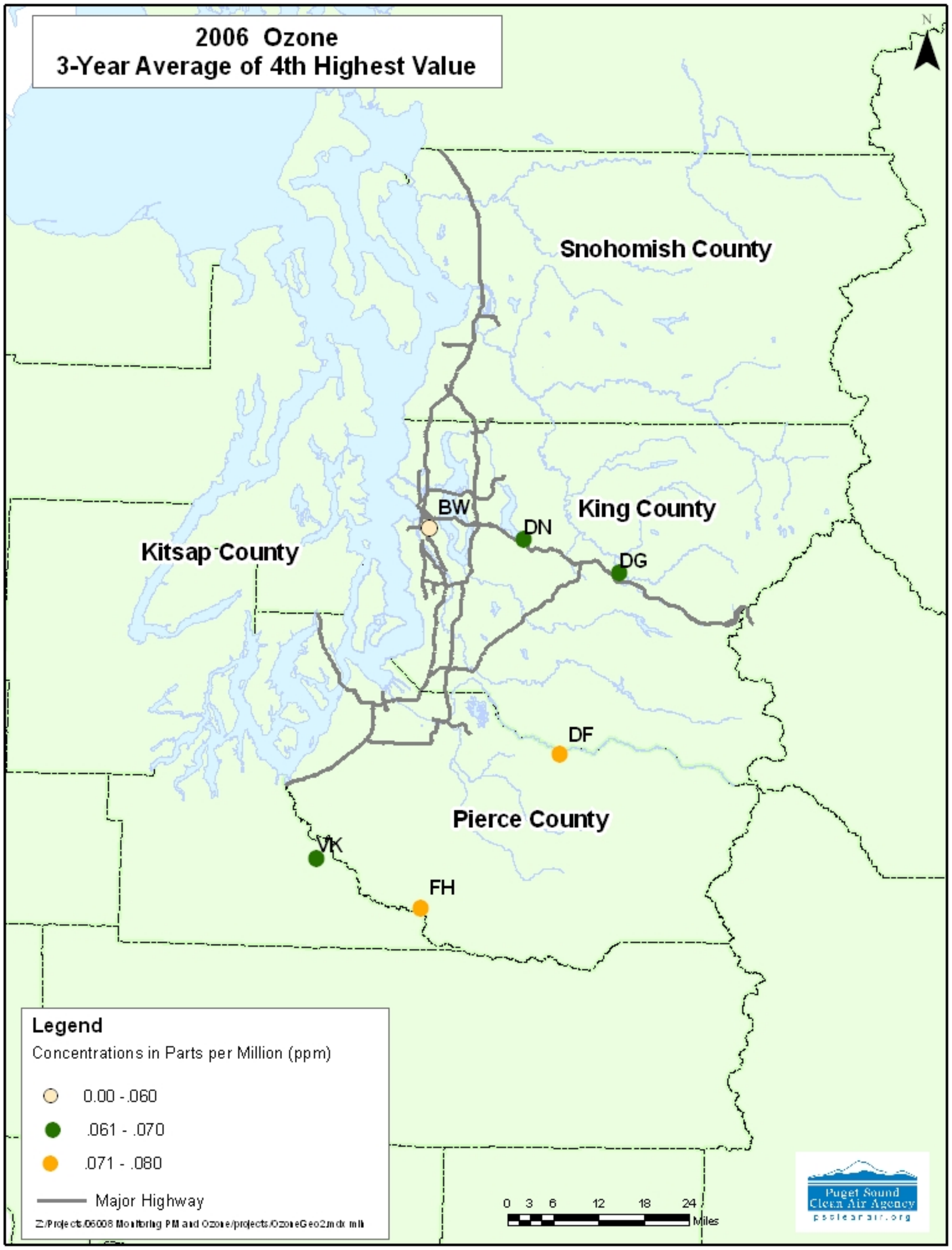


Figure 40 presents data for each monitoring station and the current 8-hour federal standard, and shows that ozone concentrations in the Puget Sound region have fallen below the standard since 1993. Although ozone levels have remained fairly stable, it is still a concern for the region because EPA proposed a stricter ozone standard in June 2006, ranging from 0.070 to 0.075 parts per million (ppm).[38] This proposal was based on health information that indicated that the current standard (0.08 ppm) is not protective of human health. Monitored concentrations at sites such as Enumclaw could violate this proposed standard if it is adopted. EPA is scheduled to adopt a new ozone standard in 2008, after receiving comments on its proposal. The Agency will include this information in the 2007 data summary.

The federal standard is based on the 3-year average of the 4th-highest 8-hour concentration. This means the three highest concentrations can exceed the level of the standard while still maintaining attainment. There is also a 3-year averaging component to the standard. Values presented on the graph are 3-year averages of 4th-highest concentrations. The year on the x-axis represents the last year averaged. For example, concentrations shown for 2006 are an average of 2004, 2005, and 2006 concentrations. The table on page A-13 of the Appendix shows that the 8-hour standard of 0.08 ppm was exceeded on multiple days in 2006. The highest 2006 8-hour ozone concentration of 0.122 ppm was recorded on July 22 at the Enumclaw Mud Mountain monitor.

Figure 41 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, based on the 8-hour average. Figure 42 shows the trend of ozone over the summer for the last eight years. This graph highlights that 2006 ozone levels were higher in the Puget Sound region than they have been since 1998. Concentrations reached the “unhealthy” AQI zone in 2006 and in 1998.

EPA phased out a 1-hour standard in June of 2005. The maximum 1-hour concentrations are shown as additional information on page A-14 of the Appendix.

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.

[38] **2007 Proposed Revisions to Ground-Level Ozone Standards**
http://www.epa.gov/air/ozonepollution/naaqsrev2007.html

Figure 40:

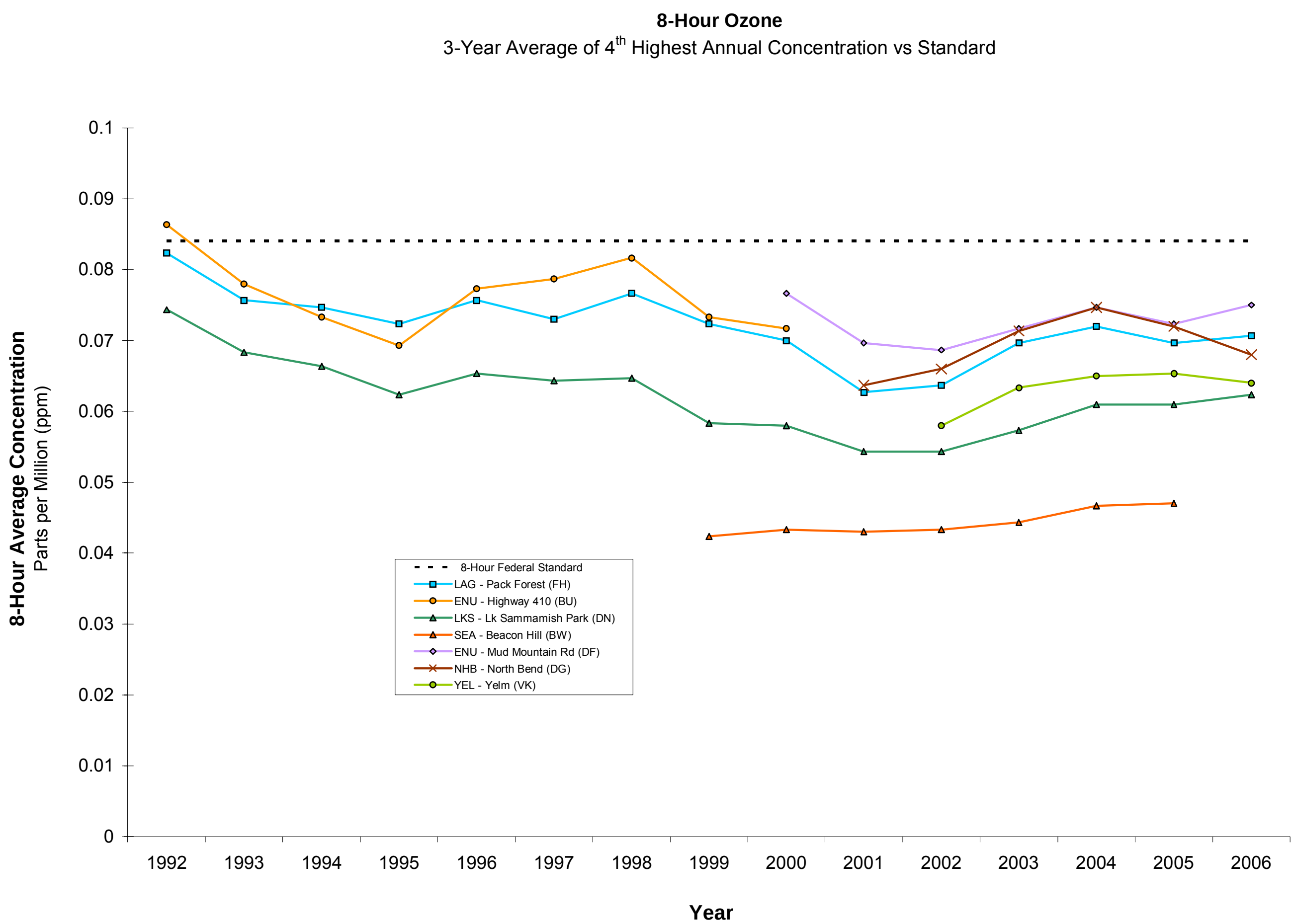

8-Hour Ozone
3-Year Average of 4th Highest Annual Concentration vs Standard
8-Hour Average Concentration
Parts per Million (ppm)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year
8-Hour Federal Standard
LAG - Pack Forest (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)

Figure 41:

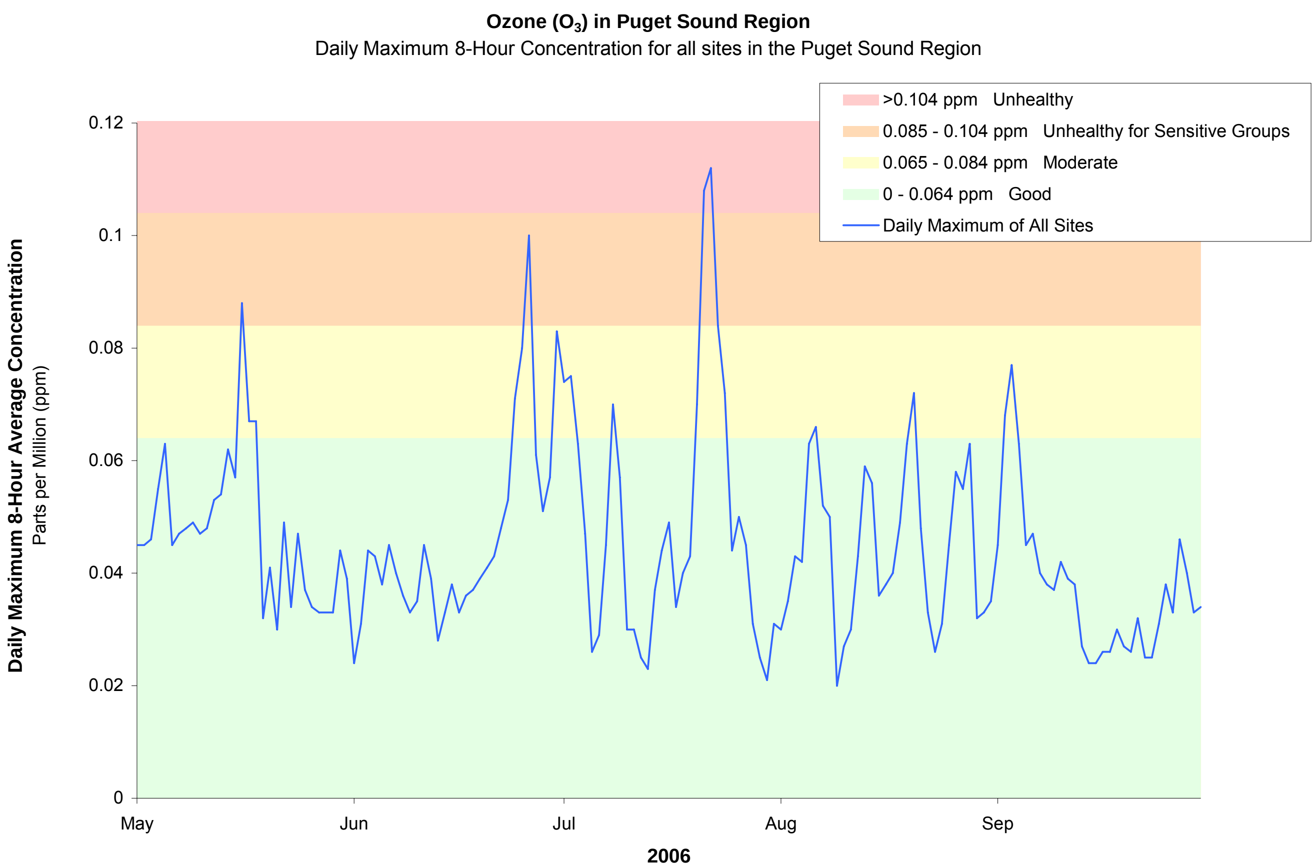
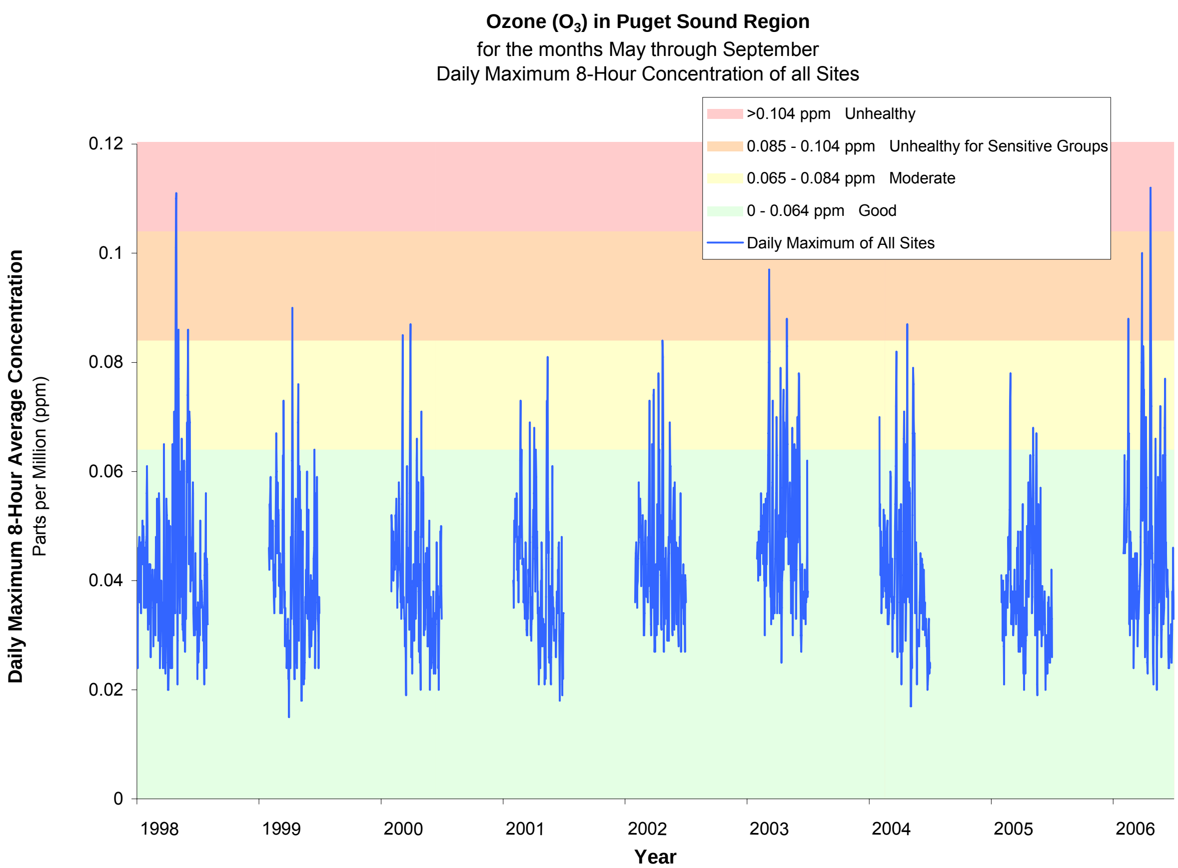

Ozone (O_3) in Puget Sound Region
Daily Maximum 8-Hour Concentration for all sites in the Puget Sound Region
>0.104 ppm Unhealthy
0.085 - 0.104 ppm Unhealthy for Sensitive Groups
0.065 - 0.084 ppm Moderate
0 - 0.064 ppm Good
Daily Maximum of All Sites
Daily Maximum 8-Hour Average Concentration
Parts per Million (ppm)
0.12
0.1
0.08
0.06
0.04
0.02
0
May
Jun
Jul
Aug
Sep
2006

Figure 42:



Ozone (O3) in Puget Sound Region
for the months May through September
Daily Maximum 8-Hour Concentration of all Sites
>0.104 ppm Unhealthy
0.085 - 0.104 ppm Unhealthy for Sensitive Groups
0.065 - 0.084 ppm Moderate
0 - 0.064 ppm Good
Daily Maximum of All Sites
Daily Maximum 8-Hour Average Concentration
Parts per Million (ppm)
0.12
0.1
0.08
0.06
0.04
0.02
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year

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 volatile organic compounds (VOCs) and can result in the formation of ozone. NO_X can also form nitrates in the atmosphere, a component of fine particulate matter. On-road vehicles such as trucks and automobiles are the major sources of NO_X. Industrial boilers and processes, home heaters, and gas stoves also produce NO_X. NO_X 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.[39] Long-term exposure can lead to respiratory infections.

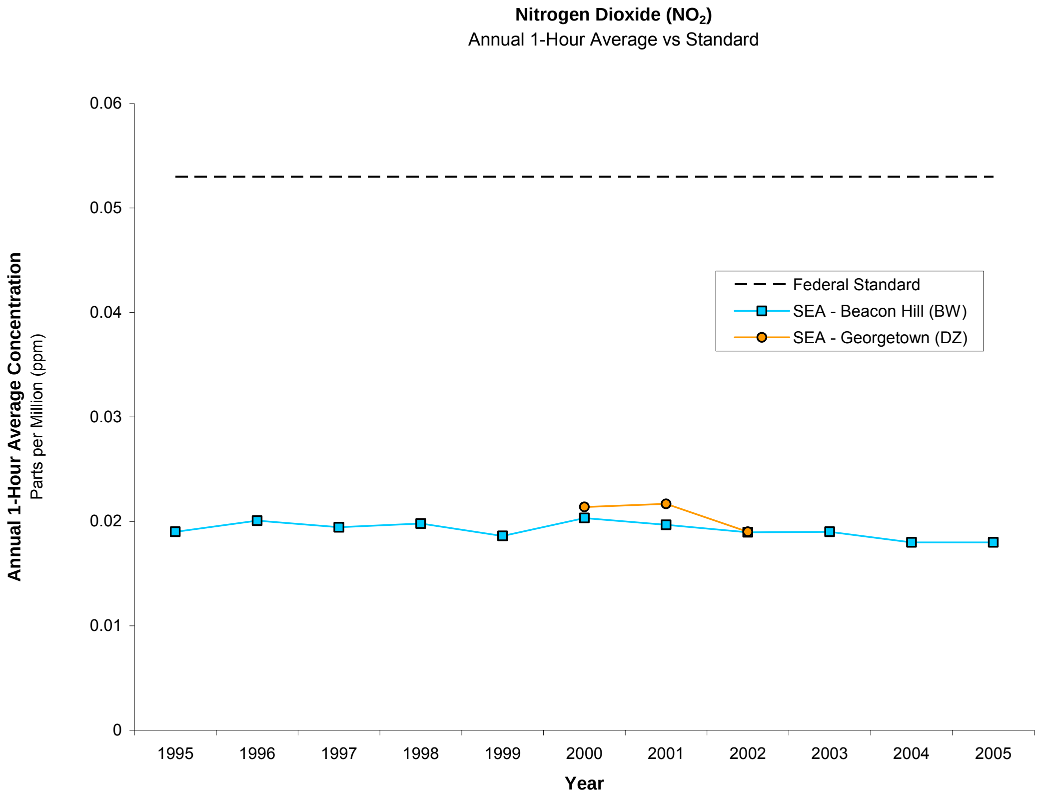
Motor vehicle manufacturers have been required to reduce NO_X emissions from cars and trucks since the 1970s, and emissions have reduced dramatically. Nitrogen dioxide in itself is not considered a significant pollution problem in the Puget Sound area. However, NO_X emissions are important, as they affect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

The Washington State Department of Ecology maintains one monitoring site for nitrogen dioxide at the Beacon Hill monitoring site. Because this site has an incomplete 2006 dataset (due to relocation) the 2005 NO_X data are presented in this summary. The annual average for each year has consistently been less than half of the federal standard, as shown in Figure 43 and in the statistical summary on page A-15 of the Appendix.

The maximum 1-hour average of NO_2 measured in 2005 was 0.078 ppm on June 6. Visit www.epa.gov/air/urbanair/nox/index.html for additional information on NO_2.

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

Figure 43:


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
Federal Standard
SEA - Beacon Hill (BW)
SEA - Georgetown (DZ)
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year

Carbon Monoxide

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

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

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. Although urban portions of the Puget Sound region violated the CO standard for many years, CO levels have decreased significantly in the Puget Sound area, primarily due to cleaner car technology. The Department of Ecology has substantially reduced its CO monitoring network, and 2006 concentrations shown in the following graphs are generally based on monitoring conducted from January through June 2006. Only the Bellevue site will be continued into 2007. Please refer to page A-16 of the Appendix for sampling periods for each site.

The federal CO standard is based on the second highest 8-hour average. Figures 44 through 46 show the second highest 8-hour concentrations and the federal standard for Snohomish, King, and Pierce counties. There are no CO monitoring stations in Kitsap County. These graphs show the general downward trend that CO has taken place 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 2006 was 3.7 parts per million (ppm) on December 8 at the Bellevue, 148 Avenue NE site.

EPA's federal standards also include a 1-hour standard for CO of 35 ppm, not to be exceeded more than once a year. Measured 1-hour concentrations in the Puget Sound area are historically much lower than the 35 ppm standard, and therefore 1-hour CO trends are not graphed. The maximum 1-hour CO concentration in 2005 was 5.1 ppm on December 8 at the Bellevue, 148 Avenue NE site.

Statistical summaries for 8-hour and 1-hour average CO data are provided on page A-16 of the Appendix.

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

Figure 44:

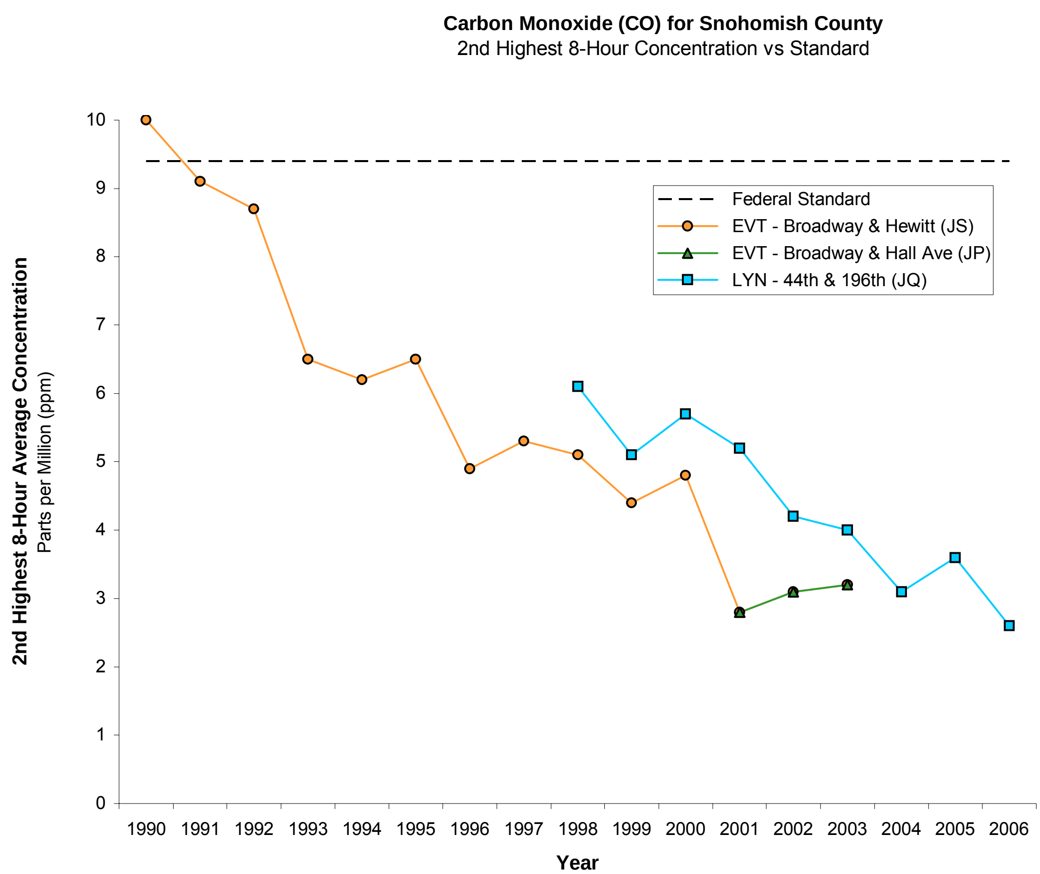

Carbon Monoxide (CO) for Snohomish County
2nd Highest 8-Hour Concentration vs Standard
2nd Highest 8-Hour Average Concentration
Parts per Million (ppm)
Federal Standard
EVT - Broadway & Hewitt (JS)
EVT - Broadway & Hall Ave (JP)
LYN - 44th & 196th (JQ)
0
1
2
3
4
5
6
7
8
9
10
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year

Figure 45:

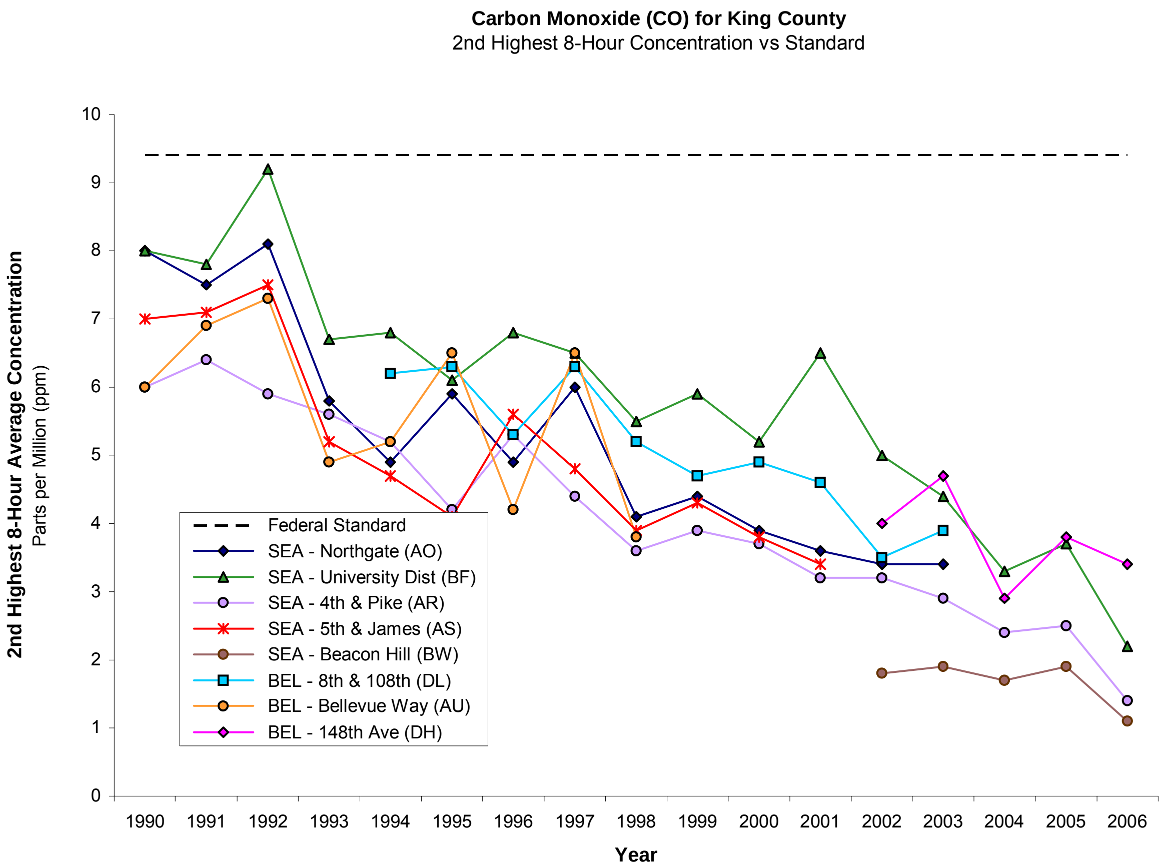
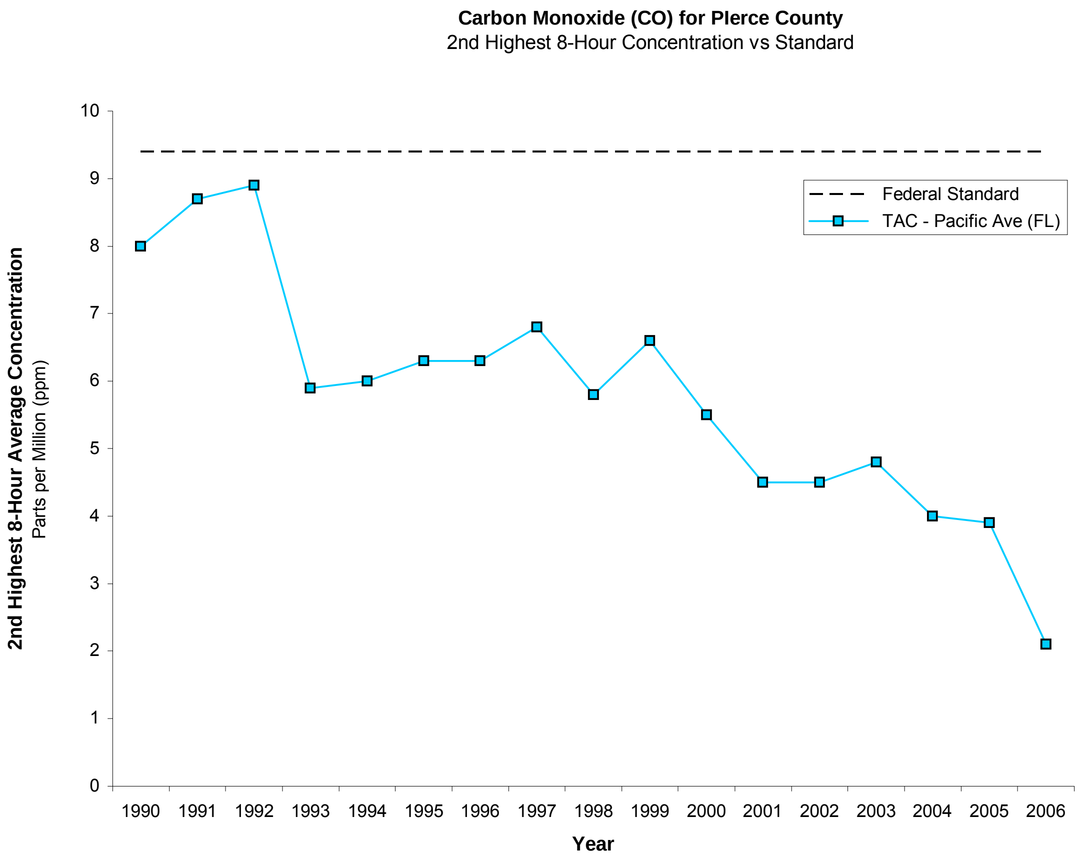

Carbon Monoxide (CO) for King County
2nd Highest 8-Hour Concentration vs Standard
2nd Highest 8-Hour Average Concentration
Parts per Million (ppm)
Year
Federal Standard
SEA - Northgate (AO)
SEA - University Dist (BF)
SEA - 4th & Pike (AR)
SEA - 5th & James (AS)
SEA - Beacon Hill (BW)
BEL - 8th & 108th (DL)
BEL - Bellevue Way (AU)
BEL - 148th Ave (DH)
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
2005
2006

Figure 46:


Carbon Monoxide (CO) for PIerce County
2nd Highest 8-Hour Concentration vs Standard
2nd Highest 8-Hour Average Concentration
Parts per Million (ppm)
10
9
8
7
6
5
4
3
2
1
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year
Federal Standard
TAC - Pacific Ave (FL)

Sulfur Dioxide

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

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

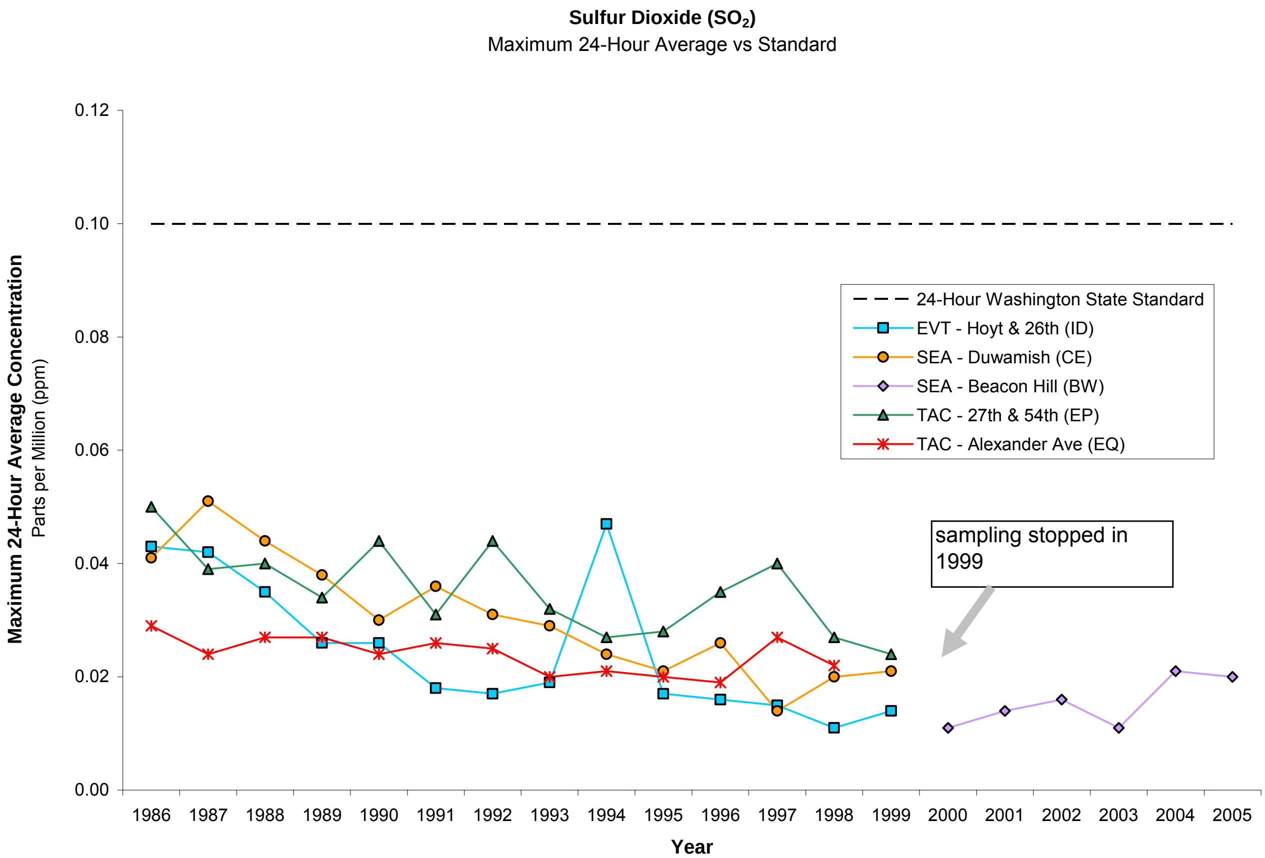
The Puget Sound area has experienced a significant decrease in SO_2 from sources such as pulp mills, cement plants, and smelters in the last two decades. Additionally, levels of sulfur in diesel and gasoline fuels are decreasing due to EPA regulations. The Puget Sound Clean Air Agency stopped monitoring for SO_2 in 1999 because of these decreases. Monitoring sites for SO_2 were historically sited in or near former industrial areas. The Washington State Department of Ecology currently monitors for SO_2 at the Beacon Hill site. This monitoring started in May 2000.

The Beacon Hill site was not operating for most of 2006 due to relocation, so this report summarizes data from 2005. Figures 47 and 48 show the maximum 24-hour and 1-hour concentrations, respectively, at individual monitoring sites. The July 1994 spike shown on these graphs was the result of a release from an Everett paper mill. The maximum measured SO_2 concentrations in 2005 were below all federal and regional standards. The maximum 24-hour and 1-hour Beacon Hill averages in 2005 were 0.020 ppm on April 7 and 0.044 ppm on October 21, respectively.

Statistical summaries for SO_2 data from the Beacon Hill site are available on page A-17 of the Appendix.

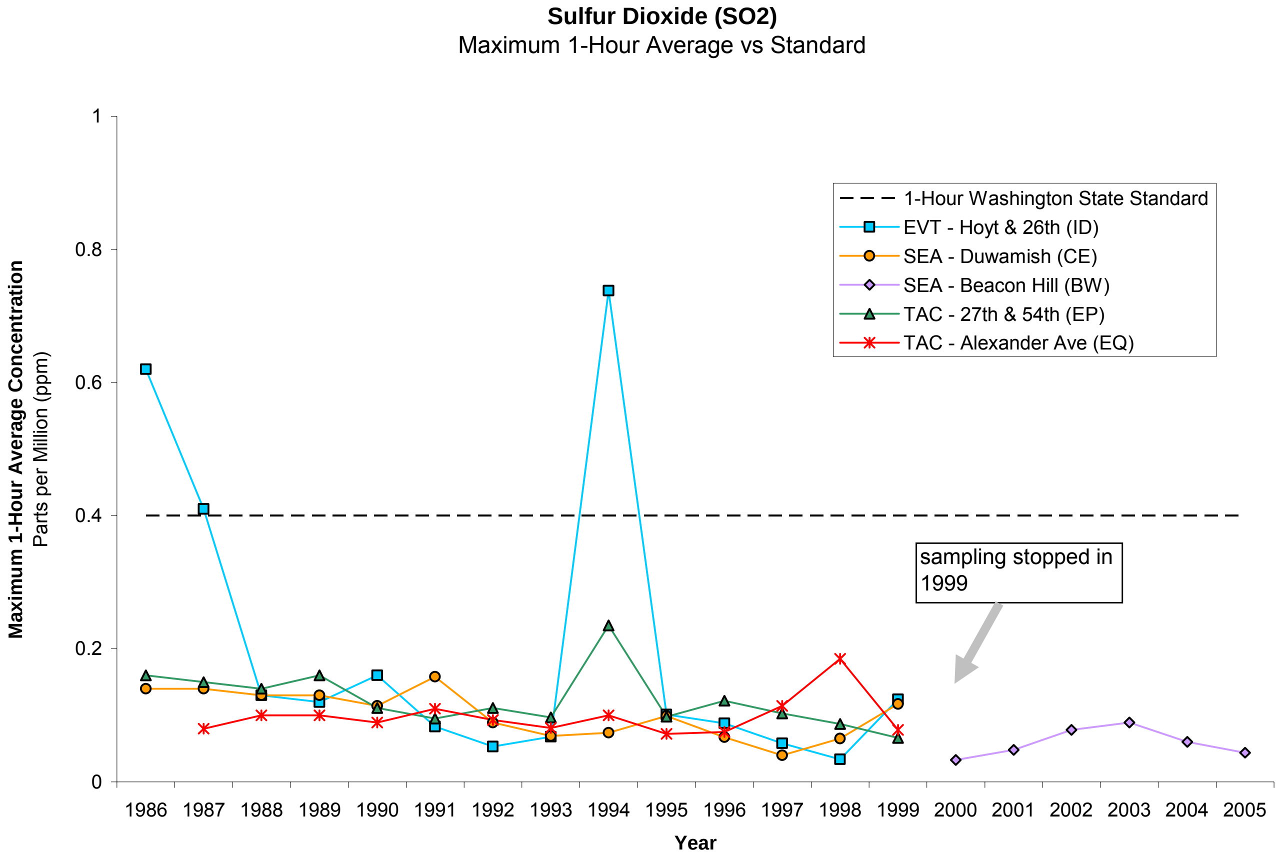
Additional information on SO_2 is available at www.epa.gov/air/urbanair/so2/index.html. SO_2 information is also provided in question/answer format in the definitions section of this document.

Figure 47:



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 2005
Year

Figure 48:



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
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
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

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 remaining lead emissions.

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

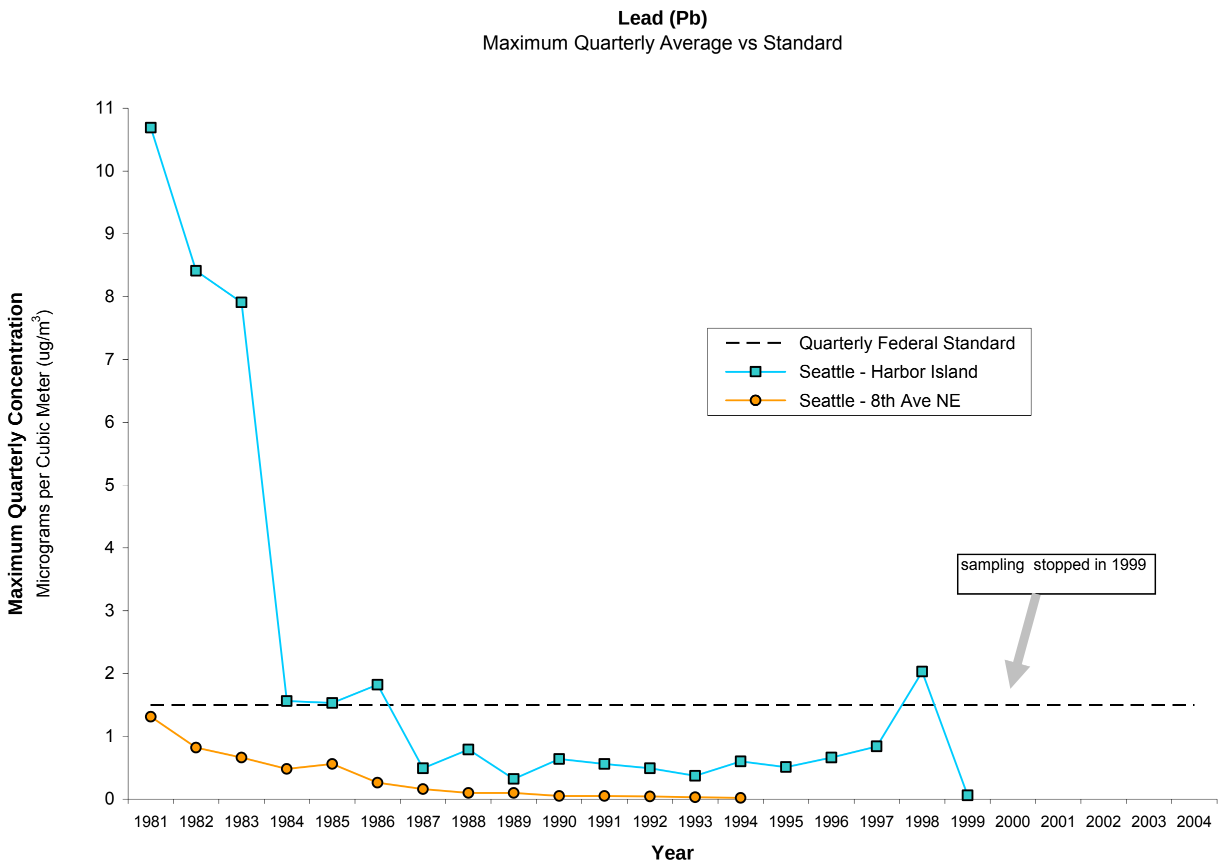
According to the EPA, the primary sources of lead exposure are lead-based paint, lead-contaminated dust, and lead-contaminated residual soils. Refer to the EPA website at www.epa.gov/ttnatw01/hlthef/lead.html for ways to limit your exposure to these lead sources.

Lead has not been monitored in the Puget Sound area since 1999.[40] Since the phase-out of lead in fuel and the closure of the Harbor Island secondary lead smelter, lead in ambient air is no longer a public health concern in the region. Figure 49 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.

[40] Lead is a pollutant that is both a criteria air pollutant and an air toxic. Lead is no longer monitored by FRM as a criteria air pollutant in Puget Sound. However, the lead fraction of $PM_{2.5}$ is measured at speciation monitors.

Figure 49:


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 indicator of air quality. Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance—usually miles or kilometers—that you can see a black object against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction, the shorter the visual range. Visual range as measured by nephelometer instruments using light-scattering methodology provides an objective approach to measuring visibility at a specific location, but does not address individual perceptions regarding the "quality" of a view on a given day.

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

Figures 50 through 54 show visibility for the overall Puget Sound area, as well as Snohomish, King, Pierce, and Kitsap counties. Visibility on these graphs, in units of miles, is determined by continuous nephelometer monitoring. The nephelometer measures light scattering due to particulate matter, and then converts this unit (b_{sp}) into miles, more readily understood. The nephelometer does not take into account meteorology visibility effects such as cloudiness, so the visibility in these graphs is visibility as related to particulate matter. Nephelometer data are shown on page A-9 of the Appendix.

The red line on the graphs represents the monthly average visibility; it is apparent that there are large fluctuations, which correspond to the highest levels of visibility in the summer months and the lowest levels in the winter. The blue line shows a 12-month moving average, which incorporates the average of the previous 12 months to aid in smoothing out this seasonal variation. The blue line shows that the average visibility for the Puget Sound area has steadily increased over the last decade with year-to-year variability caused by meteorology. For the 17-year period from December 1990 through December 2006, the 12-month moving average of visual range increased from 46 miles to 72 miles.

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

Figure 50:

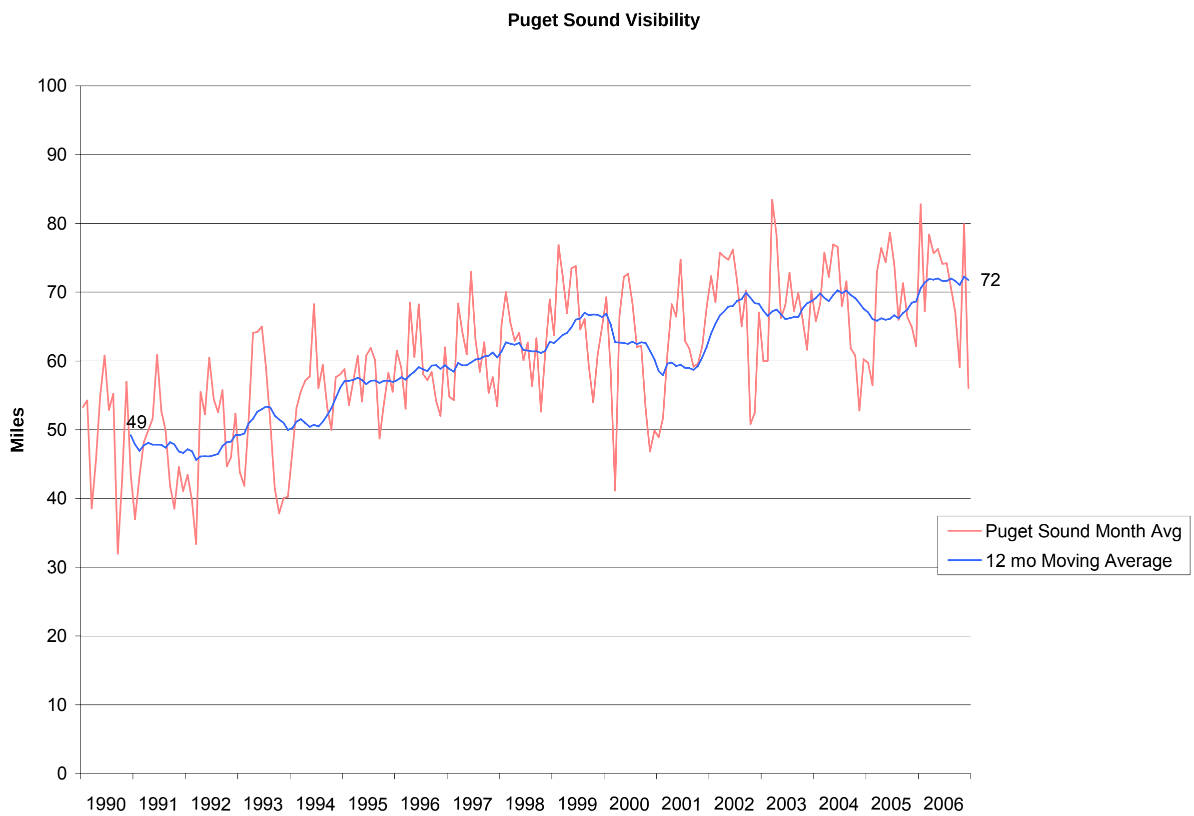

Puget Sound Visibility
Miles
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
49
72
Puget Sound Month Avg
12 mo Moving Average

Figure 51:

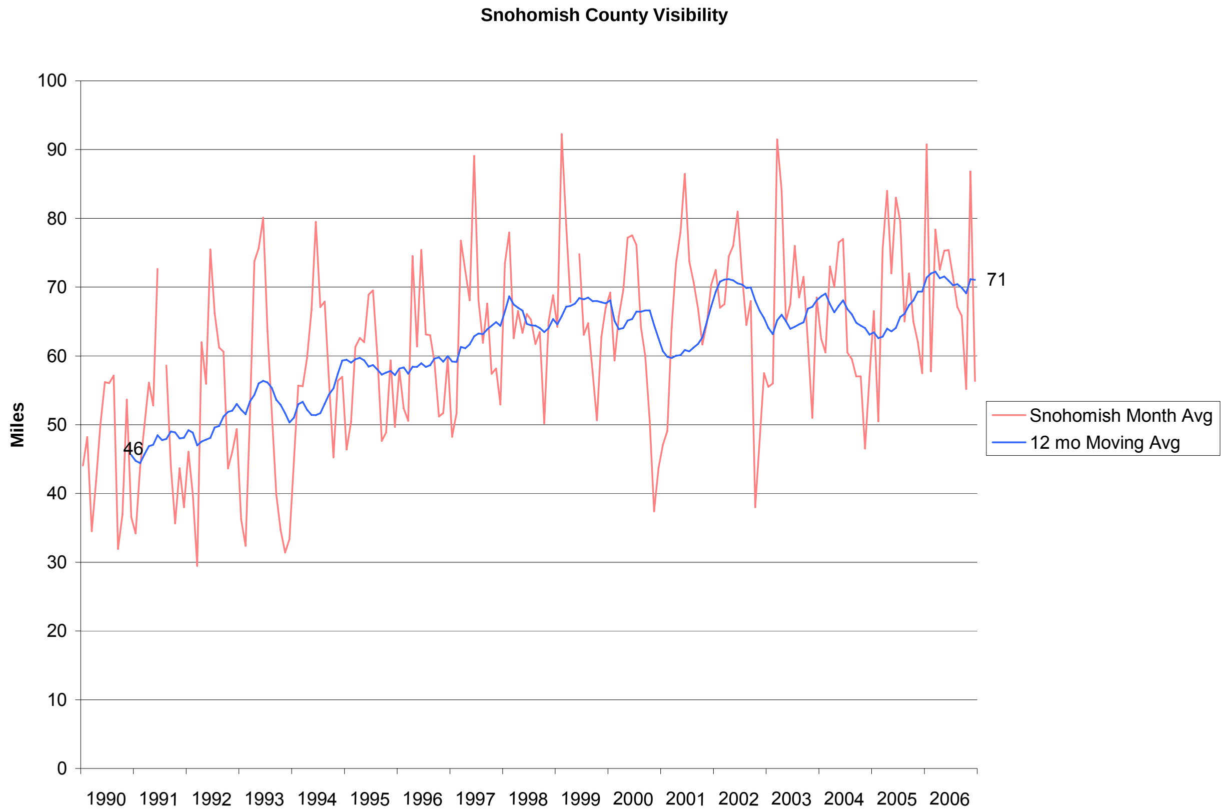

Snohomish County Visibility
Miles
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
46
71
Snohomish Month Avg
12 mo Moving Avg

Figure 52:

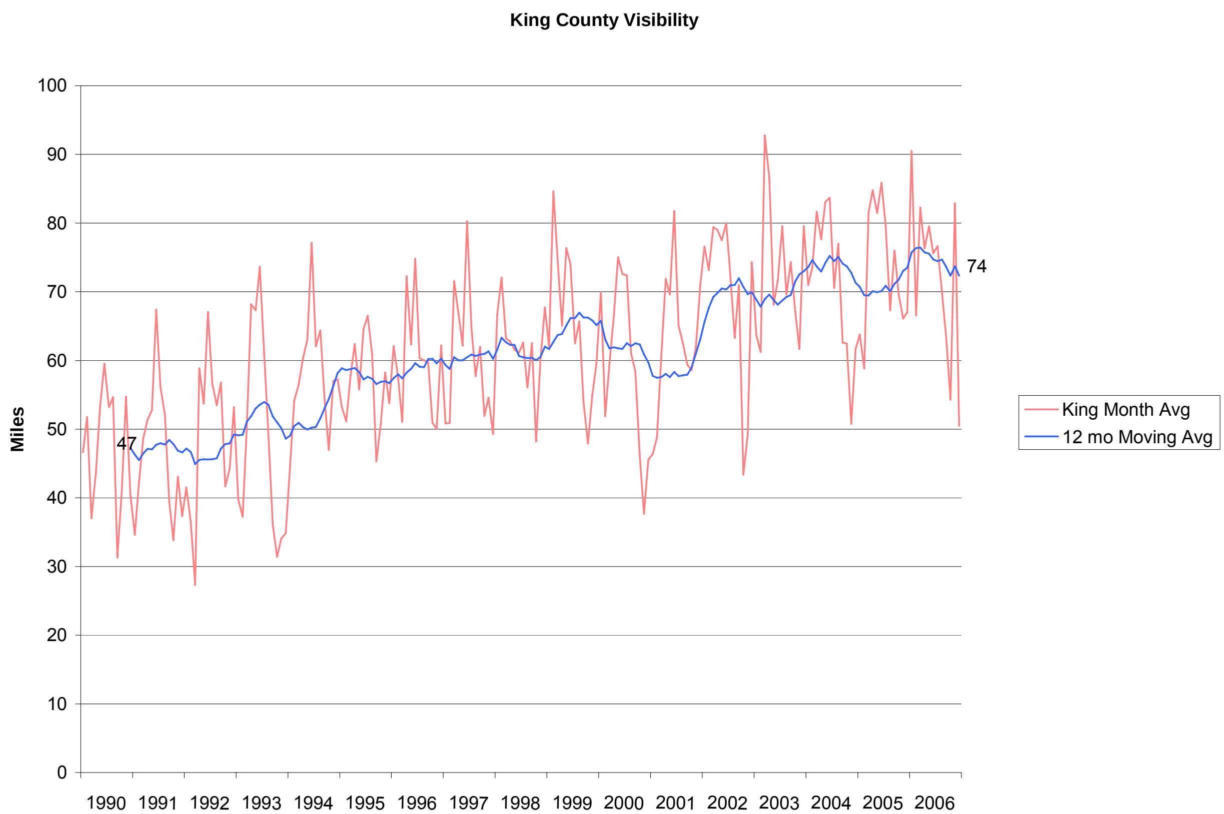

King County Visibility
100
90
80
70
60
50
40
30
20
10
0
Miles
47
74
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
King Month Avg
12 mo Moving Avg

Figure 53:

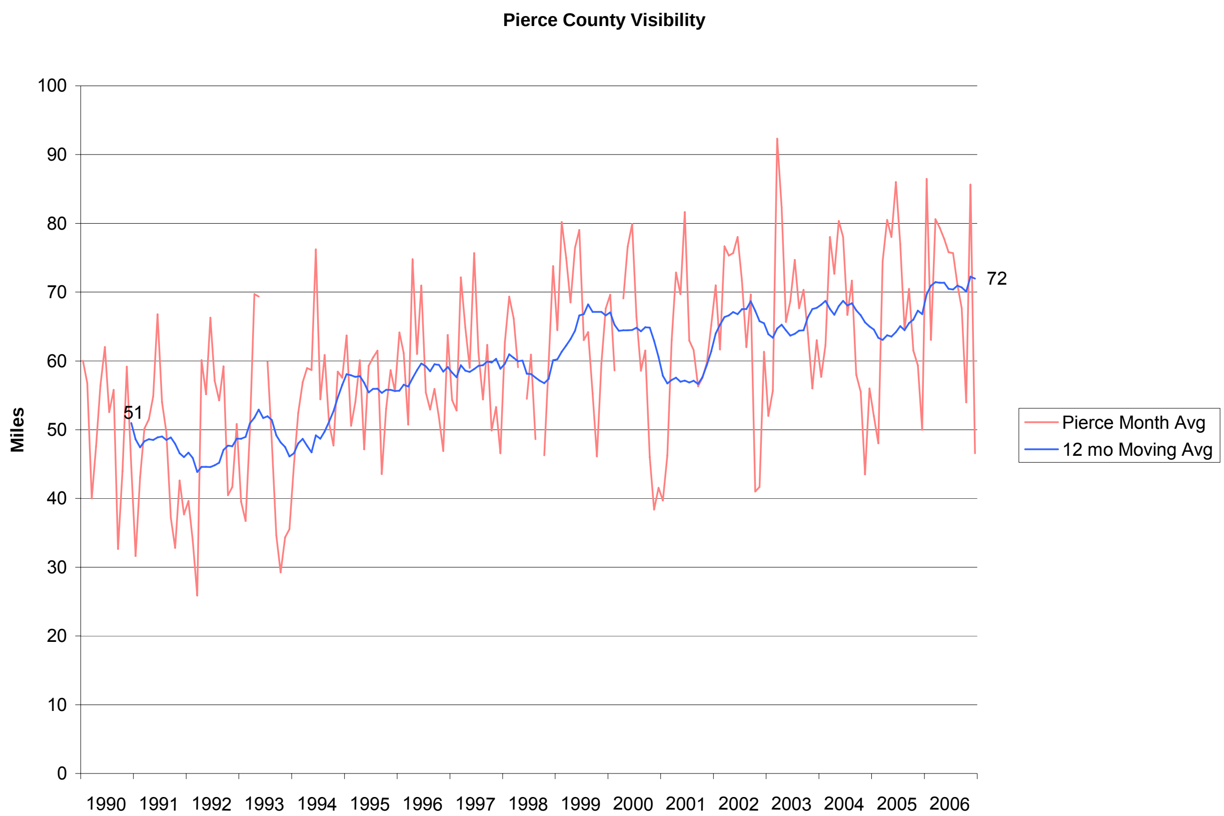
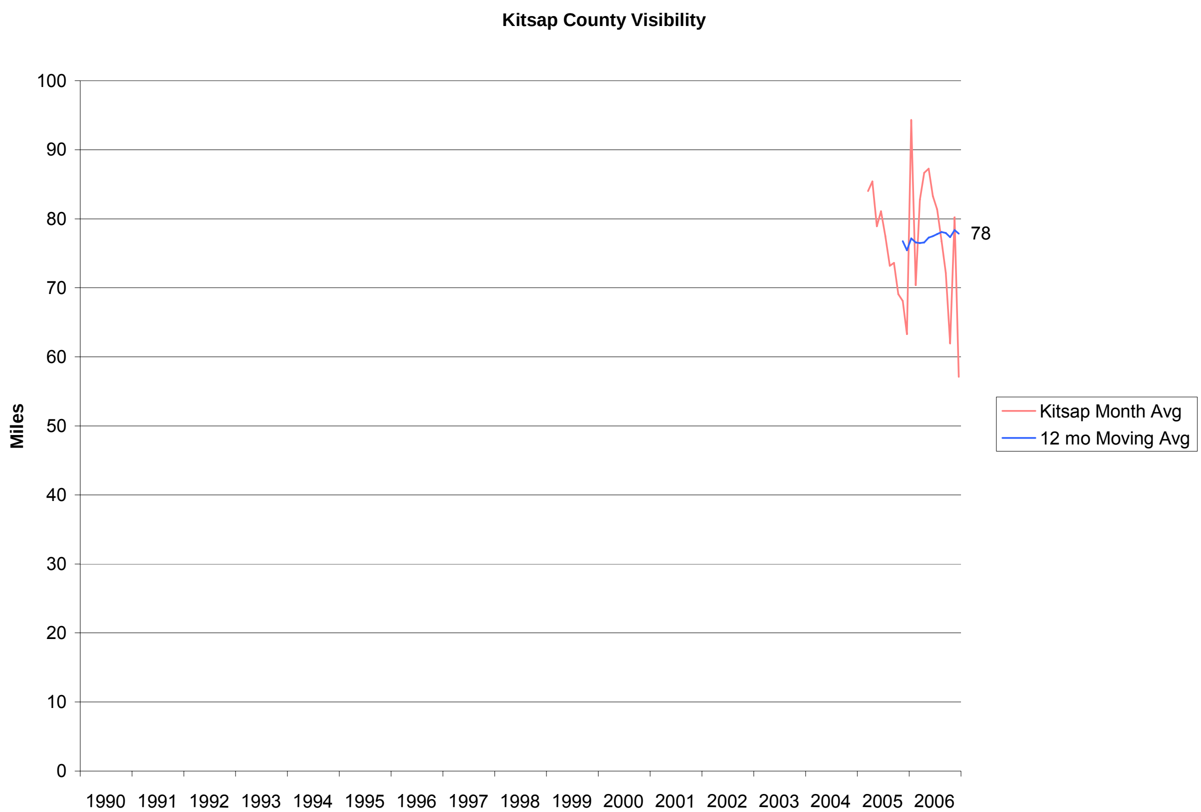

Pierce County Visibility
Miles
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
51
72
Pierce Month Avg
12 mo Moving Avg

Figure 54:


Kitsap 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 2005 2006
78
Kitsap Month Avg
12 mo Moving Avg

Air Toxics

The Washington State Department of Ecology monitors air toxics at the Seattle Beacon Hill site, where air toxics have been monitored since 2000. The Beacon Hill site was not operating for a large portion of the year, due to relocation. The Agency does not present the incomplete 2006 dataset, as we normally present them on an annual average basis. The 2005 air toxics relative ranking based on potential cancer health risk is provided here, and more detailed graphs and explanations of health effects for 2005 air toxics are available in the 2005 data summary at http://www.pscleanair.org/news/library/reports/2005AQDSFinal.pdf. For more information, consult the 2003 Puget Sound Air Toxics Evaluation at http://www.pscleanair.org/airq/basics/psate_final.pdf. For general information on air toxics, visit our website at http://www.pscleanair.org/airq/basics/airtoxics.aspx.

2005 air toxics statistical summaries are provided on page A-18 of the Appendix. Summaries include the minimum detection limit (MDL) for each air toxic. This is the minimum analytical level at which each air toxic can be detected.

Table 7 ranks 2005 air toxics according to mean potential cancer risk per million. 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.[41] Unit risk factors used and their sources are listed on page A-19 of the Appendix. Potential cancer risk estimates can be interpreted as the number of potential additional cancers (out of a population of one million) that may develop from exposure to air toxics.

Mean risks are also presented in this table and are based on annual average concentrations. Upper bound risks based on 95th percentile concentrations are included on page A-20 of the Appendix.[42] 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.

[41] Potential cancer risks use Unit Risk Factors (URFs), which are based on an assumed 70-year (lifetime) inhalation exposure.
[42] Upper bound estimates are often protectively used in health evaluations. Use of upper bounds is intended to conservatively account for populations that may be exposed to air toxics at concentrations greater than a mean statistic.

Table7: 2005 Beacon Hill Potential Cancer Risk Estimates per 1,000,000

AIR TOXIC	MEAN RISK
Formaldehyde	16.8
Chromium (M)	0.5 – 10.1[43]
Carbon Tetrachloride	9.4
Chloroform	5.3
Benzene[44]	4.4
Arsenic (M)	4.4
Acetaldehyde	3.2
1,3-Butadiene	2.3
Nickel (M)	1.5
Tetrachloroethylene	1.4
Trichloroethylene	0.3
Cadmium (M)	0.3
Lead (M)	0.05
Beryllium (M)	0.01
Manganese (M)	na[45]

M = metal
Two air toxics monitored in 2005, vinyl chloride and 1,2-dichloropropane, are not listed in the table because they were never detected at measurable levels.

The two air toxics that present the majority of potential health risk in the Puget Sound area, diesel particulate matter and wood smoke particulate, are not included in the table. No direct monitoring method currently exists for these toxics.[46]

Acrolein is an air toxic that also presents potential health risk in the Puget Sound area, in the form of respiratory irritation.[47] An accurate monitoring method for acrolein is currently being developed.

Air toxics annual concentrations, risk estimates, and ranking order in 2005 are generally similar to those in our 2003 Air Toxics Evaluation.[48]

[43] Chromium estimated risks of 10.1 in a million are based on PM_{10} total chromium and EPA's 1999 estimate that 66% of total chromium (hexavalent and trivalent) is hexavalent in the Beacon Hill Census Tract. EPA 1999 National Air Toxic Assessment. http://www.epa.gov/ttn/atw/nata1999/. Hexavalent chromium pilot monitoring conducted in 2005 shows that hexavalent is only 3% of total chromium, and that risks are less than one in a million.
[44] 2005 Benzene risk is much lower than previous years based on Beacon Hill monitoring. The Agency is still exploring possible reasons why Benzene levels appear so low in 2005. See page 109.
[45] 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
[46] 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.
[47] Acrolein health effects estimate is based on modeling. EPA 1999 National Air Toxics Assessment. http://www.epa.gov/ttn/atw/nata1999/.
[48] The 2003 Puget Sound Air Toxics Evaluation is based on 2001 monitoring. http://www.pscleanair.org/airq/basics/psate_final.pdf.

Definitions

General Definitions

Air Quality Index

Table 8: 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	

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 O_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/regulated/reg3/asil.pdf. Hazardous air pollutants (see below) are checked on this list to identify them as a subset of air toxics. Air toxics are also called Toxic Air Contaminants (TAC) under Regulation III.

Certified Wood Stove

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 http://www.pscleanair.org/actions/woodstoves/default.aspx 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. The six criteria air pollutants are: particulate matter (10 micrometers and 2.5 micrometers), ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead.

Hazardous Air Pollutant (HAP)

A *hazardous air pollutant* is an air contaminant listed in the Federal Clean Air Act, Section 112(b). 188 pollutants are currently listed as HAPs. 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, 2005.

Visibility/Regional Haze

Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance—usually miles or kilometers—that you can see a black object against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction you have, the shorter your visual range will be. Reduced visibility (or visual range) is caused by weather (clouds, fog, and rain) and air pollution (fine particles and gases). 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 1 on page 19 for locations of active monitoring sites. The Washington State Department of Ecology maintains all ozone monitoring stations.

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

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

- **How is it caused?**
  – $PM_{2.5}$ comes from all types of combustion, including wood burning, vehicle exhaust, and industrial emissions. It can also be formed in the atmosphere by chemical reactions of pollutant gases.
  – The "coarse" particles in PM_{10} typically come from crushing or grinding operations and dust from roads.

- **When does it happen?**
  Highest PM2.5 concentrations typically occur in the winter months, when wood smoke is a contributor and meteorology is conducive to inversions.

- **Who is affected?**
  Everyone. People with asthma or heart or lung diseases, the elderly, and children are particularly susceptible. $PM_{2.5}$ also significantly affects visibility.

- **What are the health effects?**
  Fine particulates ($PM_{2.5}$) pose a greater risk to human health than coarse particulates, because they penetrate deeper into the respiratory system.
  - $PM_{2.5}$ exposure can result in serious health effects, especially respiratory and and cardiac effects. People with heart or lung diseases are at increased risk of attacks or premature death. Children and the elderly are more likely to develop heart or lung problems.
  - PM_{10} can aggravate respiratory conditions such as asthma.

- **What can I do about it?**
  - If $PM_{2.5}$ levels are high, people with respiratory or heart disease, the elderly, and children should avoid outdoor exertion.
  - Reduce your $PM_{2.5}$ emissions by upgrading a wood burning heat source to a cleaner source of heat. Options are described at http://www.pscleanair.org/actions/woodstoves/default.aspx.
  - If PM_{10} levels are high, people with respiratory conditions should avoid outdoor exertion.

- **Where is it measured?**
  Due to the health risks associated with $PM_{2.5}$, it is monitored throughout the Puget Sound. The majority of $PM_{2.5}$ monitoring stations are maintained by the Agency.

Carbon Monoxide (CO)

- **What is it?**
  CO is an odorless, colorless gas that can enter the bloodstream through the lungs and reduce the amount of oxygen that reaches organs and tissues.

- **How is it caused?**
  Carbon monoxide forms when the carbon in fuels doesn't burn completely. 60% of all CO comes from vehicle exhaust, and up to 95% occurs in cities.

- **When does it happen?**
  CO pollution is 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, and substantially reduced its CO monitoring network in 2006.

Sulfur Dioxide (SO_2)

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

Lead (Pb)

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

dust, and lead-contaminated residual soils. Refer to EPA's website for ways to limit your exposure to these lead sources.

- **Where is it measured?**
  Due to the phase-out of leaded fuels and the closure of Seattle's lead smelter in 1998, the Agency no longer monitors for airborne lead.

Nitrogen Dioxide (NO_2)

- **What is it?**
  Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that forms from the reaction of nitrogen oxide (NO) and oxygen in the atmosphere. NO_2 will react with VOCs and can result in the formation of ozone.
- **How is it caused?**
  High temperature combustion sources such as power plants and automobiles are major producers of NO. Home heaters and gas stoves can also produce NO.
- **When does it happen?**
  NO_2 pollution is greatest in cold weather. It follows a similar trend to CO.
- **Who is affected?**
  People with respiratory diseases such as asthma; also children.
- **What are the health effects?**
  NO_2 can cause respiratory symptoms such as coughing, wheezing, and shortness of breath. Long-term exposure can lead to respiratory infections.
- **What can I do about it?**
  Since the 1970s, motor vehicle manufacturers have been required to reduce NO emissions from cars and trucks. It is not a significant pollution problem in the Puget Sound area.
- **Where is it measured?**
  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 or activity levels.

Non-road Mobile Sources

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

PUGET SOUND CLEAN AIR AGENCY www.pscleanair.org

2006

Air Quality Data Summary Appendix

July 2006

Working Together for Clean Air

Air Quality Index
1980 – 2006

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
2005	288	72	5	0	0	360	5			5	0		139	Dec 11	PM
2006	301	57	7	0	0	364	1			7	0		143	Dec 17	PM
Totals	7495	2270	36	20	0	5085	4467	236	33	37	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 – 2006

King County															
Days in Each Air Quality Category						**Pollutant Determining the AQI**							**Highest Value**		
						All Days				Unhealthy Days					
Year	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	PM	CO	SO_2	O_3	PM	CO	O_3	AQI	Date	Pollutant
1980	73	275		18	0	95	270	1		1	17		194	Jan 23	PM
1981	69	267		28	1	109	254	2		5	24		213	Jan 15	CO
1982	86	268		10	1	96	264	5		1	10		214	Feb 6	PM
1983	98	258		9	0	101	261	3		0	9		183	Jan 28	CO
1984	146	218		2	0	111	242	13		2	0		103	Dec 6	PM
1985	150	202		10	3	156	206	3		6	7		204	Dec 12	PM
1986	130	226		8	1	113	246	6		1	8		206	Jan 7	PM
1987	120	238		7	0	119	246	0		3	4		184	Feb 6	PM
1988	215	146		5	0	67	298	1		2	3		150	Dec 3	CO
1989	231	134		0	0	129	233	3		0	0		100	Jan 19 #	CO
1990	216	145		4	0	139	201	6	19	0	0	4	131	Aug 11	O_3
1991	229	136		0	0	140	190	8	27	0	0	0	100	Dec 15 #	CO
1992	206	159		1	0	103	230	1	32	0	1	0	167	Feb 3	CO
1993	240	125		0	0	118	235	1	11	0	0	0	88	Jan 11	PM
1994	293	70		2	0	72	270	1	22	0	0	2	134	Jul 21	O_3
1995	299	66		0	0	95	249	5	16	0	0	0	89	Jan 3	CO
1996	297	69		0	0	85	252	2	27	0	0	0	100	Oct 9	CO
1997	302	63		0	0	117	230	0	18	0	0	0	94	Jan 16	PM
1998	317	46		2	0	111	228	0	26	0	0	2	114	Jul 27 #	O_3
1999	267	92	6	0	0	251	60	0	54	5	0	1	134	Jan 4	PM
2000	241	118	7	0	0	288	25		53	5	0	2	114	Nov 21	PM
2001	273	86	6	0	0	295	10		60	6	0	0	118	Nov 10	PM
2002	262	99	4	0	0	275	11		79	4	0	0	113	Nov 27	PM
2003	268	95	2	0	0	250	5		110	0	0	2	132	Jun 6	O_3
2004	257	103	6	0	0	279	2		85	5	0	1	132	Dec 18	PM
2005	254	106	5	0	0	302	3		60	5	0	0	117	Dec 11	PM
2006	268	87	6	4	0	273	2		90	6	0	4	169	Jul 22	O_3
Totals	5807	3897	42	110	6	4289	4723	61	789	57	83	18			

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 – 2006

Pierce County

Year	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	PM (All Days)	CO (All Days)	SO_2 (All Days)	O_3 (All Days)	PM (Unhealthy Days)	CO (Unhealthy Days)	O_3 (Unhealthy Days)	AQI (Highest Value)	Date (Highest Value)	Pollutant (Highest Value)
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	0	137	Nov 5	PM
2005	275	82	8	0	0	276	2		87	8	0	0	120	Dec 10	PM
2006	283	71	7	4	0	270			95	8	0	3	170	Dec 17	PM
Totals	6329	3371	67	90	5	6694	2118	293	757	88	66	8			

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 – 2006

Kitsap County															
	Days in Each Air Quality Category					Pollutant Determining the AQI							Highest Value		
			Unhealthy for Sensitive		Very	All Days				Unhealthy Days					
Year	Good	Moderate	Groups	Unhealthy	Unhealthy	PM	CO	SO_2	O_3	PM	CO	O_3	AQI	Date	Pollutant
1990															
1991															
1992	353	8		0	0	361				0			68	Nov 25	PM
1993	343	12		0	0	355				0			62	Jan 11	PM
1994	364	1		0	0	248	117			0	0		54	Dec 23	CO
1995	361	4		0	0	86	279			0	0		57	Jan 5	CO
1996	361	1		0	0	206	156			0	0		51	Mar 2	PM
1997	361	1		0	0	362				0			55	Jan 15	PM
1998	347	9		0	0	356				0			87	Nov 8	PM
1999	333	32	0	0	0	365				0			81	Jan 5 #	PM
2000	290	75	0	1	0	366				1			159	Jul 4	PM
2001	320	42	0	0	0	362				0			91	Dec 25	PM
2002	324	41	0	0	0	365				0			78	Nov 2	PM
2003	318	47	0	0	0	365				0			78	Nov 3	PM
2004	340	26	0	0	0	366				0			80	Jul 4	PM
2005	328	35	2	0	0	365				2			136	Jul 4	PM
2006	339	25	1	0	0	365				1			105	Dec 17	PM
Totals	5082	359	3	1	0	4893	552	0	0	4	0	0			

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

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

Burn Bans
1988 – 2006

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

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

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

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

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

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

1994 None

1995
Jan 4 - Jan 7

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

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

1998 None

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

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

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

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

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

2004 None

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

2006
None

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

2006

Location	Method	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	99th Percentile	Max Value
Duwamish, 4752 E Marginal Way S, Seattle	T	342	24.6	23.7	24.4	25.3	24.5	54	71
James St & Central Ave, Kent	T	360	15.4	16.2	19.5	23.2	18.6	59	74
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	360	17.9	18	23.9	24.1	21	57	65

Notes
(1) Sampling occurs continuously for 24 hours each day.
Quarterly averages are shown only if 75 percent or more of the data is available.
(2) Annual averages are shown only if there are at least three quarterly averages.
(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	Dec 7 Thu	Dec 8 Fri	Dec 17 Sun
Duwamish, 4752 E Marginal Way S, Seattle	T	71	67	--
James St & Central Ave, Kent	T		67	74
Port of Tacoma, 2301 Alexander Ave, Tacoma	T		65	

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Method	Good	Moderate	Unhealthy for Sensitive Groups
Duwamish, 4752 E Marginal Way S, Seattle	T	339	3	0
James St & Central Ave, Kent	T	353	7	0
Port of Tacoma, 2301 Alexander Ave, Tacoma	T	356	4	0

PARTICULATE MATTER ($PM_{2.5}$)

Micrograms per Cubic Meter

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

2006

Location	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	98th Percentile	Max Value
Darrington HS, 1085 Fir St, Darrington	76			6.0	10.0		30	31
Marysville JHS, 1605 7th St, Marysville	113	9.5	6.7	7.9	12.9	9.3	33	44
6120 212th St SW, Lynnwood	87	9.8	5.9	7.3		9.4	23	41
17171 Bothell Way NE, Lake Forest Park	120	8.9	6.0	7.3	15.6	9.5	37	68
Duwamish, 4752 E Marginal Way S, Seattle	82	10.0	8.7		13.4	12.1	33	35
7802 South L St, Tacoma	117	8.9	5.9	7.4	15.9	9.5	43	68

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	Feb 19 Sun	Oct 22 Sun	Dec 7 Thu	Dec 16 Sat	Dec 28 Thu	Dec 31 Sun
Darrington HS, 1085 Fir St, Darrington	--	31				
Marysville JHS, 1605 7th St Marysville	44					
6120 212th St SW, Lynnwood	41	--	--	--	--	--
17171 Bothell Way NE, Lake Forest Park	--			68		
Duwamish, 4752 E Marginal Way, Seattle	--		35	--		
7802 South L St, Tacoma	--	--		68	43	50

-- Indicates no sample on specified day

Air Quality Index Summary

Location	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Darrington HS, 1085 Fir St, Darrington	68	8		
Marysville JHS, 1605 7th St, Marysville	96	16	1	
6120 212th St SW, Lynnwood	81	5	1	
17171 Bothell Way NE, Lake Forest Park	106	13		1
Duwamish, 4752 E Marginal Way S, Seattle	69	13		
7802 South L St, Tacoma	103	11	2	1

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

2006

Location	Method	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean	98th Percnetile	Max Value
Marysville JHS, 1605 7th St, Marysville	T	355	11.5	6.9	8.4	13.4	10.1	28	37
6120 212th St SW, Lynnwood	T	286	10.3	5.9	7.3		8.7	27	41
17171 Bothell Way NE, Lake Forest Park	T	350	11.0	6.3	7.1	15.2	9.9	29	72
Duwamish, 4752 E Marginal Way S, Seattle	T	161	11.7	9.1				21	29
James St & Central Ave, Kent	T	360	10.6	8.2	9.4	15.0	10.8	30	65
7802 South L St, Tacoma	T	360	10.8	6.5	7.5	16.7	10.4	37	85
South Hill, 9616 128th St E, Puyallup	B	302	11.5	8.9	9.7		10.9	24	39
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	B	277	8.5		8.0			17	35
10955 Silverdale Way NW, Silverdale	B	313	7.0	8.1	9.8		8.2	15	25

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	Feb 7 Tue	Feb 19 Sun	Jul 4 Tue	Dec 3 Sun	Dec 8 Fri	Dec 16 Sat	Dec 17 Sun	Dec 18 Mon	Dec 28 Thu	Dec 31 Sun
Marysville JHS, 1605 7th St, Marysville	T		37								
6120 212th St SW, Lynnwood	T		41		--	--	--	--	--	--	--
17171 Bothell Way NE, Lake Forest Park	T						64	72			
Duwamish, 4752 E Marginal Way S, Seattle	T	29		--	--	--	--	--	--	--	--
James St & Central Ave, Kent	T						47	65			
7802 South L St, Tacoma	T				42	44	62	85	65	43	48
South Hill, 9616 128th St E, Puyallup	B			39	--	--	--	--	--	--	--
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	B			35	--	--	--	--	--	--	--
10955 Silverdale Way NW, Silverdale	B			25	--	--	--	--	--	--	--

-- 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	307	48		
6120 212th St SW, Lynnwood	T	266	19	1	
17171 Bothell Way NE, Lake Forest Park	T	305	43	1	1
Duwamish, 4752 E Marginal Way S, Seattle	T	144	17		
James St & Central Ave, Kent	T	307	51	2	
7802 South L St, Tacoma	T	311	42	6	1
South Hill, 9616 128th St E, Puyallup	B	263	39		
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	B	269	8		
10955 Silverdale Way NW, Silverdale	B	309	4		

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

Micrograms per Cubic Meter

Sampling Method: Equivalent - Radiance Research M903 Nephelometer

2006

Location	Number of Values	Quarterly Arithmetic Averages				Year Arith Mean	98th Percentile	Max Value
		1st	2nd	3rd	4th			
Darrington HS, 1085 Fir St, Darrington	340	9.5	4.9	6.8	14.7	9.0	37	67
Marysville JHS, 1605 7th St, Marysville	365	8.9	6.3	7.8	10.8	8.5	26	42
6120 212th St SW, Lynnwood	363	9.1	6.0	7.2	12.7	8.8	30	54
17171 Bothell Way NE, Lake Forest Park	363	8.1	5.7	6.9	13.4	8.5	29	83
Queen Anne Hill, 400 W Garfield St, Seattle	364	5.8	6.8	7.8	9.1	7.4	20	31
Olive & Boren, Seattle	362	5.6	5.1	6.4	9.5	6.7	20	29
Duwamish, 4752 E Marginal Way S, Seattle	334	9.4	8.4	8.4	11.5	9.4	24	38
South Park, 8025 10th Ave S, Seattle	364	7.6	7.1	8.3	14.1	9.3	30	71
305 Bellevue Way NE, Bellevue	359	5.9	5.4	6.3	10.0	6.9	19	39
42404 SE North Bend Way, North Bend	359	3.4	5.0	6.9	5.8	5.3	15	24
James St & Central Ave, Kent	351	7.7	6.4	8.0	14.5	9.2	35	92
Port of Tacoma, 2301 Alexander Ave, Tacoma	365	7.8	6.6	8.0	14.5	9.2	37	63
7802 South L St, Tacoma	363	7.6	5.4	6.3	14.4	8.4	41	99
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co	311		4.9	5.7	10.5	7.8	26	42
10955 Silverdale Way NW, Silverdale	345	5.9	5.1	6.5	9.2	6.7	18	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	Feb 19 Sun	Feb 20 Mon	Oct 14 Sat	Oct 22 Sun	Dec 3 Sun	Dec 7 Thu	Dec 8 Fri	Dec 16 Sat	Dec 17 Sun	Dec 18 Mon	Dec 28 Thu	Dec 30 Sat	Dec 31 Sun
Darrington HS, 1085 Fir St, Darrington		67		44		41				45			
Marysville JHS, 1605 7th St, Marysville	42												
6120 212th St SW, Lynnwood	43							41	54				
17171 Bothell Way NE, Lake Forest Park								63	83	45			
Queen Anne Hill, 400 W Garfield St, Seattle									31				
Olive & Boren, Seattle									29				
Duwamish, 4752 E Marginal Way S, Seattle						38		--	--	--			
South Park, 8025 10th Ave S, Seattle								45	71				43
305 Bellevue Way NE, Bellevue									39				
42404 SE North Bend Way, North Bend			24					--	--	--			
James St & Central Ave, Kent							41	49	92	45			
Port of Tacoma, 2301 Alexander Ave, Tacoma							46	50	63	41			
7802 South L St, Tacoma					44		42	60	99	68	41	42	51
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co									42		--		
10955 Silverdale Way NW, Silverdale			--	--					33				

-- Indicates no sample on specified day

$PM_{2.5}$ Speciation Analytes Monitored in 2006
Average Annual Concentrations in Micrograms per Cubic Meter

Analyte	Duwamish (56 samples) Average (ug/m3)	Olive Street (34-35 samples) Average (ug/m3)	Tacoma South L (56 samples) Average (ug/m3)	Minimum Detection Level (ug/m3)
Ammonium	0.476	0.470	0.353	
Nitrate	0.803	0.892	0.759	
Potassium	0.086	0.056	0.100	
Sodium	0.334	0.244	0.250	
Sulfate	1.779	1.406	1.133	
Elemental Carbon	1.258	0.900	0.767	
Organic Carbon Blank Adjusted	2.941	2.680	3.479	
Total Carbonaceous Mass	5.375	4.652	5.637	
XRF - Aluminum	2.80E-02	1.41E-02	1.61E-02	4.36E-03
XRF - Antimony	6.82E-03	7.39E-03	6.92E-03	5.92E-03
XRF - Arsenic	1.72E-03	7.33E-04	1.75E-03	9.90E-04
XRF - Barium	3.50E-02	8.38E-03	6.97E-03	2.36E-02
XRF - Bromine	2.80E-03	2.17E-03	2.55E-03	8.00E-04
XRF - Cadmium	2.99E-03	3.01E-03	3.06E-03	4.21E-03
XRF - Calcium	2.11E-01	5.28E-02	2.81E-02	1.39E-03
XRF - Cerium	2.19E-02	4.88E-03	3.64E-03	3.45E-02
XRF - Cesium	6.43E-03	3.68E-03	3.63E-03	1.48E-02
XRF - Chlorine	1.58E-01	7.88E-02	1.89E-01	2.32E-03
XRF - Chromium	6.29E-03	1.48E-03	1.14E-03	6.30E-04
XRF - Cobalt	3.28E-04	3.01E-04	2.92E-04	5.60E-04
XRF - Copper	5.99E-03	7.51E-03	3.38E-03	5.40E-04
XRF - Europium	2.73E-03	4.28E-03	1.26E-03	4.51E-03
XRF - Gallium	5.04E-04	4.61E-04	4.45E-04	1.33E-03
XRF - Gold	8.33E-04	7.85E-04	7.34E-04	2.01E-03
XRF - Hafnium	2.91E-03	2.54E-03	2.57E-03	1.05E-02
XRF - Indium	3.35E-03	3.34E-03	3.45E-03	4.52E-03
XRF - Iridium	9.01E-04	9.12E-04	1.06E-03	2.38E-03
XRF - Iron	1.66E-01	1.38E-01	5.19E-02	7.90E-04
XRF - Lanthanum	1.86E-02	3.95E-03	3.00E-03	2.79E-03
XRF - Lead	7.34E-03	3.26E-03	5.35E-03	2.20E-03
XRF - Magnesium	2.15E-02	1.92E-02	1.86E-02	7.38E-03
XRF - Manganese	1.68E-02	2.94E-03	2.21E-03	9.20E-04
XRF - Mercury	1.48E-03	1.45E-03	1.45E-03	1.75E-03
XRF - Molybdenum	1.67E-03	1.16E-03	1.35E-03	1.91E-03
XRF - Nickel	4.28E-03	2.33E-03	1.38E-03	5.00E-04
XRF - Niobium	7.79E-04	7.10E-04	7.50E-04	1.68E-03
XRF - Phosphorus	2.66E-03	2.55E-03	2.54E-03	2.51E-03
XRF - Potassium	9.98E-02	7.22E-02	1.22E-01	1.37E-03
XRF - Rubidium	4.60E-04	4.02E-04	4.32E-04	8.70E-03
XRF - Samarium	1.70E-03	1.54E-03	1.09E-03	2.47E-03
XRF - Scandium	3.29E-03	3.01E-03	3.22E-03	9.70E-04
XRF - Selenium	1.38E-03	5.51E-04	5.26E-04	8.50E-04
XRF - Silicon	1.01E-01	6.86E-02	5.82E-02	3.02E-03

Analyte	Duwamish (56 samples) Average (ug/m3)	Olive Street (34-35 samples) Average (ug/m3)	Tacoma South L (56 samples) Average (ug/m3)	Minimum Detection Level (ug/m3)
XRF - Silver	2.38E-03	2.50E-03	2.74E-03	4.20E-03
XRF - Sodium	2.97E-01	2.03E-01	2.02E-01	2.05E-02
XRF - Strontium	2.31E-03	1.39E-03	1.74E-03	1.01E-03
XRF - Sulfur	6.17E-01	4.69E-01	4.03E-01	2.65E-03
XRF - Tantalum	1.44E-03	1.46E-03	1.68E-03	7.84E-03
XRF - Terbium	2.82E-03	2.97E-03	1.47E-03	3.02E-03
XRF - Tin	8.62E-03	4.95E-03	4.98E-03	7.17E-03
XRF - Titanium	6.11E-03	4.76E-03	1.63E-03	8.30E-04
XRF - Vanadium	1.16E-02	6.68E-03	3.48E-03	6.00E-04
XRF - Wolfram	1.41E-03	1.30E-03	1.23E-03	5.54E-03
XRF - Yttrium	5.41E-04	5.57E-04	4.99E-04	1.22E-03
XRF - Zinc	1.86E-02	2.07E-02	1.08E-02	5.80E-04
XRF - Zirconium	1.22E-03	1.41E-03	9.50E-04	1.44E-03

Pm2.5 BLACK CARBON

Micrograms per Cubic Meter

Sampling Method: Light Absorption by Aethalometer

2006

Location	Number of Values	Quarterly Arithmetic Averages				Annual Mean	Max Value
		1st	2nd	3rd	4th		
Darrington HS, 1085 Fir St, Darrington	331	0.5	0.4	0.7	0.8	0.6	7.7
Marysville JHS, 1605 7th St, Marysville	322	1.0		0.9	1.2	1.0	4.2
17171 Bothell Way NE, Lake Forest Park	360	1.1	0.6	0.8	1.8	1.1	8.1
Olive & Boren, Seattle	343	1.7	1.2	1.2	1.9	1.5	5.9
Duwamish, 4752 E Marginal Way S, Seattle	218	1.7	1.5				5.6
7802 South L St, Tacoma	348	1.1	0.7	0.9	1.7	1.1	6.7

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	Feb 7 Tue	Jul 23 Sun	Dec 7 Thu	Dec 8 Fri	Dec 17 Sun
Darrington HS, 1085 Fir St, Darrington		7.7			
Marysville JHS, 1605 7th St, Marysville				4.2	
17171 Bothell Way NE, Lake Forest Park					8.1
Olive & Boren, Seattle			5.9		--
Duwamish, 4752 E Marginal Way S, Seattle	5.6				
7802 South L St, Tacoma					6.7

-- Indicates no sample on specified day

OZONE
(Parts per Million)
2006

Location / Continuous Sampling Period(s)	2006 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	2004	2005	2006	2004 - 2006
Beacon Hill, 15th S & Charlestown Seattle, Wa 3 Sep-30 Sep	.033	4 Sep	1200				
	.029	9 Sep	1600				
	.029	10 Sep	2000				
	.029	18 Sep	2000	.048	.043	.029	.040
	.027	3 Sep	1900				
	.026	30 Sep	2300				
20050 SE 56^{th} Lake Sammamish State Park, Wa 1 May-30 Sep	.088	22 Jul	2000				
	.087	21 Jul	1900				
	.073	26 Jun	1900				
	.070	16 May	1900	.063	.054	.070	.062
	.068	25 Jun	1900				
	.065	24 Jun	2000				
42404 SE North Bend Way, North Bend, Wa 1 May-30 Sep	.081	16 May	1900				
	.077	30 Jun	2000				
	.069	1 Jul	2000				
	.067	17 May	2000	.076	.061	.067	.068
	.067	26 Jun	2000				
	.065	25 Jun	2000				
30525 SE Mud Mountain Road, Enumclaw, Wa 1 May-30 Sep	.112	22 Jul	2000				
	.108	21 Jul	2000				
	.100	26 Jun	2000				
	.088	16 May	1900	.074	.063	.088	.075
	.084	23 Jul	1900				
	.083	30 Jun	2000				
Charles L Pack Forest La Grande, Wa 1 May-30 Sep	.109	22 Jul	2100				
	.093	21 Jul	1900				
	.088	26 Jun	2000				
	.080	25 Jun	2000	.071	.061	.080	.071
	.076	3 Sep	1900				
	.072	24 Jul	1900				
931 Northern Pacific Rd SE, Yelm, Wa 1 May-30 Sep	.084	22 Jul	2000				
	.072	21 Jul	2000				
	.069	25 Jun	1900				
	.068	3 Sep	1900	.065	.059	.068	.064
	.066	26 Jun	2000				
	.064	30 Jun	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.

OZONE
(Parts per Million)
2006

Location / Continuous Sampling Period(s)	Six Highest Daily Maximum 1 Hour Averages: Value	Date	End Time	Estimated No. of Days Daily Maximum 1 Hour Average Exceeded .12 ppm: 2004	2005	2006	No. of Days Daily Maximum 1 Hour Average Expected to Exceed .124 ppm
Beacon Hill, 15th S & Charlestown	.046	4 Sep	1500	0	0	0	0.0
Seattle, Wa	.040	7 Sep	1700				
3 Sep-30 Sep	.040	8 Sep	1700				
	.037	10 Sep	1500				
	.036	3 Sep	1400				
	.036	18 Sep	1500				
20050 SE 56th	.109	22 Jul	1800	0	0	0	0.0
Lake Sammamish State Park, Wa	.103	21 Jul	1700				
1 May-17 May, 3 Jun-30 Sep	.084	26 Jun	1600				
	.076	16 May	1500				
	.075	20 Jul	1700				
	.075	23 Jul	1500				
42404 SE North Bend Way,	.091	16 May	1700	0	0	0	0.0
North Bend	.088	30 Jun	1500				
1 May-30 Sep	.079	20 Aug	1800				
	.078	1 Jul	1700				
	.076	8 Jul	1700				
	.076	17 May	1700				
30525 SE Mud Mountain Road,	.134	21 Jul	1800	0	0	2	0.7
Enumclaw	.129	22 Jul	1600				
1 May-30 Sep	.113	26 Jun	1700				
	.098	16 May	1700				
	.097	23 Jul	1400				
	.093	30 Jun	1700				
Charles L Pack Forest	.123	22 Jul	1800	0	0	0	0.0
La Grande, Wa	.104	21 Jul	1500				
1 May-30 Sep	.094	26 Jun	1600				
	.091	25 Jun	1700				
	.090	3 Sep	1700				
	.088	24 Jul	1800				
931 Northern Pacific Rd SE,	.093	22 Jul	1400	0	0	0	0.0
Yelm, Wa	.081	21 Jul	1700				
1 May-30 Sep	.080	25 Jun	1600				
	.079	3 Sep	1600				
	.073	26 Jun	1700				
	.072	30 Jun	1600				

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)
2005

Monthly and Annual Arithmetic Averages

Location	Monthly Arithmetic Averages Jan	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	Jul	No of 1 Hour Samples	Year Arith Mean
Beacon Hill, 15th S & Charlestown, Seattle	.020	.024	.018	.015 .018	.015	.015	.017	6449	.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-16 Aug, 8 Sep-28 Sep, 1 Nov-12 Dec, 27 Dec-31 Dec	.078 .078	6 Jun 6 Jun	0000 0100

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)
2006

Location / Continuous Sampling Period(s)	Six Highest Concentrations					Number of 8 Hour Averages Exceeding 9 ppm	Number of Days 8 Hour Average Exceeded 9 ppm
	1 Hour Average			8 Hour Average			
	Value	Date	End Time	Value	Date		
44th Ave W & 196th St SW	3.3	24 Jan	2200	2.7	19 Feb	0	0
Lynnwood	3.0	24 Jan	1800	2.6	24 Jan		
1 Jan-26 Jun	3.0	24 Jan	2000	2.6	20 Feb		
	3.0	19 Feb	2200	2.2	25 Jan		
	3.0	3 Mar	0800	2.2	18 Feb		
	2.9	19 Feb	2100	2.1	20 Jan		
2421 148th Ave NE	5.1	8 Dec	2000	3.7	8 Dec	0	0
Bellevue	4.4	7 Dec	1900	3.4	7 Dec		
1 Jan-31 Dec	4.3	7 Dec	1700	3.2	9 Dec		
	4.3	7 Dec	1800	3.2	18 Dec		
	4.2	18 Dec	1800	2.9	24 Jan		
	4.1	8 Dec	2100	2.9	17 Dec		
University District, 1307 NE 45th St	3.4	19 Feb	2200	2.4	24 Jan	0	0
Seattle	3.0	20 Jan	2100	2.2	20 Jan		
1 Jan-26 Jun	3.0	10 Feb	2200	2.1	11 Feb		
	2.9	24 Jan	1900	2.1	19 Feb		
	2.9	26 Feb	2000	2.1	4 Jan		
	2.8	19 Feb	2000	2.1	10 Feb		
1424 4th Ave	2.8	25 Jun	1000	1.6	3 Jan	0	0
Seattle	2.0	3 Jan	0900	1.4	3 Apr		
1 Jan-29 Jan	1.9	24 Apr	0600	1.4	4 Apr		
1 Mar-26 Jun	1.9	3 Jan	0700	1.3	4 Jan		
	1.8	5 Apr	1600	1.3	21 Apr		
	1.8	4 Apr	0700	1.3	24 Apr		
Beacon Hill, 15th S and Charlestown	2.3	7 Feb	0900	1.5	7 Feb	0	0
Seattle	2.0	7 Feb	1000	1.1	26 Feb		
1 Jan-1 Mar	2.0	7 Feb	0800	0.9	19 Feb		
	1.4	7 Feb	1100	0.9	20 Feb		
	1.4	7 Feb	0700	0.8	23 Feb		
	1.3	26 Feb	1800	0.8	11 Feb		
1101 Pacific Ave	4.1	25 May	0500	2.3	7 Feb	0	0
Tacoma	3.8	26 Jun	2000	2.1	26 Feb		
1 Jan-30 Jun	3.6	5 Jan	1700	2.1	25 Jan		
	3.4	26 Feb	2300	2.0	19 Feb		
	3.2	7 Feb	1900	2.0	25 Feb		
	3.1	16 Jan	1700	1.9	20 Feb		

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)
2005

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		.006	.004	.005	.003		.003	8095	.004
		.005	.004	.003	.002	.002			

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	.044 .042	21 Oct 14 Aug	1800 0900	.030 .027	23 Feb 6 Apr	2300 1400	.020 .016	7 Apr 24 Feb	0100 1200

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
2005 Beacon Hill Statistical Summaries
Concentrations in parts per billion by volume (ppbv)

Statistic	Benzene	1,3-butadiene	Carbon Tetrachloride	Chloroform	Perc	Trichloroethylene	Acetaldehyde	Formaldehyde
2005 Count	60	60	60	60	60	60	56	56
Non detects	0	0	0	0	0	0	0	0
Median	0.116	0.022	0.100	0.032	0.030	0.025	0.800	1.050
Mean	0.176	0.035	0.100	0.047	0.034	0.030	0.813	1.055
95th Percentile	0.530	0.111	0.110	0.101	0.079	0.078	1.550	1.900
Maximum	0.700	0.130	0.120	0.140	0.110	0.097	1.900	2.700
MDL	0.009	0.018	0.010	0.020	0.010	0.009	0.009	0.016

Perc = tetrachloroethylene
All 60 vinyl chloride and 1,2-dichloropropane samples were non-detect (MDL for both is 0.05 ppb)
All air toxics data (VOC and metals) received from John Williamson, WA Department of Ecology.
MDL = minimum detection limit, provided by WA Department of Ecology.
TSP – total suspended particulate

Statistical Summaries for 2005 Beacon Hill Air Toxics PM_{10} Metals
Concentrations in nanograms per cubic meter (ng/m^3)

Statistic	Arsenic	Beryllium	Cadmium	Hexavalent Chromium TSP	Total Chromium	Lead	Manganese	Nickel
2005 Count	61	45	61	49	58	61	61	61
Non detects	0	16	0	10	2	0	0	0
Median	0.883	0.003	0.135	0.031	0.916	3.540	7.300	1.610
Mean	1.022	0.005	0.181	0.041	1.342	4.362	10.386	3.100
95th Percentile	2.510	0.009	0.400	0.101	3.229	9.840	34.800	12.600
Maximum	3.350	0.024	1.560	0.166	10.571	13.400	53.600	16.206
MDL	0.008	0.002	0.001	0.012	0.139	0.069	0.091	0.084

2005 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	IRIS
Acetaldehyde	2.2E-06	B2	IRIS
Nickel (Subsulfide) (M)	4.8E-04	A	IRIS
Tetrachloroethylene	5.9E-06	B2	CAL EPA[3]
Trichloroethylene	2E-06	B2	CAL EPA, EPA NATA[4]
Cadmium (M)	1.8E-03	B1	IRIS
Lead (M)	1.2E-05	B2	CAL EPA
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] California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. http://www.arb.ca.gov/toxics/healthval/healthval.htm.
[4] EPA. National Air Toxics Assessment. Health Effects Information. 1999. http://www.epa.gov/ttn/atw/nata1999/99pdfs/healtheffectsinfo.pdf.

2005 Beacon Hill Potential Cancer Risk Estimate per 1,000,000
Upper Bound – 95th Percentile

AIR TOXIC	UPPER-BOUND POTENTIAL RISK (95TH PERCENTILE)
Formaldehyde	30.3
Chromium (M)[5]	25.6
Benzene	13.2
Chloroform	11.3
Arsenic (M)	10.8
Carbon Tetrachloride	10.4
1,3-Butadiene	7.3
Acetaldehyde	6.1
Nickel (M)	6.0
Tetrachloroethylene	3.1
Trichloroethylene	0.8
Cadmium (M)	0.7
Lead (M)	0.1
Beryllium (M)	0.02
Manganese (M)	na

M = Metal, na = not applicable (manganese is not classified as a carcinogen)

[5] Chromium estimated risks are based on EPA's 1999 National Air Toxics Assessment (NATA) estimate that 66% of total chromium at Beacon Hill is hexavalent, the most toxic form. EPA 1999 National Air Toxic Assessment. http://www.epa.gov/ttn/atw/nata1999/.