DRAFT

AIR QUALITY TRENDS WASHINGTON, DC REGION 1993-2003

Department of Environmental Programs
Metropolitan Washington Council of Governments
Washington, DC

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Introduction

The U.S. Environmental Protection Agency (EPA) has established health standards (National Ambient Air Quality Standards, NAAQS) for six air pollutants. These six pollutants, which are also called the criteria air pollutants, are regulated under the federal Clean Air Act (CAA). Table 1 lists the criteria pollutants and their possible precursors.

Table 1: Criteria Pollutants and Precursors[a]

Carbon Monoxide (CO)
Sulfur Dioxide (SO_2)
Nitrogen Dioxide (NO_2)
Particulate Matter (PM)
Lead (Pb)
Ground-Level Ozone (O_3) *Precursors*: Volatile Organic Compounds (VOCs) Nitrogen Oxides (NO_x)

[a]*precursors of a criteria pollutant are chemical compounds that react in the air with other chemical compound(s) to form that criteria pollutant.*

In general, there are two types of ambient air quality standards - primary and secondary. The primary NAAQS are designed to protect human health and, by law, are established with an adequate margin of safety to protect all individuals. The secondary NAAQS are established to protect welfare-related values such as agricultural production, forests, building materials, and ecosystems. Sometimes the primary and secondary NAAQS have the same numerical value. For certain pollutants, no secondary standard has been established. Table 2 summarizes the NAAQS for all six criteria pollutants.

Table 2: National Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Carbon monoxide (CO)	1-Hour [a] 8-Hour [a]	35 ppm 9 ppm	None None
Sulfur dioxide (SO_2)	24-Hour [a] Annual [b] 3-Hour [a]	0.14 ppm 0.03 ppm -	- - 0.50 ppm
Nitrogen dioxide (NO_2)	Annual [b]	0.053 ppm	None
Particulate Matter: **PM_{10}**	24-Hour [a] Annual [b]	150 μg/m^3 50 μg/m^3	150 μg/m^3 50 μg/m^3
$PM_{2.5}$	24-Hour Annual	65 μg/m^3 15 μg/m^3	65 μg/m^3 15 μg/m^3
Lead (Pb)	Quarterly [b]	1.5 μg/m^3	1.5 μg/m^3
Ground-Level Ozone (O_3)	1-Hour [c] 8-Hour [d]	0.12 ppm 0.08 ppm	0.12 ppm 0.08 ppm

[a] Not to be exceeded more than once in a given year at any monitor.
[b] Not to be exceeded at any monitor.
[c] Not to be exceeded more than three times in three consecutive years at any monitor.
[d] The fourth highest daily concentration each year (averaged over 3 consecutive years) is not to exceed the standard.

The Metropolitan Washington Council of Governments (MWCOG) analyzes monitored air quality data in the Washington, DC region and prepares a synthesis report on the status of the air quality in the region. This information is useful for policy makers, local and state governmental planning agencies, the media, and the public with an interest in air quality trends in the national capital region. Figure 1 shows a map of the current air quality monitors in the Washington, DC region. Table 3 contains the location names and monitored air pollutants at each location.

This report presents an air quality data analysis for all criteria pollutants during an eleven year period, 1993-2003. Only those monitors located within the Washington, DC region, during this period, were used in preparing the data summaries. The measured data for the period 1993-2003 are presented in tables complimented by graphs in a manner that permits direct comparison to the NAAQS.

Air quality in the Washington, DC region is generally improving. Five of the six criteria pollutants in the region are meeting the minimum federal health standards. The region is in nonattainment of the federal health standard for one pollutant, ground-level ozone.

In general, ozone levels have decreased over the past decade. Ten years ago the Washington, DC region experienced twelve days with unhealthy ozone levels compared to six days in the most recent year.

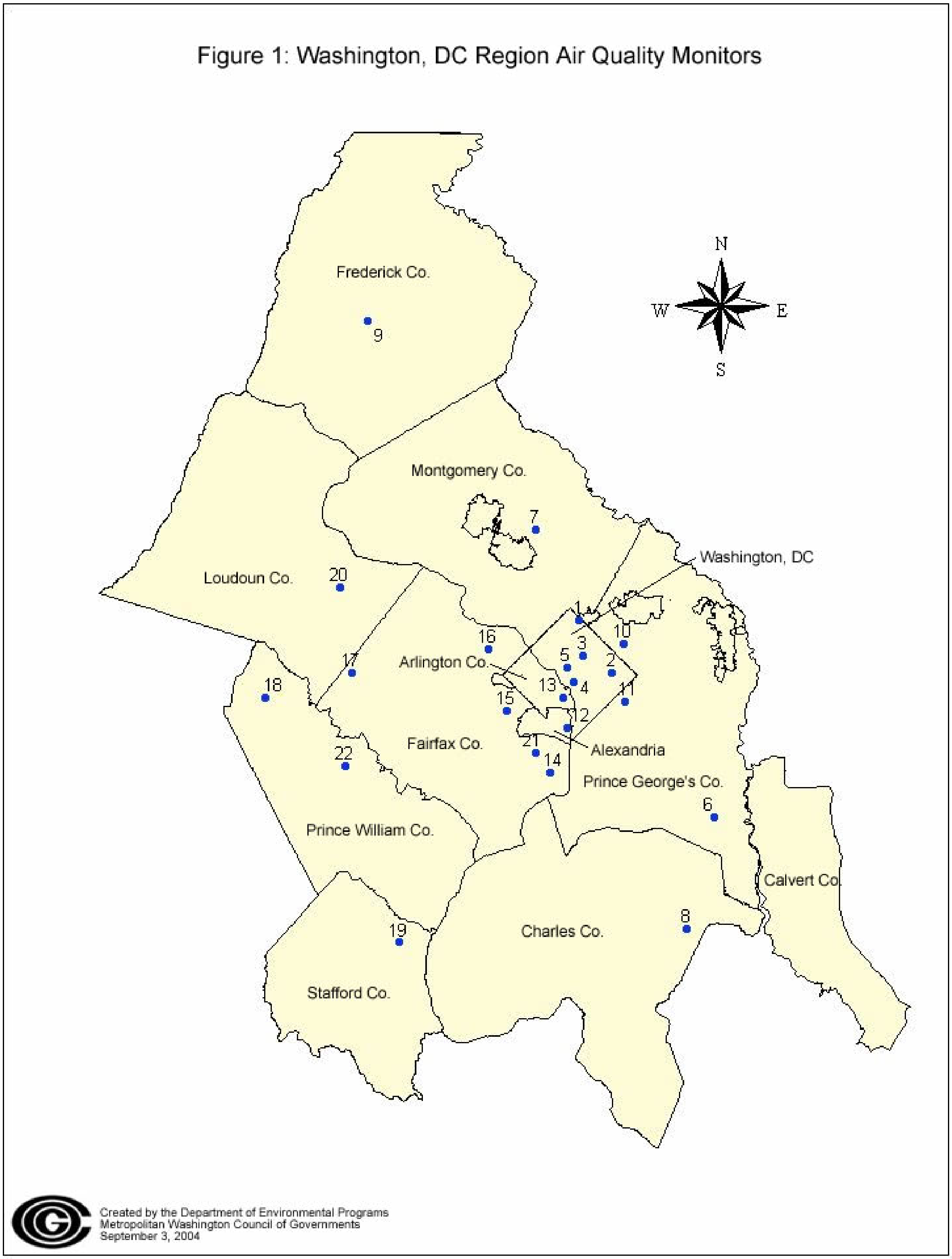


Table 3: Current Washington, DC Region Air Quality Monitors (Key to Figure 1)

Monitor Number	Monitor Name	Jurisdiction	Pollutants Monitored						
			O3	$PM_{2.5}$	PM_{10}	CO	NO_2	SO_2	PB
1	Takoma Park	Washington, DC	●				●		
2	River Terrace	Washington, DC	●	●	●	●	●	●	
3	McMillan	Washington, DC	●	●			●		
4	Park Services	Washington, DC		●					
5	C&P Telephone	Washington, DC				●			
6	PG Equestrian Center	Prince George's Co, MD	●	●					
7	Rockville	Montgomery Co, MD	●	●					
8	Southern Maryland	Charles Co, MD	●						
9	Frederick	Frederick Co, MD	●						
10	Bladensburg	Prince George's Co, MD		●					
11	Suitland	Prince George's Co, MD		●					
12	Alexandria	Alexandria, VA	●			●	●	●	
13	Aurora Hills	Arlington Co, VA	●	●		●	●		
14	Mount Vernon	Fairfax Co, VA	●		●				
15	Annandale	Fairfax Co, VA	●			●	●	●	
16	Lewinsville	Fairfax Co, VA	●	●		●	●	●	
17	Cub Run	Fairfax Co, VA	●		●	●	●	●	
18	James Long Park	Prince William Co, VA	●				●		
19	Widewater Elementary	Stafford Co, VA	●						
20	Ashburn	Loudoun CO, VA	●	●			●		
21	Franconia	Fairfax Co, VA	●	●		●			
22	Manassas	Prince William Co, VA			●				

O_3: Ozone $PM_{2.5}$: Particulate Matter 2.5 μm in diameter or less CO: Carbon Monoxide PB: Lead
NO_2: Nitrogen Dioxide PM_{10}: Particulate Matter 10 μm in diameter or less SO_2: Sulfur Dioxide

1.0 Ground-Level Ozone (O_3)

Health Effects and Sources

Ozone is a colorless odorless gas that can be found in the air we breathe. Each molecule of ozone has three atoms of oxygen. The additional oxygen atom makes ozone extremely reactive and irritating to tissues in the respiratory system.

Ozone exists naturally in the stratosphere, the Earth's upper atmosphere, where it shields the Earth from the sun's ultraviolet rays. However, ozone is also found close to the Earth's surface, where we live and breathe. There, ground-level ozone is an air pollutant.

High concentrations of ground-level ozone may cause inflammation and irritation of the respiratory tract, even during short exposures and particularly during heavy physical exercise. The resulting symptoms may include coughing, throat irritation, and difficulty breathing. Inhaling moderate amounts of ozone, for seven or eight hours, can reduce the ability of our lungs to function properly even in healthy individuals and may worsen asthma attacks in vulnerable people. Ozone may increase the susceptibility of the lungs to infections, allergens, and other air pollutants.

Ground-level ozone is not emitted directly into the air by specific sources. It is created by the chemical reaction between volatile organic compounds (VOCs) and oxides of nitrogen (NO_x), in the presence of sunlight and elevated temperatures. For this reason, ground-level ozone concentrations only become elevated during the warmer months of the year. In the Washington, DC region, almost all elevated ground-level ozone concentrations are recorded between May through September, during afternoon or early evening hours. Man-made sources of VOCs and NO_x are industrial and automobile emissions, commercial products such as paints, insecticides, and cleaners, and the evaporation of gasoline from large and small gasoline and diesel-powered engines. Plants and trees also emit VOCs, which combine especially quickly with NO_x to create ozone.

Nitrogen oxides and VOCs are also released from sources hundreds of miles away. Such transported emissions contribute to ground-level ozone in this region and elsewhere in the Eastern United States. Further progress in the control of transported ozone, as well as the implementation of our regional plan, will be needed to meet the ground-level ozone health standard.

National Ambient Air Quality Standards for Ground-Level Ozone

There are currently two primary NAAQS for ground-level ozone applicable in the Washington, DC region, 1-hour and 8-hour ozone standards. The Washington, DC region has been in violation of the health standard for ground-level ozone based on 1-hour average concentrations. In 1990, the U.S. EPA classified the Washington, DC region as a serious nonattainment area for meeting the 1-hour health standard. The Washington, DC region failed to meet the 1-hour ozone standard by the November 1999 attainment deadline, due to the influence of transported pollution. In 2001, the region was named in a lawsuit against the EPA for failure to attain the 1-hour ozone standard. This lawsuit stated that EPA was legally required to “bump up” any area that has not met the 1-hour standard by the required attainment date. As a result of this lawsuit, in January 2003 EPA “bumped up” and re-designated the Washington, DC region as a severe nonattainment area.

In 1997, EPA revised the air quality standards for ozone to better reflect new scientific health studies that demonstrated cumulative effects from exposure over an entire day. This new standard is based on an 8-hour averaging period. In June 2004, the EPA officially designated the Washington, DC region as moderate nonattainment for the 8-hour ozone standard.

Table 4: Ground-Level Ozone National Ambient Air Quality Standards

Averaging Period	Primary Standard	Secondary Standard
1-Hour	0.12 ppm	0.12 ppm
8-Hour	0.08 ppm	0.08 ppm

Ground-Level Ozone Trends

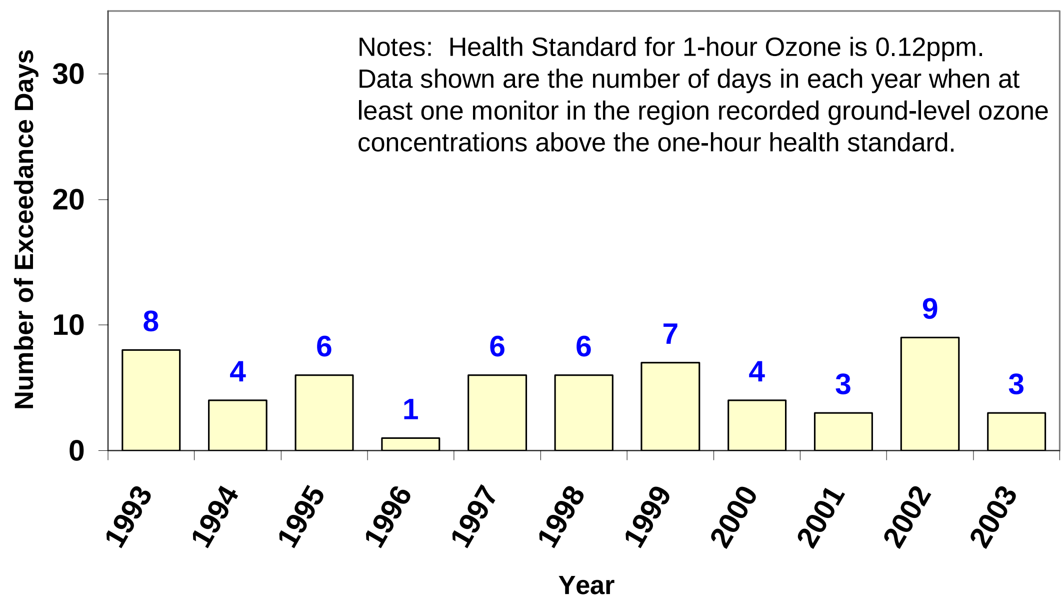
Trends analysis of ground-level ozone is complicated by the influence of weather systems on the formation of ozone. In particular, temperatures above 90 degrees, light winds, and stationary high pressure systems contribute to the formation of unhealthy ozone levels. Some years may have warmer and sunnier summers than other years and in those years, ozone levels can reach high values more often, although emission rates of ozone-forming precursors remain unchanged.

The influence of weather is partially removed by averaging the highest levels of ozone over a three-year period. This method is consistent with EPA's method of using three consecutive year periods as a basis for determining compliance.

<u>One-Hour Ozone Levels:</u>

The second-highest 1-hour ozone concentrations at each monitor in the region are given in Table A-1. Table A-2 gives the data on the first and second highest 1-hour levels in the region. Figure 2 shows the number of days in each year, since 1993, that the 1-hour NAAQS has been exceeded for at least one hour at one or more monitors. In the 1990’s, the region experienced an average of five days per year with the measured ozone levels exceeding the 1-hour standard. By 2003, such events occurred an average of four days per year.

Figure 2: Exceedances of 1-Hr Ozone Standard Washington, DC Region, 1993-2003



Figures 3 and 4 shows the peak and the second highest 1-hour ozone concentrations each year in the region. Both the highest and the second high show an overall downward trend in peak ozone concentrations. In 2003, peak ozone concentrations are approximately 6 parts per billion lower than the average peak concentrations in the 1990's.

Figure 3: Peak 1-Hour Ozone Levels Washington, DC Region, 1993-2003

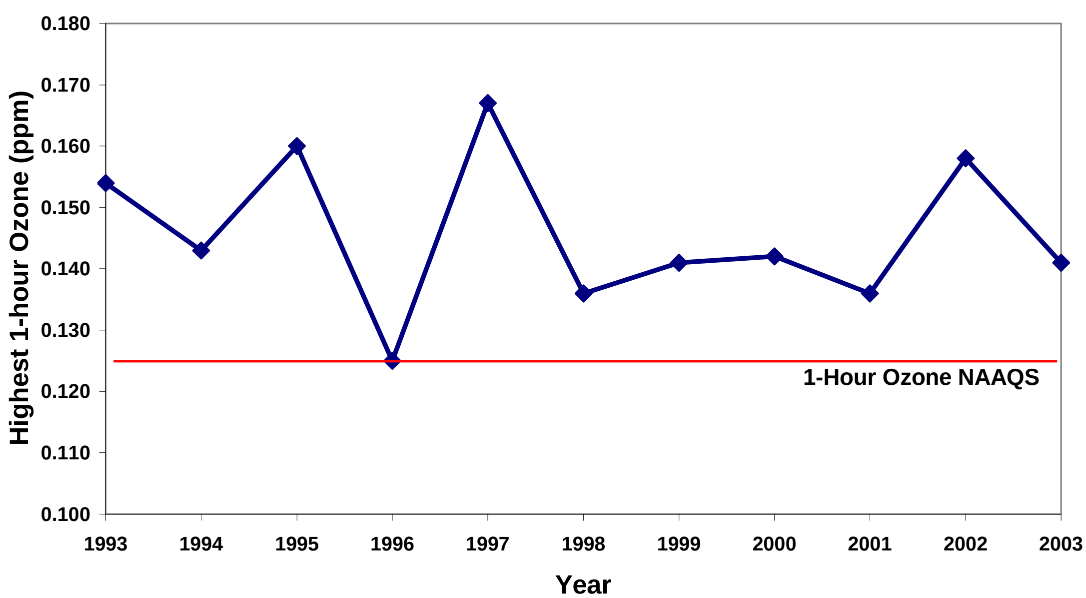
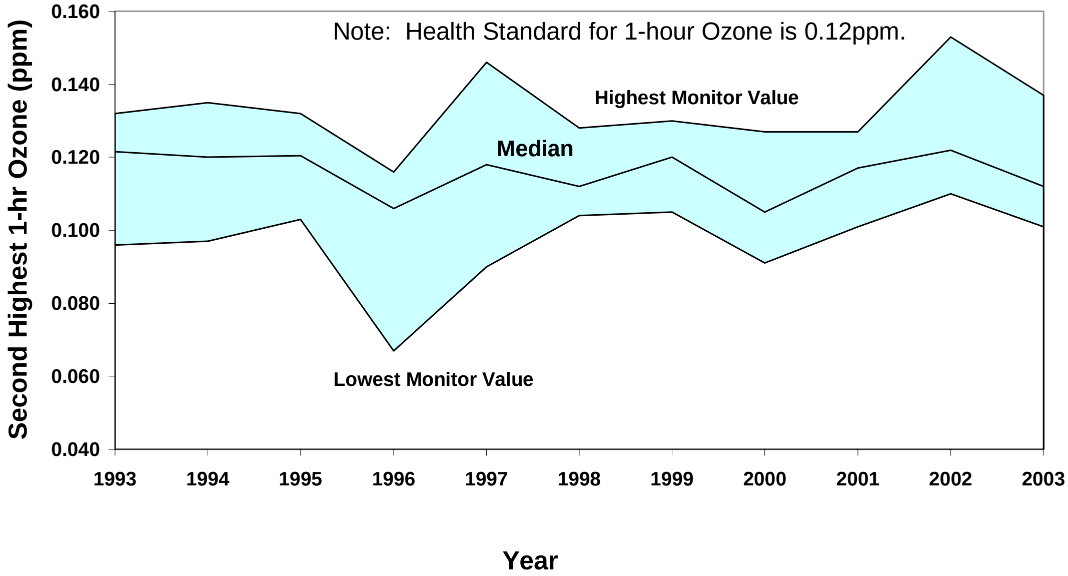


Figure 4: Second Highest 1-hr Ozone Levels
Washington, DC Region, 1993-2003



<u>Eight-Hour Average Ozone Levels:</u>
The fourth highest 8-hour ozone data statistics are tabulated in Table A-3 and Table A-4. Figure 5 shows how often this new ozone standard would have been exceeded, had it been in effect during the reporting period. Data shows that there is a gradual improvement in the number of exceedances of the 8-hour standard from year to year.

Figure 5: Exceedances of 8-Hour Ozone Standard
Washington, DC Region, 1993-2003

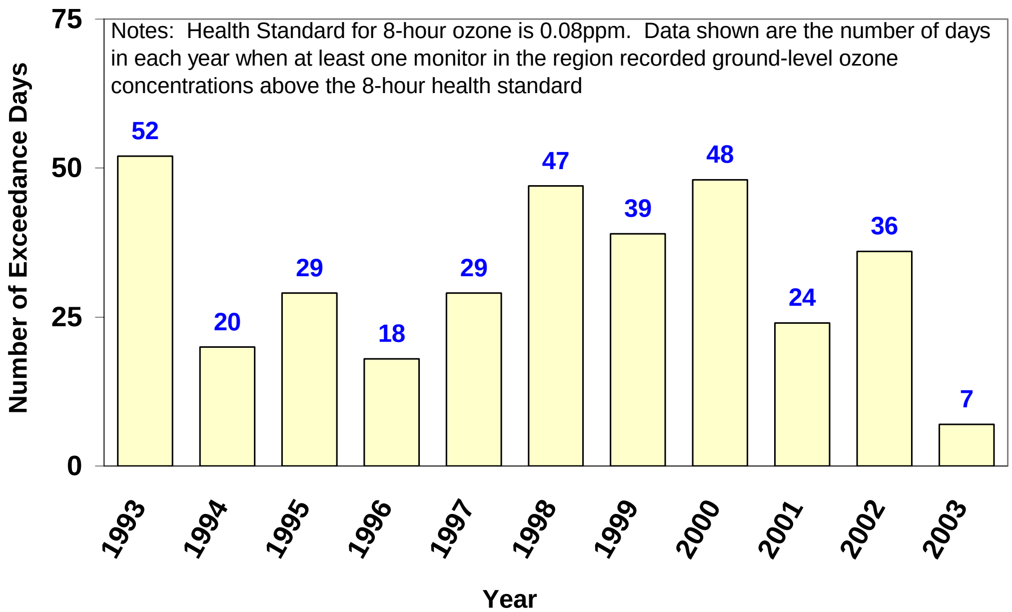
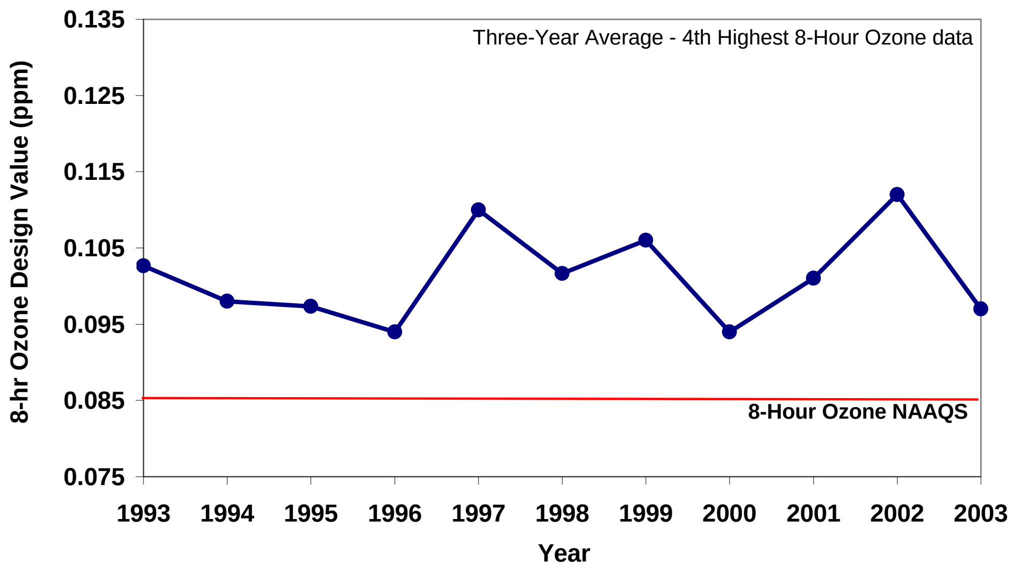


Figure 6 shows the three-year average fourth-highest 8-hour ozone levels in the region. EPA developed this averaging method as a means to remove some of the variability in ozone concentrations caused by the changing weather patterns. Even after averaging the data over the three-year period, there is no clear trend in the 8-hour ozone design values.

Figure 6: 8-Hr Ozone Design Values
Washington, DC Region, 1993-2003



Summary of Ozone Trends
All measures of controlling ground-level ozone and its precursor emissions in the Washington, DC region are gradually resulting in fewer days when the 1-hour ozone NAAQS are exceeded. In addition, 1-hour ground-level ozone concentrations on these days are generally lower now than ten years ago.

Data shows that there is a slight downward trend in the number of 8-hour ozone exceedances days per year. However, 8-hour ozone design values do not show a decrease in concentrations and remain above the NAAQS.

2. Carbon Monoxide (CO)

Health Effects and Sources
Carbon monoxide (CO) is a colorless, odorless, and in high concentrations, poisonous gas that forms when carbon in fuels is not completely burned. When CO enters the bloodstream, it reduces the capacity of the body to deliver oxygen to its organs and tissues, thus depriving the body of an essential for life. The health threat from ambient CO is most serious for those who suffer from particular cardiovascular diseases. Elevated CO levels can lead to visual impairment, reduced work capacity, poor learning ability, and difficulty in the performance of complex tasks. At still higher levels (levels that can occur in the indoor environment); CO can lead to headaches and nausea in

healthy persons. Fortunately, the health threat from current levels of ambient CO in the Washington, DC region is minimal for healthy individuals.

Carbon Monoxide concentrations in the ambient air mainly come from the incomplete combustion of fuels in motor vehicles. Concentrations tend to be highest in winter months as a result of the presence of thermal inversions in combination with the "cold starting" of automobile engines and the use of inefficient or poorly maintained space heating systems in certain local areas.

Other sources of CO emissions include industrial processes (such as metals processing and chemical manufacturing), residential wood burning, and natural sources such as forest fires. Woodstoves, gas stoves, cigarette smoke, and unvented gas and kerosene space heaters are sources of CO indoors.

National Ambient Air Quality Standards for CO

Table 5: CO National Ambient Air Quality Standards

Averaging Period*	Primary Standard	Secondary Standard
1-Hour	35 ppm	None
8-Hour	9 ppm	None

*Not to be exceeded more than once in a given year at any monitor.

Carbon Monoxide Trends

One measure of change in ambient CO is the trend in the second highest 8-hour daily concentration. The second highest 8-hour average level is used because the federal health standard permits one occurrence each year at each monitoring site to exceed the 8-hour NAAQS for CO (9 ppm). The NAAQS requires that the second highest be less than 9 ppm at all area monitors in order for the region to be in attainment.

Table A-5 shows that 8-hour averaged CO levels in the Washington, DC region have been steadily declining since 1990 and the region is in attainment of the health standards. Presented in Figure 7 are the second highest CO concentrations based on (a) 8-hour averages, and (b) 1-hour averages. Currently, the second highest 8-hour average CO levels at the highest regional monitor are approximately half of the NAAQS for CO.

Figure 7a: Carbon Monoxide - 2nd High 8-Hour Levels
Washington, DC Region, 1993-2003

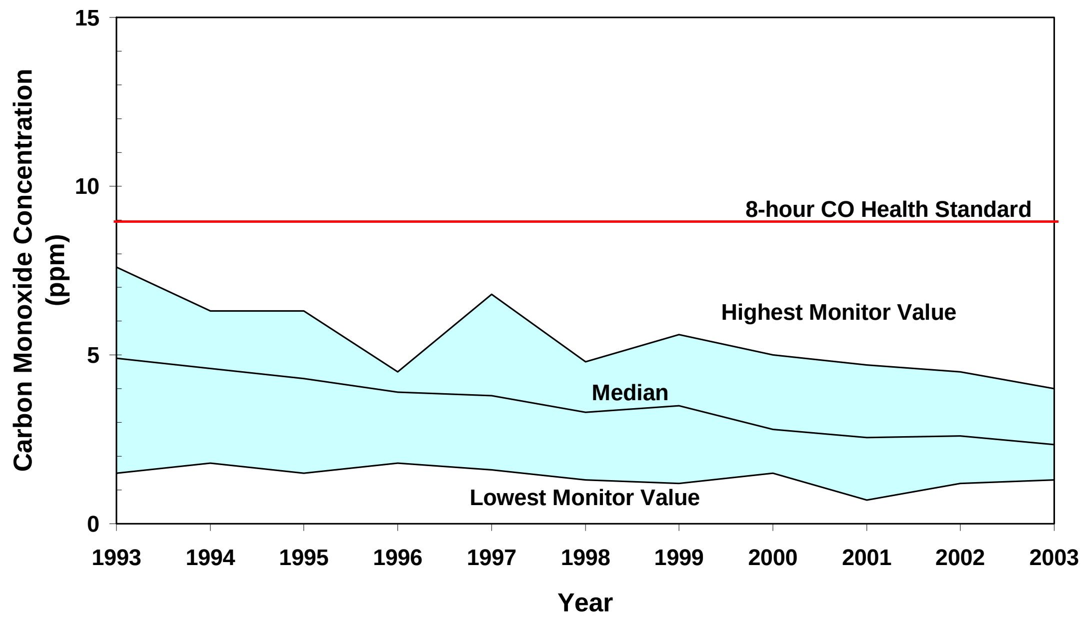
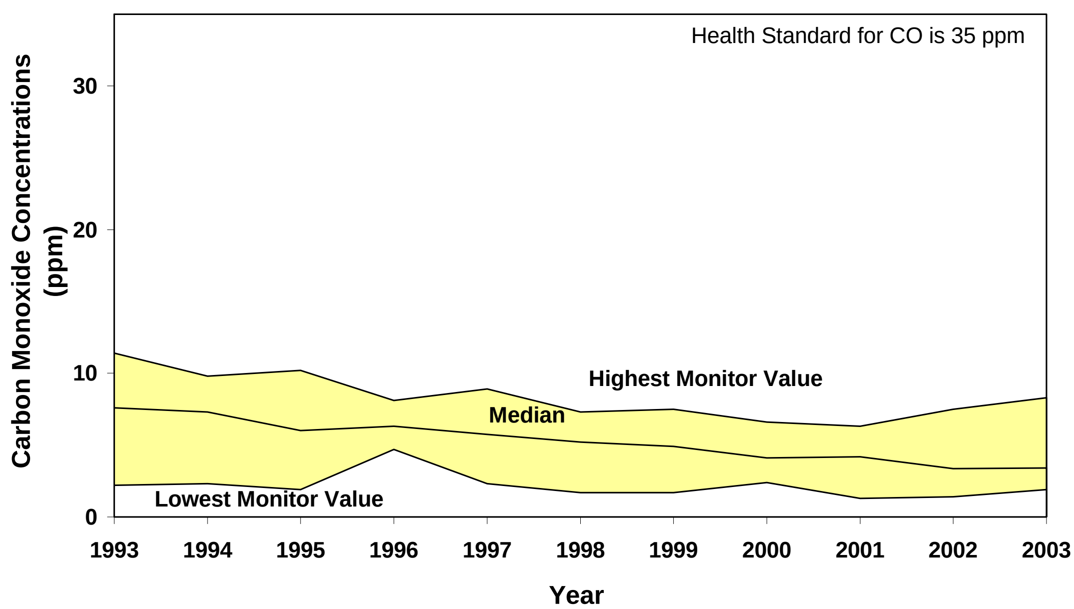


Figure 7b: Carbon Monoxide - 2nd High 1-Hour Levels
Washington, DC Region, 1993-2003



Another measure of progress is the second highest 1-hour average CO concentrations (Table A-8) at the highest recording monitors. Currently, the peak 1-hour concentrations are about one-fifth the magnitude of the 1-hour CO NAAQS.

Summary

Both the 8-hour and 1-hour data illustrate that carbon monoxide levels in the Washington, DC region have been steadily improving for the past decade. Since 1990, both 1-hour and 8-hour averaged CO concentrations are below the health standards at all monitors in the region.

3. Sulfur Dioxide (SO_2)

Health Effects and Sources

Sulfur dioxide is a gas that forms when sulfur-bearing fuels (mainly coal and oil) are burned. SO_2 can also be released into the air during certain industrial processes. High concentrations of SO_2 can result in difficulties in breathing, respiratory illness, the aggravation of existing cardiovascular disease, and can cause alterations in the lung's defenses. The primary ambient air quality standard is intended to protect against these adverse health effects.

SO_2 can produce damage to the foliage of trees and agricultural crops. The presence of both sulfur dioxide and nitrogen dioxide can also lead to acidic deposition (acid rain). For this reason, EPA has also established a secondary ambient air quality standard for SO_2 based on 3-hour averaged concentrations.

National Ambient Air Quality Standards for SO_2

For the region as a whole, all monitors must be in attainment with both primary standards for the region to be considered in attainment with the primary NAAQS.

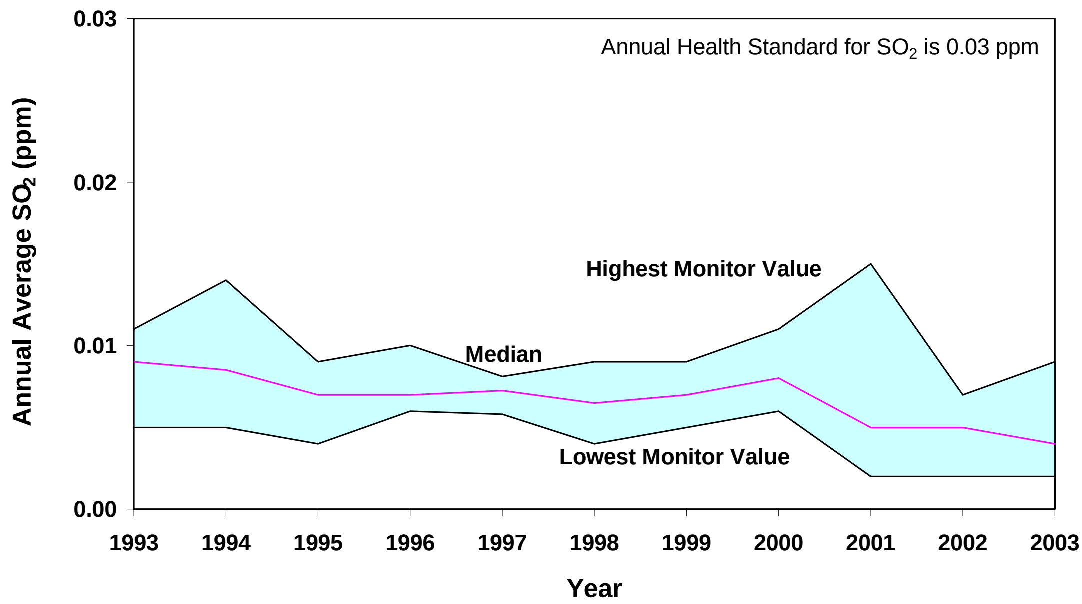
Table 6: SO_2 National Ambient Air Quality Standards

Averaging Period	Primary Standard	Secondary Standard
24-Hour	0.14 ppm	-
Annual	0.03 ppm	-
3-Hour	-	0.50 ppm

SO_2 Trends

A general characterization of SO_2 concentrations in the Washington, DC region is that levels are low and declining. Figure 8 and Table A-7 show the annual average SO_2 concentrations at both the highest and the lowest monitors in the region in each year for the analysis period, 1993-2003. The data show that in recent years the highest SO_2 levels in the region have been approximately one-fourth of the federal health standard value of 0.03 ppm. Additionally, there have not been any recorded exceedances of the 24-hour federal health standard of 0.14 ppm at any of the monitors during the entire analysis period.

Figure 8: Sulfur Dioxide, SO_2 - Annual Averages
Washington, DC Region, 1993-2003



Summary
All monitors in the Washington, DC region are well within each of the sulfur dioxide NAAQS.

4. Nitrogen Dioxide (NO_2)

Health Effects and Sources
Nitrogen dioxide is a gaseous pollutant, one of a class of compounds called oxides of nitrogen (NO_x). NO_2 can irritate the lungs and lower resistance to respiratory infections. NO_2 is a brownish and highly chemically reactive gas. It is formed during the high-temperature combustion of fuels, both in vehicle engines and in industrial facilities, primarily electric generating power plants. NO_2 plays a major role in the atmospheric reactions that produce ground-level ozone in the warmer months.

National Ambient Air Quality Standards for NO_2
EPA has established a long-term (annual average) ambient air quality standard for NO_2, as follows. There is no secondary standard for this pollutant.

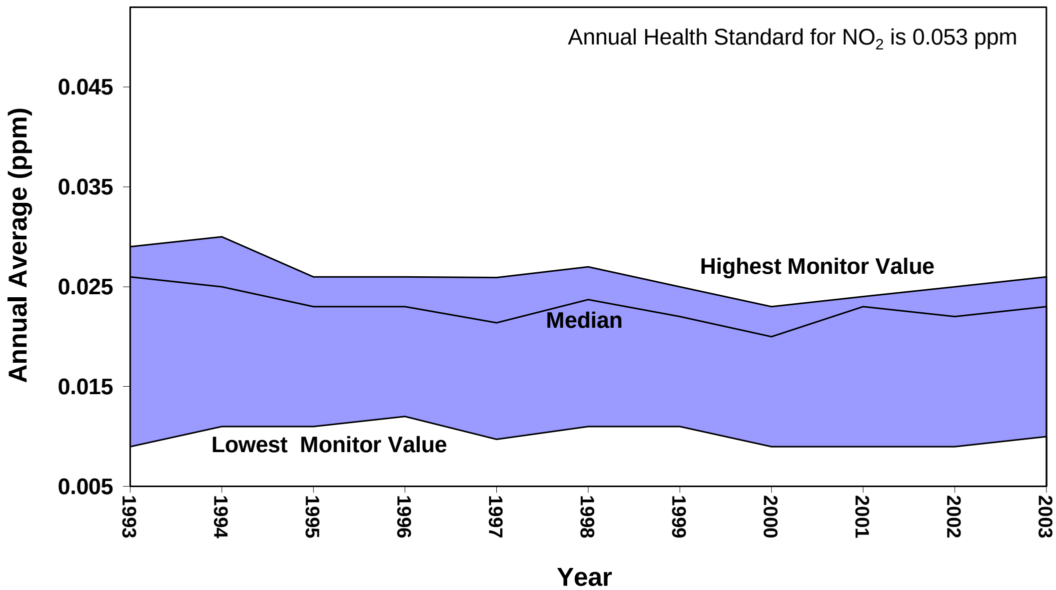
Table 7: NO_2 National Ambient Air Quality Standards

Averaging Period	Primary Standard	Secondary Standard
Annual	0.53 ppm	None

NO_2 Trends

Figure 9 and Table A-8 show the annual average NO_2 concentrations at both the highest and the lowest monitors in the region in each year for the analysis period, 1993-2003. There seems to be no discernable trend in the annual NO_2 values in the region. However, during the past ten years, the maximum annual average NO_2 levels are approximately half of the federal standard at the highest recording monitors in the region.

Figure 9: Nitrogen Dioxide (NO_2) - Annual Averages
Washington, DC Region, 1993-2003



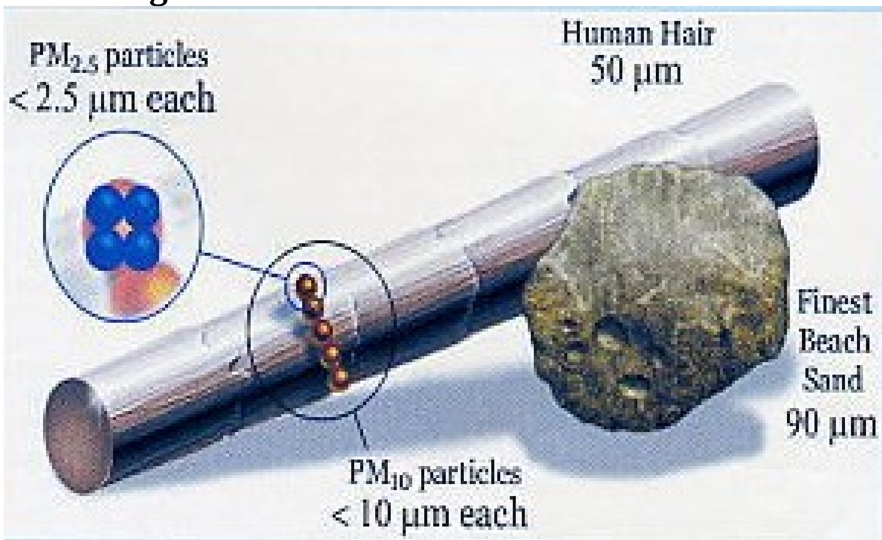
Summary
All monitors in the Washington, DC region are well within each of the nitrogen dioxide NAAQS.

5. Particulate Matter (PM)
Particulate Matter is a mixture of microscopic solid and liquid droplets suspended in air. This pollution is comprised of a number of components including acids (nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as pollen or mold spores).

The size of the particles is directly related to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into the lungs and some may even get into the bloodstream. Exposure to such particles can affect both the respiratory and cardiovascular systems. Larger particles are of less concern, although they can irritate the eyes, nose, and throat.

The two types of particles the region is required to monitor are PM_{10} and $PM_{2.5}$. PM_{10} refers to those particles less than 10 microns in diameter. $PM_{2.5}$ refers to those particles less than 2.5 microns in diameter. Figure 10 graphically depicts the relative size of both PM_{10} and $PM_{2.5}$.

Figure 10: The Size of Particulate Matter



Particulate matter in the region is measured by two types of methods; the federal reference method and the continuous monitor method. Federal reference method instruments acquire deposits over 24-hour periods on filters from ambient air drawn into the monitor through an inlet. This method requires the samples to be sent to a laboratory for analysis.

To make particulate matter data available to the public in a timely manner, continuous monitors are also used in the Washington, DC region. These monitors collect particle data on an hourly basis. Since these monitors collect particle samples more frequently, this data is used to calculate the Air Quality Index posted on the MWCOG website.

Health Effects and Sources

Particulate matter comprises a broad class of aerosol particles from fine smokes and soots (products of incomplete combustion) to larger sized dusts and industrially generated particles. Particulate matter also includes particles formed by reactions in the atmosphere from gaseous pollutants. The largest components of particulates in urban areas along the east coast are sulfates formed from SO_2 emissions.

Concerns about the health effects of breathing particles include potential damage to the respiratory and cardiovascular systems, lung tissue damage, cancer, and premature death. Particulate matter is a major cause of reduced visibility in many regions and national parks, and it can also cause damage to building materials.

National Ambient Air Quality Standards for Particulate Matter

The national ambient air quality standards for PM_{10} were established in 1987. These should not be confused with the newer standards for very fine particles, known as $PM_{2.5}$. In 1997, the EPA established a new health standard for fine particulate (particles with aerodynamic diameters of less than 2.5 microns, $PM_{2.5}$).

Table 8: Particulate Matter National Ambient Air Quality Standard

Pollutant	Averaging Time	Primary Standard	Secondary Standard
PM_{10}	24-Hour [a] Annual [b]	150 µg/m^3 50 µg/m^3	150 µg/m^3 50 µg/m^3
$PM_{2.5}$	24-Hour Annual	65 µg/m^3 15 µg/m^3	65 µg/m^3 15 µg/m^3

PM_{10} Trends

The federal health standard for particulate matter was changed in 1987 from Total Suspended Particulate (TSP) to PM_{10} in order to reflect the fact that non-respirable particles greater than 10 microns in diameter were being measured by the TSP samplers then in place. Therefore, the trend data for PM_{10} begin with the year 1989 data when broad scale PM_{10} sampling began in this area.

Particulate matter data measured as PM_{10} are presented in Figure 11 and 12. Figure 11 shows the annual averages of PM_{10} levels at both the highest and lowest regional monitors in the Washington, DC region. Figure 12 shows the maximum PM_{10} 24-hour concentrations.

Figure 11: Particulate Matter, PM_{10} - Annual Averages
Washington, DC Region, 1993-2003

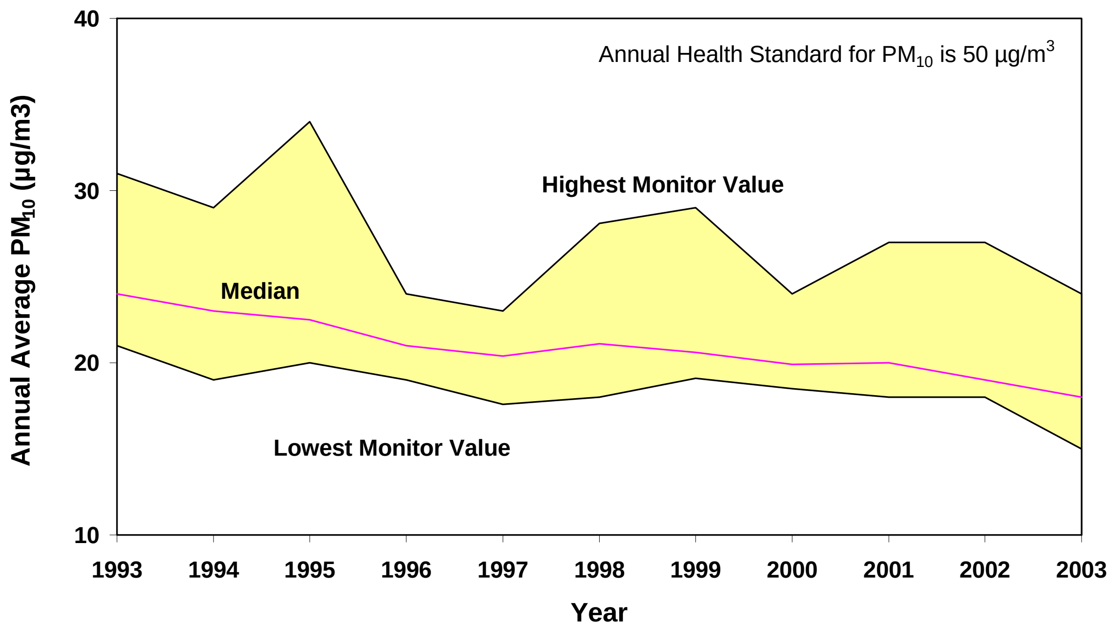
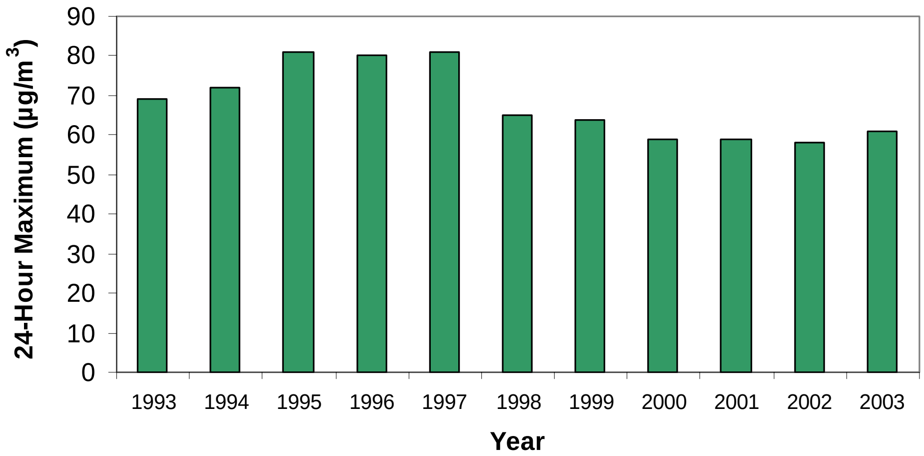


Figure 12: PM$_{10}$ 24-Hour Maximum - Washington, DC Region, 1993-2003



PM$_{2.5}$ Trends

A new federal health standard for particulate matter was created in 1997 for PM$_{2.5}$. The Washington, DC region trend analysis for PM$_{2.5}$ begins with the data from 1999, when broad scale PM$_{2.5}$ sampling began in this area.

Particulate matter data measured as PM$_{2.5}$ are presented in Figure 13 and 14. Figure 13 shows the annual average PM$_{2.5}$ design values for the Washington, DC region. Data show a general downward trend.

Figure 13: Particulate Matter, PM$_{2.5}$ - Annual Averages Washington, DC Region, 1999-2003

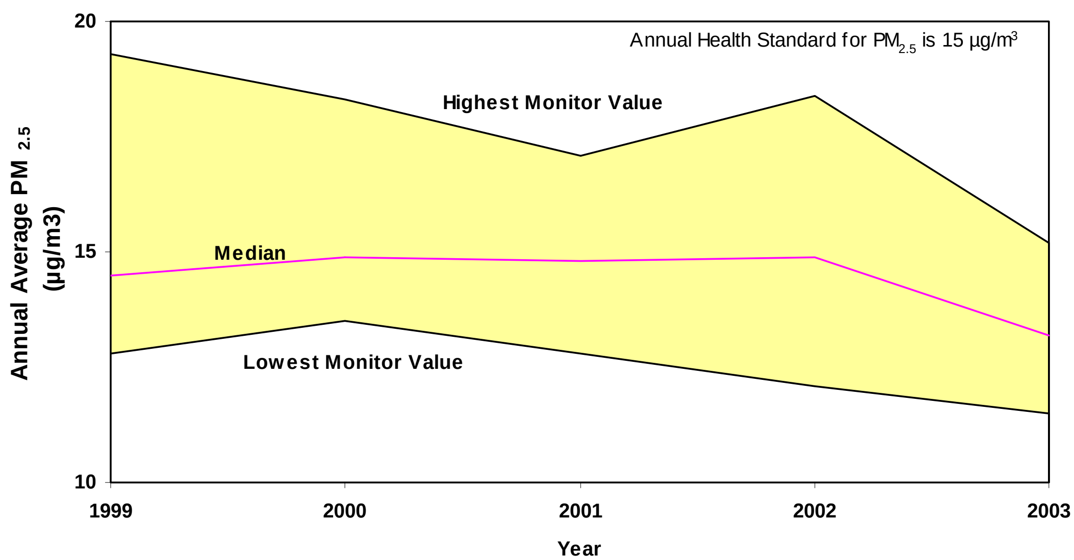
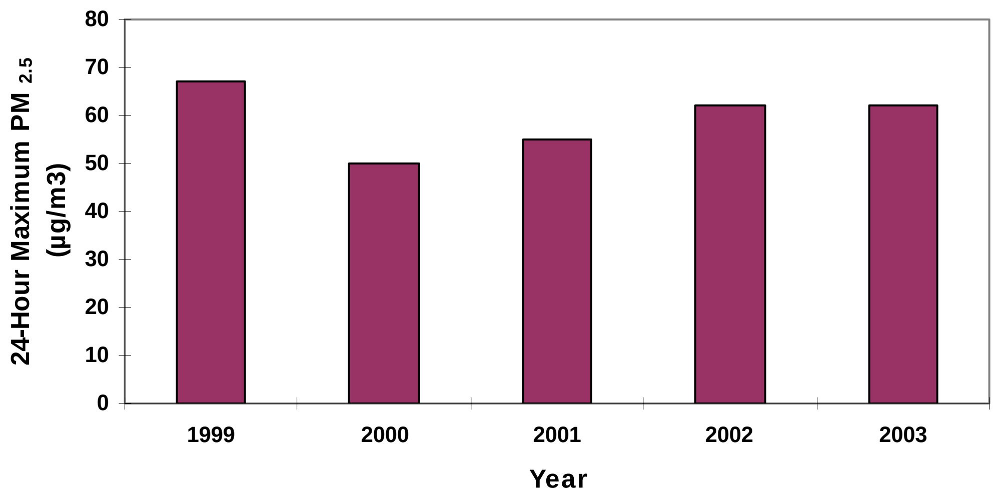


Figure 14 shows 24-hour average $PM_{2.5}$ design values for the Washington, DC region for the same period. Data shows that the Washington, DC region is well below the 24-hour $PM_{2.5}$ NAAQS.

Figure 14: $PM_{2.5}$ 24-Hour Maximum Washington, DC Region, 1999-2003



Summary
All monitors in the metropolitan area are well within each of the PM_{10} NAAQS.

The Washington, DC region began monitoring for $PM_{2.5}$ in 1999. Since that time, data has shown that the region is not meeting the annual $PM_{2.5}$ standard of 15 $\mu g/m^3$. However, the region remains well below the 24-hour $PM_{2.5}$ standard.

7. Lead (Pb)

Health Effects and Sources
Lead in the ambient air mainly derives from soils and dusts that have acquired lead from older paints and other lead-containing construction material. The elimination of lead as an additive to motor fuels two decades ago has substantially reduced lead in ambient atmospheres.

Exposure to lead is a serious health concern because lead can accumulate in the body in blood, bone, and soft tissue. Excessive exposure may cause anemia, kidney disease, reproductive disorders and neurological impairments. Even at low doses, lead exposure is associated with fundamental processes in the body. For children, susceptibility to low doses may lead to central nervous system damage or slowed growth.

National Ambient Air Quality Standards for Pb

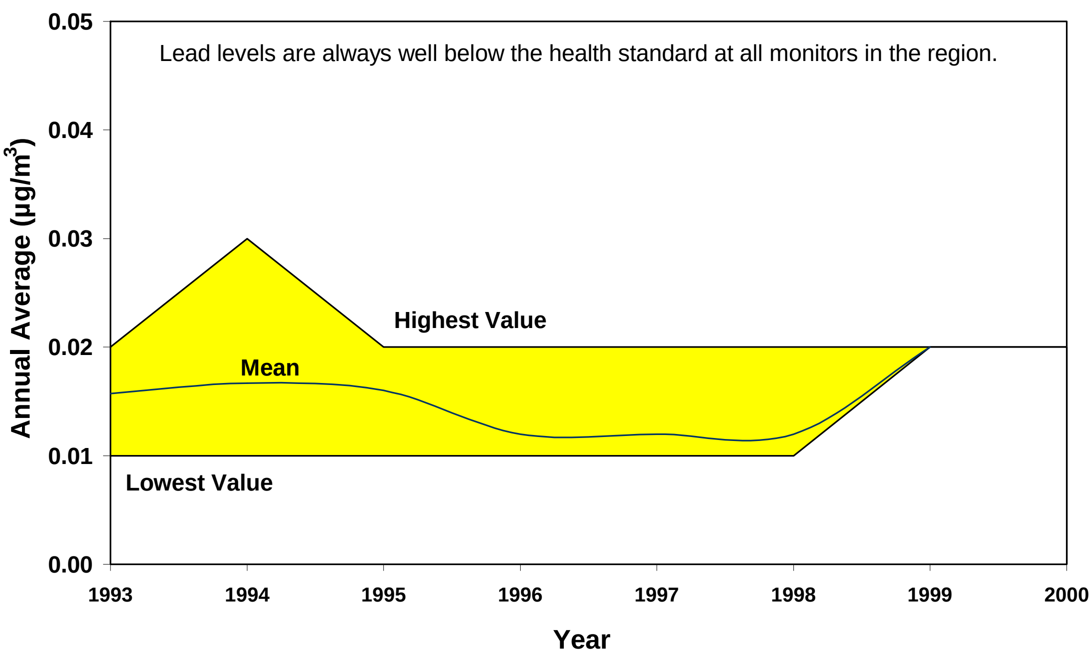
Table 9: Pb National Ambient Air Quality Standards

Averaging Period	Primary Standard	Secondary Standard
Quarterly	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$

Pb Trends

Lead levels are low and in steady decline. Ambient lead data are summarized in Figure 15 and Table A-10. The worst case lead concentrations fell three-fold in the mid-1980s, and have continued a slower but clear decline since. The ambient levels of Pb are uniformly very low in the region, and the concentrations range between 10-15 percent of the health standard value.

Figure 15: LEAD (Pb) - Annual Averages
Washington, DC Region, 1993-2000



Summary

All monitors in the Washington, DC region are well within each of the Pb NAAQS.

Appendix A

Table A-1: Second Highest 1-Hour Ozone Data (1993-2003) (ppm)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
West End Library	0.096	0.112	0.103	0.067							
Takoma	0.107	0.121	0.123	0.106	0.116	0.112	0.117	0.112	0.126	0.119	0.108
River Terrace	0.123	0.122	0.117	0.106	0.127	0.112	0.120	0.119	0.117	0.140	0.112
McMillan		0.133	0.125	0.110	0.128	0.116	0.129	0.105	0.125	0.143	0.110
Calvert				0.094	0.116	0.112	0.112	0.113	0.107		
Southern Maryland	0.124	0.104	0.112	0.099	0.125	0.123	0.130	0.111	0.109	0.122	0.119
Frederick							0.114	0.108	0.117	0.107	0.105
Rockville	0.121	0.113	0.121	0.108	0.117	0.122	0.113	0.091	0.114	0.110	0.113
Greenbelt	0.132	0.128	0.123	0.116	0.139	0.128	0.130	0.128	0.119	0.119	0.120
Suitland	0.120	0.123	0.124	0.106	0.134	0.125	0.121	0.106	0.126		
PG Equestrian										0.140	0.137
Beltsville	0.123	0.135									
Arlington	0.125	0.127	0.118	0.112	0.126	0.110	0.130	0.107	0.121	0.149	0.118
Cub Run	0.122	0.120	0.131	0.095	0.090	0.127	0.114	0.095	0.109	0.117	0.094
Mt Vernon	0.130	0.116	0.120	0.116	0.106	0.125	0.121	0.114	0.115	0.153	0.127
Franconia							0.120	0.093	0.117	0.137	0.113
Annandale										0.137	0.112
Seven Corners	0.125	0.125	0.119	0.105	0.119	0.119	0.113	0.101			
Lewinsville	0.106	0.115	0.132	0.106	0.107	0.104	0.114	0.105	0.121	0.122	0.105
Ashburn						0.104	0.105	0.088	0.111	0.117	0.101
Long Park	0.112	0.097	0.126	0.098	0.106	0.098	0.109	0.094	0.101	0.113	0.105
Stafford	0.115	0.105	0.111	0.100	0.108	0.101	0.120	0.095	0.106	0.119	0.107
Alexandria	0.121	0.115	0.115	0.093	0.124	0.109	0.123	0.099	0.117	0.143	0.119
Highest	*0.132*	*0.135*	*0.132*	*0.116*	*0.139*	*0.128*	*0.130*	*0.128*	*0.126*	*0.153*	*0.137*
Lowest	*0.096*	*0.097*	*0.103*	*0.067*	*0.090*	*0.098*	*0.105*	*0.088*	*0.101*	*0.107*	*0.094*
Median	*0.122*	*0.120*	*0.121*	*0.106*	*0.118*	*0.112*	*0.120*	*0.105*	*0.117*	*0.122*	*0.112*

Table A-2: Peak 1-Hour Ozone Concentrations and Exceedances (1993-2003) (ppm)

	Highest Monitor Highest 1-Hr	Lowest Monitor Highest 1-Hr	Highest Monitor 2nd Highest 1-Hr	Lowest Monitor 2nd Highest 1-Hr	3-Year Average Highest 1-Hr	3-Year Average 2nd Highest 1-Hr	Number of 1-Hr Exceedance Days	Number of 8-Hr Exceedance Days
1993	0.154	0.102	0.132	0.096	0.142	0.129	8	52
1994	0.143	0.105	0.135	0.097	0.152	0.133	4	20
1995	0.160	0.115	0.132	0.103	0.143	0.128	6	29
1996	0.125	0.083	0.116	0.067	0.151	0.131	1	18
1997	0.167	0.109	0.146	0.090	0.143	0.130	6	29
1998	0.136	0.113	0.128	0.104	0.148	0.137	6	47
1999	0.141	0.111	0.13	0.105	0.140	0.128	7	39
2000	0.142	0.097	0.127	0.091	0.140	0.128	4	48
2001	0.136	0.108	0.127	0.101	0.145	0.136	3	24
2002	0.158	0.114	0.153	0.11	0.145	0.139	9	36
2003	0.141	0.108	0.137	0.101	0.150	0.145	3	7

Table A-3: Fourth Highest 8-Hour Average Ozone Data (1993-2003) (ppm)

MONITOR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
West End Library	0.073	0.071	0.080	0.055							
Takoma	0.085	0.091	0.095	0.087	0.090	0.098	0.097	0.094	0.088	0.097	0.079
River Terrace	0.087	0.097	0.078	0.077	0.086	0.091	0.094	0.081	0.092	0.102	0.082
McMillian	0.093	0.099	0.088	0.088	0.096	0.102	0.103	0.083	0.097	0.106	0.081
Calvert				0.083	0.087	0.092	0.104	0.089	0.087		
Southern Maryland	0.109	0.083	0.093	0.087	0.102	0.105	0.106	0.088	0.091	0.098	0.093
Frederick						0.095	0.095	0.086	0.094	0.095	0.077
Rockville	0.096	0.092	0.097	0.085	0.096	0.097	0.092	0.083	0.095	0.092	0.078
Greenbelt	0.101	0.090	0.101	0.091	0.110	0.104	0.104	0.090	0.099	0.098	0.083
Suitland	0.102	0.087	0.098	0.086	0.095	0.104	0.099	0.080	0.101		
PG Equestrian										0.101	0.097
Beltsville	0.103	0.096									
Arlington	0.101	0.090	0.098	0.084	0.094	0.098	0.100	0.081	0.098	0.112	0.087
Cub Run	0.100	0.084	0.094	0.079	0.079	0.103	0.092	0.079	0.093	0.092	0.083
Mt. Vernon	0.104	0.093	0.095	0.089	0.088	0.101	0.100	0.092	0.095	0.106	0.091
Franconia						0.097	0.099	0.076	0.096	0.108	0.089
Annandale										0.108	0.083
Seven Corners	0.098	0.089	0.095	0.083	0.093	0.099	0.093	0.080			
Lewinsville	0.084	0.084	0.098	0.077	0.080	0.090	0.087	0.083	0.09	0.099	0.075
Ashburn						0.102	0.090	0.076	0.093	0.102	0.083
Long Park	0.082	0.097	0.082	0.082	0.086	0.098	0.089	0.080	0.089	0.087	0.086
Stafford	0.085	0.089	0.081	0.081	0.091	0.092	0.092	0.079	0.086	0.094	0.085
Alexandria	0.096	0.088	0.091	0.070	0.085	0.094	0.096	0.078	0.091	0.103	0.083
Highest	*0.109*	*0.099*	*0.101*	*0.091*	*0.110*	*0.105*	*0.106*	*0.094*	*0.101*	*0.112*	*0.097*
Lowest	*0.073*	*0.071*	*0.078*	*0.055*	*0.079*	*0.090*	*0.087*	*0.076*	*0.086*	*0.087*	*0.075*
Median	*0.094*	*0.089*	*0.092*	*0.081*	*0.091*	*0.098*	*0.096*	*0.083*	*0.093*	*0.100*	*0.084*

Table A-4: Three-Year Average Fourth Highest 8-Hour Ozone Data (1993-2003) (ppm)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
West End Library	0.074	0.071	0.075								
Takoma	0.086	0.086	0.090	0.091	0.091	0.092	0.095	0.096	0.093	0.093	0.088
River Terrace	0.096	0.096	0.087	0.084	0.080	0.085	0.090	0.089	0.089	0.092	0.092
McMillian		0.096	0.093	0.092	0.091	0.095	0.100	0.096	0.094	0.095	0.095
Calvert					0.085	0.087	0.094	0.095	0.093		
Southern Maryland	0.103	0.097	0.095	0.088	0.094	0.098	0.104	0.100	0.095	0.092	0.094
Frederick							0.095	0.092	0.092	0.092	0.089
Rockville	0.092	0.091	0.095	0.091	0.093	0.093	0.095	0.091	0.090	0.090	0.088
Greenbelt	0.101	0.095	0.097	0.094	0.110	0.102	0.106	0.099	0.098	0.096	0.093
Suitland	0.097	0.093	0.096	0.090	0.093	0.095	0.099	0.094	0.093		
Beltsville	0.102	0.098								0.101	0.099
Arlington	0.096	0.092	0.096	0.091	0.092	0.092	0.097	0.093	0.093	0.097	0.099
Cub Run	0.091	0.088	0.093	0.086	0.084	0.087	0.091	0.091	0.088	0.088	0.089
Mt. Vernon	0.100	0.096	0.097	0.092	0.091	0.093	0.096	0.098	0.096	0.098	0.097
Franconia							0.098	0.091	0.090	0.093	0.098
Seven Corners	0.099	0.091	0.094	0.089	0.090	0.092	0.095	0.091		0.108	0.096
Lewinsville	0.088	0.085	0.089	0.086	0.085	0.082	0.086	0.087			
Ashburn							0.096	0.089	0.087	0.091	0.088
Long Park	0.086	0.091	0.087	0.087	0.083	0.089	0.091	0.089	0.086	0.090	0.093
Stafford	0.079	0.089	0.085	0.084	0.084	0.088	0.092	0.088	0.086	0.085	0.087
Alexandria	0.090	0.089	0.092	0.083	0.082	0.083	0.092	0.089	0.086	0.086	0.088
Highest	*0.103*	*0.098*	*0.097*	*0.094*	*0.110*	*0.102*	*0.106*	*0.100*	*0.098*	*0.108*	*0.099*
Lowest	*0.074*	*0.071*	*0.075*	*0.083*	*0.080*	*0.082*	*0.086*	*0.087*	*0.086*	*0.085*	*0.087*
Median	*0.093*	*0.091*	*0.091*	*0.089*	*0.089*	*0.091*	*0.095*	*0.092*	*0.091*	*0.093*	*0.093*

Table A-5: Second Highest 8-Hour Average Carbon Monoxide Data (1993-2003) (ppm)

MONITOR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
West End Library	6.7	5.5	4.5	3.3							
C&P Telephone	7.6	5.1	6.2	4.5	5.2	4.4	3.5	3.3	4.7	3.2	3.2
River Terrace	6.3	6.3	5.3	4.2	6.4	4.6	5.6	5.0	4.5	4.5	4.0
Rockville Pike	4.4	4.2	3.4	3.0	2.5						
Bladensburg	5.9	6.1	6.3	4.5	6.8	4.8	4.3				
Arlington	4.9	4.1	4.6	4.0	2.4	2.3	3.8	2.7	2.7	2.6	2.5
Cub Run					1.6	1.3	1.2	1.5	1.3	1.2	1.4
Mt Vernon	1.5	1.8	1.5	1.8	4.3	3.3					
Seven Corners	4.1	4.8	4.3	3.9	2.1	1.7	2.1	2.3	1.7		
Lewinsville	3.2	2.3	2.6	3.0	4.6	2.6	3.1	3.5	3.0	2.3	2.7
Alexandria	5.4	4.6	4.0	4.4	3.3	3.5	3.6	2.9	2.4	2.4	2.8
Massey	4.8	4.4	3.8	3.7							
Franconia							1.8	1.9	1.9	1.5	1.5
Annandale										1.5	1.6
Highest	*7.6*	*6.3*	*6.3*	*4.5*	*6.8*	*4.8*	*5.6*	*5.0*	*4.7*	*4.5*	*4.0*
Lowest	*1.5*	*1.8*	*1.5*	*1.8*	*1.6*	*1.3*	*1.2*	*1.5*	*1.3*	*1.2*	*1.4*
Median	*4.9*	*4.6*	*4.3*	*3.9*	*3.8*	*3.3*	*3.5*	*2.8*	*2.6*	*2.4*	*2.6*

Table A-6: Second Highest 1-Hour Average Carbon Monoxide Data (1993-2003) (ppm)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
West End Library	8.4	7.5	7.0	7.0							
C&P Telephone	11.4	7.3	7.8	7.5	6.8	6.7	5.4	5.9	5.2	7.5	8.3
River Terrace	8.5	8.2	7.0	6.3	7.4	6.7	7.3	6.6	6.3	5.6	7.6
Rockville Pike	6.4	6.4	4.7	4.9	3.7						
Bladensburg	8.5	9.8	10.2	8.1	8.9	7.3	7.5				
Arlington	8.2	6.6	6.0	6.1	3.7	4.0	4.9	3.5	2.8	3.4	4.1
Cub Run					2.3	1.7	1.7	2.4	1.7	1.4	1.9
Mt Vernon	2.2	2.3	1.9	5.0	6.7	6.4					
Seven Corners	7.6	8.8	7.1	6.0	4.1	3.0	3.2	4.2	2.8		
Lewinsville	4.3	4.4	3.6	4.7	7.2	4.4	7.0	5.6	4.6	3.3	3.3
Alexandria	7.6	7.6	5.9	6.3	4.8	5.2	4.7	4.0	4.3	4.0	3.5
Massey	6.1	6.1	5.1	7.4							
Franconia							3.4	2.8	2.6	2.7	2.4
Annandale										2.1	2.2
Highest	*11.4*	*9.8*	*10.2*	*8.1*	*8.9*	*7.3*	*7.5*	*6.6*	*6.3*	*7.5*	*8.3*
Lowest	*2.2*	*2.3*	*1.9*	*4.7*	*2.3*	*1.7*	*1.7*	*2.4*	*1.7*	*1.4*	*1.9*
Median	*7.6*	*7.3*	*6.0*	*6.3*	*5.8*	*5.2*	*4.9*	*4.1*	*3.6*	*3.4*	*3.4*

Table A-7: Annual Average SO_2 Concentrations (1993-2003) (ppm)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
West End Library	0.011	0.011	0.009	0.010							
Garrison School	0.010	0.014									
River Terrace	0.010	0.009	0.007		0.007	0.007	0.007	0.008	0.007	0.007	0.008
Cub Run	0.005	0.005	0.004	0.006	0.008	0.005	0.006	0.008	0.004	0.004	0.003
Mt Vernon	0.008	0.007	0.006	0.006	0.006	0.004					
Seven Corners	0.009	0.008	0.007	0.009	0.008	0.008	0.007	0.010	0.015		
Lewinsville	0.009	0.008	0.007	0.007	0.008	0.009	0.009	0.010	0.007	0.007	0.005
Alexandria	0.009	0.009	0.007	0.007	0.007	0.006	0.005	0.006	0.006	0.006	0.006
Annandale										0.005	0.006
Highest	*0.011*	*0.014*	*0.009*	*0.010*	*0.008*	*0.009*	*0.009*	*0.011*	*0.015*	*0.007*	*0.008*
Lowest	*0.005*	*0.005*	*0.004*	*0.006*	*0.006*	*0.004*	*0.005*	*0.006*	*0.004*	*0.004*	*0.003*
Median	*0.009*	*0.009*	*0.007*	*0.007*	*0.007*	*0.007*	*0.007*	*0.008*	*0.007*	*0.006*	*0.006*

Table A-8: Annual Average NO_2 Concentrations (1993-2003) (ppm)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
West End Library	0.027	0.030	0.025	0.026							
Takoma	0.026	0.027	0.023	0.024	0.022	0.024	0.022	0.020	0.023	0.023	0.025
River Terrace	0.028	0.025	0.025		0.025	0.027	0.024	0.023	0.024	0.024	0.023
McMillan	0.026	0.019	0.020		0.017	0.018	0.018	0.018	0.024	0.023	0.023
Arlington	0.025	0.025	0.023	0.024	0.022	0.025	0.025	0.023	0.022	0.022	0.026
Cub Run	0.011	0.011	0.011	0.012	0.011	0.011	0.011	0.010	0.009	0.009	0.010
Mt Vernon	0.021	0.020	0.018	0.020	0.019						
Seven Corners	0.026	0.026	0.023	0.022	0.020	0.024	0.023	0.020	0.023	0.018	0.018
Lewinsville	0.028	0.025	0.022	0.022	0.024	0.022	0.020	0.021	0.020	0.019	0.023
Long Park	0.009	0.011	0.011		0.010	0.013	0.012	0.009	0.014	0.014	0.012
Alexandria	0.029	0.028	0.026	0.026	0.026	0.027	0.025	0.023	0.023	0.025	0.023
Ashburn							0.014	0.013	0.014	0.014	0.016
Highest	*0.029*	*0.030*	*0.026*	*0.026*	*0.026*	*0.027*	*0.025*	*0.023*	*0.024*	*0.025*	*0.026*
Lowest	*0.009*	*0.011*	*0.011*	*0.012*	*0.010*	*0.011*	*0.011*	*0.009*	*0.009*	*0.009*	*0.010*
Median	*0.026*	*0.025*	*0.023*	*0.023*	*0.021*	*0.024*	*0.022*	*0.020*	*0.023*	*0.022*	*0.023*

Table A-9: Annual Average PM_{10} Concentrations (1993-2003) ($\mu g/m^3$)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
West End Library	25	26	23		23	28	29		21		
Connecticut Avenue	24	23	26		22	27	21		27		
River Terrace	30	27	28	23		22				27	24
Frederick Elementary	31	29	34								
Rockville			32								
Stonemill Elementary	24	21									
Suitland	24	23	22	21	22	24	24	23	23		
Arlington	21	21	21	19	18	21					
Cub Run	22	19	20	19	19	18	19	19	18	18	15
Mount Vernon	25	23	22	21	22	22	21	22	21	19	18
Seven Corners	23	21	21	20	21	19					
Brandon Avenue	24	23	23	23	20	21	20	19	19	19	20
Lewinsville	23	21	22	21	18	20					
Manassas	21	21	21	19	20	20	20	20	18	18	16
Cameron Station	23	24	23	24							
Loudoun County					17						
Highest	*31*	*29*	*34*	*24*	*23*	*28*	*29*	*23*	*27*	*27*	*24*
Lowest	*21*	*19*	*20*	*19*	*18*	*18*	*19*	*19*	*18*	*18*	*15*
Median	*24*	*23*	*23*	*21*	*20*	*21*	*21*	*20*	*21*	*19*	*18*

Table A-10: Annual Average Pb Concentrations (1993-2000) ($\mu g/m^3$)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000
Connecticut Avenue	0.02	0.01	0.02	0.01	0.01	0.01	0.02	
Railroad	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02
Rockville Pike	0.02	0.02						
Mt. Vernon	0.01	0.01	0.01	0.01	0.01	0.01		
Furnace Road	0.02	0.03	0.02	0.02	0.02	0.02		
Brandon Avenue	0.01	0.01	0.01	0.01	0.01	0.01		
Highest	*0.02*	*0.03*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*
Lowest	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*
Median	*0.02*	*0.02*	*0.02*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*