

Air

Quality

Trends

Washington, DC Metropolitan Area  
1993-2004



**AIR QUALITY TRENDS  
METROPOLITAN WASHINGTON, D.C. REGION  
1993-2004**

**Department of Environmental Programs  
Metropolitan Washington Council of Governments  
Washington, D.C.**

**August 2005**

## Table of Contents

1. Introduction		1
2. Section 1	Ground-Level Ozone	5
	1-hour Ozone Trends	8
	8-hour Ozone Trends	10
3. Section 2	Carbon Monoxide	13
4. Section 3	Sulfur Dioxide	15
5. Section 4	Nitrogen Dioxide	17
6. Section 5	Particulate Matter	18
	PM <sub>10</sub> trends	20
	PM <sub>2.5</sub> trends	22
7. Section 6	Lead	23

## **Figures**

Figure 1: Washington, D.C. Region Air Quality Monitors

Figure 2: Number of 1-hour Exceedances of the Ozone Standard, 1993-2004

Figure 3: Peak 1-hour Ozone Concentrations, 1993-2004

Figure 4: 1-hour Ozone Design Values, 1993-2004

Figure 5: Spatial Extent of 1-hour Ozone Exceedances

Figure 6: Number of 8-hour Exceedances of the Ozone Standard, 1993-2004

Figure 7: Peak 8-hour Ozone Concentrations, 1993-2004

Figure 8: 8-hour Ozone Design Values, 1993-2004

Figure 9: Carbon Monoxide, CO - 2nd Highest Concentrations, 1993-2004  
a) 8-hour Averages, b) 1-hour Averages

Figure 10: Sulfur Dioxide, SO<sub>2</sub> - Annual Average Concentrations, 1993-2004

Figure 11: Nitrogen Dioxide, NO<sub>2</sub> - Annual Average Concentrations, 1993-2004

Figure 12: The Size of Particulate Matter

Figure 13: Particulate Matter, PM<sub>10</sub> - Annual Average Concentrations, 1993-2004

Figure 14: Particulate Matter, PM<sub>10</sub> - 24-hour Maximum Concentrations, 1993-2004

Figure 15: Particulate Matter, PM<sub>2.5</sub> - Annual Average Concentrations, 1999-2004

Figure 16: Particulate Matter, PM<sub>2.5</sub> - 24-hour Average Concentrations, 1999-2004

Figure 17: Lead, Pb - Annual Average Concentrations, 1993-2000

## **Tables**

Table 1: List of Criteria Pollutants

Table 2: National Ambient Air Quality Standards of Criteria Pollutants

Table 3: Metropolitan Washington, D.C. Region Air Quality Monitors

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

Table 5: Ozone Nonattainment Areas

Table 6: Meteorological and Exceedance Data for the Metropolitan Washington, D.C. Region

Table 7: National Ambient Air Quality Standards for Carbon Monoxide

Table 8: National Ambient Air Quality Standards for Sulfur Dioxide

Table 9: National Ambient Air Quality Standards for Nitrogen Dioxide

Table 10: National Ambient Air Quality Standards for Particulate Matter

Table 11: National Ambient Air Quality Standards for Lead

## **Appendix A**

Table A-1: 1-hour Ozone Data by Monitor - Maximum Concentrations, 1993-2004

Table A-2: Four Highest 1-hour Ozone Levels, 1993-2004

Table A-3: 8-hour Ozone Data by Monitor – Maximum Concentrations, 1993-2004

Table A-4: Four Highest 8-hour Ozone Levels, 1993-2004

Table A-5: Three-Year Average 8-hour Ozone Concentrations, 1993-2004

Table A-6: 8-hour Average Carbon Monoxide Concentrations, 1993-2004

Table A-7: 1-hour Average Carbon Monoxide Concentrations, 1993-2004

Table A-8: Annual Average Sulfur Dioxide Concentrations, 1993-2004

Table A-9: Annual Average Nitrogen Dioxide Concentrations, 1993-2004

Table A-10: Annual Average PM<sub>10</sub> Concentrations, 1993-2004

Table A-11: Annual Average PM<sub>2.5</sub> Concentrations, 1999-2004

Table A-12: Annual Average Lead Concentrations, 1993-2000

## **Appendix B**

How to Find Additional Information

## 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<sup>a</sup>**

Carbon Monoxide (CO)
Sulfur Dioxide (SO <sub>2</sub> )
Nitrogen Dioxide (NO <sub>2</sub> )
Particulate Matter (PM)
Lead (Pb)
Ground-Level Ozone (O <sub>3</sub> ) <i>Precursors: Volatile Organic Compounds (VOCs) Nitrogen Oxides (NO<sub>x</sub>)</i>

<sup>a</sup>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
Ground-Level Ozone (O <sub>3</sub> )	1-hour <sup>c</sup>	0.125 ppm	0.125 ppm
	8-hour <sup>d</sup>	0.085 ppm	0.085 ppm
Carbon monoxide (CO)	1-hour <sup>a</sup>	35 ppm	None
	8-hour <sup>a</sup>	9 ppm	None
Sulfur dioxide (SO <sub>2</sub> )	24-hour <sup>a</sup>	0.14 ppm	-
	Annual <sup>b</sup>	0.03 ppm	-
	3-hour <sup>a</sup>	-	0.50 ppm
Nitrogen dioxide (NO <sub>2</sub> )	Annual <sup>b</sup>	0.053 ppm	None
Particulate Matter: PM <sub>10</sub>	24-hour <sup>a</sup>	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>
	Annual <sup>c</sup>	50 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>
PM <sub>2.5</sub>	24-hour <sup>f</sup>	65 µg/m <sup>3</sup>	65 µg/m <sup>3</sup>
	Annual <sup>e</sup>	15 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
Lead (Pb)	Quarterly <sup>b</sup>	1.5 µg/m <sup>3</sup>	1.5 µg/m <sup>3</sup>

<sup>a</sup> Not to be exceeded more than once in a given year at any monitor.

<sup>b</sup> Not to be exceeded at any monitor.

<sup>c</sup> Not to be exceeded more than three times in three consecutive years at any monitor.

<sup>d</sup> The 4th Highest daily concentration each year (averaged over 3 consecutive years) is not to exceed the standard.

<sup>e</sup> The 3-year average of the weighted annual mean concentration at each monitor must not exceed the standard.

<sup>f</sup> The 3-year average of the 98th percentile at each monitor must not exceed the standard.

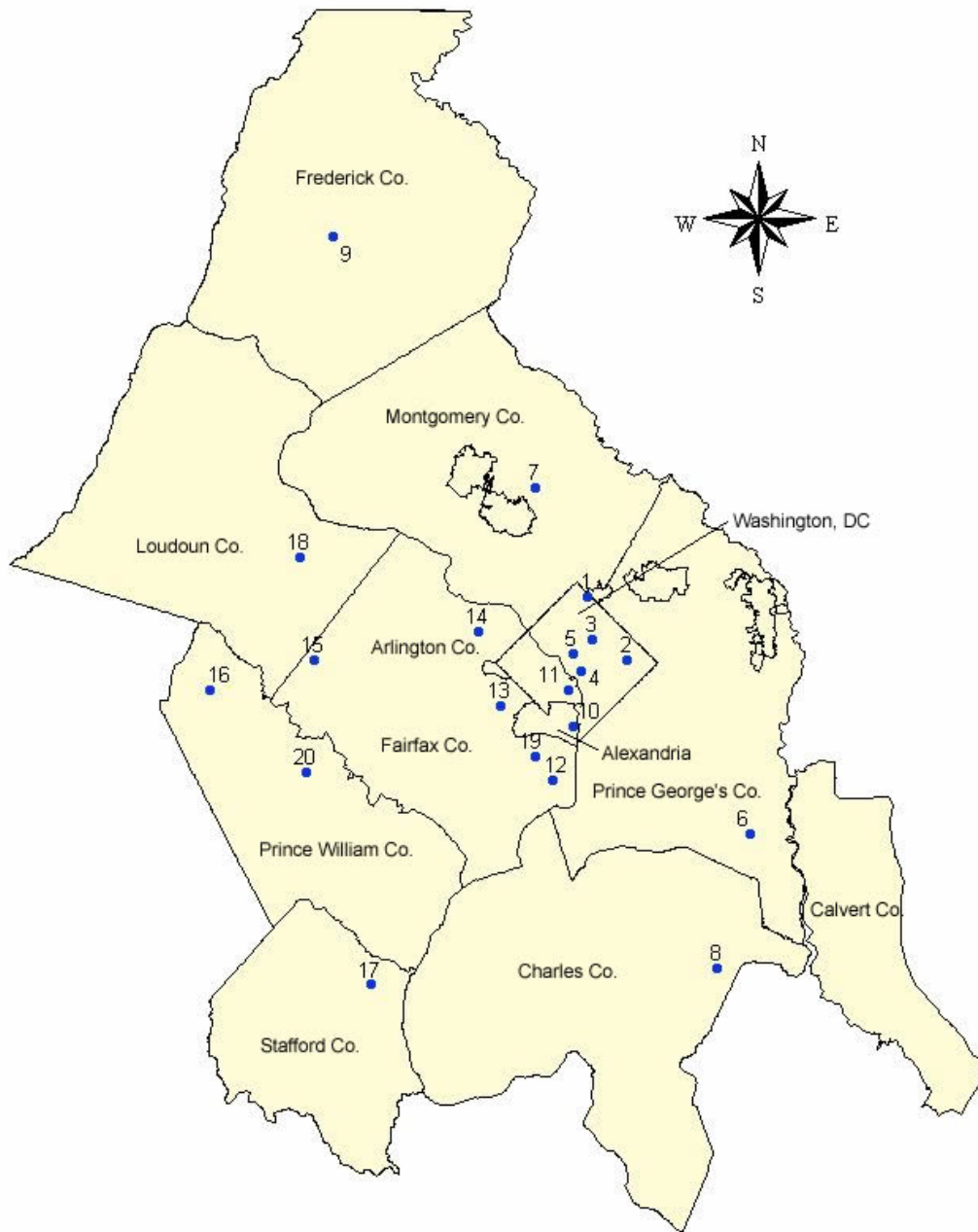
The Metropolitan Washington Council of Governments (MWCOG) analyzes monitored air quality data in the Metropolitan Washington, D.C. region and prepares a synthesis report on the status of the air quality in the region. This information is useful for policy makers, local and state governmental planning 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 air quality monitors in the Metropolitan Washington, D.C. 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, 1993-2004. During this period, only monitors located within the Metropolitan Washington, D.C. region were used in preparing the data summaries. The measured concentrations for the period 1993-2004 are presented in tables complimented by graphs in a manner that permits direct comparison to the NAAQS.

Air quality in the Metropolitan Washington, D.C. region is generally improving. The region meets the minimum federal health standards for four of the six criteria pollutants. The region is in nonattainment of the federal health standard for two pollutants, ground-level ozone and fine particles.

In general, pollution levels have decreased over the past decade. Ten years ago the Metropolitan Washington D.C. region experienced an average of six days with unhealthy ozone levels compared to two days in the most recent year. Furthermore, some of the pollutants have not exceeded the standards during the eleven year period and one pollutant, lead, is no longer monitored in Washington, D.C., because concentrations consistently remain well below the NAAQS.

Figure 1: Washington, DC Region Air Quality Monitors



 Created by the Department of Environmental Programs  
Metropolitan Washington Council of Governments  
September 3, 2004

Note: Stafford Co. not included in the 8-hour ozone nonattainment area.



**Table 3: Washington, D.C. Region Air Quality Monitors (Key to Figure 1)**

Monitor Number	Monitor Name	Years in Operation	Jurisdiction	Pollutants Monitored						
				O3	PM <sub>2.5</sub>	PM <sub>10</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	Pb
1	Takoma Park	1985-2004	Washington, D.C.	•				•		
2	River Terrace	1993-2004	Washington, D.C.	•	•	•	•	•	•	
3	McMillan Reservoir	1994-2004	Washington, D.C.	•	•			•		
4	Park Services	1999-2004	Washington, D.C.		•					
5	C&P Telephone	1985-1987 1989-2004	Washington, D.C.				•			
6	PG Equestrian Center	2002-2004	Prince George's Co, MD	•	•					
7	Rockville	1985-2004	Montgomery Co, MD	•	•					
8	Southern Maryland	1985-2004	Charles Co, MD	•						
9	Frederick	1999-2004	Frederick Co, MD	•						
10	Alexandria	1985-2004	Alexandria, VA	•			•	•	•	
11	Arlington	1985-2004	Arlington Co, VA	•	•		•	•		
12	Mt. Vernon	1985-2004	Fairfax Co, VA	•		•				
13	Annandale	2002-2004	Fairfax Co, VA	•	•		•	•	•	
14	Lewinsville	1985-2004	Fairfax Co, VA	•	•		•	•	•	
15	Cub Run	1992-2004	Fairfax Co, VA	•		•	•	•	•	
16	James Long Park	1991-2004	Prince William Co, VA	•				•		
17	Widewater Elementary*	1992-2004	Stafford Co, VA	•						
18	Ashburn	1998-2004	Loudoun Co, VA	•	•			•		
19	Franconia	1999-2004	Fairfax Co, VA	•	•		•			
20	Manassas	1990-2004	Prince William Co, VA			•				

O<sub>3</sub>: Ozone

PM<sub>2.5</sub>: Particulate Matter 2.5 µm in diameter or less

CO: Carbon Monoxide

Pb: Lead

NO<sub>2</sub>: Nitrogen Dioxide

PM<sub>10</sub>: Particulate Matter 10 µm in diameter or less

SO<sub>2</sub>: Sulfur Dioxide

\*Note: Not included in the 8-hour ozone nonattainment area.

## **1.0 Ground-Level Ozone (O<sub>3</sub>)**

### ***Health Effects and Sources***

Ozone is a colorless odorless gas that is found in the atmosphere. 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<sub>x</sub>), 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 Metropolitan Washington, D.C. 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<sub>x</sub> 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<sub>x</sub> 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 two primary NAAQS for ground-level ozone applicable in the Metropolitan Washington, D.C. region, 1-hour and 8-hour ozone standards. The Metropolitan Washington, D.C. 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 Metropolitan Washington, D.C. region as a serious nonattainment area for meeting the 1-hour health standard. The Metropolitan Washington, D.C. 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”, to a severe nonattainment area, any region that has not met the 1-hour standard by the required attainment date. As a result of this lawsuit, in January 2003 EPA re-

designated the Metropolitan Washington, D.C. region as a severe nonattainment area and established an attainment deadline of 2005.

In 1997, the 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 Metropolitan Washington, D.C. region as moderate nonattainment for the 8-hour ozone standard. On June 15, 2005, the EPA revoked the 1-hour ozone standard.

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

Averaging Period	Primary Standard	Secondary Standard
1-hour	0.125 ppm	0.125 ppm
8-hour	0.085 ppm	0.085 ppm

**Table 5: Ozone Nonattainment Areas**

Jurisdiction	1-Hour Ozone Nonattainment Area	8-Hour Ozone Nonattainment Area
Calvert County, MD	x	x
Charles County, MD	x	x
Frederick County, MD	x	x
Montgomery County, MD	x	x
Prince George's County, MD	x	x
District of Columbia	x	x
Alexandria, VA	x	x
Arlington County, VA	x	x
Fairfax County, VA	x	x
Loudoun County, VA	x	x
Prince William County, VA	x	x
Stafford County, VA	x	

### ***Transport of Ground-Level Ozone***

The Metropolitan Washington, D.C. region's air quality is significantly affected by ozone and its precursors from other regions outside the Metropolitan Washington, D.C. area. Regional transport occurs when ozone is trapped within the lower layer of the atmosphere over a wide area (e.g., several hundred square miles). These regional-scale ozone plumes become embedded within the large-scale atmospheric flows affecting areas well away from their source regions. These regional plumes are often observed at ozone monitors located in elevated terrain and can drift across regions and then mix down to the surface affecting monitors over a large area.

A recent study by Marufu *et al.* provides further evidence of regional ozone transport into the Metropolitan Washington, D.C. region.<sup>1</sup> This paper discusses the August 2003 North American electrical blackout, which provided a unique opportunity to quantify the contribution of Northeastern US and Southeastern Canada power plants' emissions to ozone levels in the Pennsylvania and Metropolitan Washington, D.C. regions. Ozone levels decreased by approximately 38 ppb in response to a 34 percent and 20 percent reductions in SO<sub>2</sub> and NO<sub>x</sub> emissions from power plants

<sup>1</sup> *The 2003 North American electrical blackout: An accidental experiment in atmospheric chemistry*, Marufu, *et al.*; Geophysical Research Letters, Vol. 31, 2004.

during that period. The improvement in air quality provides evidence that transported pollutant emissions from power plants hundreds of kilometers upwind play an important role in ozone production in the Metropolitan Washington, D.C. region.

### ***Ground-Level Ozone Trends***

Trends analysis of ground-level ozone is complicated by the influence of weather systems on the formation of ozone. Ozone concentrations are quite dependent on meteorological conditions. In particular, temperatures above 85 degrees Fahrenheit (°F), 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 despite very little change in the emission rates of ozone-forming precursors. Correlations can be made between ozone concentrations and meteorological variables such as the number of 85°F days, average temperature, and average winds, during the peak hours of ozone formation. Hot dry summers can produce long periods of elevated ozone concentrations while ozone production can be limited during cool and wet summers.

Meteorological data from the Reagan National Airport was reviewed to determine any trends between 1-hour ozone values and summertime weather conditions. Table 6 lists meteorological data for all years from 1993 through 2004 along with the average 1-hour maximum ozone concentration and the number of exceedance days within the Metropolitan Washington, D.C. region. Strong correlations were found between number of 1-hour exceedance days and warm days ( $\geq 85^\circ\text{F}$ ), between average maximum 1-hour ozone and average maximum temperature, and between 1-hour exceedance days and average maximum temperature. Since 1993, there have been 4 years with more than 20 days with temperatures  $\geq 85^\circ\text{F}$  (1998, 1999, 2002, and 2004). In comparing these years to 1993, there has been an average decline of 25 percent in the number of 1-hour exceedance days.

**Table 6. Meteorological and Exceedance Data for the Metropolitan Washington, D.C. Region at Reagan National Airport 1993-2004**

<b>Year</b>	<b>Avg 1-hour Max Ozone Concentration (ppb)</b>	<b>1-hour Exceedance Days</b>	<b>Avg Max Temperature (°F)</b>	<b>Avg Wind (2 pm)</b>	<b>Temp <math>\geq 85^\circ\text{F}</math> (# of Days)</b>
1993	135	8	94	4.7	10
1994	134	4	92	4.8	8
1995	138	6	92	4.3	7
1996	125	1	90	0	1
1997	140	6	94	5.5	6
1998	131	6	90	5.6	36
1999	133	7	91	6.1	36
2000	136	4	90	4.9	10
2001	130	3	88	3.9	18
2002	138	9	91	5.7	33
2003	135	3	89	6.6	6
2004*	132	2	92	8.1	60

\*Meteorological data for 2004 is preliminary and subject to change.

For this report, the influence of weather is partially removed by averaging the highest levels of ozone concentrations 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.

### 1-Hour Ozone Levels:

The maximum 1-hour ozone concentrations at each monitor in the region are given in Table A-1. Table A-2 gives the data on the four highest 1-hour levels in the region. The trend in total number of monitor exceedances between 1993 and 2004 is shown in Figure 2. Monitor exceedances occur whenever a monitor's 1-hour ozone concentration is greater than or equal to 0.125 ppm. The number of monitors in the Washington, D.C. region has actually increased, from 10 monitors in 1993 to 17 monitors in 2004. However, there has been a significant decrease in the number of monitored exceedances since 1993 from 8 to just 2 in 2004.

**Figure 2: Exceedances of 1-hour Ozone Standard  
Washington, D.C. Region, 1993-2004**

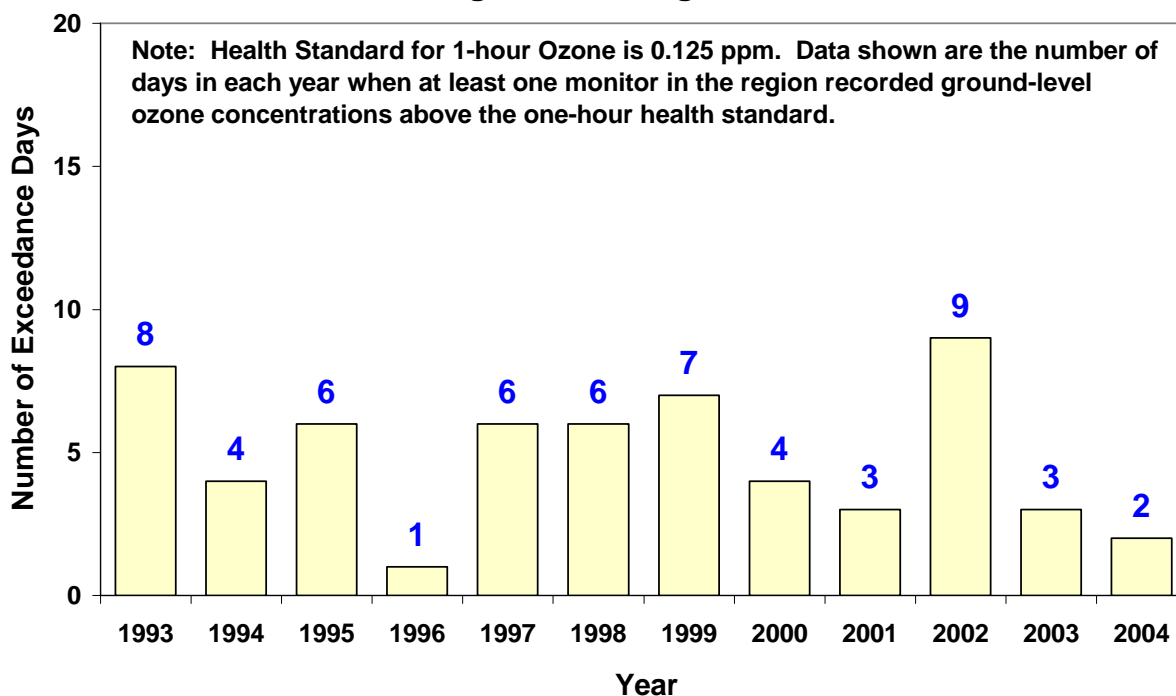
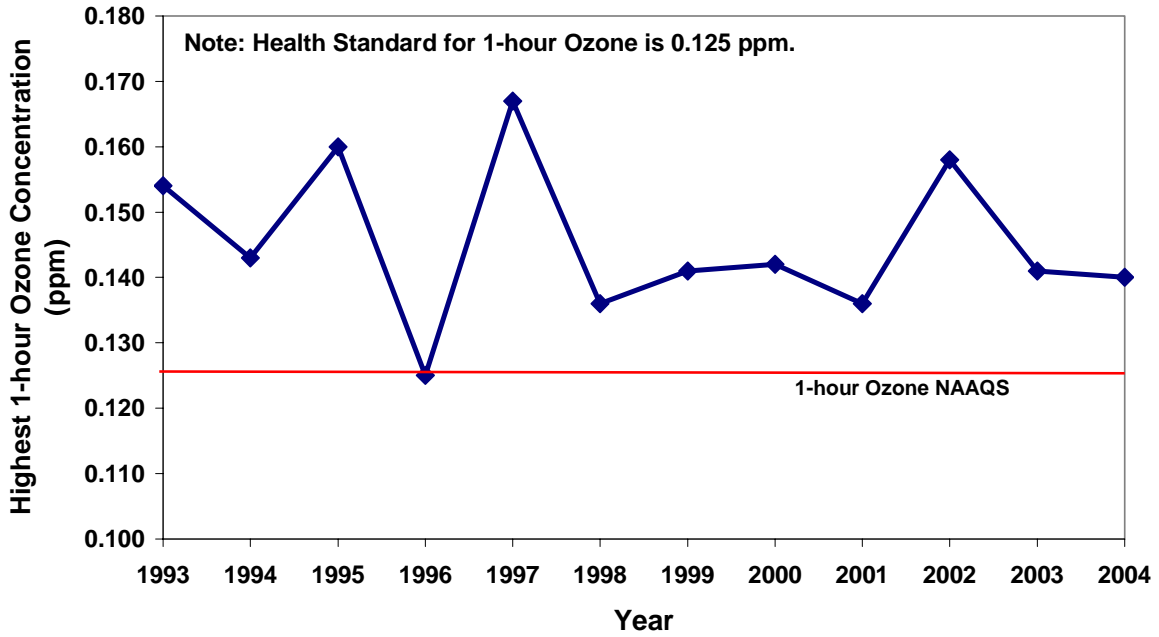


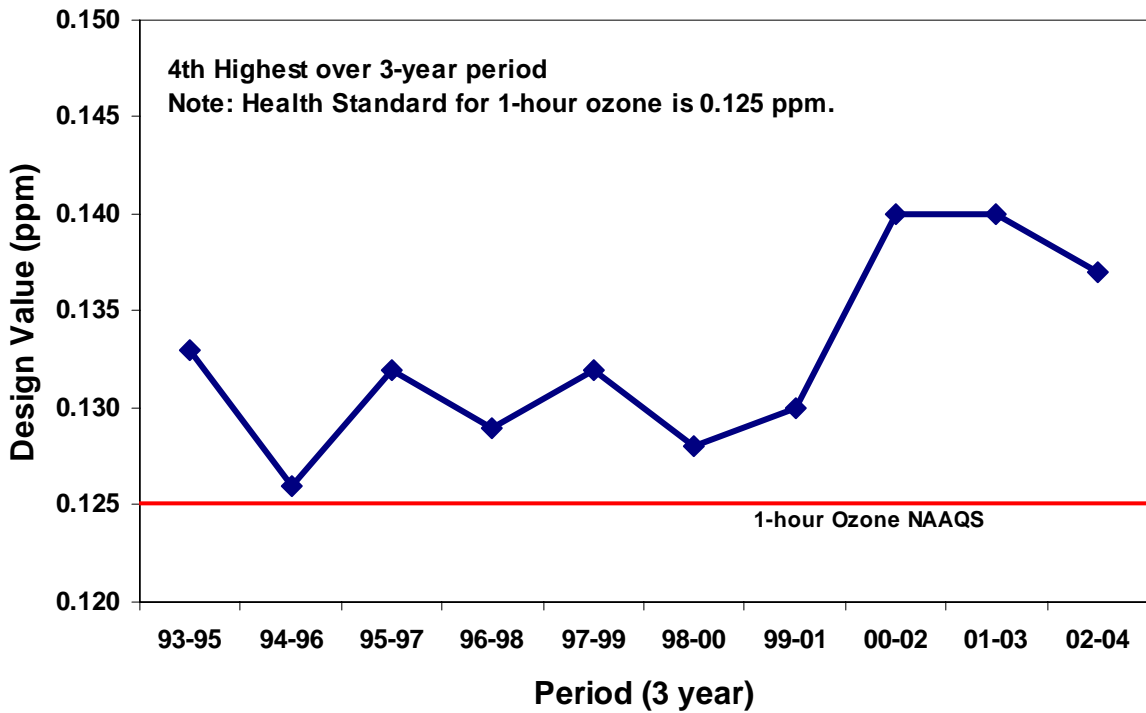
Figure 3 shows the maximum 1-hour ozone concentrations with an overall downward trend in peak ozone concentrations. Peak ozone concentrations for 2004 are approximately 7 parts per billion lower than the average peak concentrations in the 1990's.

Figure 4 is a plot of the design values for the 1-hour ozone standard. The 1-hour ozone design value is the fourth highest concentration during a consecutive three-year period. The design values in the Metropolitan Washington, D.C. region have increased slightly since 1993-1995 from 133 ppb to 137 ppb in 2002-2004. Average design values from 1994-2004 (133 ppb) have remained unchanged when compared to design values from 1993-1995.

**Figure 3: Peak 1-hour Ozone Concentrations  
Washington, D.C. Region, 1993-2004**

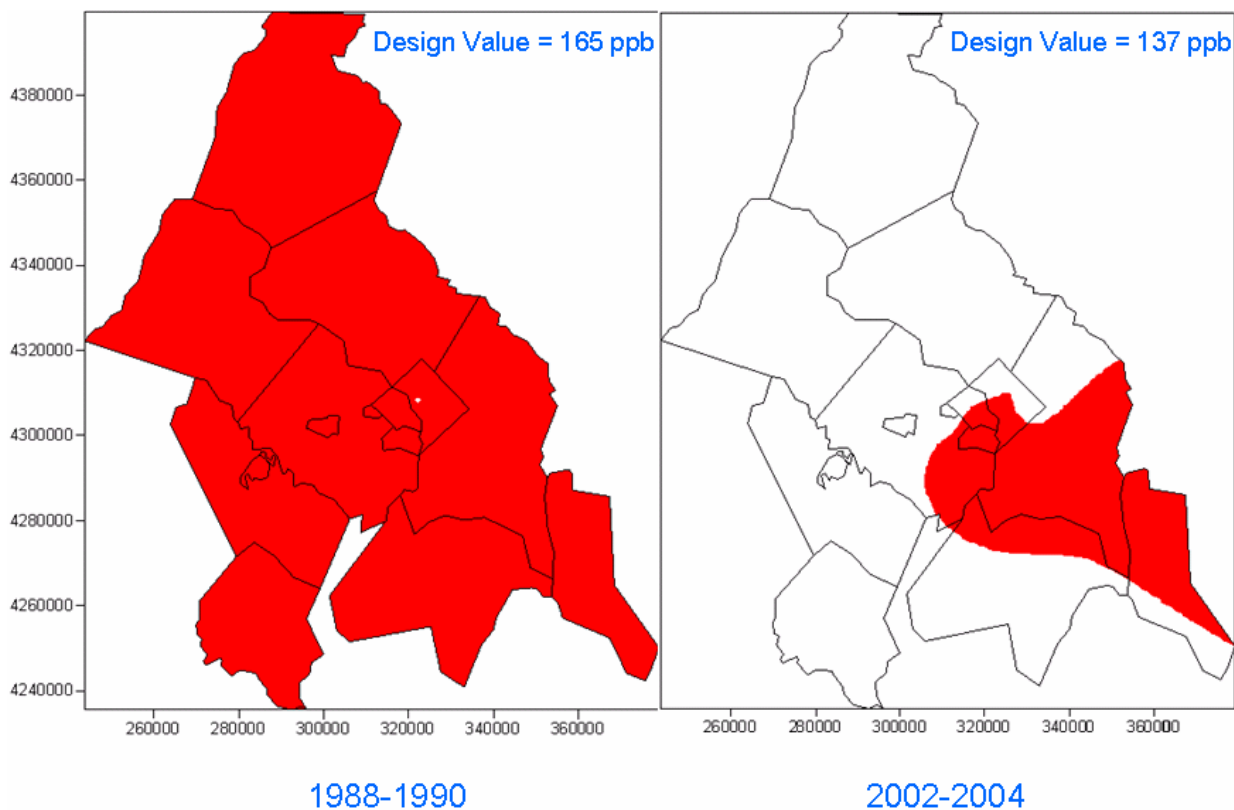


**Figure 4: 1-hour Ozone Design Values  
Washington, D.C. Region, 1993-2004**



The geographical extent of violation, in the Metropolitan Washington, D.C. region, has been decreasing since 1990. Figure 5 shows a decrease in the spatial extent of the Metropolitan Washington, D.C. region between 1990 and 2004. The actual geographical area exceeding the 1-hour ozone design value of 124 ppb is shown in red. It is clear that almost the entire Metropolitan Washington, D.C. region was in nonattainment during 1988-1990. The 2002-2004 data show that the geographical extent of this area has reduced in size to include portions of the District of Columbia, the city of Alexandria, and Arlington, Fairfax, Charles, Calvert, and Prince George's counties. Not only has the nonattainment area reduced in size by 25 percent, but also the design value has decreased by approximately 17 percent, from 165 ppb to 137 ppb.

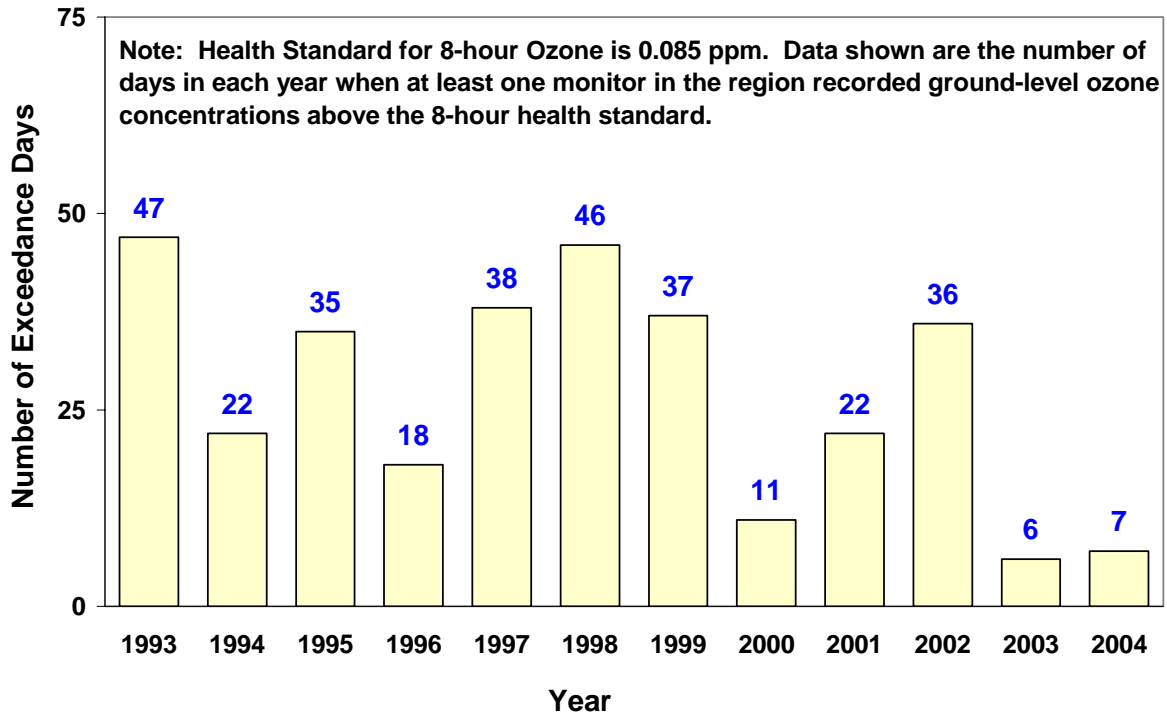
**Figure 5: Spatial Extent of 1-hour Ozone Exceedances in the Metropolitan Washington, D.C. Region**



8-Hour Average Ozone Levels:

The maximum 8-hour ozone concentrations at each monitor in the region are given in Table A-3. Table A-4 contains the four highest 8-hour ozone values in the region. Figure 6 shows how often this new ozone standard would have been exceeded, had it been in effect during the reporting period and the number of actual exceeded days after the standard was implemented. Data shows that there is a gradual improvement in the number of exceedances of the 8-hour standard from year to year.

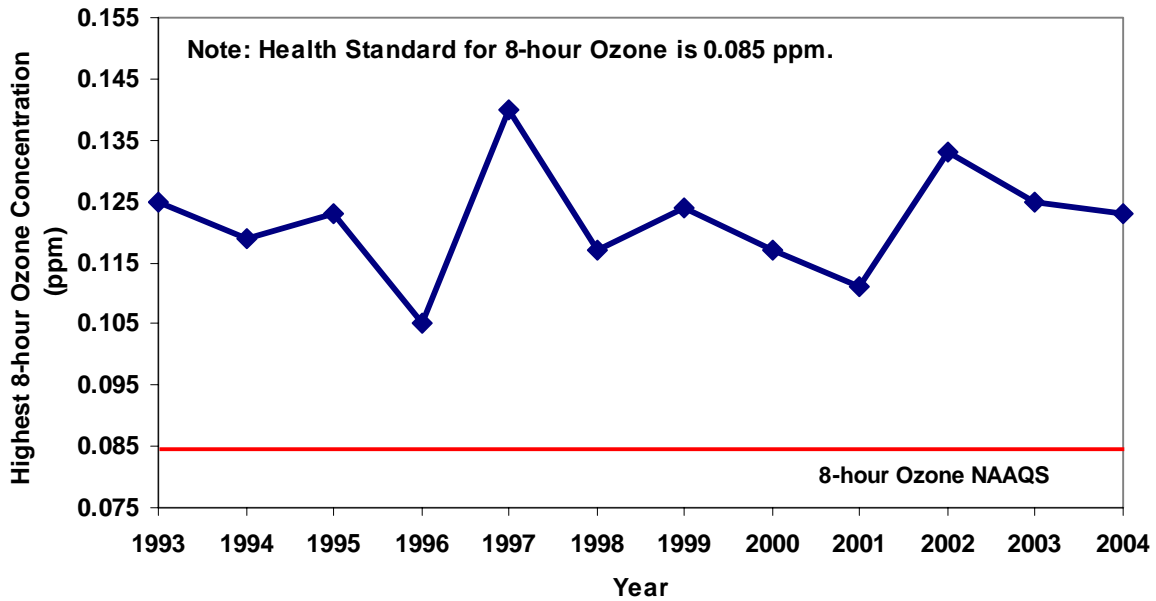
**Figure 6: Exceedances of 8-hour Ozone Standard  
Washington, D.C. Region, 1993-2004**



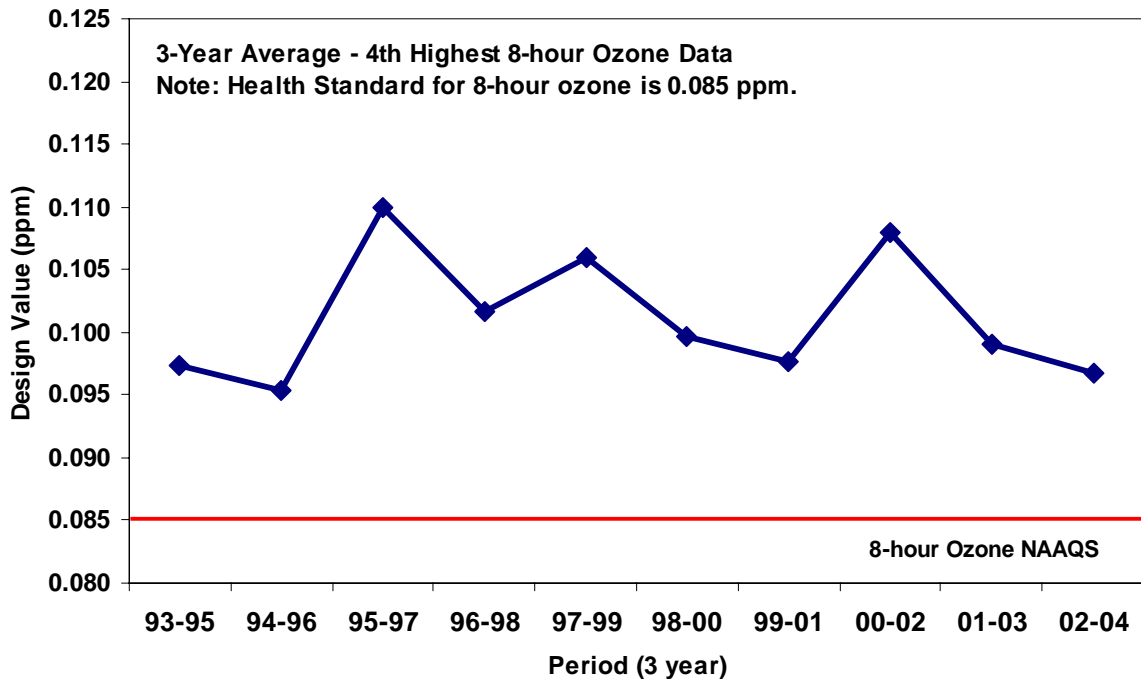
The peak 8-hour ozone values are displayed in Figure 7. Since 1993, peak values have remained above the NAAQS. Figure 8 shows the three-year average of the fourth-highest 8-hour ozone levels in the region. EPA developed this averaging method as a means to remove some of the variability in ozone concentrations 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 7: Peak 8-hour Ozone Concentrations  
Washington, D.C. Region, 1993-2004**



**Figure 8: 8-hour Ozone Design Values  
Washington, D.C. Region, 1993-2004**



## *Summary of Ozone Trends*

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

Data show that there is a slight downward trend in the number of days with monitored concentrations above the 8-hour ozone standard. 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 the 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, even in healthy persons. Fortunately, the health threat from current levels of ambient CO in the Metropolitan Washington, D.C. region is minimal for healthy individuals.

Carbon monoxide in ambient air mainly results 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 (including 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 indoor CO.

### *National Ambient Air Quality Standards for CO*

**Table 7: CO National Ambient Air Quality Standards**

<b>Averaging Period*</b>	<b>Primary Standard</b>	<b>Secondary Standard</b>
1-hour	35 ppm	None
8-hour	9 ppm	None

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

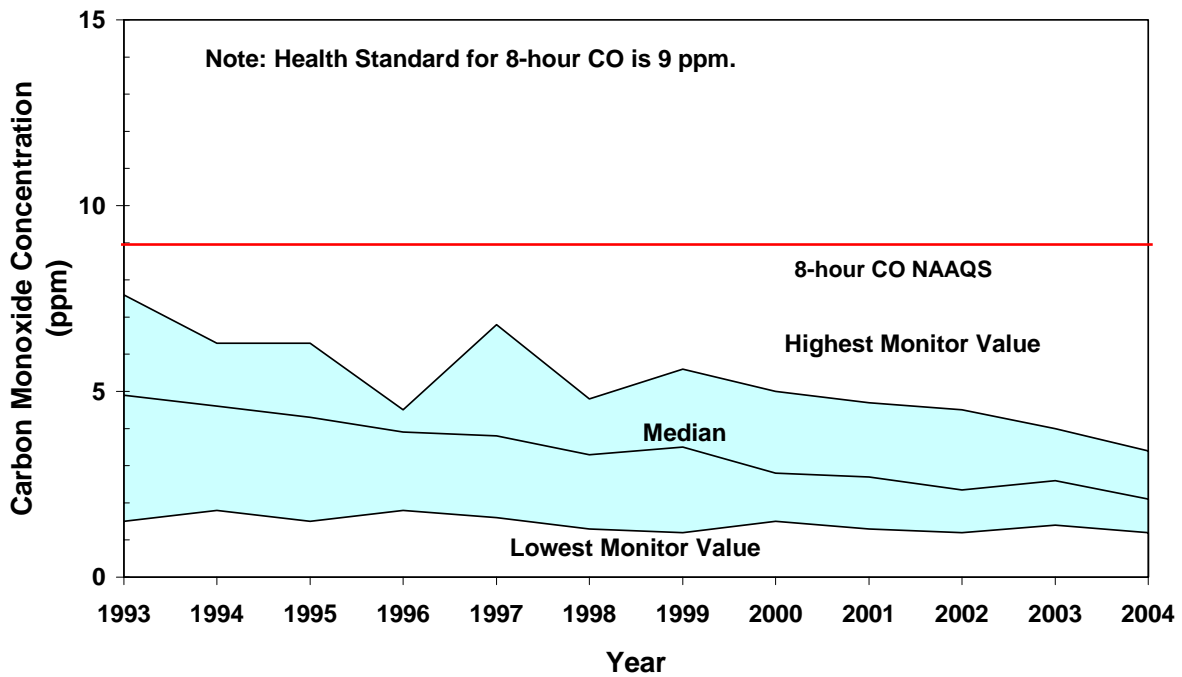
### *Carbon Monoxide Trends*

One measure of change in ambient CO is the trend in the 2<sup>nd</sup> highest 8-hour daily concentration. The 2<sup>nd</sup> highest 8-hour average level is used because the federal health standard permits one occurrence

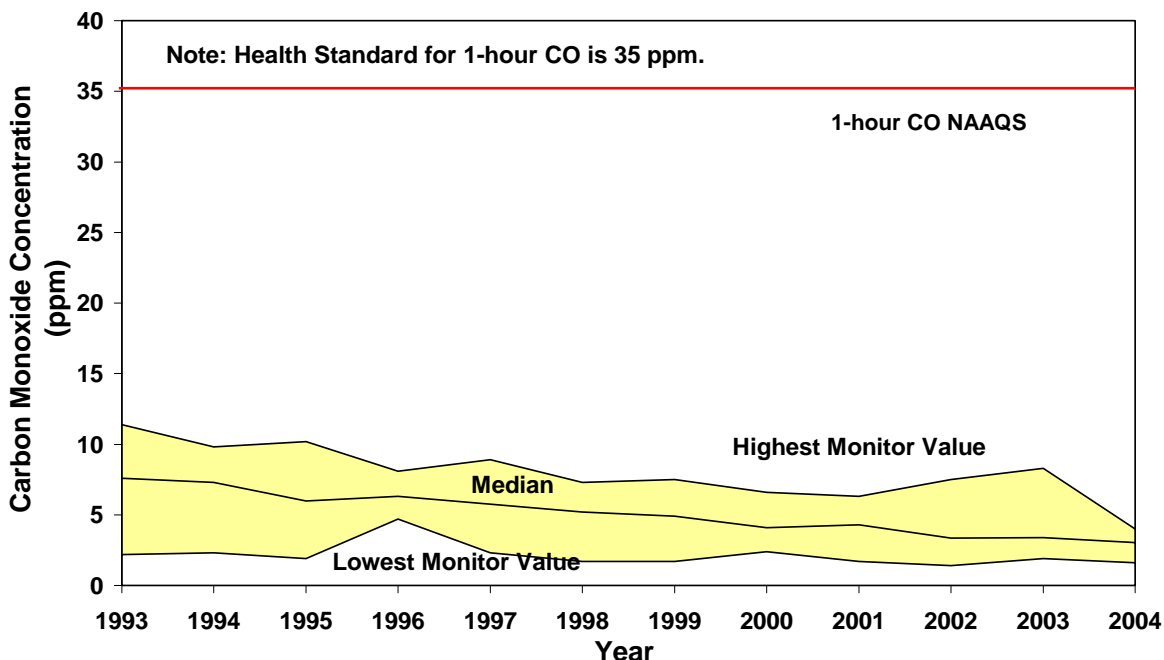
each year at each monitoring site to exceed the 8-hour NAAQS for CO (9 ppm). The NAAQS requires that the 2<sup>nd</sup> highest be less than 9 ppm at all area monitors in order for the region to be in attainment.

Table A-6 shows that 8-hour averaged CO levels in the Metropolitan Washington, D.C. region have been steadily declining since 1990 and the region is in attainment of the health standards. Presented in Figure 9 are the 2<sup>nd</sup> highest CO concentrations based on (a) 8-hour averages, and (b) 1-hour averages. Currently, the 2<sup>nd</sup> highest 8-hour average CO levels at the highest regional monitor are approximately half of the NAAQS for CO.

**Figure 9a: Carbon Monoxide 2<sup>nd</sup> High 8-Hour Concentrations  
Washington, D.C. Region, 1993-2004**



**Figure 9b: Carbon Monoxide 2<sup>nd</sup> High 1-hour Concentrations  
Washington, D.C. Region, 1993-2004**



Another measure of progress is the 2<sup>nd</sup> highest 1-hour average CO concentrations (Table A-7) at the highest recorded 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 Metropolitan Washington, D.C. 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<sub>2</sub>)**

**Health Effects and Sources**

Sulfur dioxide is a gas that forms when sulfur-bearing fuels (mainly coal and oil) are burned. SO<sub>2</sub> can also be released into the air during certain industrial processes. High concentrations of SO<sub>2</sub> 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<sub>2</sub> can produce damage to the foliage of trees and agricultural crops. The presence of both sulfur dioxide and nitrogen dioxide in the atmosphere can also lead to acidic deposition (acid rain). Thus, the EPA also established a secondary ambient air quality standard for SO<sub>2</sub> based on 3-hour averaged concentrations.

## National Ambient Air Quality Standards for SO<sub>2</sub>

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

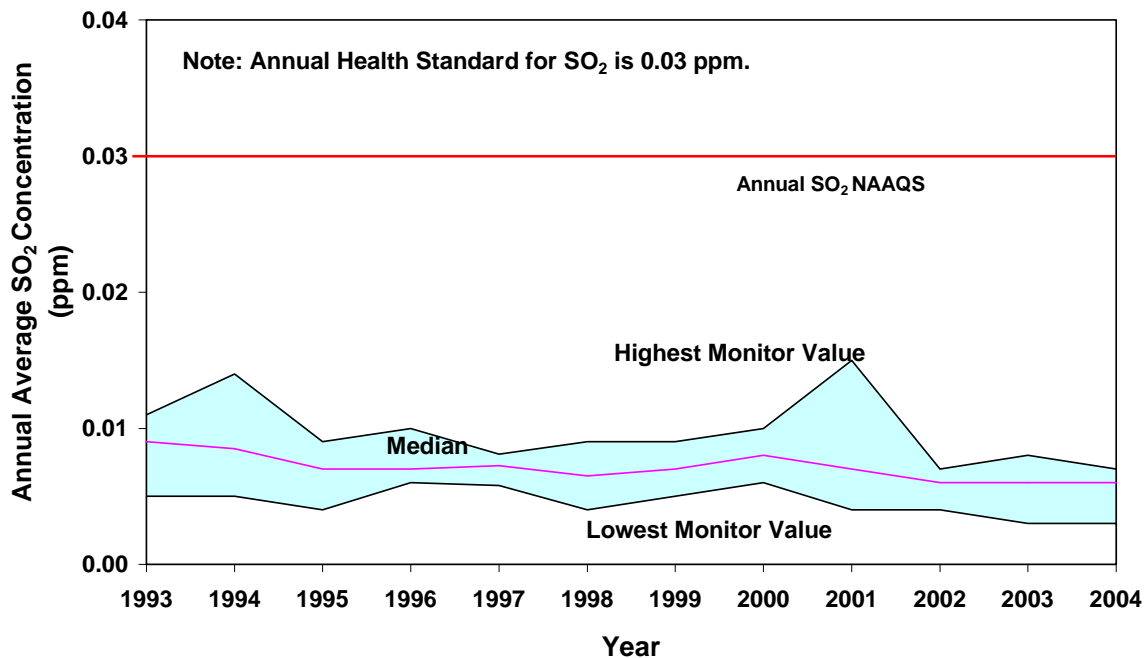
**Table 8: SO<sub>2</sub> National Ambient Air Quality Standards**

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

## SO<sub>2</sub> Trends

A general characterization of SO<sub>2</sub> concentrations in the Metropolitan Washington, D.C. region is that levels are low and declining. Figure 10 and Table A-8 show the annual average SO<sub>2</sub> concentrations at both the highest and the lowest monitors in the region in each year for the analysis period, 1993-2004. The data show that in recent years the highest SO<sub>2</sub> 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 10: Sulfur Dioxide Annual Averages Concentrations  
Washington, D.C. Region, 1993-2004**



## Summary

All monitors in the Metropolitan Washington, D.C. region are well within each of the sulfur dioxide NAAQS.

## 4. Nitrogen Dioxide (NO<sub>2</sub>)

### *Health Effects and Sources*

Nitrogen dioxide is a gaseous pollutant, one of a class of compounds called nitrogen oxides (NO<sub>x</sub>). NO<sub>2</sub> can irritate the lungs and lower resistance to respiratory infections. NO<sub>2</sub> is a brownish and highly chemically reactive gas. It is formed during the high-temperature combustion of fuels, in vehicle engines and industrial facilities (primarily electric generating power plants). NO<sub>2</sub> plays a major role in the atmospheric reactions that produce ground-level ozone in the warmer months.

### *National Ambient Air Quality Standards for NO<sub>2</sub>*

EPA has established a long-term (annual average) ambient air quality standard for NO<sub>2</sub>, as shown in Table 9. There is no secondary standard for this pollutant.

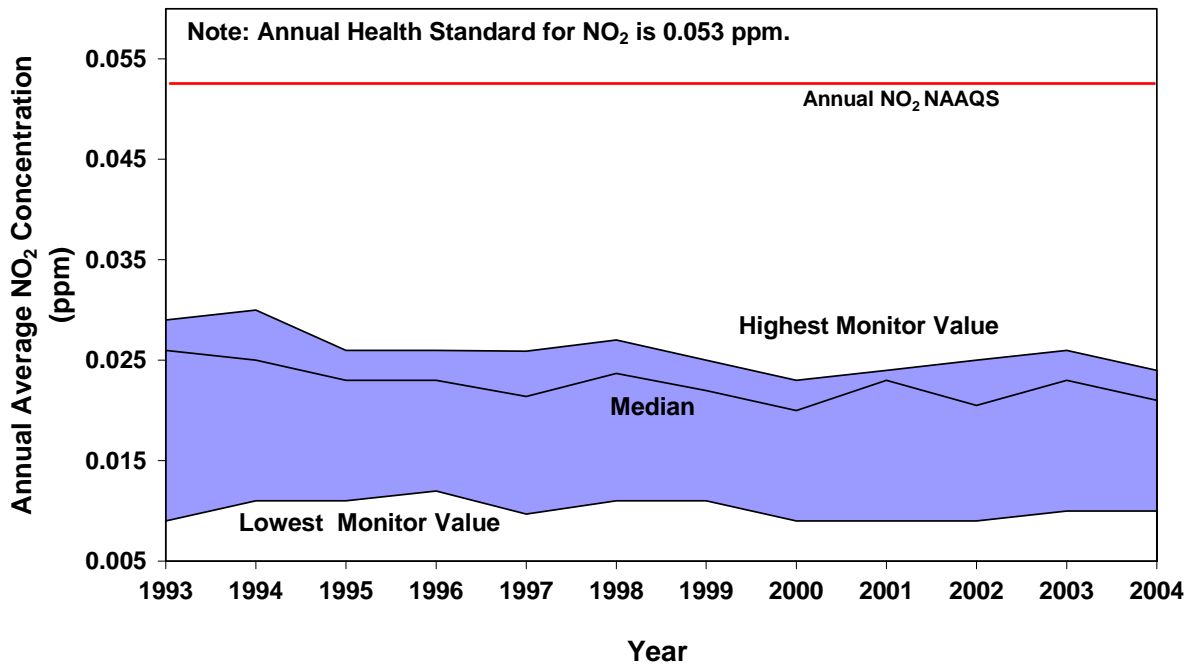
**Table 9: NO<sub>2</sub> National Ambient Air Quality Standards**

<b>Averaging Period</b>	<b>Primary Standard</b>	<b>Secondary Standard</b>
Annual	0.53 ppm	None

### *NO<sub>2</sub> Trends*

Figure 11 and Table A-9 show the annual average NO<sub>2</sub> concentrations at both the highest and the lowest monitors in the region in each year for the analysis period, 1993-2004. There seems to be no discernable trend in the annual NO<sub>2</sub> values in the region. However, during the past ten years, the maximum annual average NO<sub>2</sub> levels are approximately half of the federal standard at the monitors recording the highest concentrations in the region.

**Figure 11: Nitrogen Dioxide Annual Average Concentrations  
Washington, D.C. Region, 1993-2004**



*Summary*

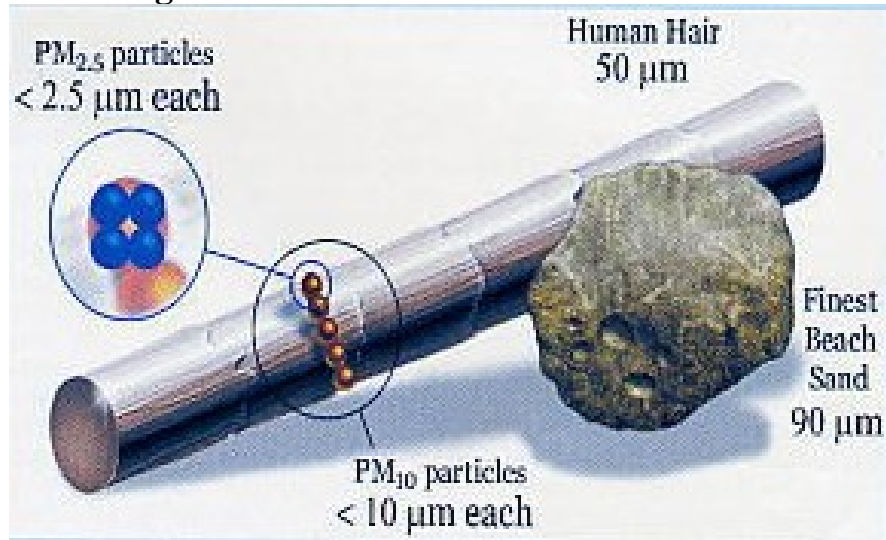
All monitors in the Metropolitan Washington, D.C. region are well within each of the nitrogen dioxide NAAQS.

**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 two types of particles the region is required to monitor are PM<sub>10</sub> and PM<sub>2.5</sub>. PM<sub>10</sub> refers to those particles less than 10 microns in diameter. PM<sub>2.5</sub> refers to those particles less than 2.5 microns in diameter. Figure 12 graphically depicts the relative size of both PM<sub>10</sub> and PM<sub>2.5</sub>.

**Figure 12: 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 Metropolitan Washington, D.C. 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 Metropolitan Washington Council of Governments (MWCOG) website.

### ***Health Effects and Sources***

Particulate matter comprises a broad class of aerosol particles from fine smoke and soot (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<sub>2</sub> emissions.

The size of the particles directly relates to their potential for causing health problems. Small particles less than 10 micrometers (microns) in diameter pose the greatest problems, because they can travel deep into the lungs and some may even move 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.

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<sub>10</sub> were established in 1987. These should not be confused with the newer standards for very fine particles, known as PM<sub>2.5</sub>. In 1997, the EPA established a new health standard for fine particulate (particles with aerodynamic diameters of less than 2.5 microns, PM<sub>2.5</sub>). In November 2004, the EPA designated the following counties in the Metropolitan Washington, D.C. region as nonattainment for the annual PM<sub>2.5</sub> standard: Charles County, MD, Frederick County, MD, Montgomery County, MD, Prince George's County, MD, District of Columbia, Alexandria, VA, Arlington County, VA, Fairfax County, VA, Loudoun County, VA, and Prince William County, VA. Table 10 provides the NAAQS for PM<sub>10</sub> and PM<sub>2.5</sub>.

**Table 10: Particulate Matter National Ambient Air Quality Standard**

<b>Pollutant</b>	<b>Averaging Time</b>	<b>Primary Standard</b>	<b>Secondary Standard</b>
<b>PM<sub>10</sub></b>	24-hour <sup>a</sup>	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>
	Annual <sup>b</sup>	50 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>
<b>PM<sub>2.5</sub></b>	24-hour <sup>c</sup>	65 µg/m <sup>3</sup>	65 µg/m <sup>3</sup>
	Annual <sup>b</sup>	15 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>

<sup>a</sup> Not to be exceeded more than once in a given year at any monitor.

<sup>b</sup> The 3-year average of the weighted annual mean concentration at each monitor must not exceed the standard.

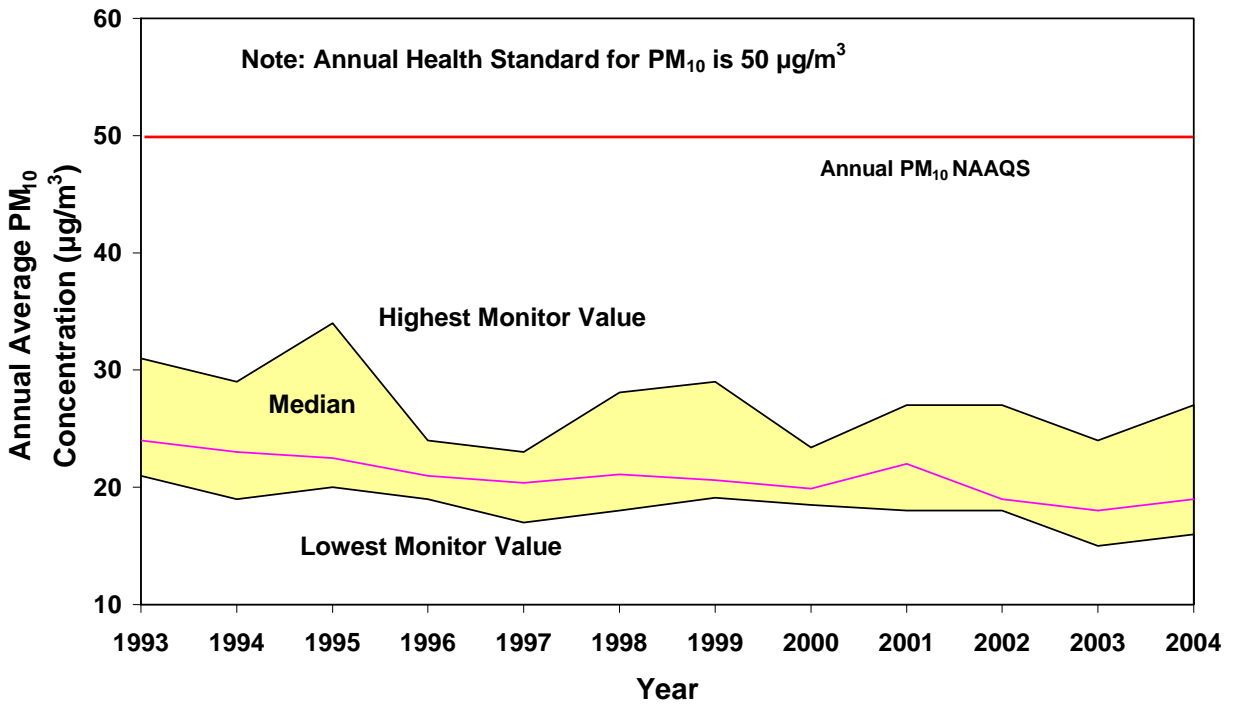
<sup>c</sup> The 3-year average of the 98th percentile at each monitor must not exceed the standard.

### ***PM<sub>10</sub> Trends***

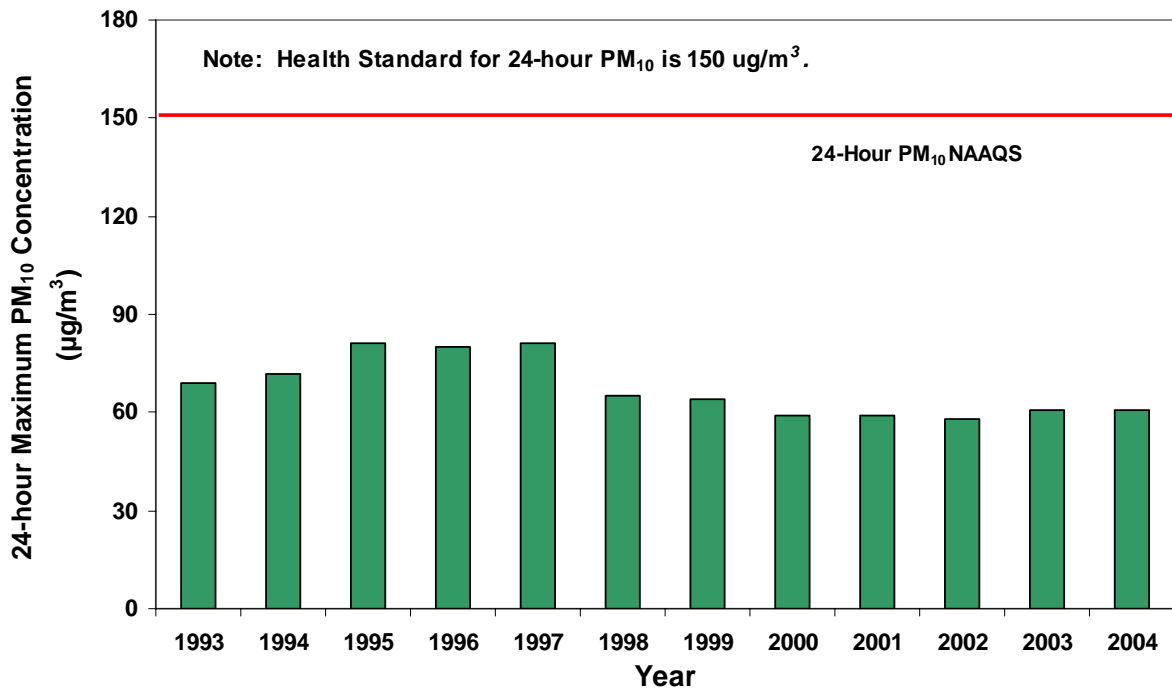
The federal health standard for particulate matter was changed in 1987 from Total Suspended Particulate (TSP) to PM<sub>10</sub> in order to reflect the fact that non-respirable particles greater than 10 microns in diameter were being measured by the TSP samplers then in place. Therefore, the trend data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

Particulate matter data measured as PM<sub>10</sub> are presented in Figure 13 and 14. Figure 13 shows the annual averages of PM<sub>10</sub> levels at both the highest and lowest regional monitors in the Metropolitan Washington, D.C. region. Figure 14 shows the maximum PM<sub>10</sub> 24-hour concentrations.

**Figure 13: PM<sub>10</sub> Annual Average Concentrations  
Washington, D.C. Region, 1993-2004**



**Figure 14: PM<sub>10</sub> 24-hour Maximum Concentrations  
Washington, D.C. Region, 1993-2004**



### *PM<sub>2.5</sub> Trends*

A new federal health standard for particulate matter was created in 1997 for PM<sub>2.5</sub>. The Metropolitan Washington, D.C. region trend analysis for PM<sub>2.5</sub> begins with the data from 1999, when broad scale PM<sub>2.5</sub> sampling began in this area.

Particulate matter data measured as PM<sub>2.5</sub> are presented in Figure 15 and 16. Figure 15 shows the annual average PM<sub>2.5</sub> design values for the Metropolitan Washington, D.C. region. Data show a general downward trend.

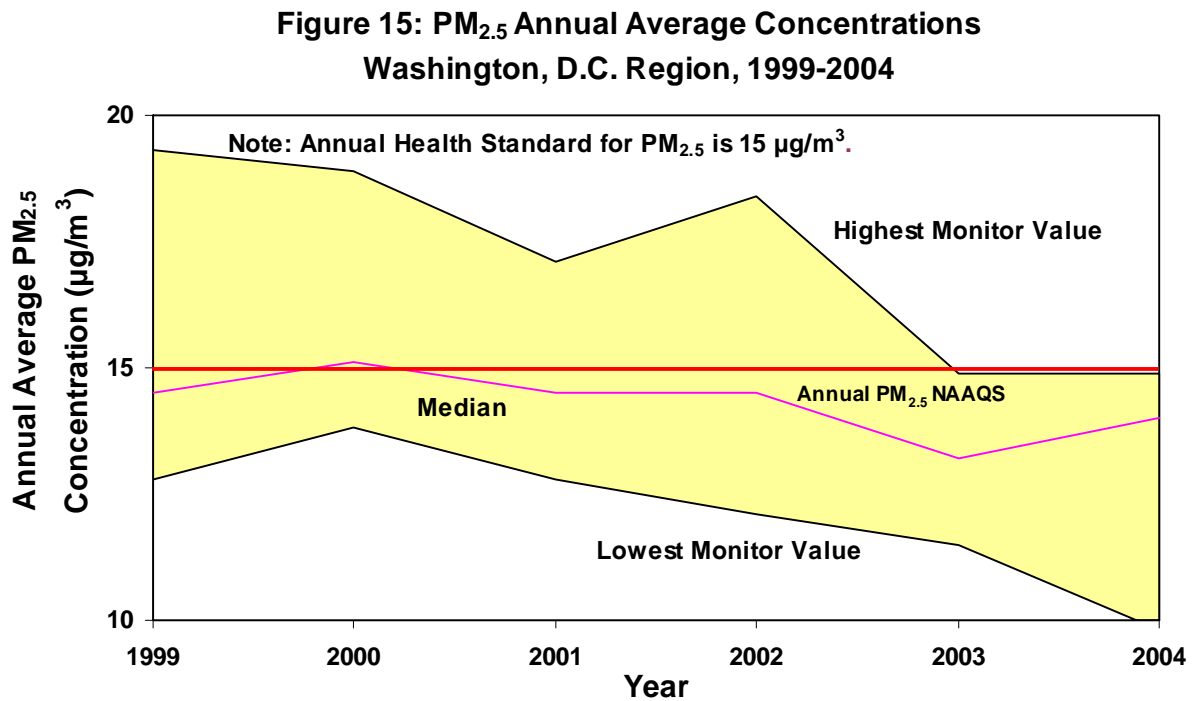
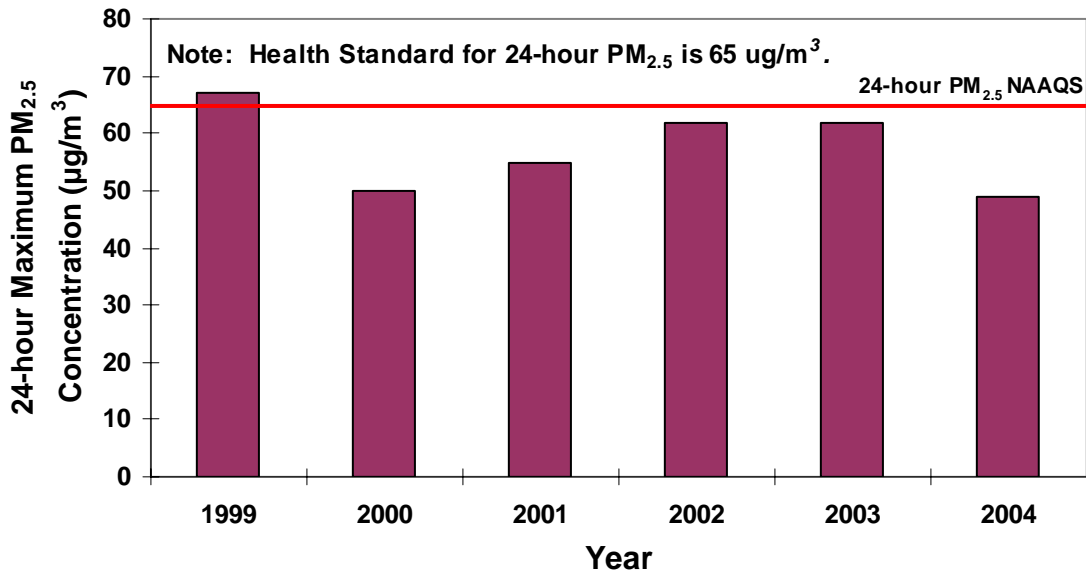


Figure 16 shows the 24-hour average PM<sub>2.5</sub> design values for the Metropolitan Washington, D.C. region for the same period. Data show that the Metropolitan Washington, D.C. region is below the 24-hour PM<sub>2.5</sub> NAAQS.

**Figure 16: PM<sub>2.5</sub> 24-hour Maximum Concentrations  
Washington, D.C. Region, 1999-2004**



### *Summary*

All monitors in the Metropolitan Washington, D.C. region are well within each of the PM<sub>10</sub> NAAQS.

The Metropolitan Washington, D.C. region began monitoring for PM<sub>2.5</sub> in 1999. Since that time, data indicate that the region is not meeting the annual PM<sub>2.5</sub> standard of 15 µg/m<sup>3</sup>. However, the region remains below the 24-hour PM<sub>2.5</sub> standard.

## **6. Lead (Pb)**

### *Health Effects and Sources*

Lead in ambient air mainly result from soils and dusts that have become contaminated with 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*

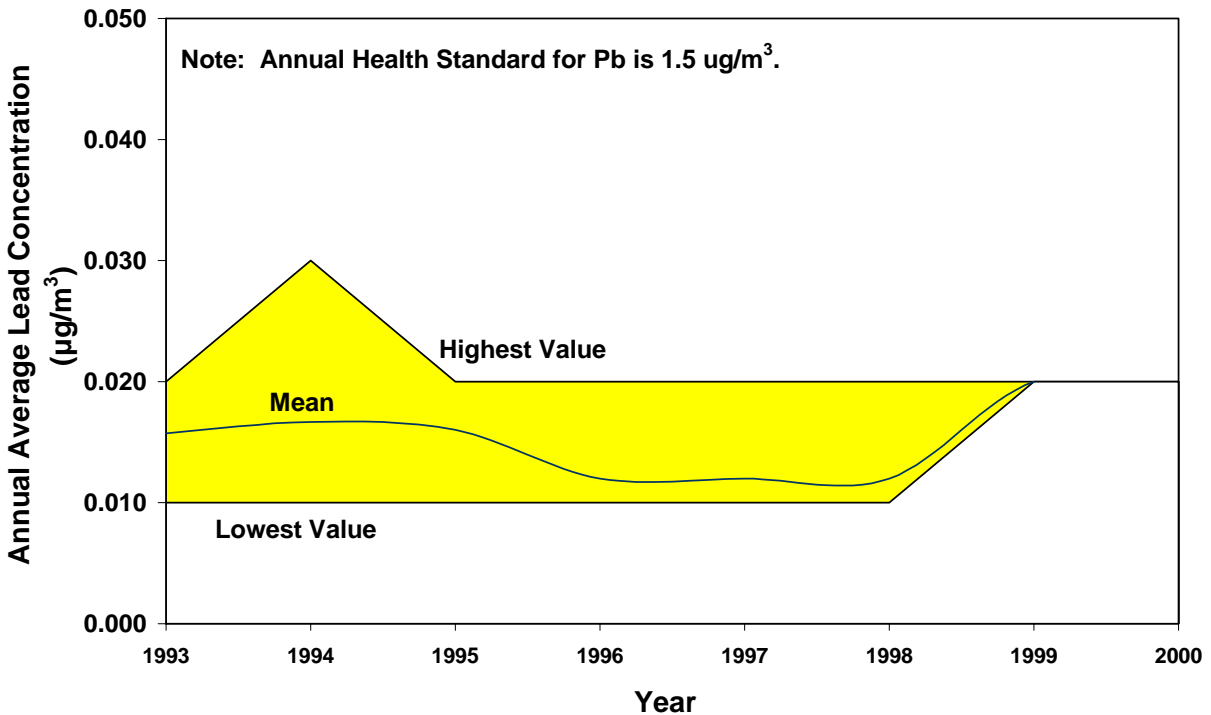
**Table 11: Pb National Ambient Air Quality Standards**

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

**Pb Trends**

Lead levels in ambient air are low. Ambient lead data are summarized in Figure 17 and Table A-12. 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 lead are uniformly very low in the Metropolitan Washington, D.C. region, and the concentrations range between 10-15 percent of the health standard.

**Figure 17: Lead Annual Average Concentrations  
Washington, D.C. Region, 1993-2000**



**Summary**

All monitors in the Metropolitan Washington, D.C. region are well within each of the lead NAAQS.

## **Appendix A**

**Table A-1: Maximum 1-hour Ozone Concentrations by Monitor (1993-2004) (ppm)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	0.102	0.112	0.115	0.083								
<b>Takoma</b>	0.112	0.122	0.127	0.107	0.129	0.118	0.120	0.115	0.132	0.138	0.119	0.104
<b>River Terrace</b>		0.137	0.132	0.114	0.155	0.115	0.126	0.120	0.122	0.151	0.115	0.093
<b>McMillan Reservoir</b>		0.135	0.155	0.117	0.147	0.118	0.135	0.120	0.127	0.151	0.118	0.113
<b>Calvert</b>				0.097	0.118	0.117	0.115	0.118	0.108			
<b>Southern Maryland</b>	0.128	0.105	0.127	0.104	0.126	0.124	0.130	0.116	0.110	0.122	0.133	0.104
<b>Frederick</b>						0.131	0.128	0.109	0.119	0.111	0.118	0.108
<b>Rockville</b>	0.125	0.123	0.132	0.111	0.118	0.136	0.125	0.093	0.117	0.114	0.125	0.108
<b>Greenbelt</b>	0.142	0.131	0.160	0.125	0.167	0.128	0.141	0.142	0.136	0.132	0.123	
<b>Suitland</b>	0.140	0.129	0.134	0.121	0.153	0.125	0.127	0.127	0.127			
<b>PG Equestrian Center</b>										0.144	0.141	0.119
<b>Beltsville</b>												
<b>Arlington</b>	0.131	0.133	0.138	0.119	0.144	0.113	0.135	0.116	0.124	0.151	0.126	0.111
<b>Cub Run</b>		0.130	0.137	0.107	0.109	0.129	0.118	0.098	0.117	0.149	0.108	0.117
<b>Mt Vernon</b>	0.154	0.119	0.130	0.124	0.124	0.127	0.130	0.125	0.121	0.158	0.132	0.140
<b>Franconia</b>						0.118	0.128	0.097	0.119	0.148	0.137	0.138
<b>Annandale</b>										0.139	0.130	0.110
<b>Seven Corners</b>		0.143	0.119	0.104	0.131	0.127	0.134	0.111				
<b>Lewinsville</b>		0.133	0.145	0.107	0.115	0.123	0.125	0.112	0.127	0.131	0.118	0.129
<b>Ashburn</b>						0.124	0.123	0.100	0.117	0.132	0.122	0.126
<b>Long Park</b>		0.109	0.133	0.109	0.110	0.135	0.111	0.100	0.116	0.129	0.115	0.113
<b>Widewater Elementary</b>	0.115	0.106	0.101	0.101	0.112	0.127	0.128	0.098	0.108	0.149	0.118	0.114
<b>Alexandria</b>	0.129	0.120	0.125	0.118	0.132	0.115	0.129	0.115	0.118	0.145	0.120	0.135
<i>Highest</i>	<i>0.154</i>	<i>0.143</i>	<i>0.160</i>	<i>0.125</i>	<i>0.167</i>	<i>0.136</i>	<i>0.141</i>	<i>0.142</i>	<i>0.136</i>	<i>0.158</i>	<i>0.141</i>	<i>0.140</i>
<i>Lowest</i>	<i>0.102</i>	<i>0.105</i>	<i>0.101</i>	<i>0.083</i>	<i>0.109</i>	<i>0.113</i>	<i>0.111</i>	<i>0.093</i>	<i>0.108</i>	<i>0.111</i>	<i>0.108</i>	<i>0.093</i>
<i>Median</i>	<i>0.129</i>	<i>0.126</i>	<i>0.132</i>	<i>0.109</i>	<i>0.128</i>	<i>0.124</i>	<i>0.128</i>	<i>0.115</i>	<i>0.119</i>	<i>0.142</i>	<i>0.121</i>	<i>0.113</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-2: Top Four Highest 1-hour Ozone Concentrations Across all Monitors (1993-2004) (ppm)**

	<b>Highest Monitor Highest 1-hour</b>	<b>Highest Monitor 2nd Highest 1-hour</b>	<b>Highest Monitor 3rd Highest 1-hour</b>	<b>Highest Monitor 4th Highest 1-hour</b>
<b>1993</b>	0.154	0.132	0.128	0.123
<b>1994</b>	0.143	0.135	0.127	0.123
<b>1995</b>	0.160	0.132	0.124	0.118
<b>1996</b>	0.125	0.116	0.109	0.108
<b>1997</b>	0.167	0.146	0.132	0.129
<b>1998</b>	0.136	0.128	0.125	0.124
<b>1999</b>	0.141	0.130	0.128	0.123
<b>2000</b>	0.142	0.127	0.113	0.104
<b>2001</b>	0.136	0.127	0.117	0.115
<b>2002</b>	0.158	0.153	0.139	0.131
<b>2003</b>	0.141	0.137	0.119	0.113
<b>2004</b>	0.140	0.118	0.118	0.106



**Table A-3: Maximum 8-hour Average Ozone Concentrations by Monitor (1993-2004) (ppm)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	0.089	0.084	0.089	0.071								
<b>Takoma</b>	0.093	0.112	0.106	0.089	0.117	0.102	0.100	0.104	0.108	0.113	0.110	0.093
<b>River Terrace</b>		0.115	0.114	0.094	0.121	0.097	0.102	0.101	0.101	0.128	0.107	0.083
<b>McMillan Reservoir</b>		0.119	0.123	0.095	0.128	0.108	0.115	0.102	0.107	0.129	0.112	0.101
<b>Calvert</b>				0.086	0.096	0.097	0.102	0.098	0.091			
<b>Southern Maryland</b>	0.116	0.091	0.101	0.094	0.111	0.113	0.113	0.112	0.097	0.113	0.121	0.097
<b>Frederick</b>						0.113	0.116	0.100	0.104	0.098	0.110	0.095
<b>Rockville</b>	0.108	0.101	0.113	0.093	0.107	0.114	0.113	0.088	0.107	0.099	0.115	0.094
<b>Greenbelt</b>	0.125	0.114	0.123	0.103	0.140	0.112	0.124	0.117	0.111	0.120	0.112	
<b>Suitland</b>	0.112	0.108	0.108	0.098	0.118	0.111	0.105	0.109	0.105			
<b>PG Equestrian Center</b>										0.114	0.125	0.100
<b>Beltsville</b>												
<b>Arlington</b>	0.110	0.111	0.117	0.086	0.125	0.100	0.105	0.098	0.103	0.133	0.115	0.101
<b>Cub Run</b>		0.100	0.120	0.093	0.087	0.117	0.106	0.094	0.099	0.099	0.103	0.105
<b>Mt. Vernon</b>	0.121	0.097	0.110	0.105	0.112	0.111	0.111	0.108	0.101	0.127	0.120	0.123
<b>Franconia</b>						0.105	0.106	0.082	0.106	0.128	0.123	0.121
<b>Annandale</b>										0.122	0.119	0.098
<b>Seven Corners</b>		0.106	0.102	0.093	0.117	0.109	0.115	0.100				
<b>Lewinsville</b>		0.095	0.122	0.094	0.104	0.105	0.105	0.101	0.103	0.104	0.112	0.109
<b>Ashburn</b>						0.107	0.106	0.092	0.104	0.119	0.116	0.107
<b>Long Park</b>		0.088	0.113	0.089	0.100	0.114	0.096	0.093	0.100	0.108	0.109	0.097
<b>Widewater Elementary</b>	0.089	0.091	0.099	0.095	0.097	0.111	0.112	0.086	0.090	0.126	0.109	0.098
<b>Alexandria</b>	0.100	0.097	0.113	0.091	0.109	0.101	0.102	0.095	0.097	0.123	0.107	0.109
<i>Highest</i>	<i>0.125</i>	<i>0.119</i>	<i>0.123</i>	<i>0.105</i>	<i>0.140</i>	<i>0.117</i>	<i>0.124</i>	0.117	<i>0.111</i>	<i>0.133</i>	<i>0.125</i>	<i>0.123</i>
<i>Lowest</i>	<i>0.089</i>	<i>0.084</i>	<i>0.089</i>	<i>0.071</i>	<i>0.087</i>	<i>0.097</i>	<i>0.096</i>	<i>0.082</i>	<i>0.090</i>	<i>0.098</i>	<i>0.103</i>	<i>0.083</i>
<i>Median</i>	<i>0.109</i>	<i>0.101</i>	<i>0.113</i>	<i>0.093</i>	<i>0.115</i>	<i>0.109</i>	<i>0.106</i>	<i>0.100</i>	<i>0.103</i>	<i>0.120</i>	<i>0.112</i>	<i>0.100</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-4: Top Four Highest 8-hour Ozone Concentrations Across all Monitors (1993-2004) (ppm)**

	<b>Highest Monitor Highest 8-hour</b>	<b>Highest Monitor 2nd Highest 8-hour</b>	<b>Highest Monitor 3rd Highest 8-hour</b>	<b>Highest Monitor 4th Highest 8-hour</b>
<b>1993</b>	0.125	0.121	0.116	0.109
<b>1994</b>	0.119	0.114	0.114	0.099
<b>1995</b>	0.123	0.111	0.108	0.100
<b>1996</b>	0.105	0.098	0.094	0.091
<b>1997</b>	0.140	0.120	0.117	0.110
<b>1998</b>	0.117	0.110	0.108	0.105
<b>1999</b>	0.124	0.112	0.112	0.106
<b>2000</b>	0.117	0.102	0.098	0.094
<b>2001</b>	0.111	0.108	0.101	0.101
<b>2002</b>	0.133	0.125	0.114	0.112
<b>2003</b>	0.125	0.124	0.106	0.097
<b>2004</b>	0.123	0.099	0.097	0.093

**Table A-5: Three-Year Average 4th Highest 8-hour Ozone Concentrations (1993-2004) (ppm)**

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	0.085
River Terrace	0.096	0.096	0.087	0.084	0.080	0.085	0.090	0.089	0.089	0.092	0.092	0.085
McMillan Reservoir		0.096	0.093	0.095	0.091	0.095	0.100	0.096	0.094	0.095	0.095	0.089
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	0.091
Frederick							0.095	0.092	0.092	0.092	0.089	0.083
Rockville	0.092	0.091	0.095	0.091	0.093	0.093	0.095	0.091	0.090	0.090	0.088	0.083
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			
PG Equestrian Center												0.095
Beltsville	0.102	0.098								0.101	0.099	0.095
Arlington	0.096	0.092	0.096	0.091	0.092	0.092	0.097	0.093	0.093	0.097	0.099	0.095
Cub Run	0.091	0.088	0.093	0.086	0.084	0.087	0.091	0.091	0.088	0.088	0.089	0.085
Mt. Vernon	0.100	0.096	0.097	0.092	0.091	0.093	0.096	0.098	0.096	0.098	0.097	0.097
Franconia							0.098	0.091	0.090	0.093	0.098	0.096
Annandale												0.094
Seven Corners	0.099	0.091	0.094	0.089	0.090	0.092	0.095	0.091		0.108	0.096	0.094
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	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	0.083
Widewater Elementary	0.079	0.089	0.085	0.084	0.084	0.088	0.092	0.088	0.086	0.085	0.087	0.084
Alexandria	0.090	0.089	0.092	0.083	0.082	0.083	0.092	0.089	0.086	0.086	0.088	0.089
<i>Highest</i>	<i>0.103</i>	<i>0.098</i>	<i>0.097</i>	<i>0.095</i>	<i>0.110</i>	<i>0.102</i>	<i>0.106</i>	<i>0.100</i>	<i>0.098</i>	<i>0.108</i>	<i>0.099</i>	<i>0.097</i>
<i>Lowest</i>	<i>0.074</i>	<i>0.071</i>	<i>0.075</i>	<i>0.083</i>	<i>0.080</i>	<i>0.082</i>	<i>0.086</i>	<i>0.087</i>	<i>0.086</i>	<i>0.085</i>	<i>0.087</i>	<i>0.083</i>
<i>Median</i>	<i>0.093</i>	<i>0.091</i>	<i>0.091</i>	<i>0.089</i>	<i>0.089</i>	<i>0.091</i>	<i>0.095</i>	<i>0.092</i>	<i>0.091</i>	<i>0.093</i>	<i>0.093</i>	<i>0.089</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-6: Second Highest 8-hour Average Carbon Monoxide Concentrations (1993-2004) (ppm)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	6.7	5.5	4.5	3.3								
<b>C&amp;P Telephone</b>	7.6	5.1	6.2	4.5	5.2	4.4	3.5	3.3	4.7	3.2	3.2	2.4
<b>River Terrace</b>	6.3	6.3	5.3	4.2	6.4	4.6	5.6	5.0	4.5	4.5	4.0	3.4
<b>Rockville</b>	4.4	4.2	3.4	3.0	2.5							
<b>Bladensburg</b>	5.9	6.1	6.3	4.5	6.8	4.8	4.3					
<b>Arlington</b>	4.9	4.1	4.6	4.0	2.4	2.3	3.8	2.7	2.7	2.6	2.5	2.2
<b>Cub Run</b>					1.6	1.3	1.2	1.5	1.3	1.2	1.4	1.2
<b>Mt. Vernon</b>	1.5	1.8	1.5	1.8	4.3	3.3						
<b>Seven Corners</b>	4.1	4.8	4.3	3.9	2.1	1.7	2.1	2.3	1.7			
<b>Annandale</b>										1.5	1.6	1.4
<b>Lewinsville</b>	3.2	2.3	2.6	3.0	4.6	2.6	3.1	3.5	3.0	2.3	2.7	2.3
<b>Alexandria</b>	5.4	4.6	4.0	4.4	3.3	3.5	3.6	2.9	2.4	2.4	2.8	2
<b>Massey</b>	4.8	4.4	3.8	3.7								
<b>Franconia</b>							1.8	1.9	1.9	1.5	1.5	1.2
<b>Annandale</b>										1.5	1.6	
<b>Highest</b>	7.6	6.3	6.3	4.5	6.8	4.8	5.6	5.0	4.7	4.5	4.0	3.4
<b>Lowest</b>	1.5	1.8	1.5	1.8	1.6	1.3	1.2	1.5	1.3	1.2	1.4	1.2
<b>Median</b>	4.9	4.6	4.3	3.9	3.8	3.3	3.5	2.8	2.6	2.4	2.6	2.1

Blank data indicates the monitor has not been installed or has been removed.

**Table A-7: Second Highest 1-hour Average Carbon Monoxide Concentrations (1993-2004) (ppm)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	8.4	7.5	7.0	7.0								
<b>C&amp;P Telephone</b>	11.4	7.3	7.8	7.5	6.8	6.7	5.4	5.9	5.2	7.5	8.3	3.4
<b>River Terrace</b>	8.5	8.2	7.0	6.3	7.4	6.7	7.3	6.6	6.3	5.6	7.6	4.0
<b>Rockville</b>	6.4	6.4	4.7	4.9	3.7							
<b>Bladensburg</b>	8.5	9.8	10.2	8.1	8.9	7.3	7.5					
<b>Arlington</b>	8.2	6.6	6.0	6.1	3.7	4.0	4.9	3.5	2.8	3.4	4.1	3.2
<b>Cub Run</b>					2.3	1.7	1.7	2.4	1.7	1.4	1.9	1.6
<b>Mt. Vernon</b>	2.2	2.3	1.9	5.0	6.7	6.4						
<b>Seven Corners</b>	7.6	8.8	7.1	6.0	4.1	3.0	3.2	4.2	2.8			
<b>Annandale</b>										2.1	2.2	1.8
<b>Lewinsville</b>	4.3	4.4	3.6	4.7	7.2	4.4	7.0	5.6	4.6	3.3	3.3	3.6
<b>Alexandria</b>	7.6	7.6	5.9	6.3	4.8	5.2	4.7	4.0	4.3	4.0	3.5	2.9
<b>Massey</b>	6.1	6.1	5.1	7.4								
<b>Franconia</b>							3.4	2.8	2.6	2.7	2.4	1.6
<b>Annandale</b>										2.1	2.2	
<b><i>Highest</i></b>	<i>11.4</i>	<i>9.8</i>	<i>10.2</i>	<i>8.1</i>	<i>8.9</i>	<i>7.3</i>	<i>7.5</i>	<i>6.6</i>	<i>6.3</i>	<i>7.5</i>	<i>8.3</i>	<i>3.6</i>
<b><i>Lowest</i></b>	<i>2.2</i>	<i>2.3</i>	<i>1.9</i>	<i>4.7</i>	<i>2.3</i>	<i>1.7</i>	<i>1.7</i>	<i>2.4</i>	<i>1.7</i>	<i>1.4</i>	<i>1.9</i>	<i>1.6</i>
<b><i>Median</i></b>	<i>7.6</i>	<i>7.3</i>	<i>6.0</i>	<i>6.3</i>	<i>5.8</i>	<i>5.2</i>	<i>4.9</i>	<i>4.1</i>	<i>3.6</i>	<i>3.4</i>	<i>3.4</i>	<i>3.05</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-8: Annual Average Sulfur Dioxide Concentrations (1993-2004) (ppm)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	0.011	0.011	0.009	0.010								
<b>Garrison School</b>	0.010	0.014										
<b>River Terrace</b>	0.010	0.009	0.007		0.007	0.007	0.007	0.008	0.007	0.007	0.008	0.007
<b>Cub Run</b>	0.005	0.005	0.004	0.006	0.008	0.005	0.006	0.008	0.004	0.004	0.003	0.003
<b>Mt. Vernon</b>	0.008	0.007	0.006	0.006	0.006	0.004						
<b>Seven Corners</b>	0.009	0.008	0.007	0.009	0.008	0.008	0.007	0.010	0.015			
<b>Lewinsville</b>	0.009	0.008	0.007	0.007	0.008	0.009	0.009	0.010	0.007	0.007	0.005	0.006
<b>Alexandria</b>	0.009	0.009	0.007	0.007	0.007	0.006	0.005	0.006	0.006	0.006	0.006	0.006
<b>Annandale</b>										0.005	0.006	0.006
<b><i>Highest</i></b>	<i>0.011</i>	<i>0.014</i>	<i>0.009</i>	<i>0.010</i>	<i>0.008</i>	<i>0.009</i>	<i>0.009</i>	<i>0.010</i>	<i>0.015</i>	<i>0.007</i>	<i>0.008</i>	<i>0.007</i>
<b><i>Lowest</i></b>	<i>0.005</i>	<i>0.005</i>	<i>0.004</i>	<i>0.006</i>	<i>0.006</i>	<i>0.004</i>	<i>0.005</i>	<i>0.006</i>	<i>0.004</i>	<i>0.004</i>	<i>0.003</i>	<i>0.003</i>
<b><i>Median</i></b>	<i>0.009</i>	<i>0.009</i>	<i>0.007</i>	<i>0.007</i>	<i>0.007</i>	<i>0.007</i>	<i>0.007</i>	<i>0.008</i>	<i>0.007</i>	<i>0.006</i>	<i>0.006</i>	<i>0.006</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-9: Annual Average Nitrogen Dioxide Concentrations (1993-2004) (ppm)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	0.027	0.030	0.025	0.026								
<b>Takoma</b>	0.026	0.027	0.023	0.024	0.022	0.024	0.022	0.020	0.023	0.023	0.025	0.021
<b>River Terrace</b>	0.028	0.025	0.025		0.025	0.027	0.024	0.023	0.024	0.024	0.023	0.021
<b>McMillan Reservoir</b>	0.026	0.019	0.020		0.017	0.018	0.018	0.018	0.024	0.023	0.023	0.022
<b>Arlington</b>	0.025	0.025	0.023	0.024	0.022	0.025	0.025	0.023	0.022	0.022	0.026	0.022
<b>Cub Run</b>	0.011	0.011	0.011	0.012	0.011	0.011	0.011	0.010	0.009	0.009	0.010	0.010
<b>Mt. Vernon</b>	0.021	0.020	0.018	0.020	0.019							
<b>Seven Corners</b>	0.026	0.026	0.023	0.022	0.020	0.024	0.023	0.020	0.023	0.018	0.018	
<b>Annandale</b>										0.018	0.018	0.017
<b>Lewinsville</b>	0.028	0.025	0.022	0.022	0.024	0.022	0.020	0.021	0.020	0.019	0.023	0.018
<b>Long Park</b>	0.009	0.011	0.011		0.010	0.013	0.012	0.009	0.014	0.014	0.012	0.010
<b>Alexandria</b>	0.029	0.028	0.026	0.026	0.026	0.027	0.025	0.023	0.023	0.025	0.023	0.024
<b>Ashburn</b>							0.014	0.013	0.014	0.014	0.016	0.015
<i>Highest</i>	<i>0.029</i>	<i>0.030</i>	<i>0.026</i>	<i>0.026</i>	<i>0.026</i>	<i>0.027</i>	<i>0.025</i>	<i>0.023</i>	<i>0.024</i>	<i>0.025</i>	<i>0.026</i>	<i>0.024</i>
<i>Lowest</i>	<i>0.009</i>	<i>0.011</i>	<i>0.011</i>	<i>0.012</i>	<i>0.010</i>	<i>0.011</i>	<i>0.011</i>	<i>0.009</i>	<i>0.009</i>	<i>0.009</i>	<i>0.010</i>	<i>0.010</i>
<i>Median</i>	<i>0.026</i>	<i>0.025</i>	<i>0.023</i>	<i>0.023</i>	<i>0.021</i>	<i>0.024</i>	<i>0.022</i>	<i>0.020</i>	<i>0.023</i>	<i>0.022</i>	<i>0.023</i>	<i>0.021</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-10: Annual Average PM<sub>10</sub> Concentrations (1993-2004) (µg/m<sup>3</sup>)**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>West End Library</b>	25	26	23		23	28	29		27			
<b>Connecticut Avenue</b>	24	23	26		22	27	21		27			
<b>River Terrace</b>	30	27	28	23		22				27	24	27
<b>Frederick Elementary</b>	31	29	34									
<b>Rockville</b>			32									
<b>Stonemill Elementary</b>	24	21										
<b>Suitland</b>	24	23	22	21	22	24	24	23	23			
<b>Arlington</b>	21	21	21	19	18	21						
<b>Cub Run</b>	22	19	20	19	19	18	19	19	18	18	15	16
<b>Mt. Vernon</b>	25	23	22	21	22	22	21	22	21	19	18	21
<b>Seven Corners</b>	23	21	21	20	21	19						
<b>Brandon Avenue</b>	24	23	23	23	20	21	20	19	19	19	20	19
<b>Lewinsville</b>	23	21	22	21	18	20						
<b>Manassas</b>	21	21	21	19	20	20	20	20	18	18	16	18
<b>Cameron Station</b>	23	24	23	24								
<b>Loudoun County</b>					17							
<i>Highest</i>	31	29	34	24	23	28	29	23	27	27	24	27
<i>Lowest</i>	21	19	20	19	17	18	19	19	18	18	15	16
<i>Median</i>	24	23	23	21	20	21	21	20	21	19	18	19

Blank data indicates the monitor has not been installed or has been removed.



**Table A-11: Annual Average PM<sub>2.5</sub> Concentrations (1999-2004) (µg/m<sup>3</sup>)**

<b>MONITOR</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>River Terrace</b>	15.9	18.9	16.9	16.3	14.9	14.9
<b>Park Services</b>	15.3	15.3	15.0	15.6	13.4	14.5
<b>McMillan Reservoir</b>	18.1	15.7	16.1	15.6	14.3	14.4
<b>Rockville</b>	13.5	14.3	12.8	13.0	11.9	12.6
<b>Bladensburg</b>	19.3	18.3	17.1	18.4		
<b>Greenbelt</b>				12.1	11.5	9.8
<b>Beltsville</b>						12.6
<b>Suitland</b>	15.2	14.4	13.5			
<b>PG Equestrian Center</b>				15.4	12.6	13.3
<b>Arlington</b>	13.8	14.9	14.7	14.9	14.1	14.5
<b>Franconia</b>	13.4	14.1	14.3	13.1	13.2	13.9
<b>Seven Corners</b>	14.5	15.3	13.9			
<b>Annandale</b>				13.7	13.2	13.7
<b>Lewinsville</b>	14.3	15.1	14.5	14.1	13.6	14.0
<b>Ashburn</b>	12.8	13.8	14.1	13.5	13.1	14.1
<i>Highest</i>	<i>19.3</i>	<i>18.9</i>	<i>17.1</i>	<i>18.4</i>	<i>14.9</i>	<i>14.9</i>
<i>Lowest</i>	<i>12.8</i>	<i>13.8</i>	<i>12.8</i>	<i>12.1</i>	<i>11.5</i>	<i>9.8</i>
<i>Median</i>	<i>14.5</i>	<i>15.1</i>	<i>14.5</i>	<i>14.5</i>	<i>13.2</i>	<i>14.0</i>

Blank data indicates the monitor has not been installed or has been removed.

**Table A-12: Annual Average Lead Concentrations (1993-2000) ( $\mu\text{g}/\text{m}^3$ )**

<b>MONITOR</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>
<b>Connecticut Avenue</b>	0.02	0.01	0.02	0.01	0.01	0.01	0.02	
<b>Railroad</b>	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02
<b>Rockville</b>	0.02	0.02						
<b>Mt. Vernon</b>	0.01	0.01	0.01	0.01	0.01	0.01		
<b>Furnace Road</b>	0.02	0.03	0.02	0.02	0.02	0.02		
<b>Brandon Avenue</b>	0.01	0.01	0.01	0.01	0.01	0.01		
<b><i>Highest</i></b>	<i>0.02</i>	<i>0.03</i>	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>
<b><i>Lowest</i></b>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.02</i>	<i>0.02</i>
<b><i>Median</i></b>	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.02</i>	<i>0.02</i>

Blank data indicates the monitor has not been installed or has been removed.

## **Appendix B**

## How to Find Additional Information

<b>States</b>	<b>Organization</b>	<b>Address</b>	<b>Telephone/Internet</b>
	District of Columbia Department of Health	825 North Capitol Street, NE Washington, D.C. 20002	(202) 671-5000 www.dchealth.dc.gov
	Maryland Department of the Environment	Air & Radiation Management Administration 1800 Washington Blvd.  Baltimore, MD 21230	(410) 631-3245 www.mde.state.md.us/arma
	Virginia Department of Environmental Quality Office of Air Monitoring	5324 Distribution Drive Richmond, VA 23225	(804) 230-7734 www.deq.state.va.us
<b>Forecasts &amp; Data</b>	<b>Organization</b>	<b>Address</b>	<b>Telephone/Internet</b>
	Baltimore-Washington Real Time AQ Data Map	1800 Washington Blvd. Baltimore, MD 21230	www.air-watch.net
	EPA Air Quality Data Maps & Forecasts	Environmental Protection Agency 109 TW Alexander Drive (E 143-03) Research Park Triangle, NC 27711	www.airnow.gov
	Metropolitan Washington Council of Governments	Suite 300 777 N. Capitol Street, NE Washington, D.C. 20002	(202) 962-3200 www.mwcog.org
<b>Organizations</b>	<b>Organization</b>	<b>Address</b>	<b>Telephone/Internet</b>
	Clean Air Partners	777 N. Capitol Street, NE Washington, D.C. 20002	(877) 515-4593 www.cleanairpartners.net
	EPA Homepage	Environmental Protection Agency Ariel Rios Building 1200 Pennsylvania Avenue, N.W. Washington, D.C. 20460	www.epa.gov
	EPA Region 3	US EPA Region III Air Protection Division 1650 Arch Street (3AP00) Philadelphia, PA 19103-2029	(215) 814-2100 www.epa.gov/reg3artd
	EPA Air Quality Data Policy and Standards	Research Triangle Park North Carolina, 27711 Mail Drop C404-04	(919) 541-5618 www.epa.gov/oar/oaqps
	EPA Office of Transportation and Air Quality	1200 Pennsylvania Avenue, N.W. Washington, D.C. 20460	(734) 214-4269 www.epa.gov/otaq
	Mid-Atlantic Regional Air Management Association	711 West 40th Street Suite 312 Baltimore, MD 21211-2109	(410) 467-0170 www.marama.org
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