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

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

August 2005

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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
Ground-Level Ozone (O_3)	1-hour [c] 8-hour [d]	0.125 ppm 0.085 ppm	0.125 ppm 0.085 ppm
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 [e]	 150 $\mu g/m^3$ 50 $\mu g/m^3$	 150 $\mu g/m^3$ 50 $\mu g/m^3$
$PM_{2.5}$	24-hour [f] Annual [e]	65 $\mu g/m^3$ 15 $\mu g/m^3$	65 $\mu g/m^3$ 15 $\mu g/m^3$
Lead (Pb)	Quarterly [b]	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$

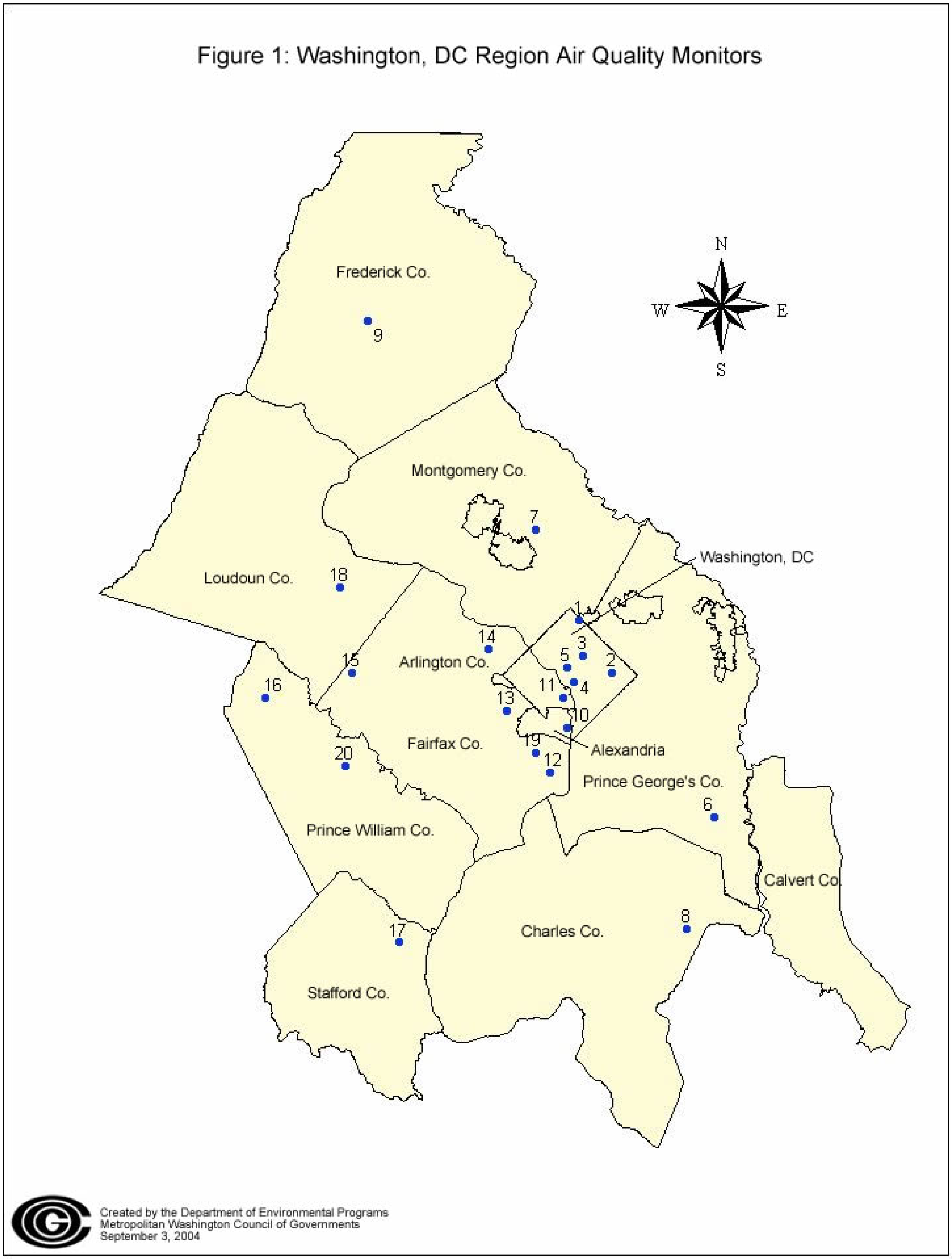
[a] Not to be exceeded more than once in a given year at any monitor.
[b] Not to be exceeded at any monitor.
[c] Not to be exceeded more than three times in three consecutive years at any monitor.
[d] The 4th Highest daily concentration each year (averaged over 3 consecutive years) is not to exceed the standard.
[e] The 3-year average of the weighted annual mean concentration at each monitor must not exceed the standard.
[f] 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.



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	$PM_{2.5}$	PM_{10}	CO	NO_2	SO_2	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_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
*Note: Not included in the 8-hour ozone nonattainment area.

1.0 Ground-Level Ozone (O_3)

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_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 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_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 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 redesignated 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.[1] 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_2 and NO_X emissions from power plants

[1] *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 (ºF), 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 85ºF 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 (≥ 85ºF), 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 ≥ 85ºF (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

Year	Avg 1-hour Max Ozone Concentration (ppb)	1-hour Exceedance Days	Avg Max Temperature (ºF)	Avg Wind (2 pm)	Temp ≥ 85ºF (# of Days)
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

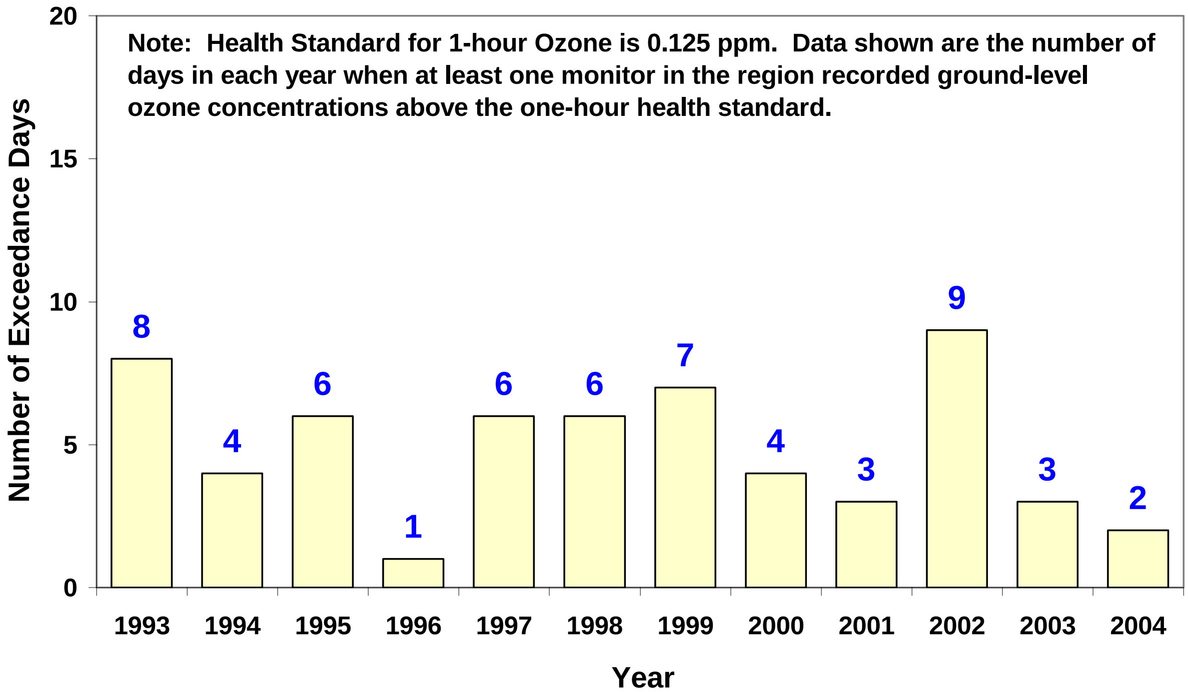


Figure 3 shows the maximum 1-hour ozone concentrations with an overall downward trend in peak ozone concentrations. Peak ozone concentrations for 2004 are approximately 7 parts per billion lower than the average peak concentrations in the 1990's.

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

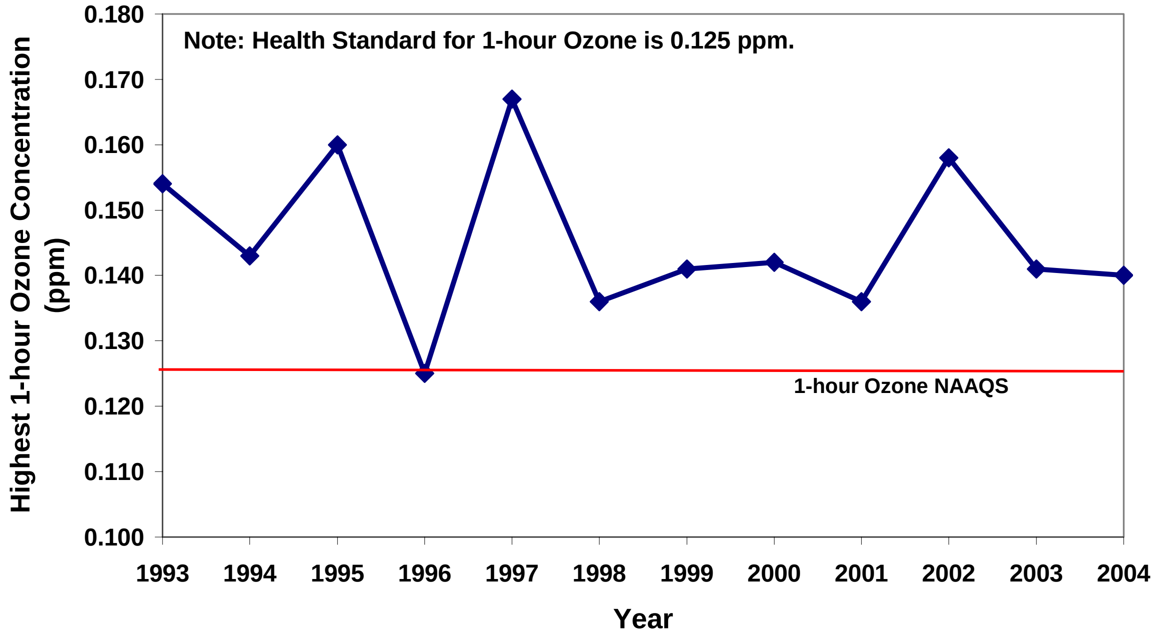
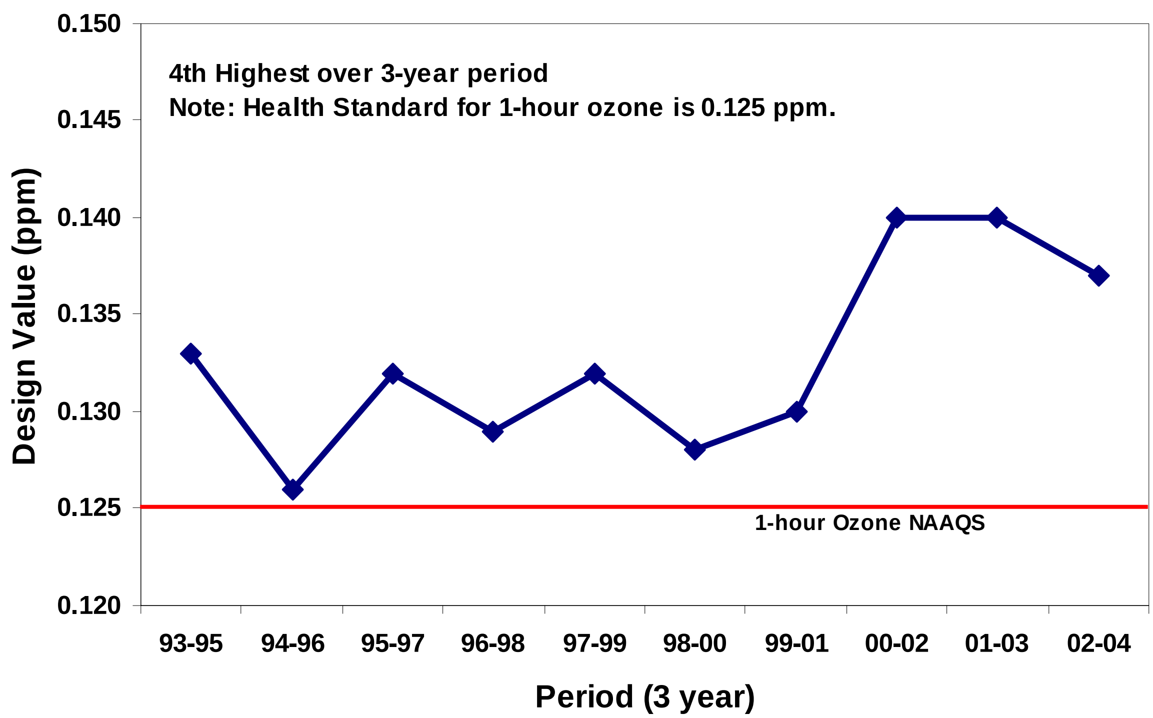
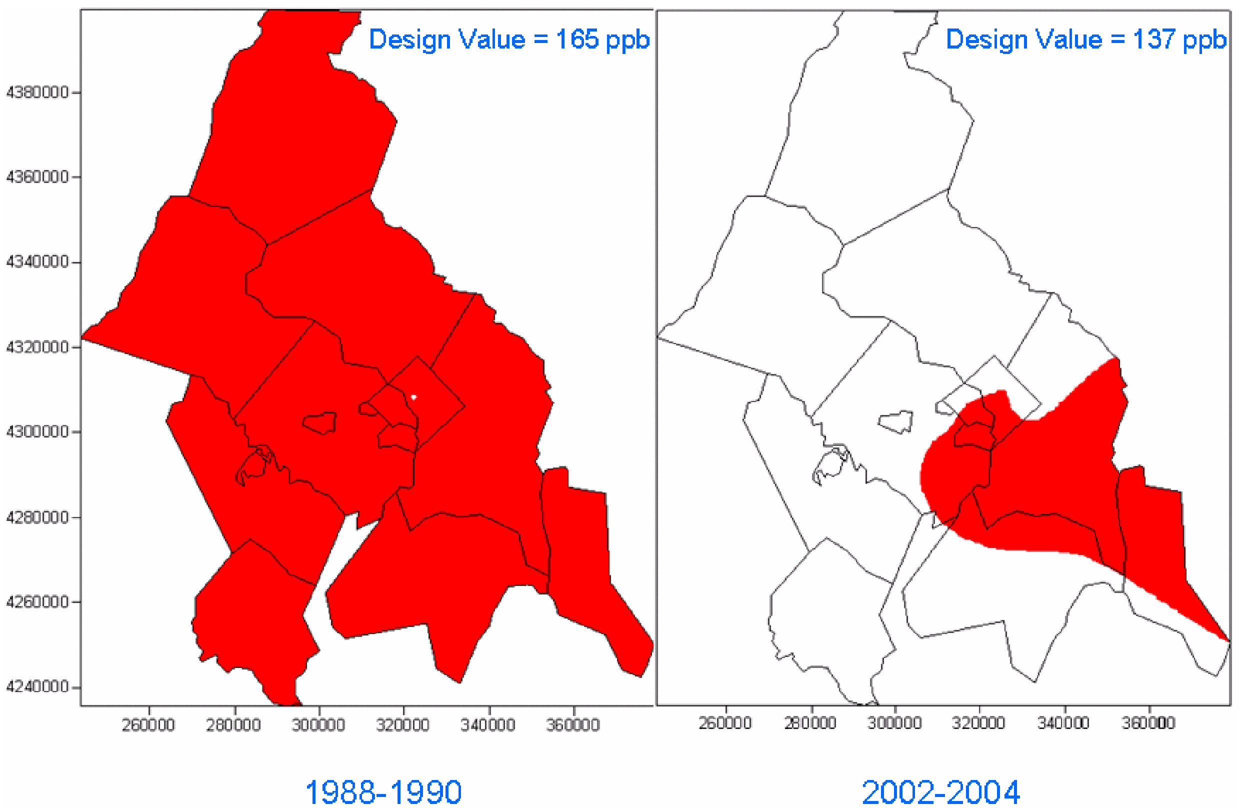


Figure 4: 1-hour Ozone Design Values
Washington, D.C. Region, 1993-2004



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.

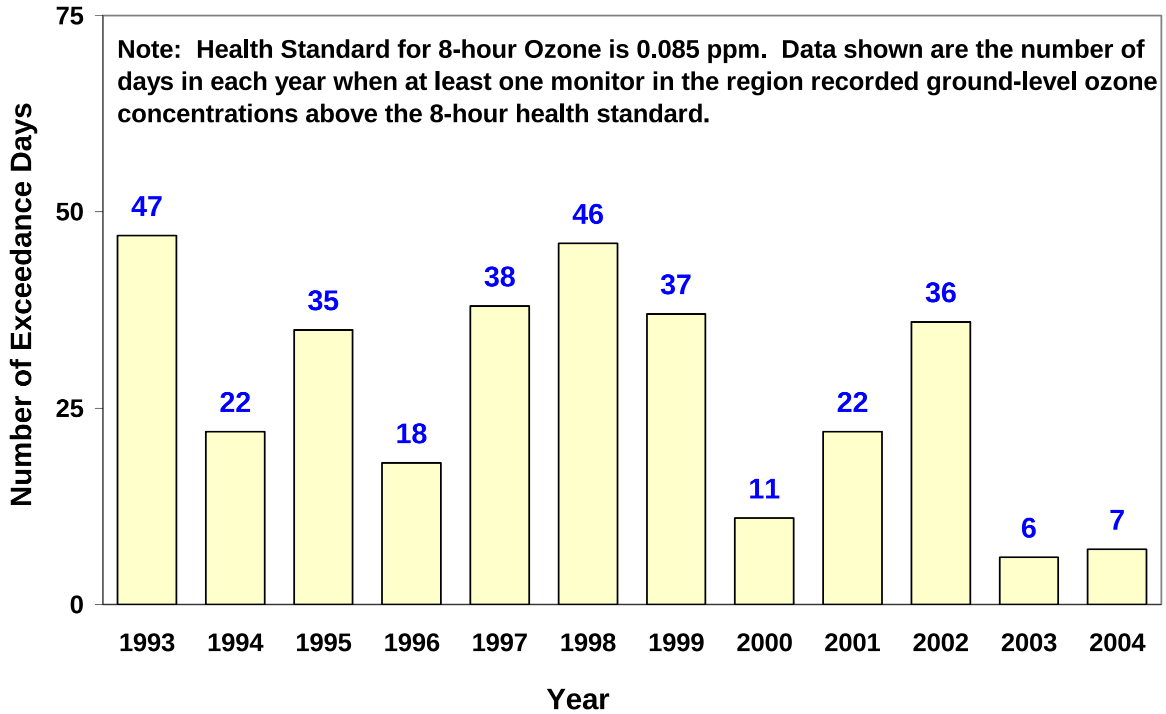
Figure 5: Spatial Extent of 1-hour Ozone Exceedances in the Metropolitan Washington, D.C. Region



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

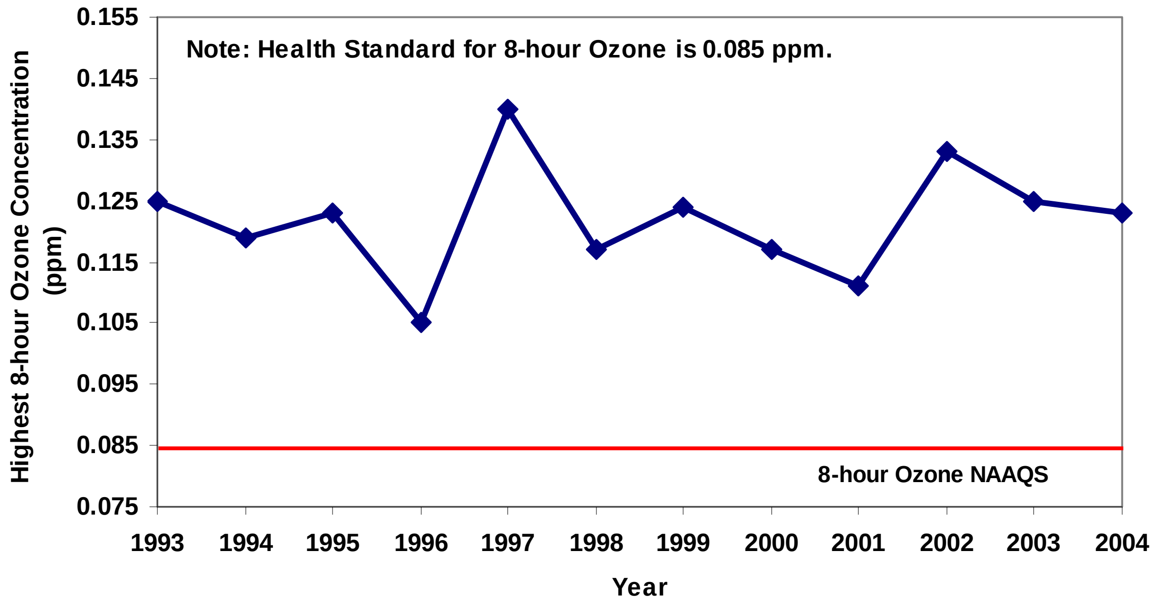
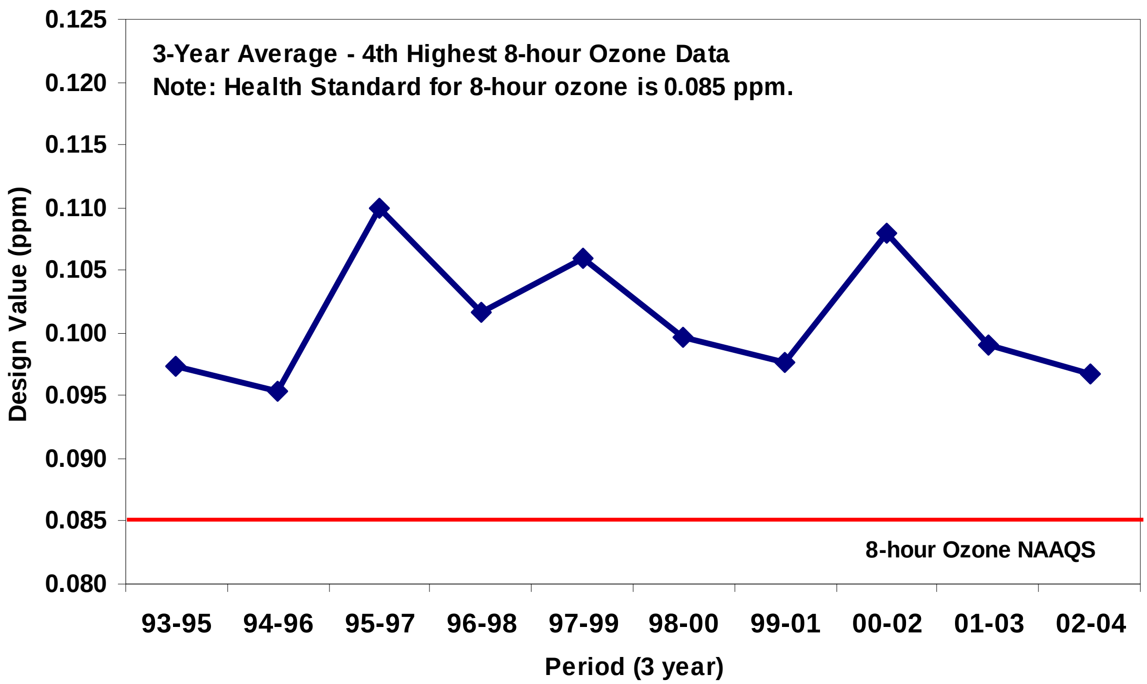


Figure 8: 8-hour Ozone Design Values Washington, D.C. Region, 1993-2004



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

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 2nd highest 8-hour daily concentration. The 2nd 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 2nd 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 2nd highest CO concentrations based on (a) 8-hour averages, and (b) 1-hour averages. Currently, the 2nd highest 8-hour average CO levels at the highest regional monitor are approximately half of the NAAQS for CO.

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

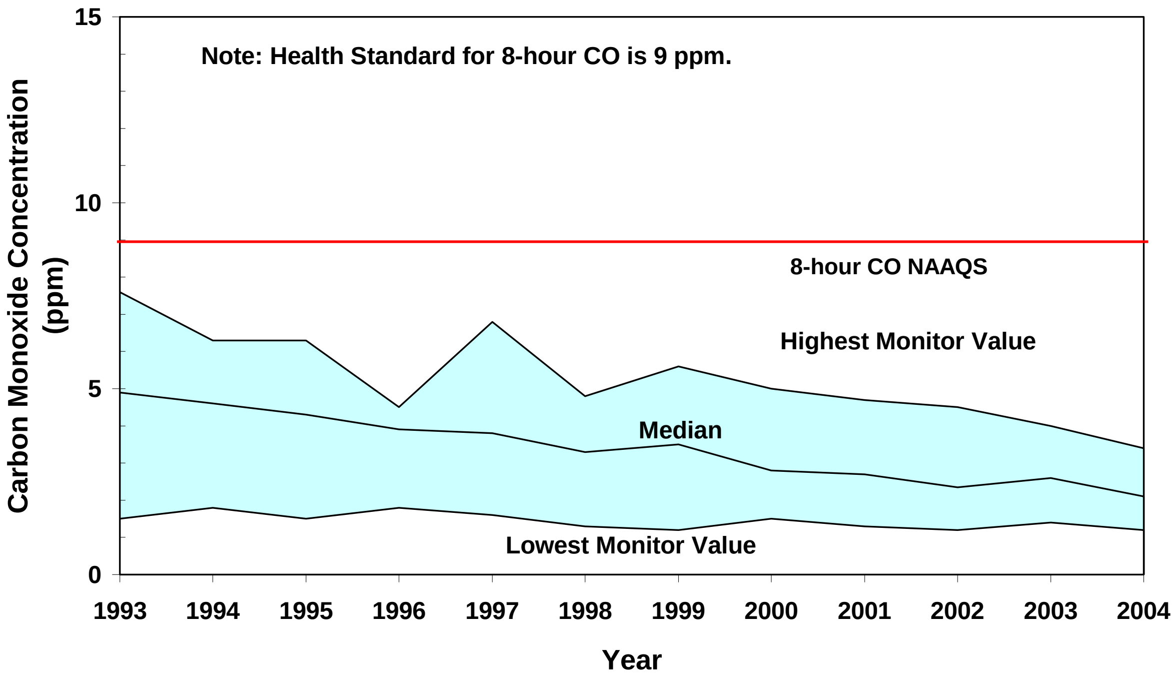
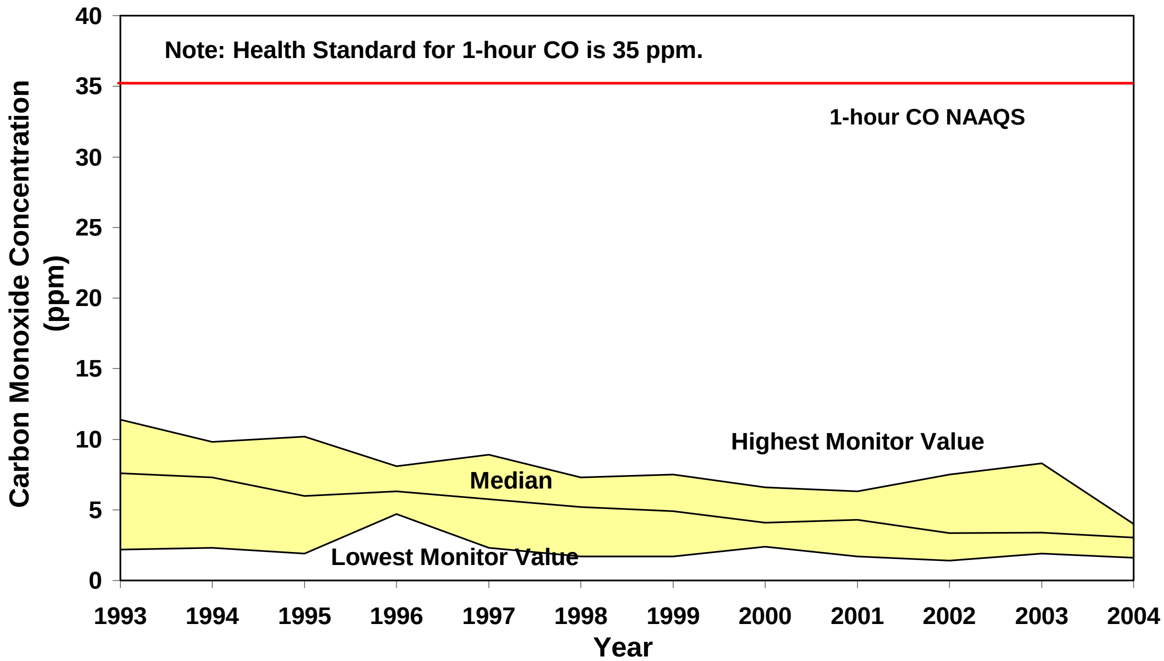


Figure 9b: Carbon Monoxide 2nd High 1-hour Concentrations Washington, D.C. Region, 1993-2004



Another measure of progress is the 2nd 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_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 in the atmosphere can also lead to acidic deposition (acid rain). Thus, the EPA 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 attain both primary standards for the region to be considered in attainment with the primary NAAQS.

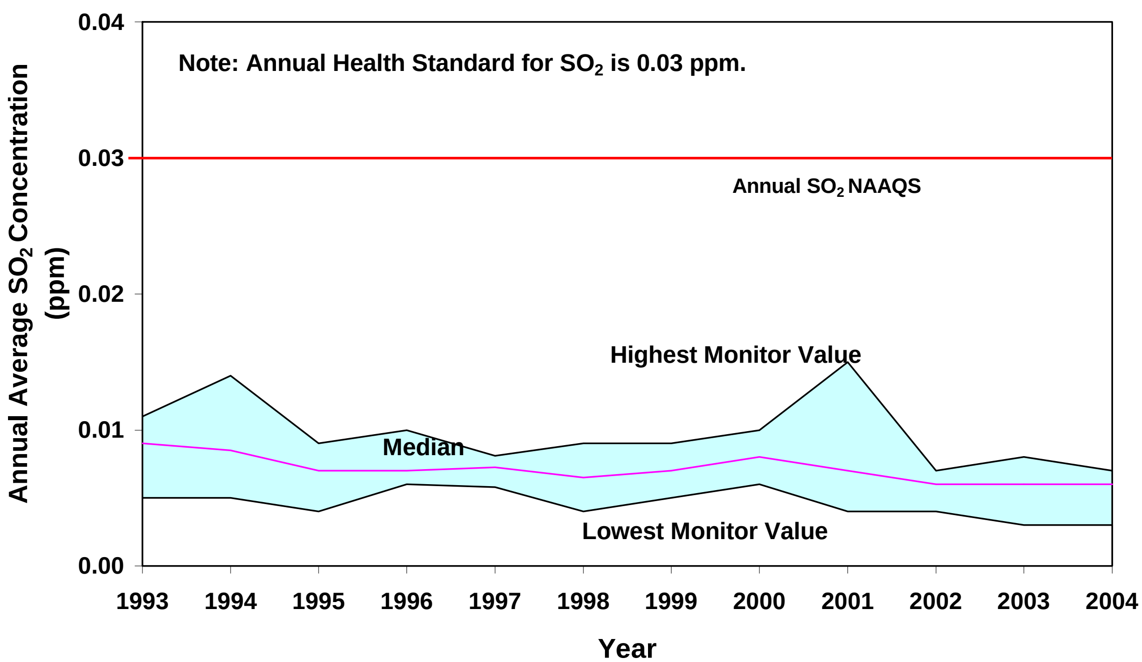
Table 8: SO_2 National Ambient Air Quality Standards

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 Metropolitan Washington, D.C. region is that levels are low and declining. Figure 10 and Table A-8 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, 1993-2004. 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 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_2)

Health Effects and Sources

Nitrogen dioxide is a gaseous pollutant, one of a class of compounds called nitrogen oxides (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, in vehicle engines and 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 shown in Table 9. There is no secondary standard for this pollutant.

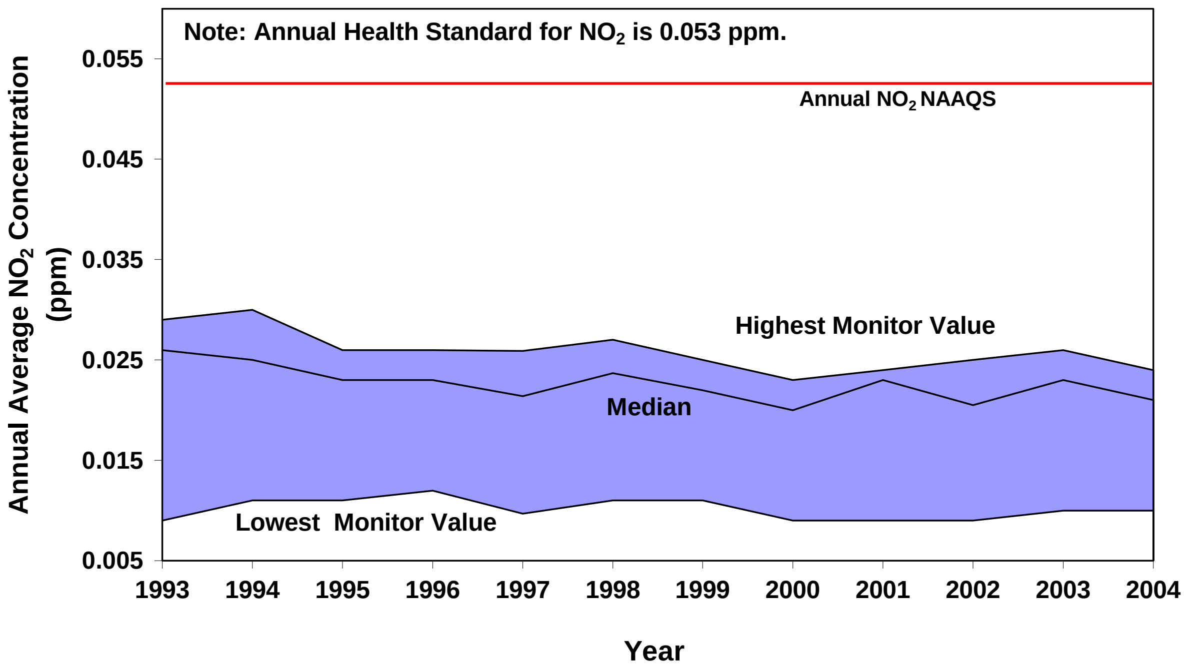
Table 9: NO_2 National Ambient Air Quality Standards

Averaging Period	Primary Standard	Secondary Standard
Annual	0.53 ppm	None

NO_2 Trends

Figure 11 and Table A-9 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, 1993-2004. 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 monitors recording the highest concentrations in the region.

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



Summary

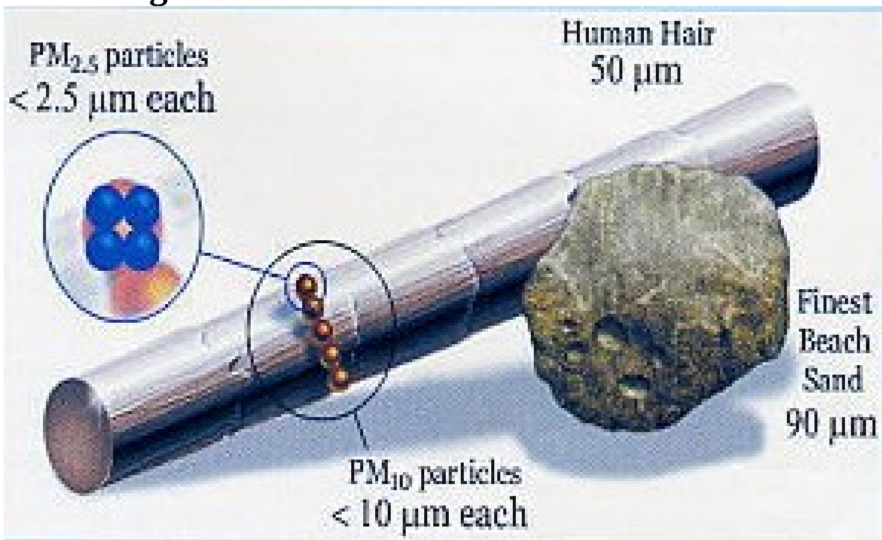
All monitors in the Metropolitan Washington, D.C. region are well within each of the nitrogen dioxide NAAQS.

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_{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 12 graphically depicts the relative size of both PM_{10} and $PM_{2.5}$.

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_2 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_{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, $PM_{2.5}$). In November 2004, the EPA designated the following counties in the Metropolitan Washington, D.C. region as nonattainment for the annual $PM_{2.5}$ 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_{10} and $PM_{2.5}$.

Table 10: Particulate Matter National Ambient Air Quality Standard

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

[a] Not to be exceeded more than once in a given year at any monitor.
[b] The 3-year average of the weighted annual mean concentration at each monitor must not exceed the standard.
[c] The 3-year average of the 98th percentile at each monitor must not exceed the standard.

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 13 and 14. Figure 13 shows the annual averages of PM_{10} levels at both the highest and lowest regional monitors in the Metropolitan Washington, D.C. region. Figure 14 shows the maximum PM_{10} 24-hour concentrations.

Figure 13: PM_{10} Annual Average Concentrations Washington, D.C. Region, 1993-2004

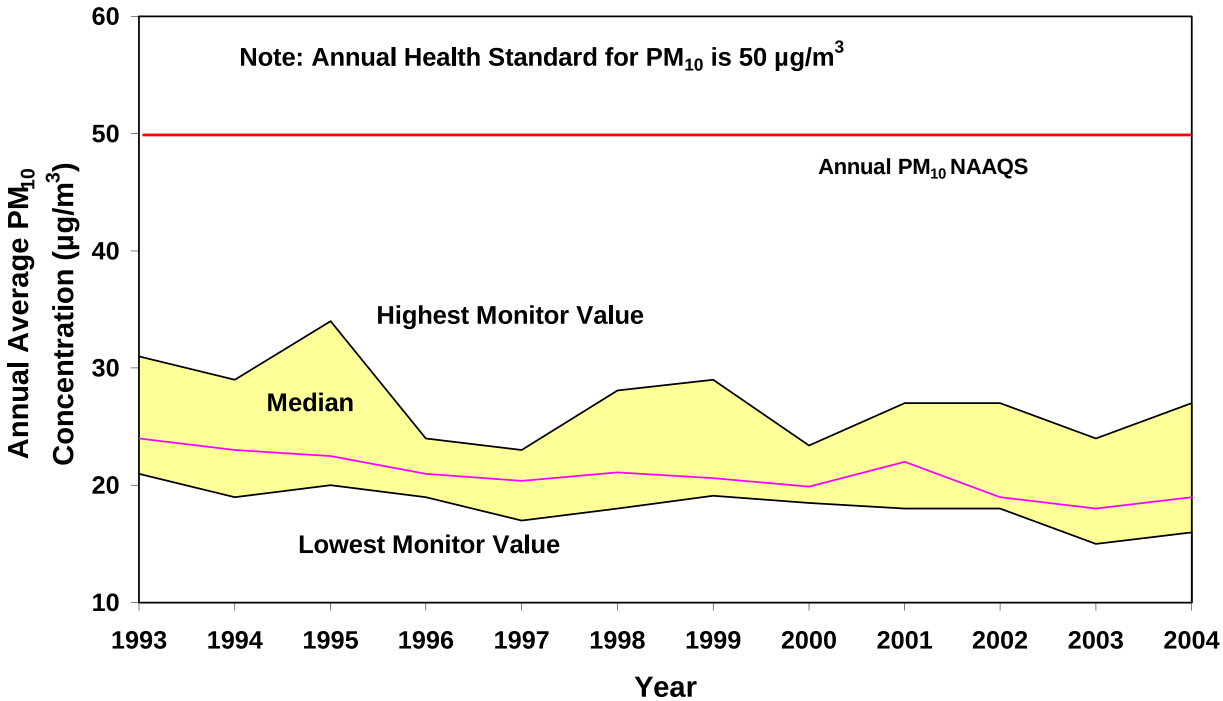
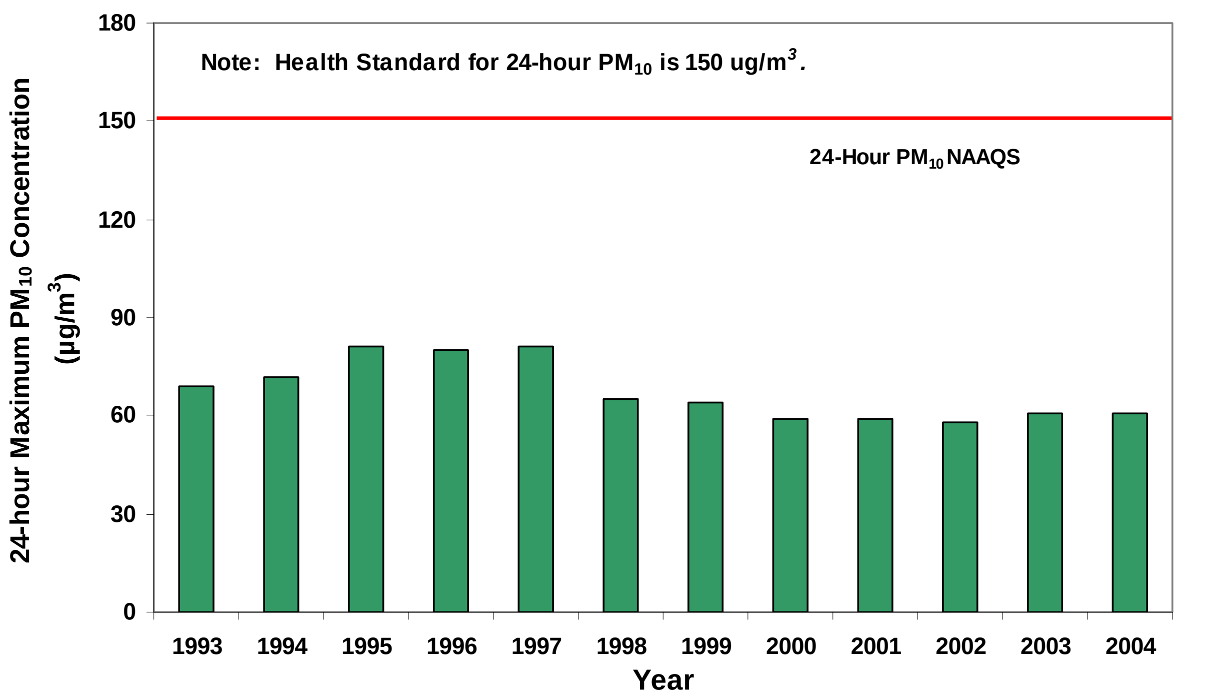


Figure 14: PM_{10} 24-hour Maximum Concentrations Washington, D.C. Region, 1993-2004



$PM_{2.5}$ Trends

A new federal health standard for particulate matter was created in 1997 for $PM_{2.5}$. The Metropolitan Washington, D.C. 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 15 and 16. Figure 15 shows the annual average $PM_{2.5}$ design values for the Metropolitan Washington, D.C. region. Data show a general downward trend.

Figure 15: $PM_{2.5}$ Annual Average Concentrations
Washington, D.C. Region, 1999-2004

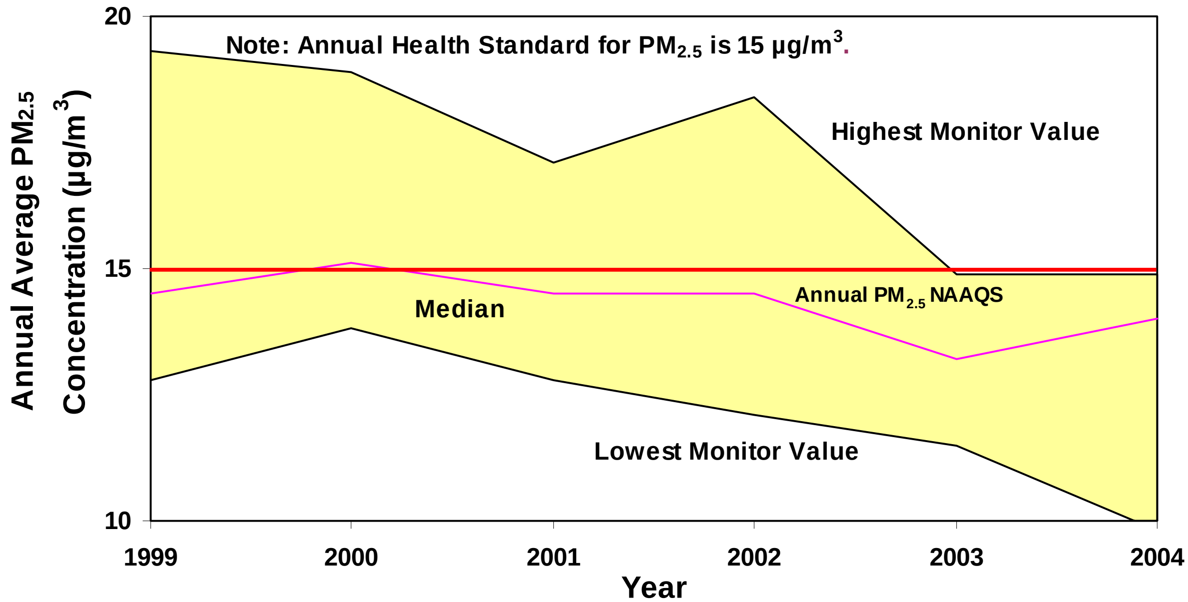
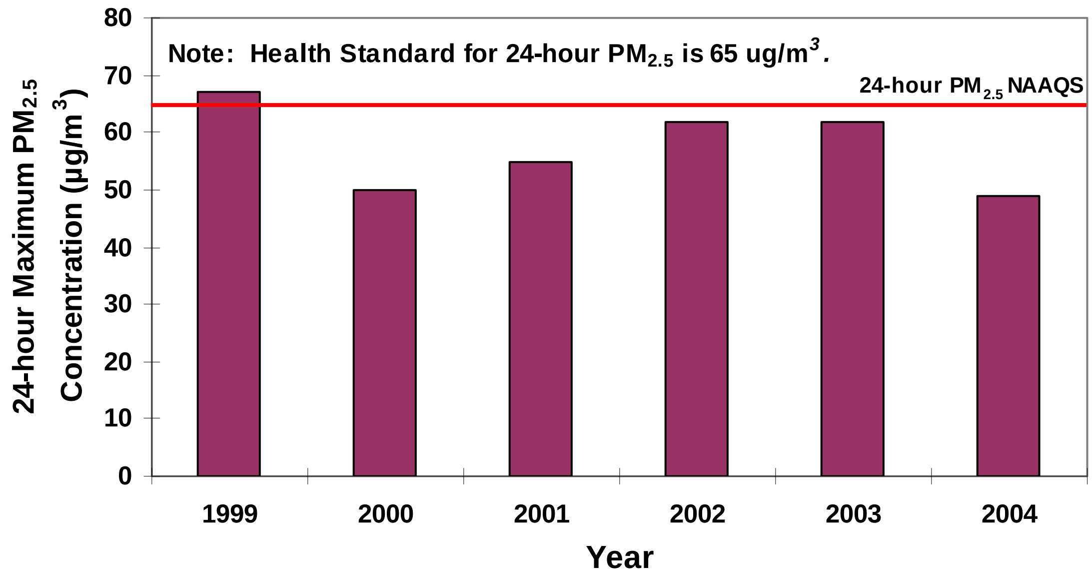


Figure 16 shows the 24-hour average $PM_{2.5}$ design values for the Metropolitan Washington, D.C. region for the same period. Data show that the Metropolitan Washington, D.C. region is below the 24-hour $PM_{2.5}$ NAAQS.

Figure 16: $PM_{2.5}$ 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_{10} NAAQS.
The Metropolitan Washington, D.C. region began monitoring for $PM_{2.5}$ in 1999. Since that time, data indicate that the region is not meeting the annual $PM_{2.5}$ standard of 15 $\mu g/m^3$. However, the region remains below the 24-hour $PM_{2.5}$ 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

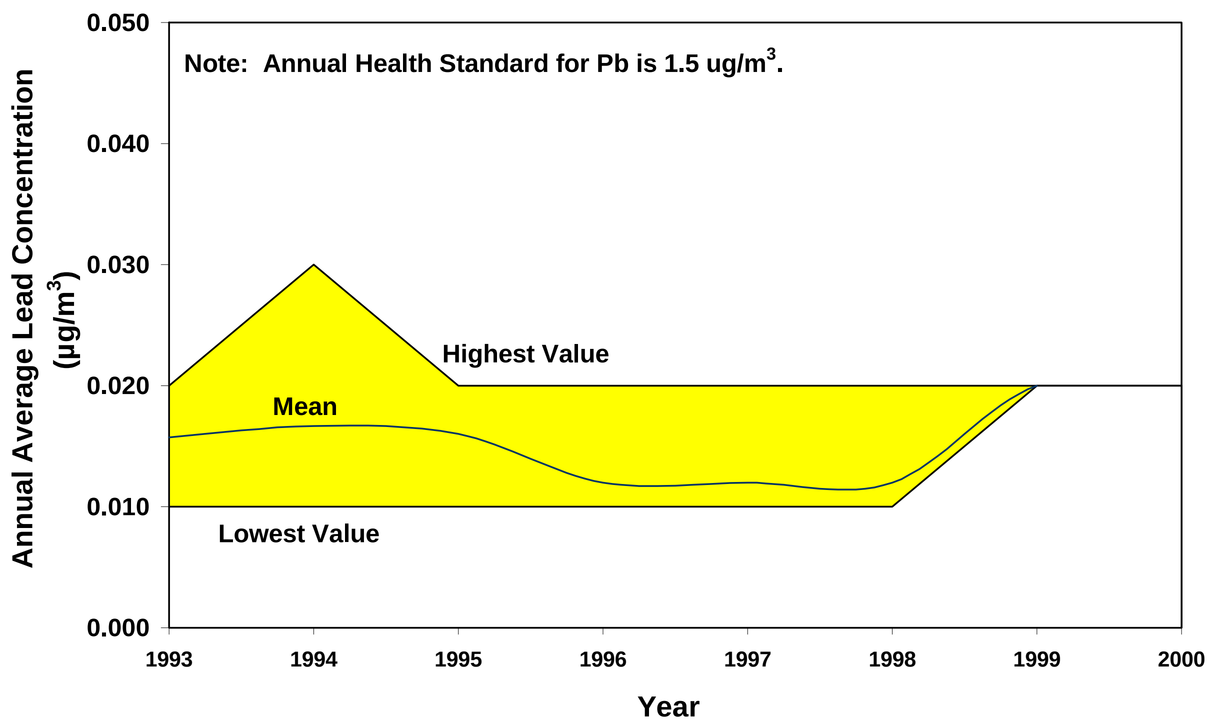
Table 11: Pb National Ambient Air Quality Standards

Averaging Period	Primary Standard	Secondary Standard
Quarterly	1.5 µg/m^3	1.5 µg/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)

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

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)

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

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

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

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)

	Highest Monitor Highest 8-hour	Highest Monitor 2nd Highest 8-hour	Highest Monitor 3rd Highest 8-hour	Highest Monitor 4th Highest 8-hour
1993	0.125	0.121	0.116	0.109
1994	0.119	0.114	0.114	0.099
1995	0.123	0.111	0.108	0.100
1996	0.105	0.098	0.094	0.091
1997	0.140	0.120	0.117	0.110
1998	0.117	0.110	0.108	0.105
1999	0.124	0.112	0.112	0.106
2000	0.117	0.102	0.098	0.094
2001	0.111	0.108	0.101	0.101
2002	0.133	0.125	0.114	0.112
2003	0.125	0.124	0.106	0.097
2004	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
Highest	*0.103*	*0.098*	*0.097*	*0.095*	*0.110*	*0.102*	*0.106*	*0.100*	*0.098*	*0.108*	*0.099*	*0.097*
Lowest	*0.074*	*0.071*	*0.075*	*0.083*	*0.080*	*0.082*	*0.086*	*0.087*	*0.086*	*0.085*	*0.087*	*0.083*
Median	*0.093*	*0.091*	*0.091*	*0.089*	*0.089*	*0.091*	*0.095*	*0.092*	*0.091*	*0.093*	*0.093*	*0.089*

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)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	2.4
River Terrace	6.3	6.3	5.3	4.2	6.4	4.6	5.6	5.0	4.5	4.5	4.0	3.4
Rockville	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	2.2
Cub Run					1.6	1.3	1.2	1.5	1.3	1.2	1.4	1.2
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			
Annandale										1.5	1.6	1.4
Lewinsville	3.2	2.3	2.6	3.0	4.6	2.6	3.1	3.5	3.0	2.3	2.7	2.3
Alexandria	5.4	4.6	4.0	4.4	3.3	3.5	3.6	2.9	2.4	2.4	2.8	2
Massey	4.8	4.4	3.8	3.7								
Franconia							1.8	1.9	1.9	1.5	1.5	1.2
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*	*3.4*
Lowest	*1.5*	*1.8*	*1.5*	*1.8*	*1.6*	*1.3*	*1.2*	*1.5*	*1.3*	*1.2*	*1.4*	*1.2*
Median	*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)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	3.4
River Terrace	8.5	8.2	7.0	6.3	7.4	6.7	7.3	6.6	6.3	5.6	7.6	4.0
Rockville	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	3.2
Cub Run					2.3	1.7	1.7	2.4	1.7	1.4	1.9	1.6
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			
Annandale										2.1	2.2	1.8
Lewinsville	4.3	4.4	3.6	4.7	7.2	4.4	7.0	5.6	4.6	3.3	3.3	3.6
Alexandria	7.6	7.6	5.9	6.3	4.8	5.2	4.7	4.0	4.3	4.0	3.5	2.9
Massey	6.1	6.1	5.1	7.4								
Franconia							3.4	2.8	2.6	2.7	2.4	1.6
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*	*3.6*
Lowest	*2.2*	*2.3*	*1.9*	*4.7*	*2.3*	*1.7*	*1.7*	*2.4*	*1.7*	*1.4*	*1.9*	*1.6*
Median	*7.6*	*7.3*	*6.0*	*6.3*	*5.8*	*5.2*	*4.9*	*4.1*	*3.6*	*3.4*	*3.4*	*3.05*

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

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

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	0.007
Cub Run	0.005	0.005	0.004	0.006	0.008	0.005	0.006	0.008	0.004	0.004	0.003	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	0.006
Alexandria	0.009	0.009	0.007	0.007	0.007	0.006	0.005	0.006	0.006	0.006	0.006	0.006
Annandale										0.005	0.006	0.006
Highest	*0.011*	*0.014*	*0.009*	*0.010*	*0.008*	*0.009*	*0.009*	*0.010*	*0.015*	*0.007*	*0.008*	*0.007*
Lowest	*0.005*	*0.005*	*0.004*	*0.006*	*0.006*	*0.004*	*0.005*	*0.006*	*0.004*	*0.004*	*0.003*	*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*	*0.006*

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

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

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	0.021
River Terrace	0.028	0.025	0.025		0.025	0.027	0.024	0.023	0.024	0.024	0.023	0.021
McMillan Reservoir	0.026	0.019	0.020		0.017	0.018	0.018	0.018	0.024	0.023	0.023	0.022
Arlington	0.025	0.025	0.023	0.024	0.022	0.025	0.025	0.023	0.022	0.022	0.026	0.022
Cub Run	0.011	0.011	0.011	0.012	0.011	0.011	0.011	0.010	0.009	0.009	0.010	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	
Annandale										0.018	0.018	0.017
Lewinsville	0.028	0.025	0.022	0.022	0.024	0.022	0.020	0.021	0.020	0.019	0.023	0.018
Long Park	0.009	0.011	0.011		0.010	0.013	0.012	0.009	0.014	0.014	0.012	0.010
Alexandria	0.029	0.028	0.026	0.026	0.026	0.027	0.025	0.023	0.023	0.025	0.023	0.024
Ashburn							0.014	0.013	0.014	0.014	0.016	0.015
Highest	*0.029*	*0.030*	*0.026*	*0.026*	*0.026*	*0.027*	*0.025*	*0.023*	*0.024*	*0.025*	*0.026*	*0.024*
Lowest	*0.009*	*0.011*	*0.011*	*0.012*	*0.010*	*0.011*	*0.011*	*0.009*	*0.009*	*0.009*	*0.010*	*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*	*0.021*

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

Table A-10: Annual Average PM_{10} Concentrations (1993-2004) ($\mu g/m^3$)

MONITOR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
West End Library	25	26	23		23	28	29		27			
Connecticut Avenue	24	23	26		22	27	21		27			
River Terrace	30	27	28	23		22				27	24	27
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	16
Mt. Vernon	25	23	22	21	22	22	21	22	21	19	18	21
Seven Corners	23	21	21	20	21	19						
Brandon Avenue	24	23	23	23	20	21	20	19	19	19	20	19
Lewinsville	23	21	22	21	18	20						
Manassas	21	21	21	19	20	20	20	20	18	18	16	18
Cameron Station	23	24	23	24								
Loudoun County					17							
Highest	*31*	*29*	*34*	*24*	*23*	*28*	*29*	*23*	*27*	*27*	*24*	*27*
Lowest	*21*	*19*	*20*	*19*	*17*	*18*	*19*	*19*	*18*	*18*	*15*	*16*
Median	*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 $PM_{2.5}$ Concentrations (1999-2004) ($\mu g/m^3$)

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

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

Table A-12: Annual Average Lead 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	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*

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

Appendix B

How to Find Additional Information

States	Organization	Address	Telephone/Internet
	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
Forecasts & Data	**Organization**	**Address**	**Telephone/Internet**
	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
Organizations	**Organization**	**Address**	**Telephone/Internet**
	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
	Ozone Transport Commission	Hall of the States 444 N. Capitol Street, NE Suite 638 Washington, D.C. 20001	(202) 508-3840 www.otcair.org