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IMPROVING THE REGION'S AIR

Air Quality Trends for Metropolitan Washington

September 2017

Metropolitan Washington
Council of Governments

IMPROVING THE REGION'S AIR
Prepared by the Metropolitan Washington Council of Governments on behalf of the Metropolitan Washington Air Quality Committee.

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EXECUTIVE SUMMARY

The United States Environment Protection Agency (EPA) has published federal air quality standards for six criteria pollutants. These criteria pollutants are ozone, particulate matter (PM_{10} & $PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and lead (Pb). The air quality standards are set at levels to protect public health and welfare. Local and state air agencies have been monitoring these pollutants and have taken actions to improve air quality in the metropolitan Washington region for many years. The data collected from these monitors are used to show if the region is above or below the federal standards.

This trends report is to make the public aware of the status of air quality in the region as these pollutants play a vital role in public health. This trends report shows that the metropolitan Washington region's air has improved tremendously from 2005 through 2016. All six criteria pollutants have shown a downward trend, and all but one pollutant, ozone, are below the federal health-based air quality standards.

Ground-level ozone (O_3), formed by chemical reactions between oxides of nitrogen and volatile organic compounds (ozone precursors), is the main pollutant of concern as it has had high concentrations over the last 30 years. Even though ozone levels have declined over the past few decades, concentrations are still above the federal standards. Controlling local emissions of ozone precursors, as well as from upwind areas outside of the region, are keys to reducing ozone levels in the region.

Particulate matter ($PM_{2.5}$ and PM_{10}), sometimes called soot, is another important pollutant that until recently has exceeded the federal air quality standards. Since 2005, metropolitan Washington has been below all particulate matter federal standards due to reductions in emissions from power plants, vehicles, and other sources.

The other criteria pollutants, CO, SO_2, NO_2, and Pb, have been well below federal standards for more than a decade.

This trends report provides information on each pollutant and shows their trends during the last twelve years. While progress has been made in improving the metropolitan Washington's air quality, there is still more work to be done to reduce pollutant levels, specifically ozone, to achieve no unhealthy air days.

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has established federal health standards for six criteria air pollutants, also referred to as the National Ambient Air Quality Standards (NAAQS), which are regulated under the Clean Air Act (CAA). The CAA also classifies areas that do not meet the federal standards (nonattainment) and establishes processes to reduce pollution.

Criteria Air Pollutants

- **Ground-Level Ozone (O_3)**
- **Particulate Matter (PM)**
- **Carbon Monoxide (CO)**
- **Sulfur Dioxide (SO_2)**
- **Nitrogen Dioxide (NO_2)**
- **Lead (Pb)**

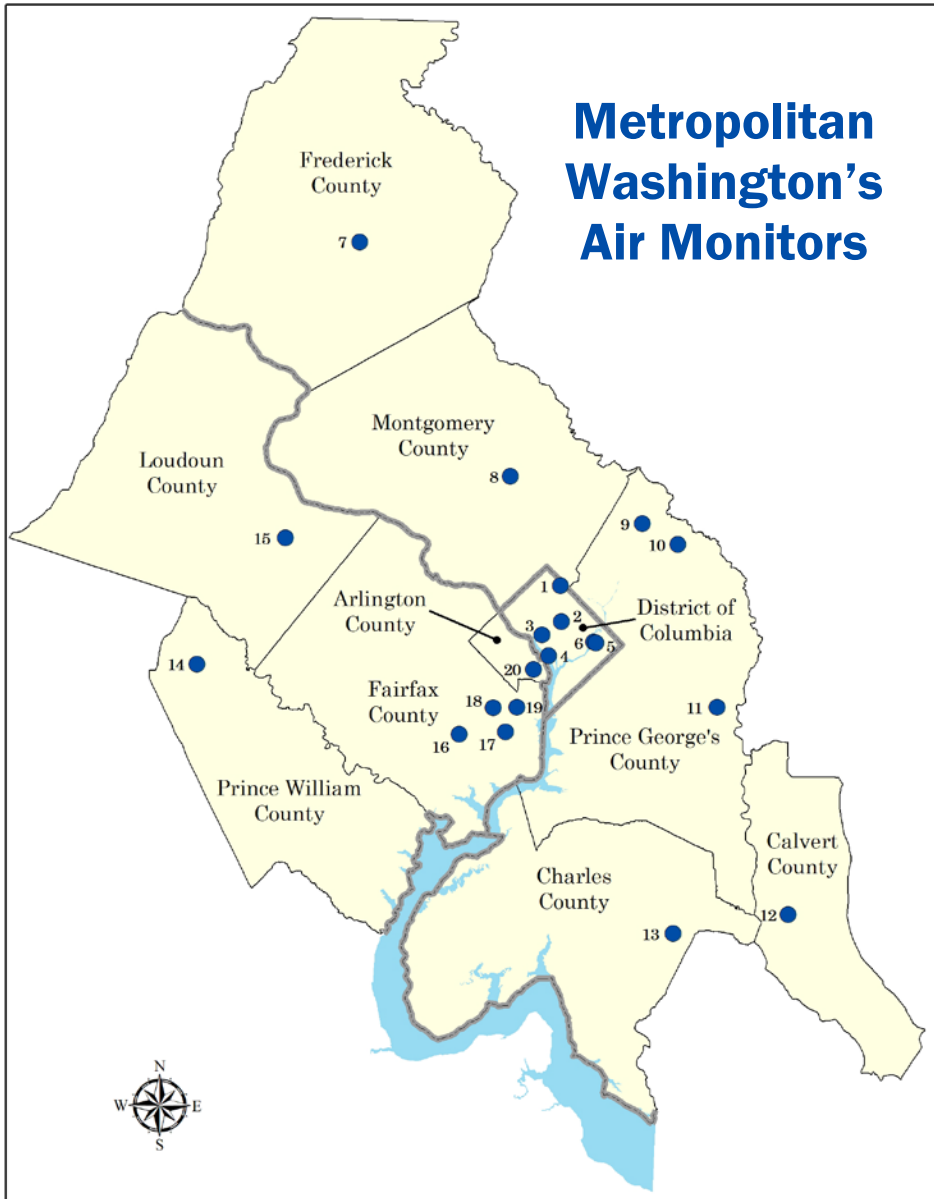
There are two types of federal air quality standards - primary and secondary. The primary standard is designed to protect human health while the secondary standard protects public welfare, such as agricultural production, forests, building materials, and ecosystems.

In order to determine if metropolitan Washington meets a federal standard, pollutant data is collected from air monitors, analyzed, and compared to its corresponding standard.

There are 20 monitors throughout the region. The District Department of Energy and Environment (DOEE), Maryland Department of the Environment (MDE), and Virginia Department of Environmental Quality (VDEQ) operate and maintain the monitors and provide the data for air quality analyses. Monitoring data is also used to produce daily forecasts for ozone and fine particles ($PM_{2.5}$). These forecasts can be found on local agency websites including DOEE, MDE, VDEQ, Metropolitan Washington Council of Governments (COG), and Clean Air Partners.

The region has made significant progress improving air pollution, reducing unhealthy air days from 77 on average in the mid-1990's to just an average of 12 over the past few years. This report shows the improving trends and health information for each criteria pollutant during a twelve-year period, 2005 to 2016.

Metropolitan Washington's Air Monitors



Monitor Name		Pollutants Currently Monitored						
		O_3	$PM_{2.5}$	PM_{10}	CO	NO_2	SO_2	Pb
1.	Takoma Rec Center	•				•		
2.	McMillan NCore	•	•	•	•	•	•	•
3.	Verizon				•			
4.	Hains Point		•					
5.	Near Road		•		•	•		
6.	River Terrace	•	•		•	•	•	
7.	Frederick Airport	•						
8.	Rockville	•	•					
9.	Beltsville (Howard University site)	•	•	•	•	•	•	
10.	Beltsville	•					•	
11.	Prince George's Equestrian Center	•	•					
12.	Calvert	•						
13.	Southern Maryland	•						
14.	James S. Long Park	•				•		
15.	Ashburn	•	•			•		
16.	Springfield Near Road		•		•	•		
17.	Lee District Park	•	•	•			•	
18.	Tucker Elementary School			•				
19.	City of Alexandria				•	•		
20.	Aurora Hills	•	•		•	•		

GROUND-LEVEL OZONE

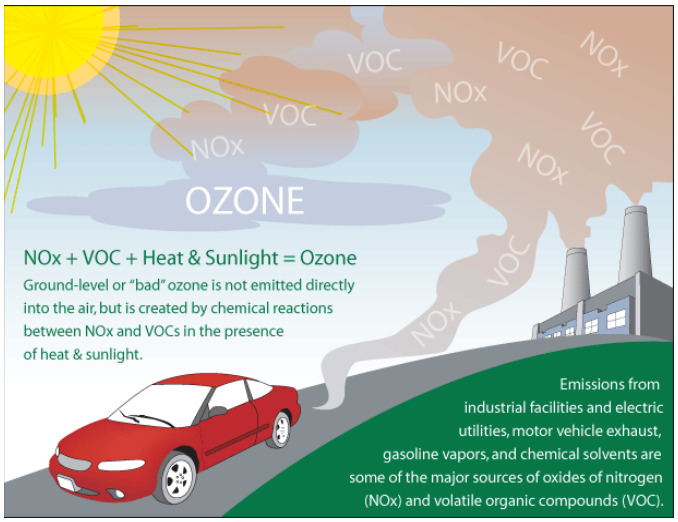
Ozone (O_3) is a colorless, odorless gas found in the atmosphere. Ozone exists naturally in the stratosphere, the Earth's upper atmosphere, where it shields the Earth from the sun's ultraviolet rays. Ozone is also found close to the Earth's surface, where we live and breathe. At ground-level, ozone is an air pollutant affecting the health and well-being of area residents.

High concentrations of ground-level ozone can reduce lung function and cause respiratory symptoms, such as coughing, throat irritation, and shortness of breath. Ozone exposure also aggravates asthma and lung diseases. Ozone may increase the susceptibility of the lungs to infections, allergens, and other air pollutants.

The most vulnerable groups affected by ground-level ozone include:

- Children
- People with respiratory problems
- Athletes and individuals who exercise outdoors
- Older adults

Ground-level ozone is not emitted directly into the air - it is created by the chemical reaction between volatile organic compounds (VOCs) and oxides of nitrogen (NO_x), in the presence of heat and sunlight. Ground-level ozone is a summer-time pollutant, only becoming elevated during the warmer months of the year. In the metropolitan Washington region, high levels of ground-level ozone occur between April through October, in the 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 engines. Plants and trees also emit natural VOCs, which can combine with NO_x to create ozone.



Source: U.S. EPA <Air Now Ozone>

Nitrogen oxides and VOCs are also released from sources hundreds of miles away and get transported into our region and other states along the east coast of the United States. Studies have shown that the metropolitan Washington region's air quality is significantly affected by the transport of ozone and its precursors from other region's air pollution.

Ground-Level Ozone Standards

Ground-level ozone standards have been revised to protect public health and welfare.

1997 Standard - 84 ppb
The region met the standard in 2009 and is designated by EPA as attainment.

2008 Standard - 75 ppb
The region met the standard in 2015. In 2017, the region will submit a plan to designate the area as attainment.

2015 Standard - 70 ppb
Revised to reflect new scientific health studies to protect public health.

Based on 2016 data, the region does not meet the standard.

EPA is expected to designate the region as nonattainment.

Ground-Level Ozone Federal Standards and Trends

EPA first established the National Ambient Air Quality Standards (NAAQS) for ground-level ozone in the 1970s. EPA has continued to lower the standards to protect human health and the environment as our understanding of the health effects of ozone has improved.

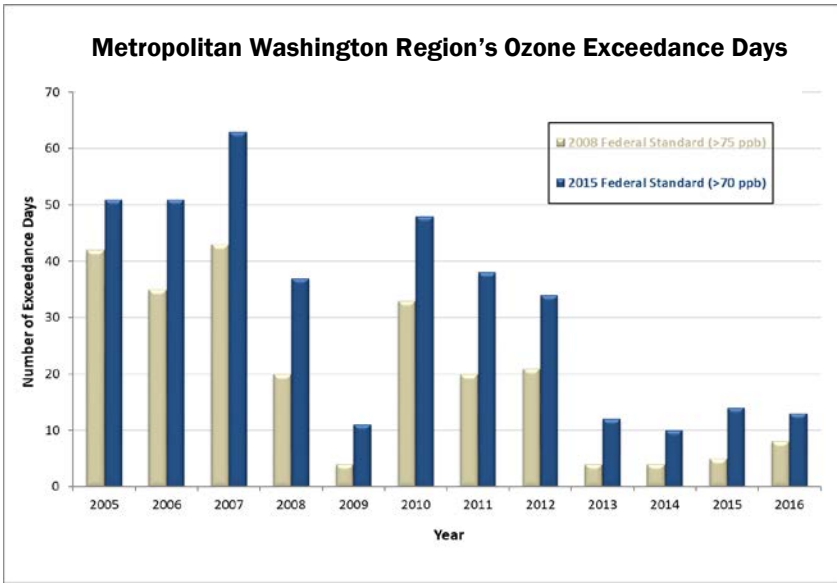
Starting in 1997, EPA established both primary and secondary standards for ground-level ozone based on an eight (8) hour period and subsequently revised the standards in 2008 and 2015.

Over the past decade, the region has made dramatic improvements in regional ozone levels and has met, or attained, both 1997 and 2008 standards. In 2015, EPA revised the federal standards to reflect scientific studies that show levels below 70 parts per billion (ppb) are more protective of public health. Current data shows that the region does not meet these standards.

Meeting federal ozone standards can be difficult because ozone concentrations are also dependent on weather conditions. Temperatures above 90 degrees Fahrenheit (°F), light winds, and stationary high-pressure systems contribute to the formation of unhealthy ozone levels. Hot, dry summers can produce long periods of elevated ozone concentrations, while cool and wet summers can limit ozone production. In warmer, drier years, ozone levels can reach high values more often despite very little change in the emission rates of ozone-forming precursors (VOCs and NO_x).

Just 10 years ago, the combination of high emissions and temperatures resulted in more than 40 unhealthy ozone days each summer. As pollution decreased, the effect of high temperatures was not as impactful, showing a dramatic decrease in ozone levels even as the region experiences warmer summer-time temperatures.

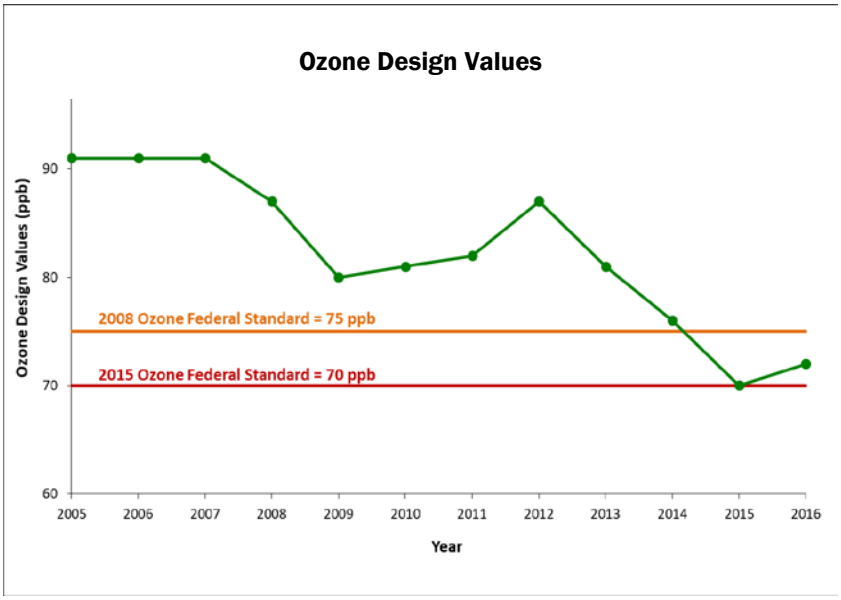
This can be seen by examining the number of exceedance days over the past 12 years. An exceedance day is when ozone concentrations, averaged over 8-hours, has reached above the ozone threshold. Since there were different federal standards in place over the years, the ozone threshold changed. Based on current data, the number of exceedance days has decreased by more than 75%.



Trends can also be illustrated using EPA's design value for ozone. Design values for ozone are the three (3) year average of the fourth highest ozone concentration. The graph below shows the design values over the twelve-year period. Before 2015, ozone concentrations were well above the federal standards. Over time, ozone levels have decreased to where the region now meets the 2008 ozone standard, and we are just above the current 2015 ozone standard, at 72 ppb.

As shown in the graphs, there have been many exceedance days in the past years, and ozone concentrations have been above the federal standards. However, federal, state, and local government's actions of lowering emissions from power plants, passenger vehicles, and heavy-duty diesel engines have helped the region meet all but the 2015 standard.

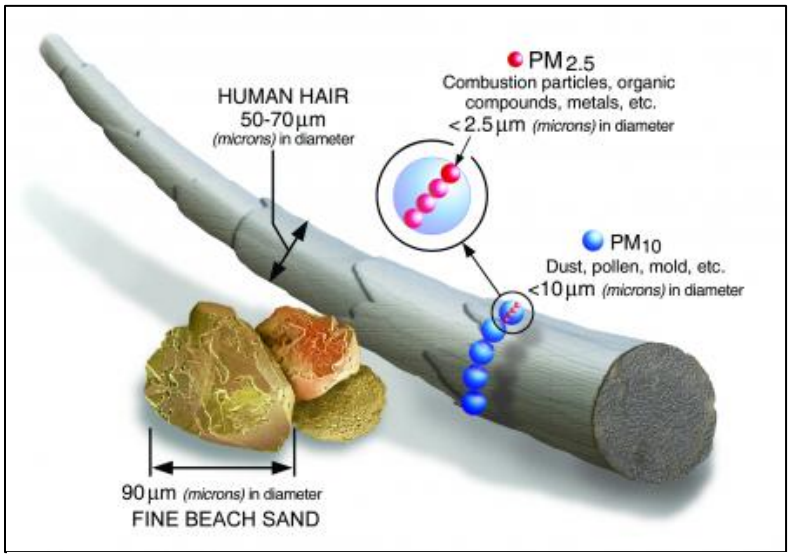
Meeting the current standard is within reach, but the region, and the nation, must continue to take actions to reduce emissions that contribute to ground-level ozone.



Design value = 3-year average of 4th highest daily maximum 8-hour average ozone concentrations

PARTICULATE MATTER

Particulate Matter (PM) is a mixture of microscopic solid particles and liquid droplets suspended in air. This pollution is comprised of several components including acids (like nitrates and sulfates), organic chemicals, metals, soil or dust particles (fine smoke and soot), and allergens. Particulate matter is released directly into the air and is 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.



Source: U.S. EPA <EPA Particulate Matter (PM) Basics Website>

The two classes of particles that the region monitors are PM_{10} and $PM_{2.5}$. PM_{10} refers to particles that are less than 10 µm (micrometers or microns) in diameter. $PM_{2.5}$, also known as fine particles, refers to particles that are less than 2.5 microns in diameter.

The size of the particles directly relates to their potential for causing health problems. Fine particles, like $PM_{2.5}$, pose the greatest problems, because they can travel deep into the lungs and move into the bloodstream. Exposure to such particles can cause health effects like damage to the respiratory and cardiovascular systems, lung tissue damage, cancer, and premature death. Larger particles (>10 microns) are of less concern, although they can irritate the eyes, nose, and throat. Particulate matter is also a major cause of reduced visibility in many regions, and it can cause damage to building materials.

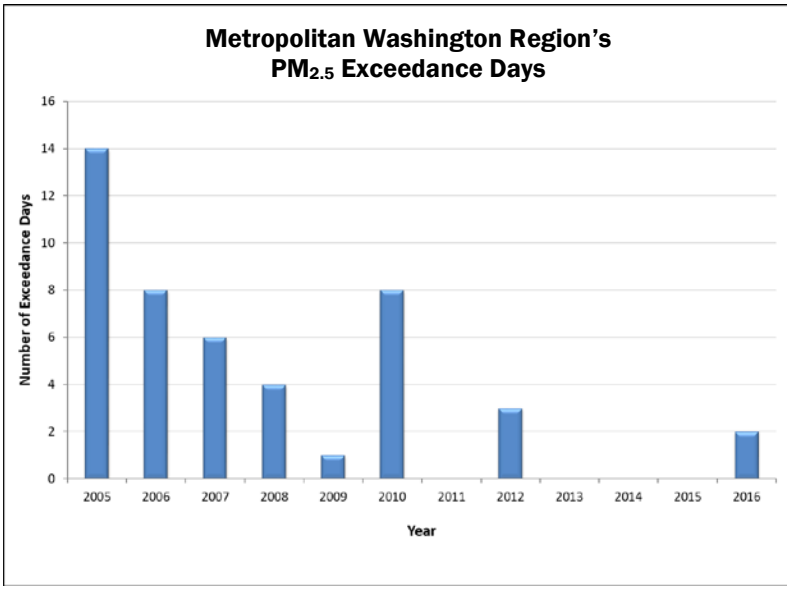
Particulate Matter Federal Standards and Trends

The EPA established a primary and secondary standard for PM_{10} in 1987. At that time, EPA required concentrations to be averaged over both a twenty-four (24) hour period and an annual period to determine if levels met the federal standards. EPA subsequently revised the standard in 1997, 2006, and 2012. The metropolitan region met the PM_{10} standards in the mid-1990s and levels have continued to be in a downward trend, with concentrations decreasing from 81 µg/m³ (micrograms per meter cubed) in 2005 to 46 µg/m³ in 2016.

Particulate Matter Standards

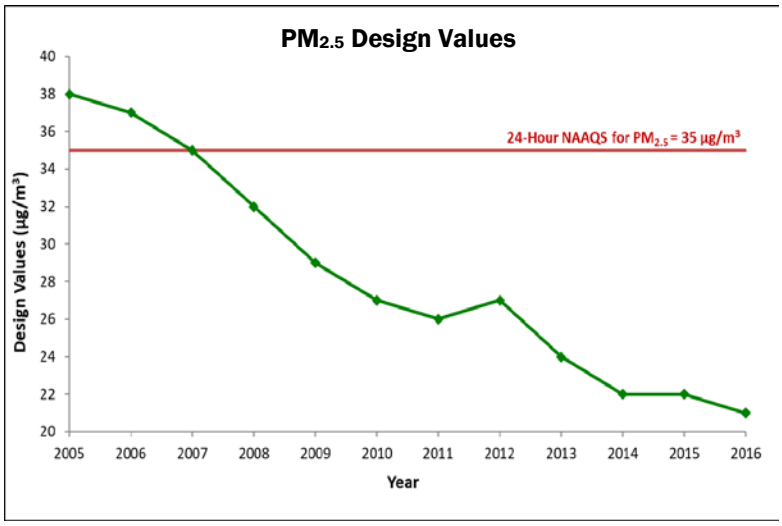
The metropolitan Washington region has met all federal standards for particulate matter.

In 1997, EPA classified $PM_{2.5}$ as a separate pollutant. Both primary and secondary standards were set for a twenty four (24) hour period and an annual period. In 2006 and 2012, EPA set stricter federal standards to ensure public health and a clean environment. Metropolitan Washington now meets both the 2006 and 2012 federal standards, and concentrations continue to decline.



The number of exceedance days for $PM_{2.5}$ is one way to illustrate this downward trend. For $PM_{2.5}$, an exceedance day is when $PM_{2.5}$ concentrations averaged over a day are above a certain $PM_{2.5}$ threshold. In the last few years, exceedance days for $PM_{2.5}$ have reduced to an average of near zero.

$PM_{2.5}$ design values for the twenty four (24) hour averaging period also show a rapid decline for the twelve-year period. $PM_{2.5}$ concentrations were above the federal, but most recently, $PM_{2.5}$ concentrations are well below the standard, at 21 µg/m³. $PM_{2.5}$ design values for the annual averaging period show a downward trend as well. Those concentrations are just under 10 µg/m³ over the last few years, which is also below the federal standards.



The 24-hr Design Value for $PM_{2.5}$ is the 3-year average of the 98th percentile

It is important that our region must continue to control emissions of particulate matter in order to keep the region's air in compliance with the federal standards.

OTHER CRITERIA POLLUTANTS

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas that forms when the carbon in fuel is not completely burned. Ambient CO is different from indoor CO in that ambient CO is produced from outside sources, and not inside buildings or homes. Ambient concentrations tend to be highest in winter months due to the presence of thermal inversions, "cold starting" of automobile engines, and the use of inefficient or poorly maintained space heating systems. Other sources of CO emissions include industrial processes, residential wood burning, and natural sources such as forest fires.

Washington DC Traffic (Ted, Flickr)

When CO enters the bloodstream, it reduces the capacity of the body to deliver oxygen to its organs and tissues. The health threat from ambient CO is most serious for those who suffer from cardiovascular diseases. Elevated CO levels can lead to visual impairment, reduced work capacity, poor learning ability, and difficulty in the performance of complex tasks. Fortunately, the health threat from current levels of ambient CO in the metropolitan Washington region is minimal for healthy individuals.

The primary and secondary federal standards for ambient CO were established in 1971 and by 1985, the EPA revoked the secondary standard. The primary federal standard for CO requires two different averaging periods. One standard averages CO over one (1) hour and the other averages CO over eight (8) hours. By 1995, metropolitan Washington met these federal standards, and the region has been below the standards for the last twenty years.

From 2005 to 2016, CO concentrations have been stable at 4,000 parts per billion (ppb). This seems high compared to ozone, but CO concentrations are more dangerous at higher levels, such as 35,000 ppb for over one hour. Even though CO levels are very low, it is important that our region continues to produce low emissions in order to keep our air healthy moving into the future.

Carbon Monoxide Standards

The metropolitan Washington region has met all federal standards for carbon monoxide.

Sulfur Dioxide

Sulfur dioxide (SO_2) 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 difficult breathing, respiratory illness, the aggravation of existing cardiovascular disease, and alterations in the lungs' defenses. The primary federal standard is intended to protect against these adverse health effects.

Chalk Point Power Plant in southern Maryland (Allie, Flickr)

Ambient sulfur dioxide can be detrimental to the environment as well. SO_2 can have damaging effects on the foliage of trees and agricultural crops. The presence of both sulfur dioxide and nitrogen dioxide in the atmosphere can lead to acidic deposition (acid rain). Thus, the EPA has established a secondary federal standard for SO_2.

Sulfur Dioxide Standards

The metropolitan Washington region has met all federal standards for sulfur dioxide.

EPA established these standards in 1971, and then revised them in later years due to updated research. The EPA revoked the federal standard that averaged SO_2 concentrations annually and revised the federal standard that averaged concentrations over three (3) hours. By 2010, the primary standard was changed from an annual and twenty-four (24) hour averaging period to a one (1) hour averaging period. By that time, SO_2 concentrations were well below both primary and secondary federal standards. In fact, SO_2 concentrations dropped significantly over the twelve-year period. In 2005, SO_2 concentrations for both averaging periods were at 80 ppb, and now they are at 10 ppb.

This dramatic decline does not mean that the region can produce more SO_2. The region needs to continue to keep these concentrations low, so our region will maintain a healthy environment for future generations.

Capitol Power Plant in DC (Apasciuto, Flickr)

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a gaseous pollutant that belongs to a class of compounds called nitrogen oxides (NO_x). NO_2 is a brownish and highly 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. It is also a main pollutant in the production of acid rain and contributes to lower visibility and haze in national parks.

NO_2 can irritate the lungs and lead to respiratory symptoms (coughing and difficulty breathing). Long exposures can cause lower resistance to respiratory infections and the development of asthma.

To reduce NO_2 concentrations, EPA established primary and secondary federal standards in 1971, where concentrations were averaged over a year. By 2010, EPA updated the primary federal standard to a one (1) hour averaging period, and the secondary federal standard was not changed. When these current federal standards were established, NO_2 concentrations in the metropolitan Washington region were already below these standards.

NO_2 concentrations continue to show a steady decline. Concentrations averaged over an hour have been reduced from 68 ppb in 2005 to 50 ppb in 2016. Additionally, annual concentrations have decreased from 24 ppb to 18 ppb during the same period. The rise in industry and population has not had much impact on our air because of the strict laws and regulations that are in put in place to protect the public and the environment in this region.

Nitrogen Dioxide Standards

The metropolitan Washington region has met all federal standards for nitrogen dioxide.

Lead

Lead (Pb) in ambient air mainly results from ore and metals processing and aircraft running on leaded aviation fuel. Other sources of lead come from waste incinerators, lead smelters, and lead-acid battery manufacturers. Lead was also in motor fuels two decades ago, but has since been removed. Unleaded fuels have substantially reduced lead in the atmosphere.

Airplane Contrails (Transport Pixels, Flickr)

Exposure to lead is a serious health concern - lead can accumulate in the blood, bone, and soft tissue of the body. Excessive exposure can affect the nervous system, kidney function, reproductive system, and the cardiovascular system. Neurological impairments mostly occur in children, but adults can experience cardiovascular problems. In the environment, lead can reduce growth and reproductive rates in plants and animals.

Lead federal standards, primary and secondary, were first established in 1978 with a quarterly averaging period. With EPA's approval, monitoring ended in Maryland in 1994, Virginia in 1998, and D.C. in 2001 because lead in the metropolitan Washington region had been far enough under the federal standards. In 2008, the federal standards for lead were changed from 1.5 µg/m^3 on a quarterly average to 0.15 µg/m^3 on a rolling three-month average.

To determine if the metropolitan Washington region was below the updated federal standards, new monitors were placed based on population and on lead industrial sources. The District of Columbia Department of Energy and Environment (DOEE) installed a Total Suspended Particle (TSP) based lead monitor at the McMillan Reservoir location on January 1, 2012. This monitor has a rolling three-month average concentration of 0.00 µg/m^3 from 2012 to 2015. In 2016, the lead concentration was .01 µg/m^3.

With such low concentrations, lead in ambient air is clearly not a problem in our region. Lead should continue to stay low as long as there are no drastic changes in sources of lead emissions.

Lead Standards

The metropolitan Washington region has met all federal standards for lead.

LOOKING TO THE FUTURE

Air pollution has been a problem in our region and across the U.S. However, air pollutants have significantly declined due to the federal, state, and local measures coupled with actions taken by individuals and businesses. Data collected from the region's monitors has shown that this downward trend has continued over the last decade.


Potomac River near Mount Vernon, MD (Intiaz Rahim, Flickr)

Metropolitan Washington is now in attainment of the federal standards for five out of the six criteria pollutants. Ozone is the only pollutant that is above its federal standards, but it has shown a downward trend.

While ozone levels can be high during hot, dry summers, emissions of ozone precursors (VOCs and NO_x) are decreasing, so days with high concentrations of ozone are less frequent. However, more action needs to be taken in order to continue to reduce ozone and its precursors. It is important that businesses follow the laws and regulations and individuals take actions to reduce emissions, so the region's air can continue to improve.

$PM_{2.5}$ was the most recent air pollutant for which our region has met the federal standards. With its steady decline, concentrations are expected to stay well below the federal standards into the future. The other criteria pollutants are substantially below the federal standards and do not pose much of a threat to our region. However, it is important to continue to maintain control of these pollutants in order to sustain a healthy environment for our region and our neighboring regions.

The public can help as well. When there are unhealthy air days, days when there are high ozone concentrations, the public should take actions such as postponing mowing, filling up gas tanks during the evening hours, using transit or carpools, and using less electricity.

Let us work together to provide a healthier place to live and to keep the beautiful views of our region around for many years to come.

RESOURCES

	Organization	Website	Phone
States	District of Columbia Department of Energy & Environment	https://doee.dc.gov/	(202) 535-2600
	Maryland Department of the Environment	http://mde.maryland.gov/Pages/index.aspx	(410) 537-3000
	Virginia Department of Environmental Quality	http://www.deq.virginia.gov/	(804) 698-4000
	Organization	**Website**	**Phone**
Forecasts & Data	Metropolitan Washington Council of Governments	https://www.mwcog.org/	(202) 962-3200
	EPA AirNow	https://www.airnow.gov/	(202)-564-4700
	Organization	**Website**	**Phone**
Other Organizations	Clean Air Partners	http://www.cleanairpartners.net/	(877) 515-4593
	Environmental Protection Agency	www.epa.gov	(202)-564-4700
	Mid-Atlantic Regional Air Management Association	http://www.marama.org/	(443) 901-1882
	Ozone Transport Commission	http://www.otcair.org/	(202) 508-3840