



DELAWARE ANNUAL AIR QUALITY REPORT

2011

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Division of Air Quality

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EXECUTIVE SUMMARY

Delaware's 2011 annual air quality report continues to document the changes and overall improvement in ambient air quality in the state. In 2011 only two pollutants, ozone and PM_{2.5}, exceed or are close to the national ambient air quality standards. Other pollutants monitored in Delaware (SO₂, CO, NO₂, and PM₁₀) are well below the national standards.

As measured by the air quality index (AQI), there are few days that fall into the category of moderate or unhealthy for sensitive populations. Continuing recent trends, there are more days with good air quality than with moderate or unhealthy air quality.

For ozone, there were 15 days with exceedances of the 8-hour ozone standard in 2011 statewide, with exceedances occurring in each county. There were no exceedances of the state 1-hour ozone standard. Ozone concentrations continue to show a generally decreasing trend in all three counties in recent years.

New Castle County was declared non-attainment for PM_{2.5} based on concentrations that were above the annual average air quality standard during 2001 – 2003. The most recent three years (2009 – 2011) show concentrations that meet the level of both the annual average standard and the 24-hour standard. Kent and Sussex counties continue to record concentrations below both the annual and 24-hour standards.

Concentrations of air toxics in Wilmington continue to show generally low or declining levels.

Emissions of air pollutants are calculated every three years as part of a comprehensive emissions inventory.



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Division of Air Quality





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INTRODUCTION

In 1970, Congress passed the Clean Air Act that authorized the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for pollutants shown to threaten human health and welfare. Primary standards were set according to criteria designed to protect public health, including an adequate margin of safety to protect sensitive populations such as children and asthmatics. Secondary standards were set according to criteria designed to protect public welfare (decreased visibility, damage to crops, vegetation, and buildings, etc.).

Seven pollutants currently have NAAQS: ozone (O₃), carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), particulate matter less than 10 microns (PM₁₀), particulate matter less than 2.5 microns (PM_{2.5}) and lead (Pb). These are commonly called the “criteria” pollutants. When air quality does not meet the NAAQS, the area is said to be in “nonattainment” with the NAAQS.

This report covers Delaware’s air quality status and trends for the criteria pollutants and some non-criteria pollutants. Non-criteria pollutants are substances that do not have standard criteria for ambient concentrations. These include acid precipitation and air toxics.

This document also contains material specifying the sources of air pollution and actual inventory data detailing information related to the compounds responsible for ozone and PM_{2.5} formation. Accompanying these data is information concerning in-use emission control measures as well as suggestions on what we can do to prevent air pollution. Technical details regarding monitoring activities and emission inventories, along with references and sources of more information, are included in the appendices.



GENERAL INFORMATION

ABOUT DELAWARE'S DIVISION OF AIR QUALITY

The Division of Air Quality is operated through an Air Quality Director and is organized by two main branches that are defined as:

- Engineering and Compliance
- Planning

Engineering and Compliance Branch

Permitting and Compliance Programs

The Engineering and Compliance Branch inspects and issues air pollution control permits for minor and major stationary air pollution sources. Branch personnel make periodic facility inspections and review emission test results to ensure that permit conditions are being met. Enforcement actions are initiated for violation of regulations or permit conditions when warranted.

Source Monitoring Program

The Source Monitoring Program verifies actual air pollution emission levels from industrial sources. Actual emission levels are needed to establish air pollution control permit conditions and to verify compliance with permit conditions after a permit has been issued. The program is also responsible for verifying the accuracy of source emission testing. This is done to evaluate the operation of facility owned Continuous Emission Monitoring Systems (CEMS).

Planning Branch

Ambient Air Quality Monitoring Program

The Ambient Air Quality Monitoring Program monitors pollutants in ambient air. This is primarily accomplished by conducting long-term, fixed-site air monitoring of specific air pollutants. Most monitoring is focused on the pollutants that have standards set by the U.S. EPA to protect public health, and are commonly called "criteria" pollutants. This program also conducts or assists in special short-term air monitoring studies as resources allow. The data are used to provide the public with information on current air quality conditions, assess compliance with or progress made towards meeting NAAQS, measure long term air quality trends for urban and non-urban areas, verify the effectiveness of air pollution control strategies, support State Implementation Plan development, evaluate air emission inventories, and verify computer models.

Emission Inventory Development Program

The Emission Inventory Development Program works to develop comprehensive emission inventories of regulated pollutants from all emission source sectors, including point sources, stationary non-point sources, mobile sources and natural sources, as well as to compile periodic inventory data, procedures and documentation into comprehensive reports that are available to



the public.

Airshed Evaluation and Planning Program

As mandated by the Federal Clean Air Act, all states must achieve and maintain attainment of the NAAQS. Delaware and the surrounding states are in "non-attainment" of some of those standards. The air quality problem that requires immediate attention is ground-level ozone. Other pollutants to be addressed include fine particulate matter, regional haze and hazardous air pollutants as defined by the Environmental Protection Agency. The Airshed Evaluation and Planning Program seeks to find ways to reverse the non-attainment of an air quality standard--the combination of air pollution problems that are either generated locally or result from emissions transported through the atmosphere from distant areas. The vehicle used to accomplish this result is the preparation and adoption of planning documents called State Implementation Plans. These are usually in the form of revisions to existing plans.

Area Sources Compliance Program

The Area Source Compliance group inspects and issues air pollution control permits for smaller sources, such as dry cleaners, auto body shops, gasoline tank trucks, open burning activity and asbestos abatement projects. Group personnel make periodic facility inspections and review data to ensure that permit and regulatory requirements are being met. Enforcement actions are initiated for violation of regulations or permit conditions when warranted.



FREQUENTLY ASKED QUESTIONS

1. What is a “criteria” air pollutant?

A “criteria” air pollutant is an air pollutant that has had a National Ambient Air Quality Standard (NAAQS) established for it by the U.S. EPA. There are currently seven criteria pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, particulate matter less than 10 microns in diameter (PM₁₀), and particulate matter less than 2.5 microns in diameter (PM_{2.5}).

2. What is the difference between a primary and secondary National Ambient Air Quality Standard?

Primary standards are set to protect human health. Secondary standards are set to protect public welfare and take into consideration such factors as crop damage, architectural damage, damage to ecosystems, and visibility in scenic areas.

3. How is the location of an air monitoring station decided?

Multiple factors are considered when determining the location of air monitoring stations. Sites are selected based on the purpose of the monitoring (representative ambient concentrations, maximum source impact, etc.), the pollutant or pollutants to be monitored, the population density, location of other monitoring stations (including those in other states) and operational efficiency. The U.S. EPA has developed siting requirements for each of the “criteria” air pollutants. These requirements include distance from trees, buildings and roadways, distance from major point sources, and height of the sampler probe or inlet. Other factors include site security and access, availability of electricity and telephone service, aesthetics and local zoning issues, and long-term (+10 years) site availability. Unfortunately, the ideal monitoring site is virtually impossible to acquire, especially in urban areas.

Air monitoring stations are primarily used to house continuous instruments that measure “criteria” air pollutants (those that have established National Ambient Air Quality Standards). Monitoring for particulate matter is often accomplished by setting up instrumentation on a sampling platform.

Delaware has had air monitoring sites located around the state since the late 1960’s. The original focus of the monitoring network was on monitoring close to “point” sources (large facilities with high emissions). As air pollution control strategies were successfully implemented and the emissions from large facilities were brought into compliance with air quality regulations, the focus has shifted to pollutants that are more of a regional problem.

4. How large an area does an air monitoring station represent?



Depending on the location of a station and the pollutant being monitored, the data from a given site can represent a large geographical area or a smaller local area impacted by specific sources.

5. What air quality factors should be considered when buying a house?

The air quality problem that affects the most Delawareans is the buildup of ground-level ozone on certain hot summer days. Ozone is a regional air quality problem that does not vary dramatically over distances of several miles, and all three counties in Delaware can have days exceeding the air quality standard.

New Castle County also does not meet the air quality standard for fine particulate matter.

Become an informed consumer. Drive and walk around the area. Do you see any potential air pollution sources? Where are the major roadways? Does anyone in your family have any known allergies or personal health problems that could make them more sensitive to a specific pollutant? Ask the current residents and neighbors if they have observed any problems. Be aware that you can sometimes be bothered more by a small air pollution source that is close than by a large source that is farther away.

6. What do I do if I have a complaint about an odor or other air quality issues?

Odors and other environmental complaints can be reported to the Environmental Emergency and Complaints 24-hour Hotline at **1-800-662-8802**.

7. How can I get current air quality data?

Near real time air quality data and other information is available on the Division of Air Quality web page.

<http://apps.dnrec.delaware.gov/AirMonitoring/>

8. How can I get historical air quality data?

Historic air quality data for Delaware and other states is available on the internet at:

<http://www.epa.gov/airdata/>



9. Why can't I burn my trash?

The open burning of trash, where smoke and other emissions are released directly into the air without passing through a chimney, is illegal throughout all of Delaware at all times of the year. Open trash burning emits large amounts of toxic air pollutants some of which may be cancer causing. The amount of air pollution from 35 average burn barrels has been estimated as the equivalent of 1 regulated hazardous waste incinerator. The burning of trash also emits pollutants that contribute to other air quality problems such as ground-level ozone formation, odor complaints, fine particles, and visibility.

10. Who can I call about an indoor air quality problem?

Indoor air quality problems are handled by the Environmental Health Evaluation Branch of the Division of Public Health. **(302) 744-4540.**

11. Where do I find the Division of Air Quality regulations?

The regulations are posted on the air quality regulations web page:
<http://www.awm.delaware.gov/AQM/Pages/AirRegulations.aspx>



DELAWARE'S AIR QUALITY STATUS

Delaware is currently in attainment with all the National Ambient Air Quality Standards except ozone.

Over the last ten years, trends in ambient concentrations of the criteria pollutants have been either level or declining.

AIR QUALITY INDEX (AQI)

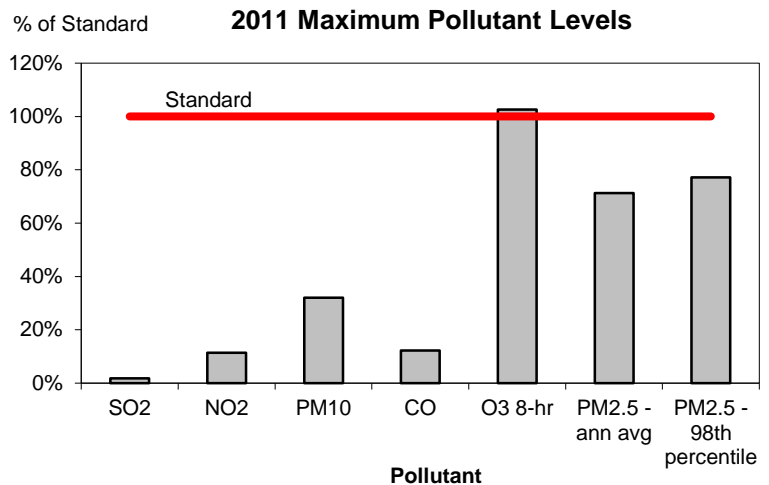
Description

The Air Quality Index or AQI was created by the U.S. EPA as a measure of overall air quality. The AQI was developed to ensure national uniformity of daily air quality reports, and the procedures and calculations used to generate the AQI are defined by EPA.

Ambient concentrations of five pollutants (PM₁₀/PM_{2.5}, SO₂, CO, O₃, and NO₂) are used to calculate a health-related value or index. The data represents the previous 24 hours. For each pollutant, a sub-index is calculated using a mathematical function that transforms ambient pollutant concentrations onto a scale from zero to 500, with 100 corresponding to the National Ambient Air Quality Standard (NAAQS). Index ranges and descriptions are listed below. In 2000, the U.S. EPA added a new category "Unhealthy for Sensitive Groups".

Air Quality Indexes and Descriptions

AQI	Description
0 to 50	"Good"
51 to 100	"Moderate"
101 to 150	"Unhealthy for Sensitive Groups"
151 to 200	"Unhealthy"
200 to 299	"Very Unhealthy"
300 and above	"Hazardous"

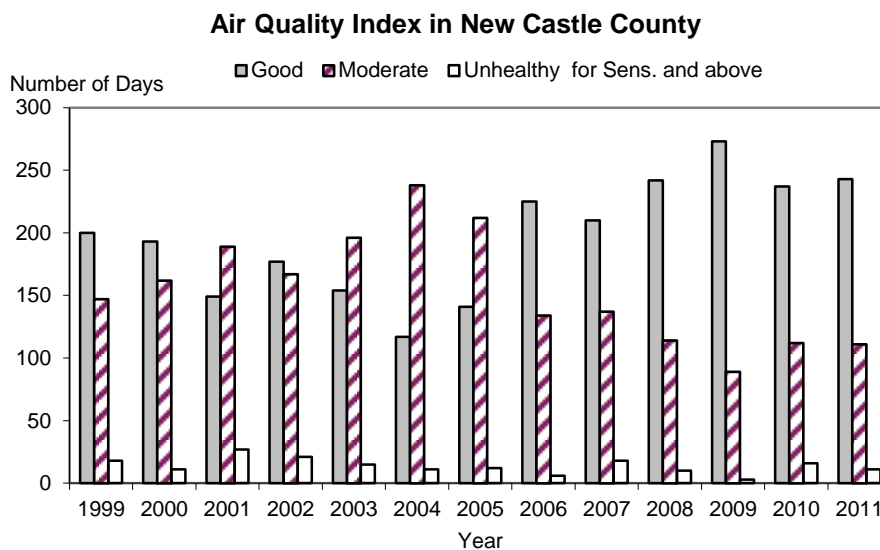




Local Air Quality Index (AQI)

Delaware calculates and reports an AQI for the Wilmington area every working day and reports it to the American Lung Association for distribution to the local media. According to EPA guidelines, only monitors that represent air quality in the Wilmington urban area are used to generate this index. In June 2000, the U.S. EPA changed the AQI to include PM_{2.5} for the first time. This change resulted in more days falling into the Moderate or Unhealthy for Sensitive People categories.

The accompanying graph reflects the AQI trends calculated for New Castle County from 1999 through 2011. Data for the entire county, not just the city of Wilmington, is used in this graph. The number of days with unhealthy air quality has been generally declining in recent years, and the number of days with good air quality has been increasing.





Delaware Air Monitoring Network

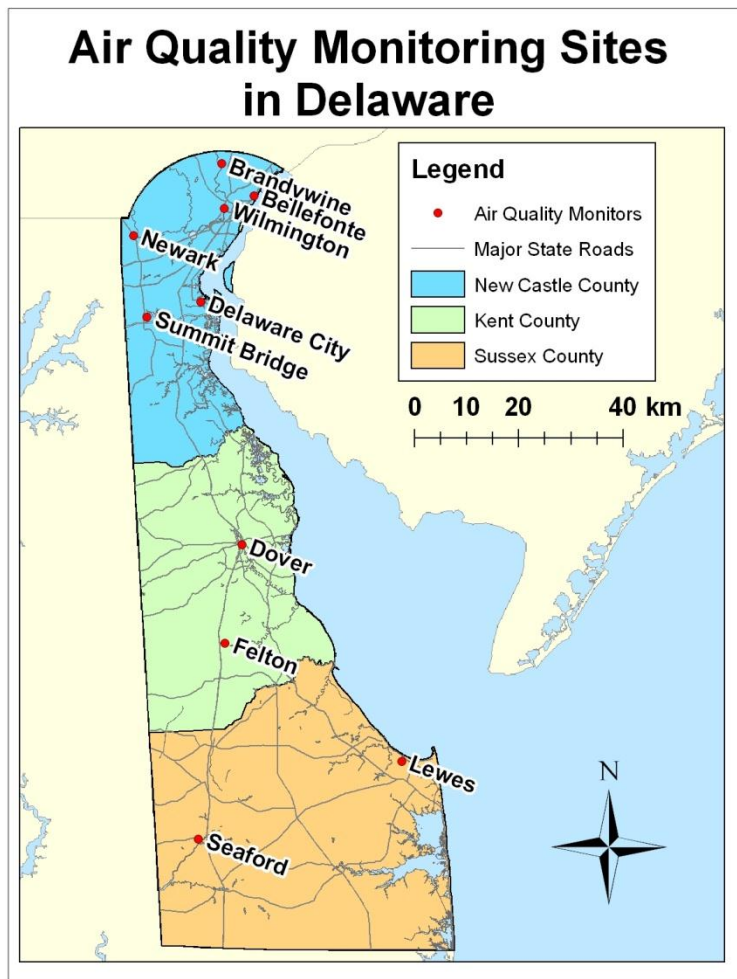
The State of Delaware has established an air monitoring network to determine the ambient levels of the pollutants for which NAAQS have been established. The Delaware Air Monitoring Network consists of the sites and monitors listed in the following table and figure. Although monitoring takes place statewide, most of the stations are concentrated in the northern urban/industrial areas, which have the highest population and number of pollutant sources. This network is maintained and operated by the Air Surveillance Branch of the Division of Air Quality (DAQ), DNREC.

The gaseous criteria pollutants, along with wind speed and wind direction, are measured continuously with hourly averages computed and reported via a telemetry system to the central data storage computer in the DAQ New Castle office. Particulates are collected as 24-hour samples that run every sixth day, and acid rain is monitored weekly.

Delaware Air Monitoring Network 2011

“X” indicates pollutant monitored

SITE	SO ₂	NO ₂	CO	O ₃	PM ₁₀	PM _{2.5}	Wind Speed/ Direction	Acid Rain
Brandywine				X				
Bellefonte	X			X		X		
Wilm. - MLK Blvd	X	X	X	X	X	X	X	
Ommelanden								X
Newark						X		
Delaware City	X		X				X	
Summit Bridge	X			X		X		
Dover						X		
Felton				X		X	X	
Seaford				X		X	X	
Lewes				X			X	



More information on Delaware’s ambient air monitoring network can be found on the Division of Air Quality’s webpage as the Delaware Ambient Air Monitoring Network Plan (<http://www.awm.delaware.gov/Info/Pages/PubComAmbientAir.aspx>).



AIR QUALITY - POLLUTANTS THAT ARE CLOSE TO OR EXCEED STANDARDS: OZONE AND PM_{2,5}

OZONE (O₃)

Description

Ozone (O₃) is a highly reactive gas that is the main component of smog. Ozone in the lower atmosphere (troposphere) is considered a pollutant and is distinct from the ozone layer in the upper atmosphere (stratosphere) where it acts as a shield from ultraviolet radiation. Ozone is a strong respiratory irritant that affects healthy individuals as well as those with impaired respiratory systems. It can cause respiratory inflammation and reduce lung function.

Ozone also adversely affects trees, crops (soybeans are a particularly sensitive species), and other vegetation. The national agricultural loss from ozone pollution is estimated by the U.S. EPA to be several billion dollars annually. It is also implicated in white pine damage and reduced growth rates for red spruce; studies have shown forest and ecosystem damage can result from high ozone concentrations.

Standards

Primary NAAQS:

Maximum eight-hour average = 0.075 ppm

The eight-hour standard is achieved when the annual fourth highest daily eight-hour concentration, averaged over three years, is less than or equal to the standard.

State standard:

Maximum one-hour = 0.12 ppm, former NAAQS, current Delaware AAQS.

Note: EPA revoked the one-hour standard for ozone in June 2005 but Delaware has maintained the one-hour standard in its regulations (Regulation 1103).

The one-hour standard is achieved when the expected number of days, averaged over three years, with a maximum hourly average of greater than 0.12 ppm (235 µg/m³) is less than or equal to one.

Sources

Ozone is not emitted directly from a pollution source but is formed in the lower atmosphere by the reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight and warm temperatures. Sources of nitrogen oxides include automobiles, power plants and other combustion activities. VOCs can come from automobiles, gasoline vapors, and a variety of large and small commercial and industrial sources that use chemical solvents, paint thinners, and other chemical compounds. These compounds or "precursors of ozone" can travel for miles before chemical reactions in the atmosphere form ozone.



Controlling ozone is a complex task due to the wide variety of sources for nitrogen oxides and VOCs as well as the long-distance transport of ozone and its precursors. Control methods include regulation to control gasoline vapor emissions, inspection and maintenance programs for motor vehicle exhausts, and regulation of VOC and NO_x emissions from industrial sources.

Locations

Ozone is monitored throughout the state. Monitors are located away from or at some distance downwind of urban areas and major traffic corridors in order to avoid “scavenging” of ozone by NO emissions. See the “Delaware Air Monitoring Network” table on page 9 for specific sites. While short-term 1-hour average peak ozone levels are usually highest in New Castle County, longer-term 8-hour averages are close to the standard throughout Delaware.

In 2011 a new urban monitor was added at the MLK site in Wilmington.

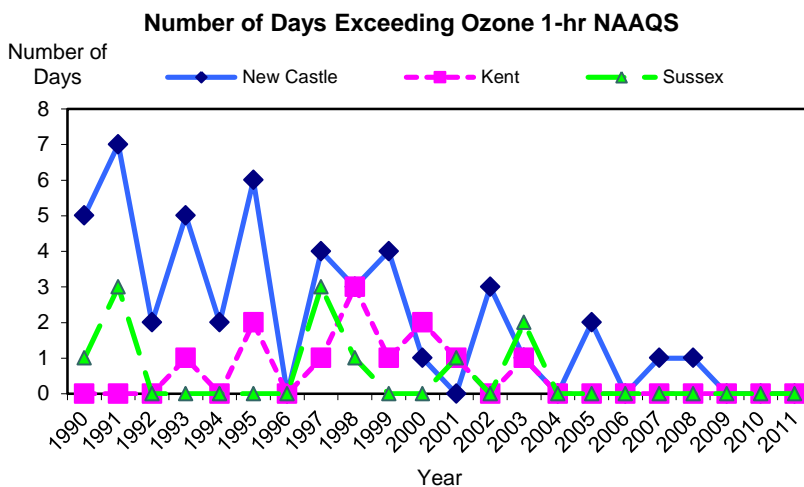
Delaware Air Quality and Trends

Trends in ozone concentrations can be difficult to discern due to the effect of meteorology. Hot, dry weather and stagnant air conditions favor the formation of ozone, and the greatest number of exceedance days typically occurs during the hottest and driest summers.

Overall, Delaware ozone levels in the 1990's were lower than in the 1980's, with continued improvement into the 2000's.

One-hour Ozone Data and Trends

In 2011 there were no days on which the one-hour NAAQS was exceeded in Delaware. This demonstrates significant improvement in air quality since the 1980's when multiple exceedances occurred throughout the state every summer.



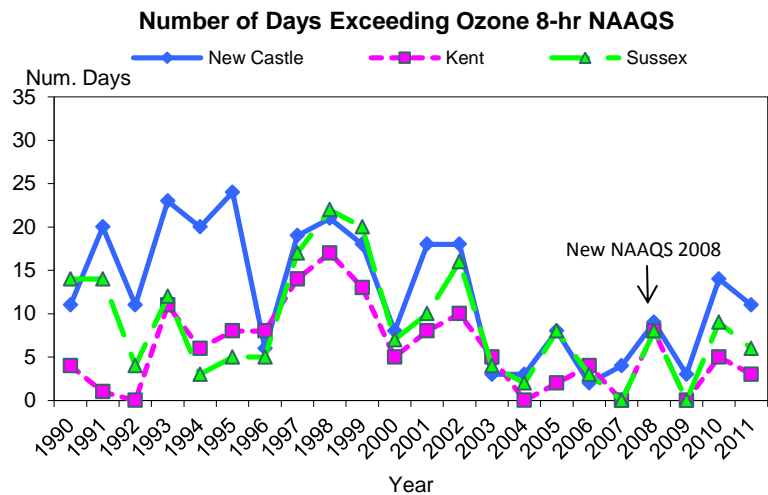


Eight-hour Ozone Data and Trends

Former NAAQS: Prior to 2008, a measured 8-hour average concentration must have been equal to or greater than 0.085 ppm to be counted as an exceedance of the 0.08 ppm standard because of numerical rounding to two decimal places.

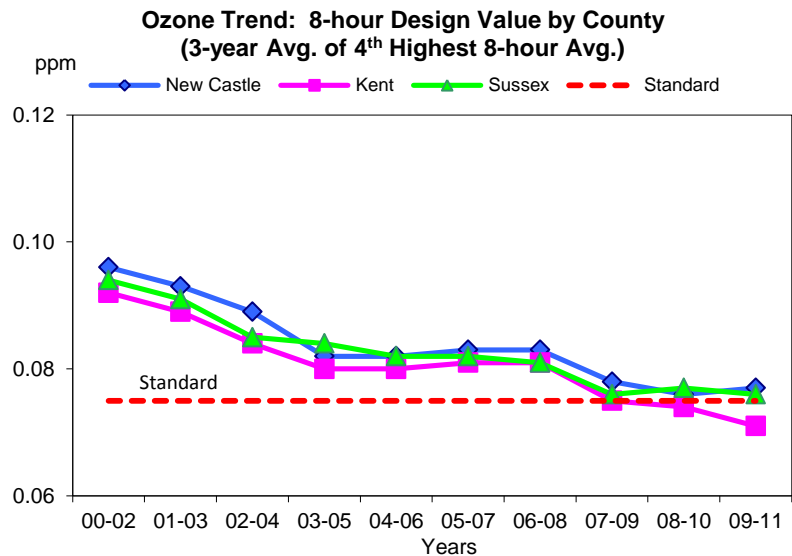
Current NAAQS: The current eight hour NAAQS does not have the rounding issue of the former standard; a measured 8-hour average concentration above 0.075 is an exceedance of the standard.

In 2011 there were 15 days that exceeded the new 8-hour standard statewide, with 11 days in New Castle County, three days in Kent County, and six days in Sussex County. The following tables contain more information on the new 8-hour standard and trends for each monitoring site.



The eight-hour standard is achieved when the annual fourth highest daily eight-hour concentration, averaged over three years, is less than or equal to the standard. This number is referred to as the “design value”.

Based on 2009 – 2011 data, New Castle and Sussex counties fail to meet the new ozone NAAQS, while Kent County is just below the new NAAQS.





2011 Ozone Eight-hour Average Exceedance Days and Maxima (ppm)

Site	Num. Exc. > 0.075 ppm	1st Max.	2nd Max.	3rd Max.	4th Max.
Brandywine	6	0.086	0.082	0.082	0.078
Bellefonte	9	0.100	0.097	0.093	0.083
Summit Bridge	7	0.082	0.079	0.078	0.078
Wilmington (MLK)	5	0.082	0.080	0.079	0.078
Felton	3	0.094	0.088	0.076	0.072
Seaford	6	0.094	0.081	0.078	0.077
Lewes	3	0.085	0.084	0.083	0.078

Num. Exceedances = Number of days with at least one 8-hour average > 0.075 ppm.

3-Year Average of 4th Highest Daily Max. Eight-hour Avg.
 NAAQS = 0.075 ppm

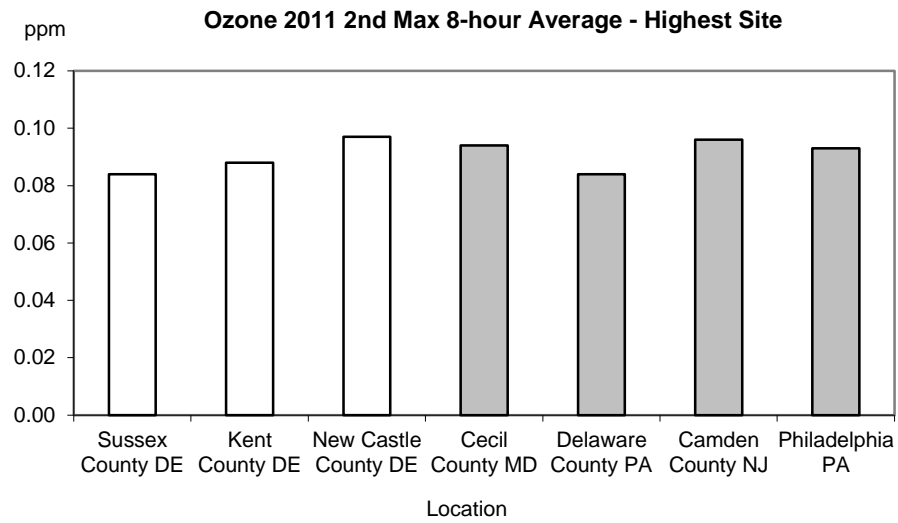
Note: The eight-hour standard is achieved when the annual fourth highest daily eight-hour concentration, averaged over three years, is less than or equal to the standard.

Site	2002 - 2004	2003 - 2005	2004 - 2006	2005 - 2007	2006 - 2008	2007 - 2009	2008 - 2010	2009 - 2011
Brandywine	0.089	0.082	0.082	0.083	0.083	0.078	0.076	0.075
Bellefonte	0.085	0.082	0.081	0.081	0.078	0.074	0.075	0.077
Summit Bridge	0.084	0.080	0.078	0.082	0.080	0.075	0.075	0.075
Felton	0.084	0.080	0.080	0.081	0.081	0.075	0.074	0.072
*Wilmington (MLK)	NA	NA	NA	NA	NA	NA	NA	NA
Seaford	0.085	0.082	0.080	0.082	0.081	0.076	0.077	0.076
Lewes	0.085	0.084	0.082	0.082	0.079	0.076	0.077	0.076

* Monitoring began in 2011.



How does Delaware's air quality compare to nearby areas?
Ozone levels in Delaware in 2011 were similar to those in nearby areas.





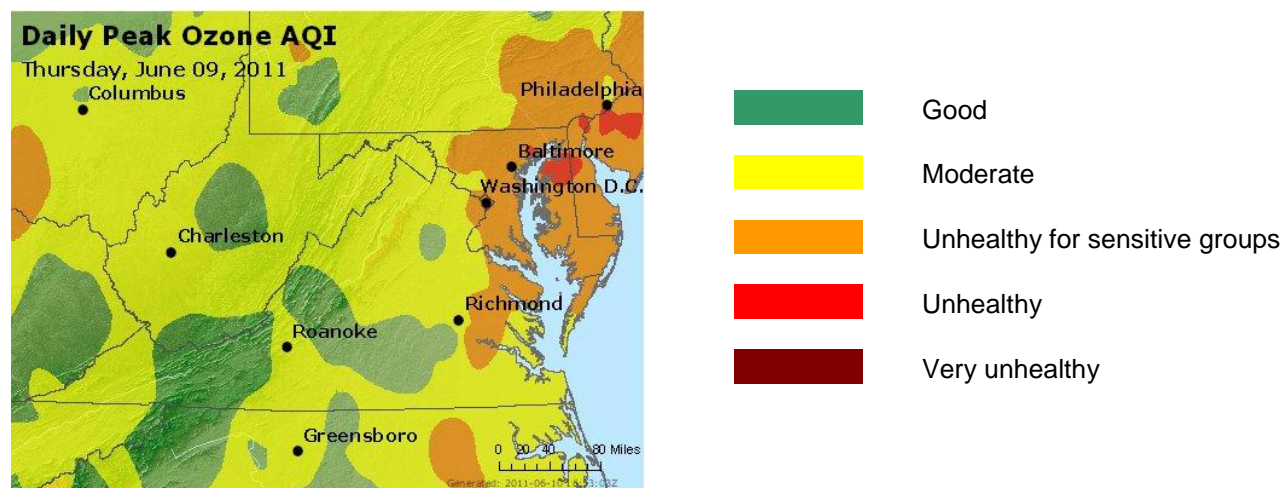
Ozone Mapping Project

As part of the Ozone Mapping Project, participating states and local agencies submit real-time ground-level ozone data to a centralized computer. The data is converted into color-coded maps of ground-level ozone concentrations. These maps are then distributed to local television stations for inclusion in the weather segment of the news program. Stations are most likely to broadcast the map during periods of poor air quality.

The purpose of the ozone mapping project is to increase awareness of elevated ozone concentrations so people can take protective measures and to educate the public about the regional nature of ozone formation and transport. For more information and examples of maps, please visit the EPA “AirNow” web site at <http://airnow.gov>

Following is an example of an ozone map showing the regional nature of ozone episodes.

Air Quality Index Ozone Peak Values – June 9, 2011



Source: EPA AIRNOW website:

<http://www.airnow.gov/index.cfm?action=airnow.mapsarchivecalendar>



PARTICULATE MATTER - FINE (PM_{2.5})

Description

Fine particulate matter is made up of particles smaller than 2.5 microns in diameter. These fine particles, also called PM_{2.5}, penetrate more deeply into the lungs than coarse particles (2.5 - 10 microns) and are more likely to contribute to health effects. Health effects of concern associated with particulate matter pollution demonstrated in recent community studies include premature death and increased hospital admissions and emergency room visits, primarily by the elderly and individuals with cardiopulmonary disease, increased respiratory symptoms and disease in children and individuals with cardiopulmonary disease, and decreased lung function and alterations in lung tissue and structure, particularly in children and people with asthma.

Standards

Primary NAAQS: Annual arithmetic mean = 15 µg/m³ averaged over three years
 24-Hour maximum = 35 µg/m³ as the 98th percentile averaged over three years

Sources

Fine particles (PM_{2.5}) are generally emitted from combustion activities (such as industrial and residential fuel burning and motor vehicles) while coarse particles come from dust emitted during activities such as construction and agricultural tilling. PM_{2.5} can also form in the atmosphere from precursor compounds, such as SO₂ and NO_x, through various physical and chemical processes.

Locations

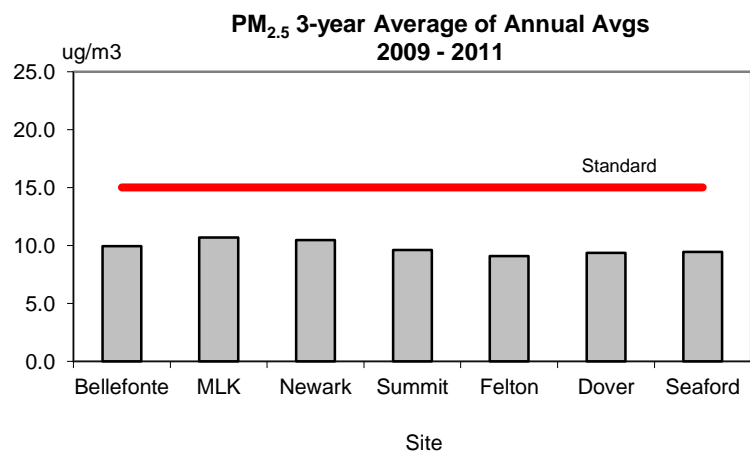
Monitors are located throughout Delaware, with the majority of monitors in New Castle County where the highest concentrations occur. See the table on page 9 for specific sites.

Delaware Air Quality and Trends

Delaware's monitoring network began collecting data in January 1999. Three years of complete data are required for comparison to the national standard.

Annual Average

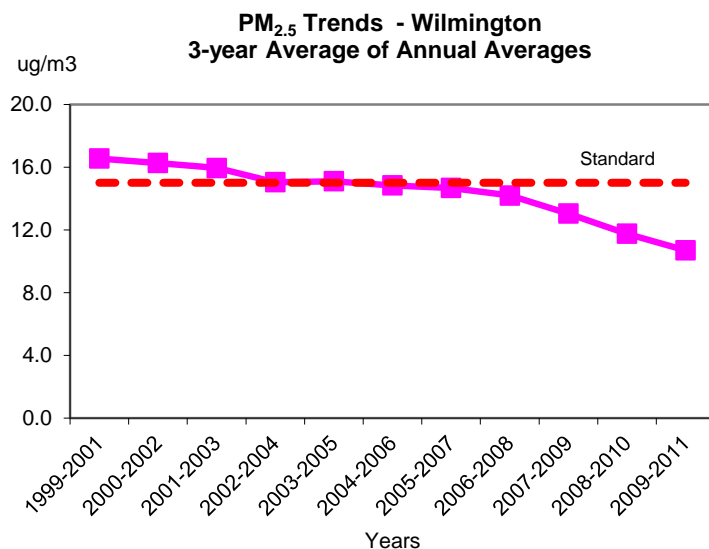
New Castle County was originally designated non-attainment for PM_{2.5} based on the 16.0 µg/m³ three-year average of the annual averages for 2001 to 2003 at the urban Wilmington site. For the most recent three-year period (2009 - 2011), the highest average in New Castle County was





10.7 $\mu\text{g}/\text{m}^3$ at the MLK site. Currently, all sites in Delaware meet the annual average standard.

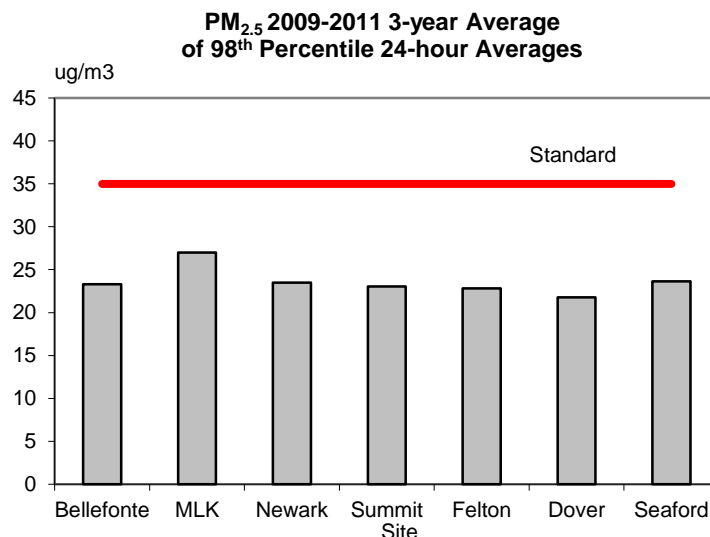
The trends chart shows the 3-year averages for the highest concentration site in Delaware, which is the MLK site in Wilmington. There is a downward trend showing continued air quality improvement at this site. Similar trends are present at other monitoring sites throughout the state, reflecting the significant correlation between average concentrations at all monitoring sites in Delaware. Both local and regional sources of fine particulate matter and its precursors (a substance that is the source of another substance) contribute to concentrations seen in Delaware.



24-hour Average

The current 98th percentile 24-hour average PM_{2.5} standard was met at all monitoring sites in Delaware as calculated with the 2009 – 2011 PM_{2.5} data.

Similar to the annual average data, there is significant correlation between 24-hour concentrations measured at all sites throughout Delaware. In other words, if high concentrations of PM_{2.5} are recorded at one site, all other sites in Delaware usually record high concentrations on that same day.

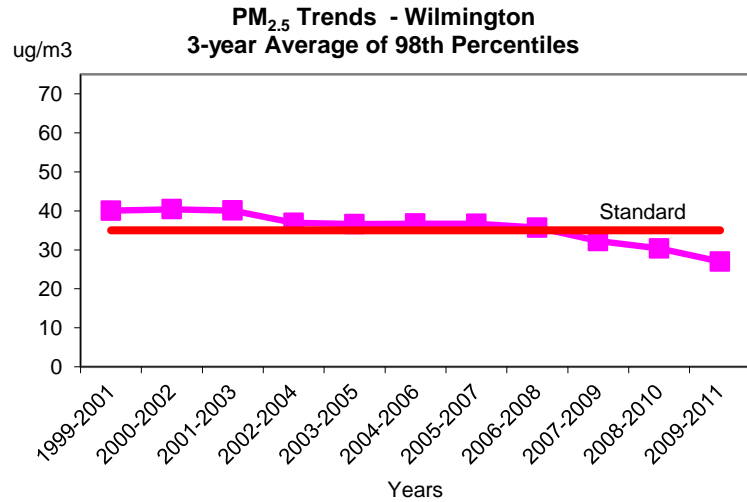


As with the annual average standard, three years of data are averaged to determine compliance with the NAAQS. The most recent three-year (2009 – 2011) average for the 98th percentiles at Wilmington was 27 $\mu\text{g}/\text{m}^3$.



The 98th percentile trends chart shows the 3-year averages for the highest concentration site in Delaware, which is the MLK site in Wilmington. There is less variation in the 98th percentile averages than in the annual averages, but a downward trend is still apparent.

Although only the MLK site is shown in the graph, the same overall improvement in air quality has been occurring at all monitoring sites in Delaware.



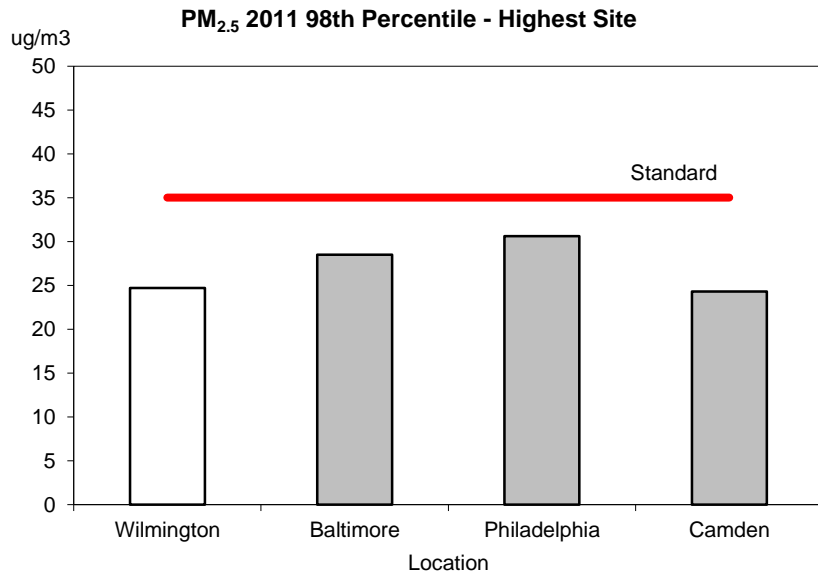
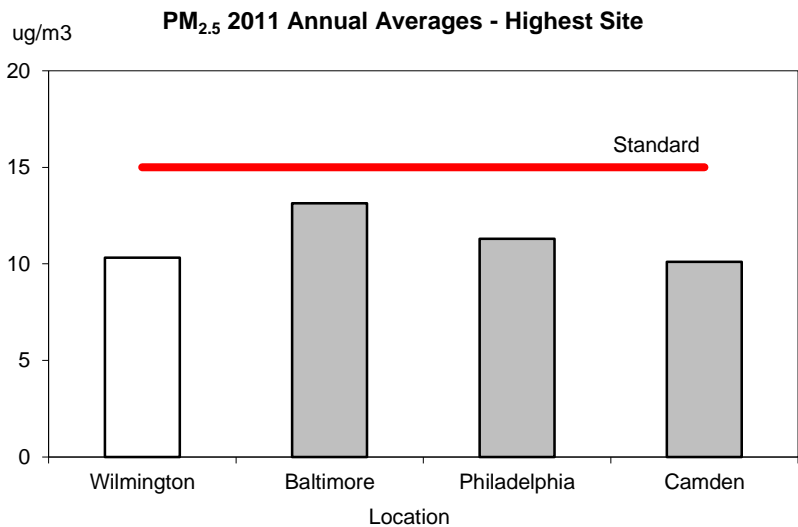
Delaware 2009 - 2011 PM_{2.5} Data Summary

Site	3-year Average of Annual Averages NAAQS = 15 µg/m ³	3-year Average of 98 th Percentiles NAAQS = 35 µg/m ³
Bellefonte	9.9	23
Wilmington MLK	10.7	27
Newark	10.5	24
Summit Bridge	9.6	23
Dover	9.4	23
Felton	9.1	22
Seaford	9.4	24



How does Delaware's air quality compare to nearby areas?

Air quality in Delaware is similar to nearby areas.

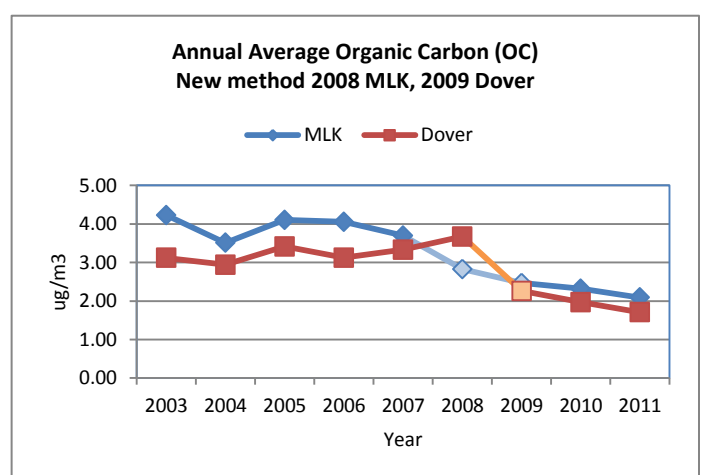
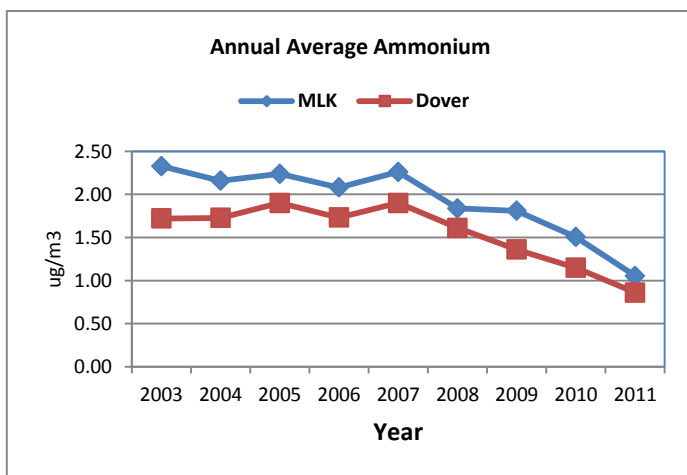
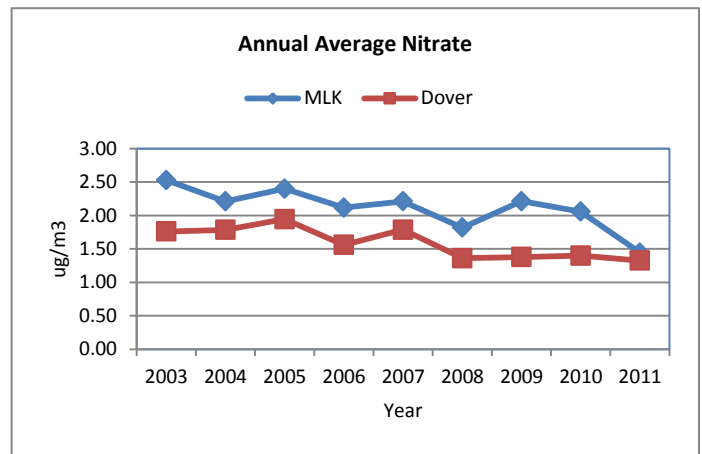
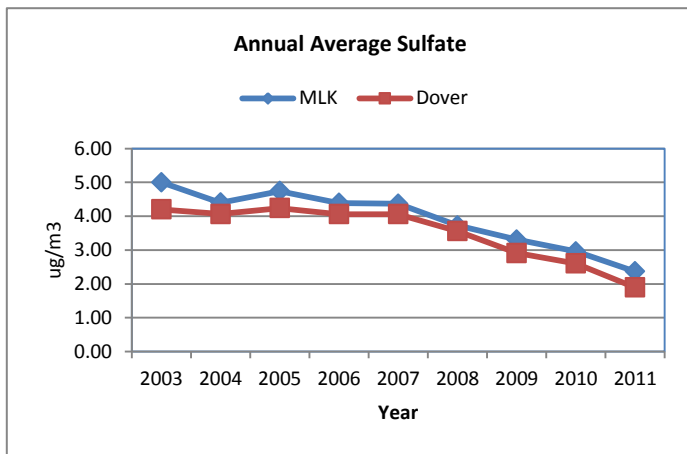




PM_{2.5} Speciation

To understand the nature of fine particle pollution and possible sources, EPA initiated a program to monitor the major components, or “species”, that make up PM_{2.5}. The main objectives of the PM_{2.5} speciation monitoring program are to provide additional information to characterize the annual and spatial aspects of PM_{2.5}, detect and track trends in aerosol component concentrations, and provide information to develop and evaluate emission control programs.

The PM_{2.5} speciation program in Delaware consists of monitors at two sites: MLK/Wilmington and Dover. Samples are collected on filters for 24 hours every 6th day. The filters are sent to a contract laboratory for chemical analyses. The target species are ions (sulfate, nitrate, ammonium, sodium, and potassium), trace elements/metals, and carbon (elemental and organic carbon). There are no ambient air quality standards for the chemical components of PM_{2.5}. Following are trends charts for some of the major components of PM_{2.5}. Trends for most major components are slightly declining. Analysis of the data is ongoing.





AIR QUALITY - POLLUTANTS THAT MEET STANDARDS: CO, NO₂, PM₁₀, SO₂, Lead

CARBON MONOXIDE (CO)

Description

Carbon monoxide is a colorless, odorless, poisonous gas produced by incomplete combustion of fossil fuels. It reduces the blood's ability to carry oxygen. Exposure can cause fatigue, headache, and impaired judgment and reflexes at moderate concentrations; at high levels unconsciousness and death can result. People with heart disease, angina, emphysema and other lung or cardiovascular diseases are most susceptible.

Standards

Primary NAAQS: 8-hour average = 9 ppm (10 mg/m³)
 1-hour average = 35 ppm (40 mg/m³)
 Not to be exceeded more than once per year

Sources

Carbon monoxide is formed when carbon in fuels is not completely burned. The U.S.EPA estimates that approximately 60% of all CO emissions are from motor vehicle exhaust. Other sources include incinerators, wood stoves, furnaces, and some industrial processes. Concentrations are highest along heavily traveled highways, and decrease significantly with increasing distance from traffic. Therefore, CO monitors are usually located close to roadways or in urban areas.

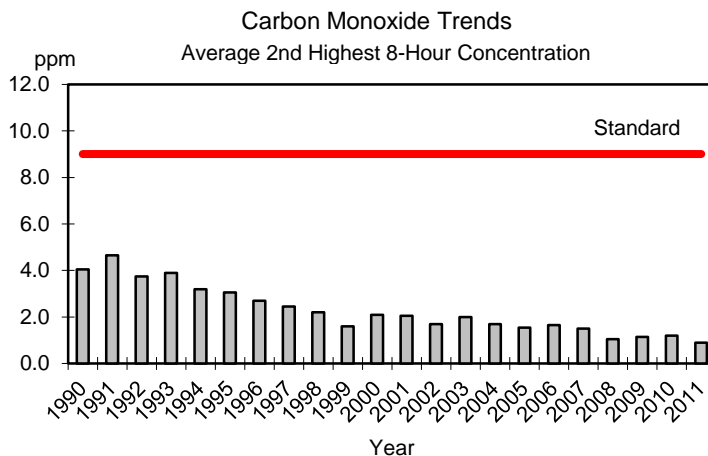
Locations

Monitors for CO are located in Wilmington and along Route 9 north of Delaware City.

Delaware Air Quality and Trends

Mobile sources cause most of the ambient CO detected at the Wilmington MLK site.

There has been a slight downward trend in CO concentrations since monitoring began in the 1970's, and no violations of the ambient standards have occurred since 1977. Improvements are largely due to cleaner burning engines in cars and tighter automobile emission standards. Low concentrations continued in 2011.



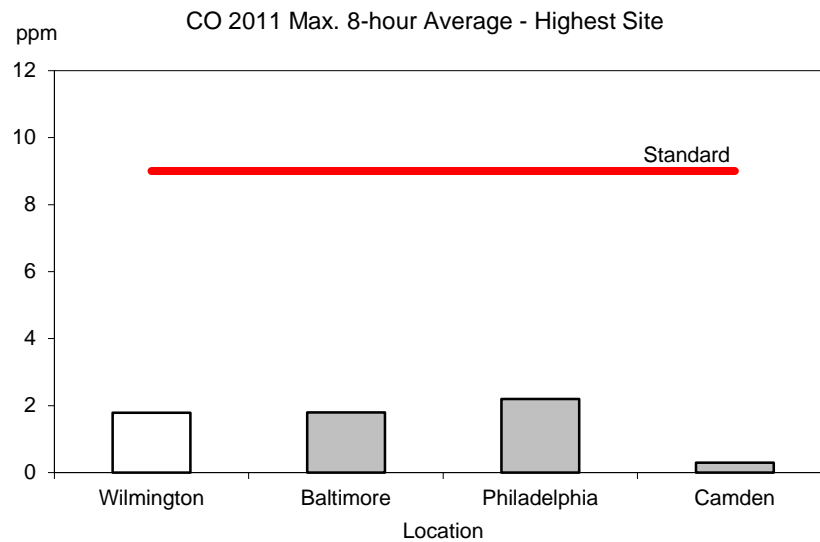


Delaware Carbon Monoxide (CO) 2011 Max. Values
ppm

Site	1-Hour Avg. NAAQS = 35 ppm		8-Hour Avg. NAAQS = 9 ppm	
	1 st Max.	2 nd Max.	1 st Max.	2 nd Max.
Wilmington	1.79	1.75	1.5	1.1
Delaware City	1.6	1.1	0.8	0.7

How does Delaware’s air quality compare to nearby areas?

Most CO monitors are located in urban areas. CO concentrations monitored in Wilmington are similar to those in nearby areas.





NITROGEN DIOXIDE (NO₂)

Description

Nitrogen dioxide (NO₂) is a reddish-brown toxic gas that is part of a group of gases containing nitrogen and oxygen called oxides of nitrogen or NO_x. Nitrogen dioxide irritates the lungs and upper respiratory system and lowers resistance to respiratory infections. It can be fatal in high concentrations. Nitrogen dioxide is also known to damage vegetation by stunting growth and reducing seed production. It acts to reduce visibility. Reactions between nitrogen dioxide and other compounds in the atmosphere can form nitric acid, which contributes to the acid rain problem. Oxides of nitrogen can also have a significant impact on fine particulate matter concentrations, most notably in the western areas of the United States.

One of the most important features of NO_x is their ability to react with volatile organic compounds (VOCs) to form ozone. Air quality computer models have shown that control of NO_x is necessary in many areas of the United States to reach attainment of the ozone standard.

Atmospheric deposition of oxides of nitrogen has recently been estimated to be a significant source of nitrogen to bodies of water such as the Chesapeake Bay and Delaware's Inland Bays. Nitrogen acts as a nutrient and contributes to excess nutrient loading and algal blooms in estuary systems.

Standards

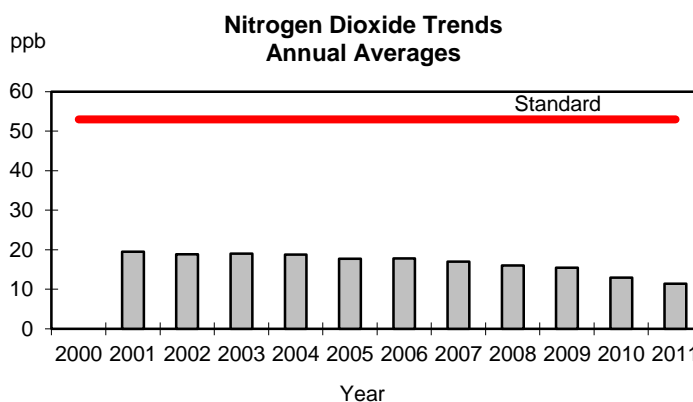
Primary NAAQS: Annual arithmetic mean = 53 ppb (100 µg/m³)
 1-hour average = 100 ppb as 3-year average of the 98th percentile daily max.
(New in 2011: 1-hour average and standards changed from ppm to ppb)

Sources

Oxides of nitrogen are produced during high-temperature burning of fuels. Sources of NO_x include motor vehicles and stationary sources that burn fossil fuels such as power plants and industrial boilers.

Locations

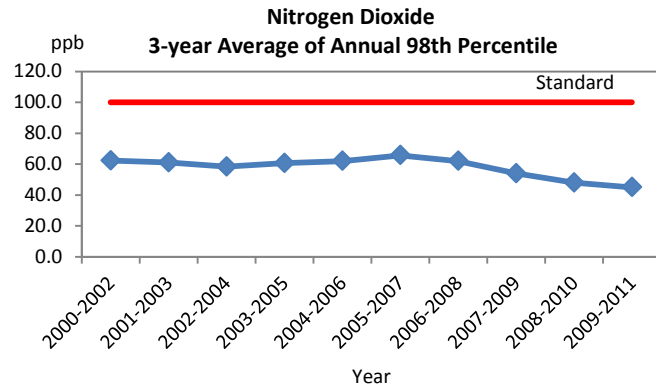
Since 2001, Delaware has monitored NO₂ only in Wilmington. There was insufficient data to generate an average for 2000.





Delaware Air Quality and Trends

Nitrogen dioxide levels in Delaware have remained well below the NAAQS since monitoring began. In 2011, levels continued to remain well below the standard.



Delaware Nitrogen Dioxide (NO₂) Annual Arithmetic Means in ppm

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Wilmington	*	.024	.019	.019	.019	.018	.018	.017	.016	.016	.013	.011

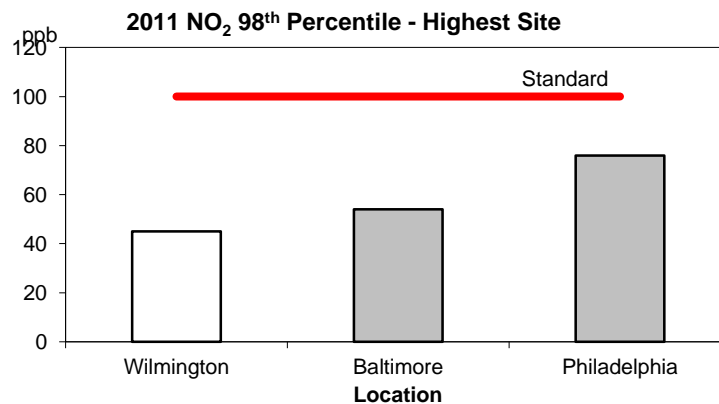
* Insufficient data to calculate annual average

Annual 98th Percentile in ppb

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Wilmington	*	65	58	60	57	65	64	68	54	40	50	45

How does Delaware's air quality compare to nearby areas?

Most NO₂ monitors are located in urban areas. NO₂ concentrations monitored in Delaware are similar to or lower than those in nearby areas.





PARTICULATE MATTER (PM₁₀)

Description

PM₁₀ is the fraction of total suspended particulate matter (TSP) that is less than 10 microns in diameter, which is about 1/7 the diameter of a human hair. Particles of this size are small enough to be inhaled into the lungs. Particulate matter can include solid or liquid droplets that remain suspended in the air for various lengths of time.

Particulates small enough to be inhaled can carry other pollutants and toxic chemicals into the lungs while larger particulates can cause coughing and throat irritation. Major effects of PM₁₀ listed by EPA include aggravation of existing respiratory and cardiovascular disease, alterations in immune responses in the lung, damage to lung tissue, carcinogenesis and premature mortality.

The most sensitive populations are those with chronic obstructive pulmonary or cardiovascular disease, asthmatics, the elderly, and children. Particulates are also a major cause of reduced visibility and can be involved in corrosion of metals (acidic dry deposition).

Standards

Primary NAAQS: 24-Hour maximum = 150 µg/m³ not to be exceeded more than once per year averaged over three years.

Sources

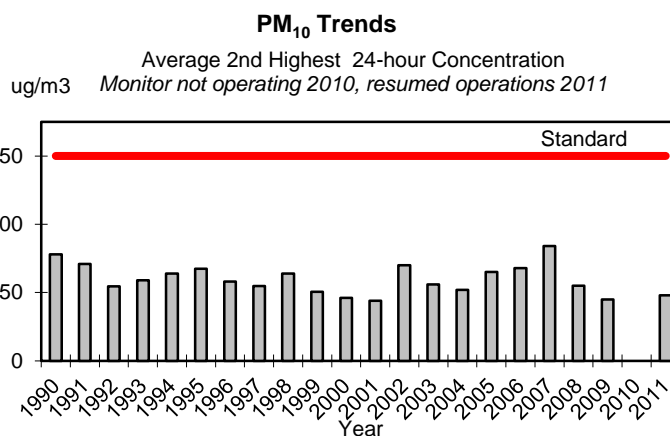
Major sources include steel mills, power plants, motor vehicles, industrial plants, unpaved roads, and agricultural tilling. The wide variety of PM₁₀ sources means that the chemical and physical composition of the particles is highly variable.

Locations

Because resources were shifted to support PM_{2.5} monitoring, and PM₁₀ concentrations have been consistently below the standard, PM₁₀ is currently monitored only at the urban Wilmington site.

Delaware Air Quality and Trends

Delaware is in attainment with the PM₁₀ NAAQS. The increases in concentrations in 2005 - 2007 were probably related to construction and road improvement projects in the Riverfront area, which is close to the monitor location. *Note: Monitoring was suspended in 2010 due to equipment problems; a new monitor was installed and operational for 2011.*





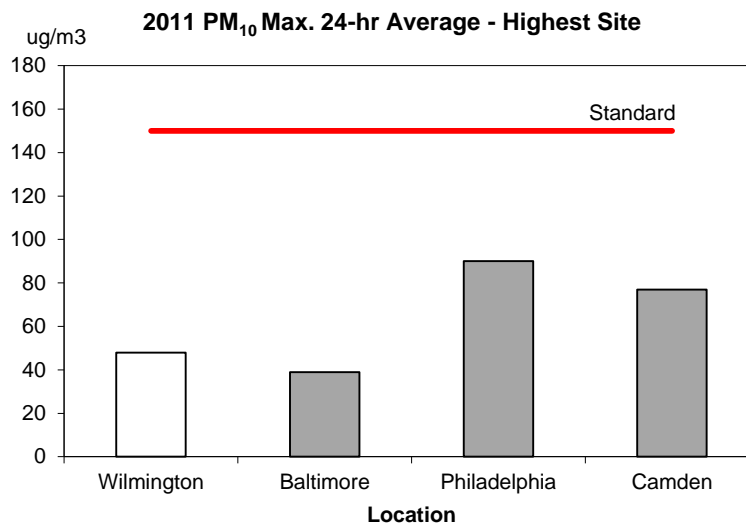
Delaware PM₁₀ Trends
Annual Average $\mu\text{g}/\text{m}^3$

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bellefonte	24.9											
Wilmington	26.4	23.0	23.0	20.3	19.8	22.5	22.6	23.2	19.8	17.8	No data	17.4

There was no PM₁₀ data for 2010 due to monitor failure; a new monitor was installed and data collected starting in January 2011.

How does Delaware’s air quality compare to nearby areas?

PM₁₀ concentrations in Delaware have been similar to those in nearby areas.





SULFUR DIOXIDE (SO₂)

Description

Sulfur dioxide (SO₂) is a pungent, poisonous gas. It is an irritant that can interfere with normal breathing functions even at low levels. It aggravates respiratory diseases such as asthma, emphysema, and bronchitis. These effects can be magnified by high particulate levels. High SO₂ levels can obstruct breathing passages and cause increased death rates among people with existing heart and lung disease.

Sulfur dioxide can bind to dust particles and aerosols in the atmosphere, traveling long distances on the prevailing winds. It can also be oxidized to SO₃ and combine with water vapor to form sulfuric acid and fall as acid rain, causing materials damage and harming aquatic life. Sulfur compounds contribute to visibility degradation in many areas including national parks. Sulfur dioxide in the atmosphere can also cause plant chlorosis and stunted growth.

Standards

Primary NAAQS: Annual arithmetic mean = 0.03 ppm (80 µg/m³)
 24-hour average = 0.14 ppm (365 µg/m³)
 1-hour average = 75 ppb (3-year average of the 99th percentile 1-hour avg.) *New standard promulgated June 2010.*

Secondary NAAQS: 3-hour average = 0.5 ppm (1300 µg/m³)

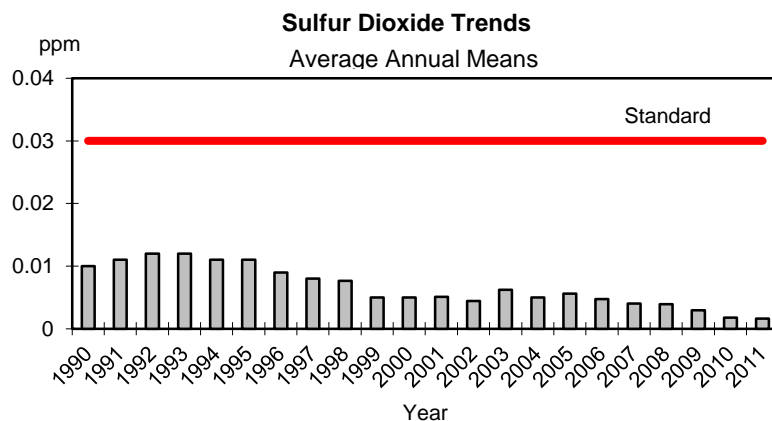
Sources

The main sources of SO₂ are combustion of coal and oil (mostly by power plants), refineries, smelters, and industrial boilers.

Nationally, two thirds of all sulfur dioxide emissions are from power plants, and coal fired plants account for 95% of these emissions.

Locations

Delaware's SO₂ monitors are located in Wilmington, Bellefonte, Summit Bridge, and Delaware City. Due to resource restrictions, there was no monitoring at the Summit Bridge site in 2009. Monitoring is planned to resume when resources become available.



Delaware Air Quality and Trends

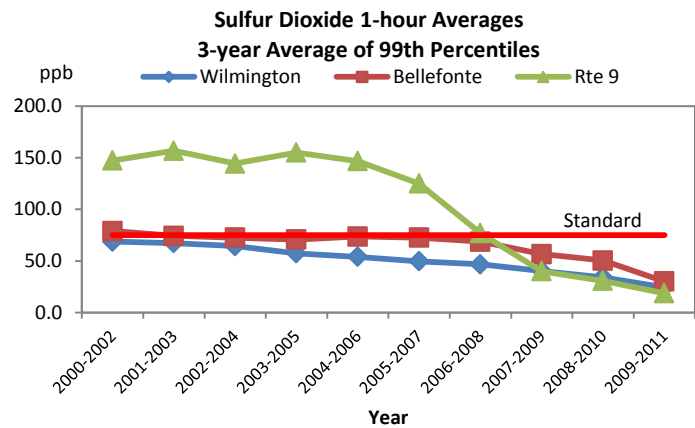
Delaware is in attainment with the NAAQS for SO₂. Over the last decade, measured ambient levels have remained well below the standard with a slight downward trend. Locally, higher



levels are found only in areas impacted by a single large source (such as a coal burning power plant or oil refinery).

In 2011, SO₂ levels remained well below the standards.

In comparing the 1-hour averages to the new standard, a significant improvement can be noted at the Delaware City site when additional emission controls were added to the nearby oil refinery.



Delaware Sulfur Dioxide 2011
24-hour Average Max. Values

Site	24-Hour Averages NAAQS = 0.14 ppm	
	1st Max	2nd Max
Bellefonte	0.015	0.013
Wilm. - MLK	0.006	0.005
Del. City/Rte 9	0.005	0.004
Summit Bridge	ND	ND

Delaware Sulfur Dioxide Trends
Annual Averages in ppm
NAAQS: Annual Arithmetic Mean = 0.03 ppm

Site	Year											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bellefonte	.007	.005	.004	.007	.005	.007	.005	.005	.004	.004	.003	.002
Wilm.-MLK	.005	.006	.005	.006	.005	.005	.005	.004	.003	.003	.002	.001
Summit Br.		.003	.003	.004	.004	.004	.003	.003	.002	ND	ND	ND
Del City	.006	.006	.006	.008	.006	.007	.007	.005	.004	.003	.001	.001

ND = no data

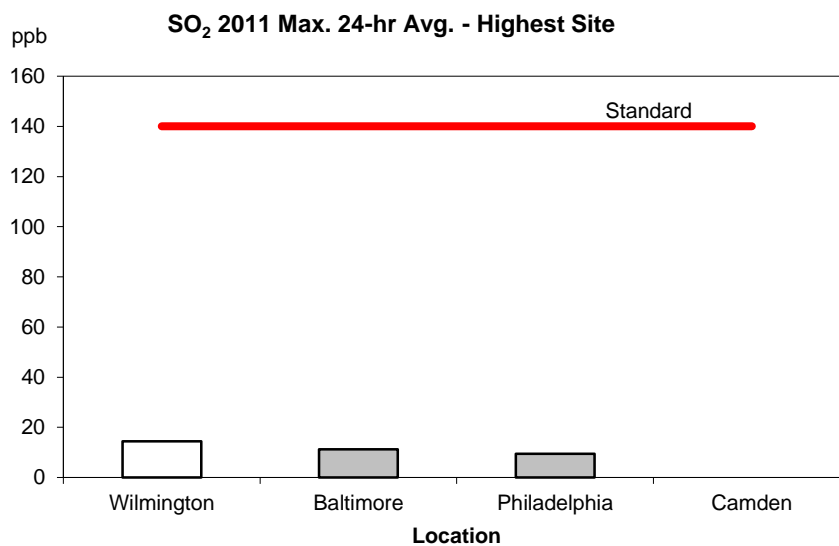


Annual 99th percentile 1-hour Average in ppb

Site	Year											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bellefonte	82	77	78	68	72	72	77	69	60	41	25.0	19.4
Wilm.-MLK	61	72	73	57	63	52	47	50	43	28	31.6	14.2
Summit Br.	64	58	86	61	58	59	42	29	ND	ND	ND	ND
Del City	136	143	163	164	106	195	139	41	51	28	13.3	14.7

How does Delaware’s air quality compare to nearby areas?

SO₂ concentrations in Delaware are similar to those in nearby areas.





LEAD (Pb) - monitoring not active in 2011

Description and Sources

Lead is a highly toxic metal emitted into the air from both mobile and stationary sources. Mobile sources include vehicles that use leaded fuel. Major stationary sources include metal smelters and lead battery plants.

Exposure can occur through a number of pathways including ingestion and inhalation. Lead affects several physiological processes including the blood-forming, reproductive, nervous and renal (kidney) systems. It accumulates in both bone and soft tissues and can cause problems long after exposure is ended. Infants and children are most susceptible to effects that can include anemia, seizures, mental retardation, and decreased learning abilities.

Standard

Primary NAAQS: 24-hour average (averaged over one calendar quarter) = $1.5 \mu\text{g}/\text{m}^3$

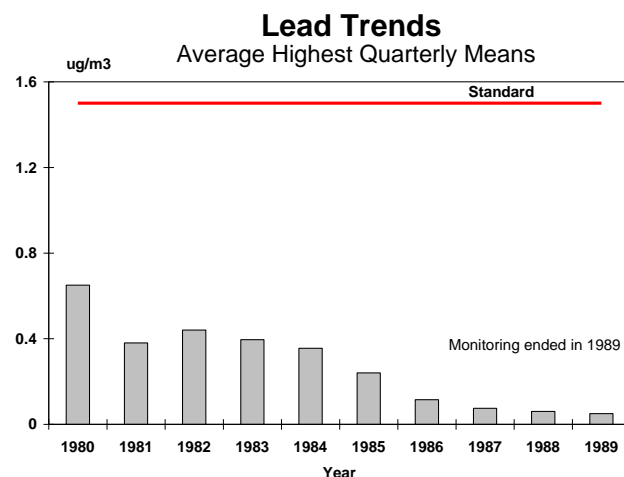
Note: New NAAQS promulgated 10/15/2008 = Rolling 3-month average of $0.015 \mu\text{g}/\text{m}^3$

Locations

Monitors were formerly located in Claymont and Wilmington. Monitoring for lead will resume at the Wilmington site in 2012.

Delaware Air Quality and Trends

Delaware is in attainment with the former NAAQS for lead and does not currently monitor lead in ambient air as a criteria pollutant. Previously, there were two lead monitoring sites placed for measuring lead coming mostly from mobile sources. Measured ambient concentrations decreased by approximately 94% between 1978 and 1988 due to the change to unleaded gasoline in cars. In 1989, the last year in which samples were collected, 63% of the samples were below the analytical detection limits.



Monitoring for the new lead NAAQS will be part of the NCore monitoring station at the Wilmington MLK site, and will begin in January 2012 in accordance with EPA regulations.



AIR QUALITY - POLLUTANTS WITHOUT STANDARDS: Acid Precipitation and Air Toxics

ACID PRECIPITATION

Description

Acid precipitation, more commonly called acid rain, is rain, snow, or fog that contains significant amounts of sulfuric and/or nitric acids. Various combustion processes release sulfur and nitrogen oxides into the air where they react to form acids and can travel for many miles. Acid rain is measured using a scale called "pH." The lower a substance's pH, the more acidic it is. Pure water has a pH of 7.0. According to the U.S. EPA, normal rain is slightly acidic because carbon dioxide dissolves into it, so it has a pH of about 5.5.

Sources

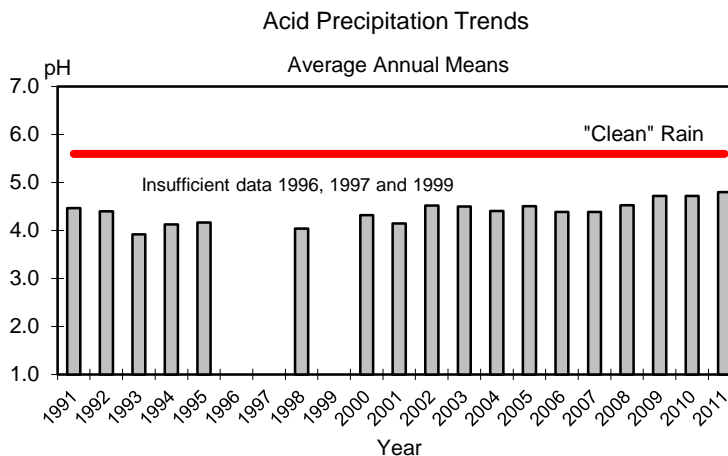
The largest sources of sulfur oxides are coal burning power plants, which are mainly located along the Ohio River valley. These plants are also significant sources of nitrogen oxides, as are motor vehicles. Prevailing winds carry these pollutants to the east and north, resulting in the most acidic precipitation occurring in the northeastern United States and Canada.

Locations

Acid precipitation was monitored at two sites, Georgetown and Summit Bridge, from 1984 to 1993. The Georgetown site was terminated in 1993. In 2000, the Summit Bridge monitor was relocated to the Ommelanden range on Route 9.

Delaware Air Quality and Trends

There was insufficient data to calculate an annual average for 1996, 1997 and 1999 due to a combination of resource and quality control issues. The relocation of the monitor in early 2000 and improved analytical equipment resolved the problems. In 2011, precipitation remained acidic, with an average annual pH of 4.80.





AIR TOXICS

Description

Toxic air pollutants, also called air toxics or hazardous air pollutants are pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. In 1990, Delaware began developing a routine ambient air sampling program for selected volatile organic compounds (VOCs). In 2000, this program was updated by changing the sampling and analytical method to detect a greater number of VOCs. In 2003, the program was expanded to include other types of chemical compounds such as carbonyls and heavy metals.

Sources

Sources of ambient air toxics include both stationary and mobile types. Stationary industrial sources can include power plants, chemical manufacturing plants, and refineries. There are many smaller stationary sources (sometimes referred to as "area" sources) such as dry cleaners, printers, and automobile paint shops. Mobile sources include both on- and off-road motor vehicles as well as boats and aircraft.

Locations

From 1990 to 1999, VOC samples were collected at four monitoring sites including Wilmington, Delaware City, Summit Bridge, and Seaford. With the change in monitoring method in 2000, samples were collected only at the Wilmington MLK site. From 2003 through 2004, VOCs, carbonyls, and heavy metals were collected at five sites throughout the state. Due to resource restrictions, in 2006 monitoring ended at three of those sites in September, and only MLK and Delaware City had a full year of data. Since then monitoring continued at those two sites.

Delaware Air Quality and Trends

Ambient VOC levels are consistently below 10 ppb for all monitored compounds, and most are below 1 ppb.

Control programs that focus on improving ambient ozone levels by reducing emissions of VOCs, as well as programs specifically aimed at controlling emissions of hazardous air pollutants, are continuing to reduce ambient concentrations of many air toxics. Although the change in monitoring method makes interpretation difficult, ambient concentrations of most VOCs are generally declining at the Wilmington site.

Division of Air Quality



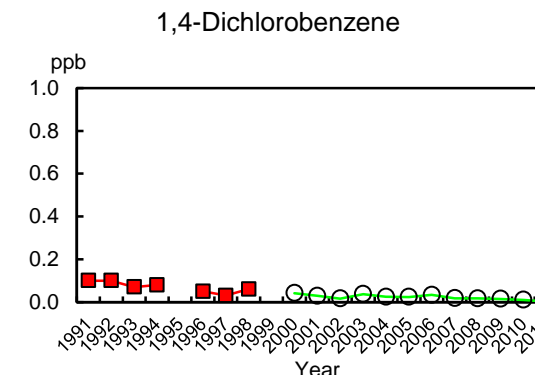
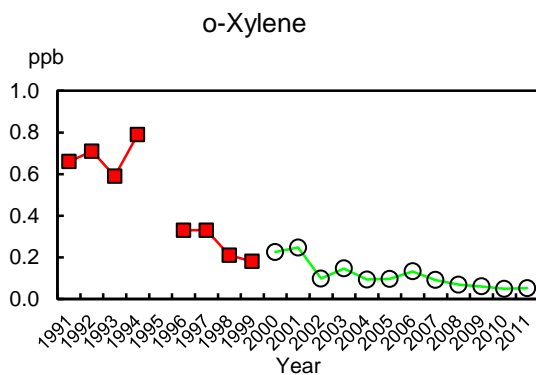
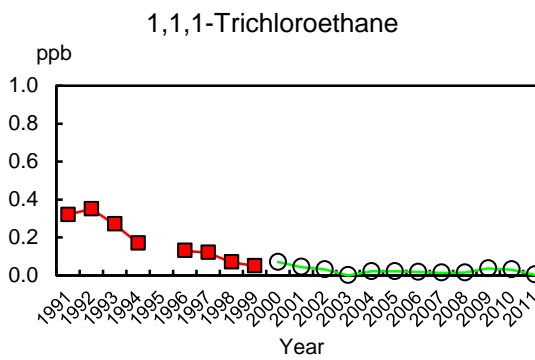
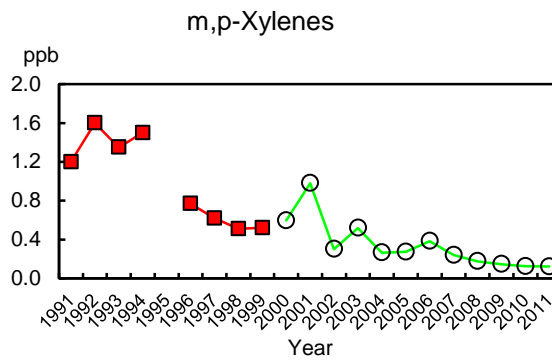
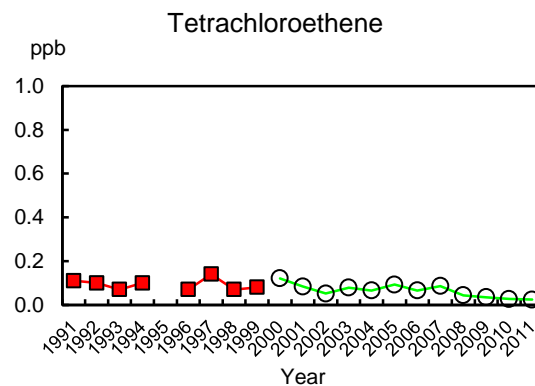
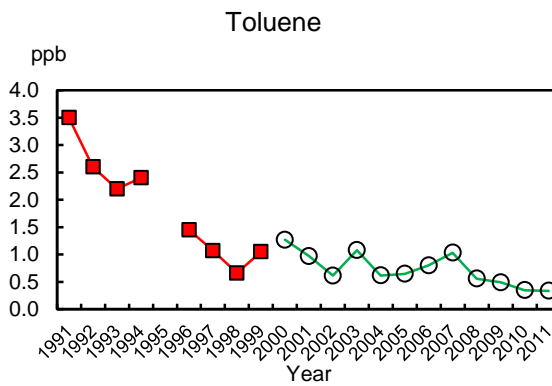
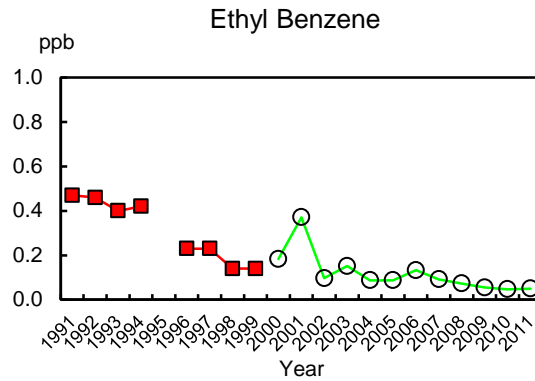
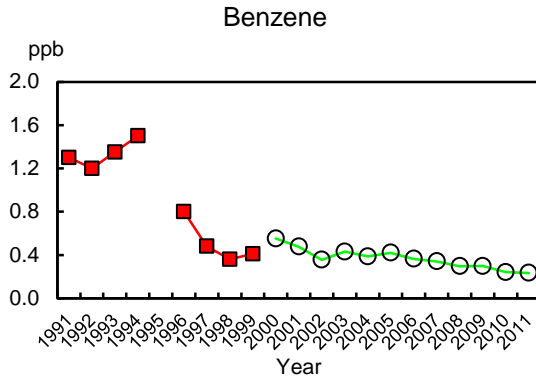
2011 Air Toxics Data in ppb – Wilmington (MLK) and Delaware City

Compound Name	MLK Avg	MLK Max	Del City Avg	Del City Max
Dichlorodifluoromethane	0.524	0.72	0.517	0.59
Chloromethane	0.548	0.79	0.551	0.74
1,2-Dichloro-1,1,2,2,tetrafluoroethane	0.016	0.05	0.016	0.03
Chloroethene	0.004	0.07	0.047	0.48
1,3-Butadiene	0.027	0.21	0.008	0.05
Trichlorofluoromethane	0.255	0.35	0.245	0.30
Acetone	4.577	19.24	3.300	26.96
Methylene Chloride	0.111	0.34	0.090	0.15
1,1,2-Trichloro-1,2,2-trifluoroethane	0.081	0.24	0.071	0.09
2-methoxy-2-methyl-Propane	0.002	0.03	0.001	0.02
Hexane	0.104	0.54	0.094	0.33
Chloroform	0.018	0.04	0.014	0.02
Tetrahydrofuran	0.073	2.34	0.002	0.02
1,2-Dichloroethane	0.011	0.02	0.010	0.02
1,1,1-Trichloroethane	0.004	0.02	0.005	0.02
Benzene	0.234	0.75	0.158	0.54
Carbon tetrachloride	0.075	0.11	0.075	0.11
Cyclohexane	0.049	0.12	0.044	0.11
1,2-Dichloropropane	0.001	0.01	0.001	0.02
Trichloroethene	0.001	0.02	0.001	0.01
Heptane	0.052	0.18	0.044	0.18
Cis-1,3-Dichloro-1-Propene	0.000	0.01	0.000	0.00
Trans-1,3-Dichloro-1-Propene	0.000	0.00	0.000	0.01
Toluene	0.335	1.54	0.151	0.38
1,2-Dibromoethane	0.000	0.01	0.001	0.01
Tetrachloroethylene	0.024	0.19	0.012	0.05
Chlorobenzene	0.002	0.01	0.003	0.02
Ethylbenzene	0.050	0.22	0.025	0.23
m & p- Xylene	0.121	0.53	0.077	1.07
Styrene	0.017	0.14	0.005	0.04
1,1,2,2-Tetrachloroethane	0.001	0.01	0.001	0.01
o-Xylene	0.052	0.21	0.032	0.48
1-Ethyl-4-Methylbenzene	0.019	0.06	0.008	0.02
1,3,5-Trimethylbenzene	0.014	0.07	0.005	0.02
1,2,4-Trimethylbenzene	0.050	0.20	0.021	0.06
1,4-Dichlorobenzene	0.003	0.02	0.001	0.01



Wilmington Air Toxics Trends - Annual Averages Selected Compounds

Notes: Insufficient data in 1995 to calculate annual average. Method changed in 2000.





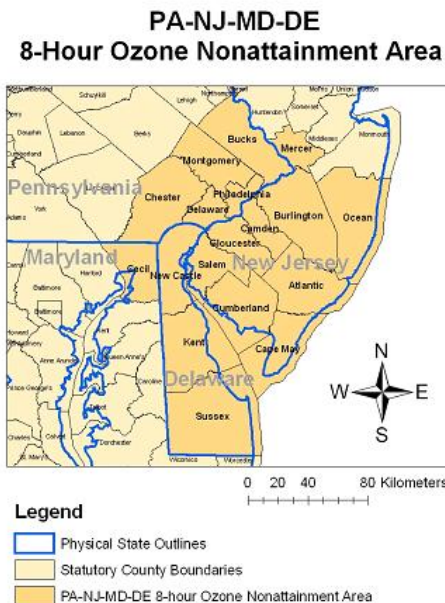
III. SOURCES OF POLLUTION

OZONE

EMISSIONS INVENTORY

In 2008, the U.S. Environmental Protection Agency (EPA) promulgated a revised National Ambient Air Quality Standard (NAAQS) for ground level ozone at a concentration of 0.075 ppm averaged over eight hours. The new standard supersedes the previous 8-hour ozone standard of 0.08 ppm. New Castle and Sussex counties exceed the new standard based on 2009-2011 monitoring data. The U.S. EPA has not established the non-attainment boundaries that would include Delaware counties for the 0.075 ppm standard.

EPA established calendar year 2002 as the base year inventory for the 0.08 ppm ozone standard, thus requiring states with 8-hour ozone non-attainment areas to submit as part of their State Implementation Plan (SIP) a comprehensive, accurate, and current base year inventory of actual emissions of ozone causing pollutants. Ozone causing pollutants, also known as ozone precursors, include volatile organic compounds (VOCs), oxides of nitrogen (NO_x), and carbon monoxide (CO). The U.S. EPA has not yet recommended a year to serve as the base year for the 0.075 ppm ozone standard.



What is an emissions inventory?

The emission inventory is a tool used to determine the amount of air pollution released from various air emission sources in a given geographic area. The inventory identifies the source types present in an area, the amount of each pollutant emitted, the types of processes and control devices employed, and other information.

Why are emissions inventories necessary?

The Clean Air Act Amendments (CAAA) of 1990 require states with nonattainment areas to submit a comprehensive, accurate, current inventory of actual emissions of ozone precursors from all sources every three years since 1990. These consecutive inventories provide the historic documentation needed to assist in demonstrating an area's progress in emission reductions and towards attainment of the NAAQS for ozone.



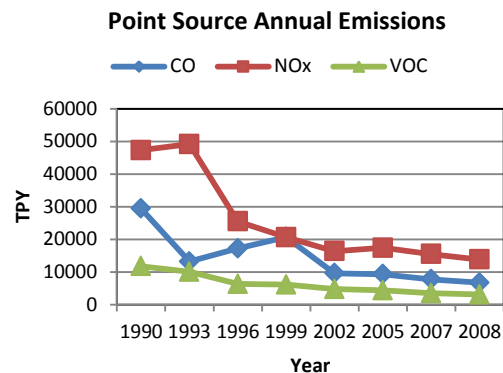
How are these inventories used?

Emission inventories can serve many purposes. They are the basis of overall air quality management planning, and are used in ambient dispersion modeling and analysis, control strategy development, and in screening sources for compliance investigations. Together with ambient monitoring data, inventory emission estimates are used to understand changes and trends in air quality.

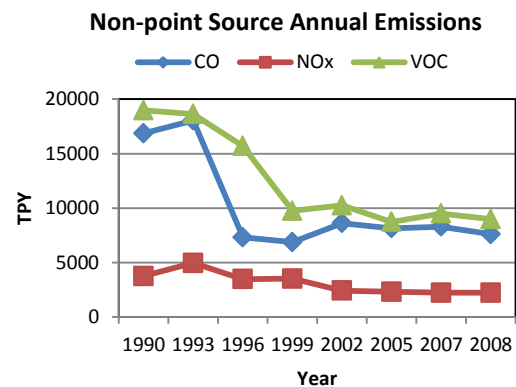
CHARACTERIZATION OF OZONE PRECURSOR EMISSIONS SOURCES

Sources of air emissions are classified into five sectors by the nature of the emissions and the physical characteristics of the emitter. These five sectors are described below and are accompanied with graphics depicting emissions from 1990 through 2008 for each ozone precursor.

Point sources are defined for emission inventory purposes as industrial, commercial, or institutional plants/operations that emit VOCs of 10 tons per year (TPY) or greater and/or NO_x or CO emissions of 25 TPY or greater. Owners or operators of about 60 such sources in Delaware are required to report annually the quantity and type of emissions. Refineries, chemical manufacturing facilities, power plants, auto assembly plants, solid waste landfills, and large building heating systems are included in this sector.



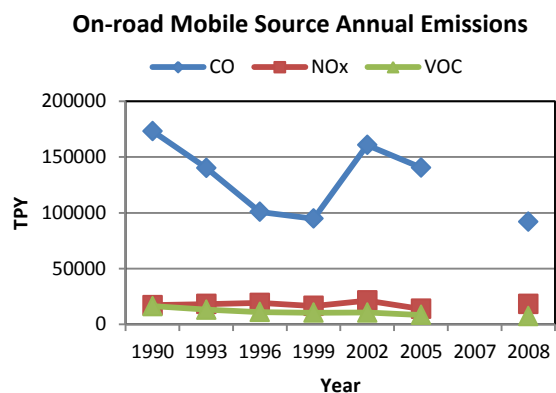
Stationary non-point sources are sources that fall below the point source emission threshold definitions given above and are thus not practical to identify individually for emission inventory purposes. The quantity and type of emissions from these sources are estimated by using established emission factors and appropriate activity data from the area. For example, emissions from service stations can be estimated based on the number of such facilities in the area and knowledge of the amount of gasoline sold. Print shops, dry cleaners, painting operations, degreasing and other solvent-using operations, small building heating, and outdoor burning are a few of the operations included in this sector.



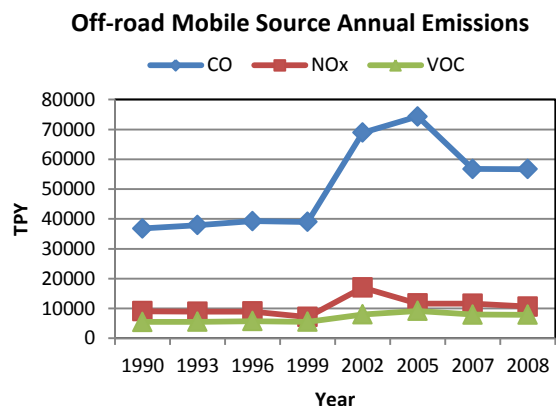
Mobile sources are usually divided into two sectors: on-road and off-road.



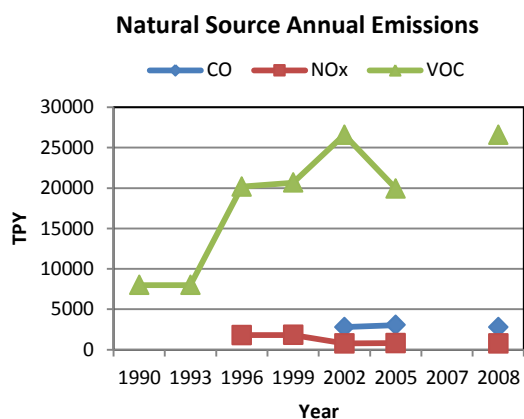
On-road mobile sources consist of automobiles, trucks, motorcycles, and other vehicles traveling on roadways in the nonattainment area. Delaware relies on the U.S. EPA’s MOVES model to estimate emissions for VOCs, NO_x, and CO. Emissions from the tailpipe of vehicles, as well as emissions due to evaporation of fuels, are estimated. Despite steady increases on overall vehicle miles traveled, emissions have decreased significantly in the past ten years due to cleaner, and more fuel efficient, cars and trucks.



Off-road mobile sources include commercial, military, and general aircraft, marine vessels, recreational boats, railroad locomotives, and a very broad subcategory that includes everything from construction equipment, forklifts, and farm tractors to lawn mowers, chain saws, and leaf blowers. Most engines in this sector have no emission controls and are considered high emitters of VOCs. Emissions are estimated primarily through the use of EPA’s NONROAD model.

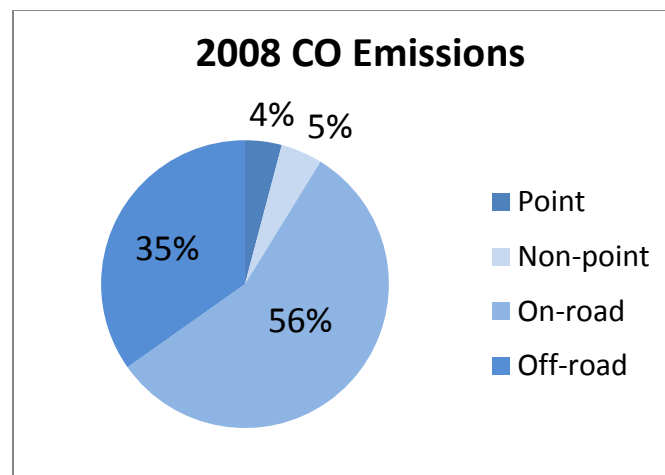
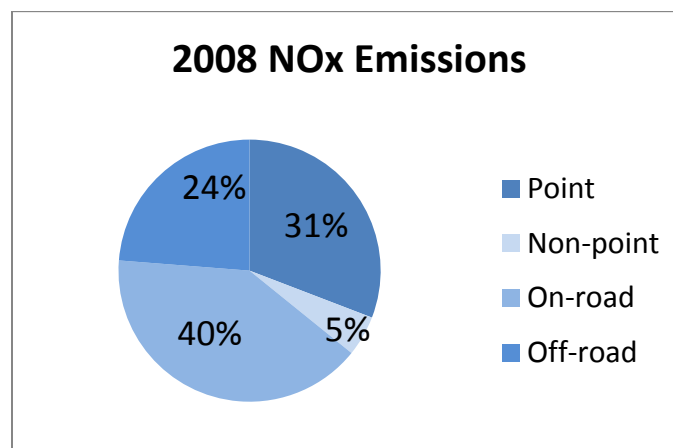
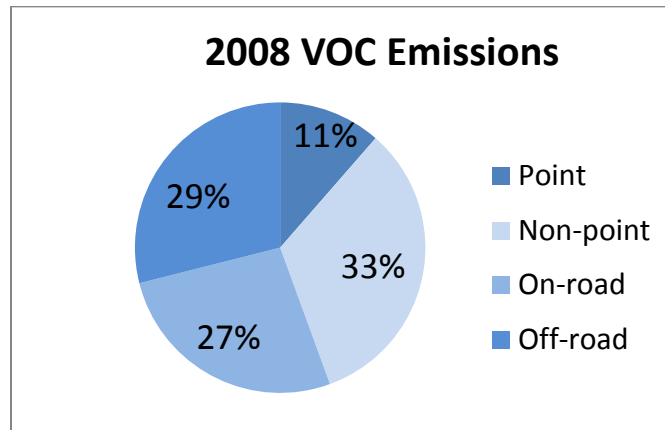


Natural sources include plant life in the area, such as crops, trees, grasses, and other vegetation. Microbial activity within soil is a source of NO_x and CO. The BEIS3.12 model is used to estimate the quantity and type of emissions from vegetation making use of tools such as satellite imaging to develop county specific land use data. While biogenic sources do emit VOCs into the atmosphere that may contribute to ozone formation, they also remove significant amounts of CO, SO₂, NO_x, O₃, and PM₁₀ from the air, and cool the air through shade and transpiration, thus reducing pollution from other sources.





Ozone Precursor Emissions by Source Category:





SULFUR DIOXIDE (SO₂) AND PARTICULATE MATTER (PM₁₀ and PM_{2.5})

As a result of recent findings describing the adverse health effects associated with fine particulates, and the establishment of a fine particulate national ambient air quality standard, the Emission Inventory Development (EID) Program has undertaken the creation of a complete 2002 particulate inventory, including both primary particulate and particulate precursors.

Primary particulate emissions consist of both solid particles of various sizes and aerosols. The solid particles can be delineated by size, such as PM_{2.5}, which designates particles with a diameter of 2.5 microns or less. PM₁₀ defines particles with a diameter of 10 microns or less, and thus includes PM_{2.5} as well as particles that range from 2.5 microns up to 10 microns. Since EPA has only recently established an air quality standard specifically for PM_{2.5}, emission estimation methodologies and emission factors are currently lacking for some source categories.

Secondary particulate emissions are precursors that react in the atmosphere to produce fine particles away from the emitting source. The precursors include sulfur dioxide, nitrogen oxides (NO_x), ammonia, and certain organic and inorganic compounds. Since NO_x and VOCs are already inventoried due to their contribution to ground-level ozone formation, the inventory program only adds sulfur dioxide and ammonia to its list of pollutants to be inventoried from all sources.

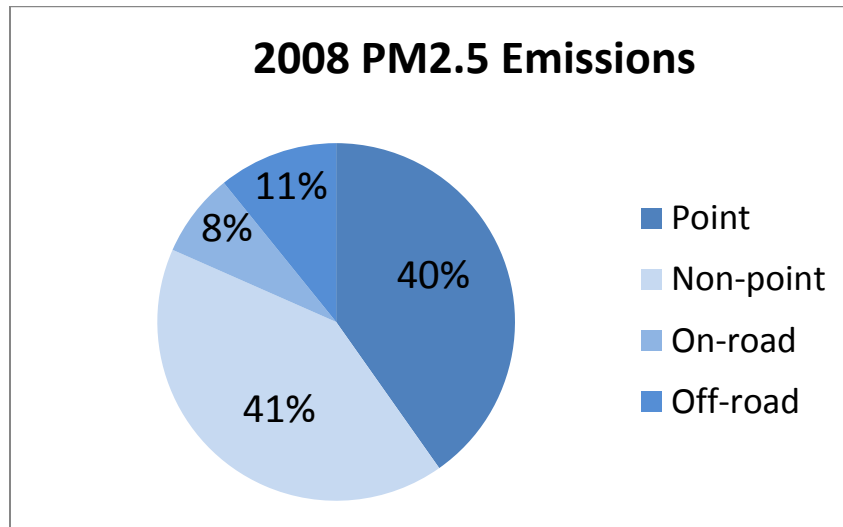
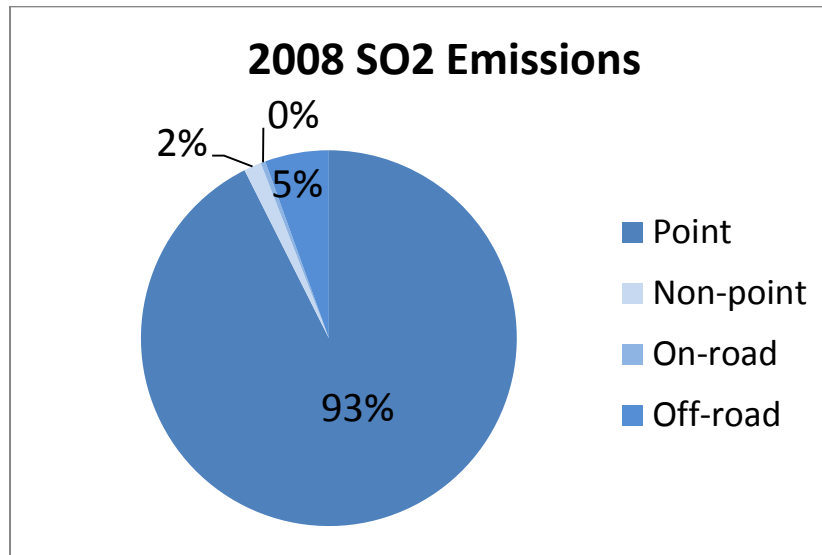
The majority of PM₁₀ emissions are primary particulate, with a large proportion being fugitive emissions, usually dust particles from non-point and natural sources. Significant contributions also come from mobile, non-point and point source fuel combustion.

The profile for PM_{2.5} is significantly different, with the vast majority of emissions being secondary emissions. Sulfates and nitrates, which are secondary compounds of PM_{2.5}, are expected to comprise almost two-thirds of the total inventory. Roughly one-third of the PM_{2.5} inventory is comprised of emissions from combustion sources. Only a very small amount, approximately 5%, is due to primary fugitive emissions, mostly dust.

Sulfur dioxide is largely a result of fossil fuel combustion, particularly from coal and diesel fuel. Electric utility generation and refineries are by far the largest SO₂ emission sources. Motor vehicle fuel combustion is also a significant source of SO₂, although on a much smaller scale than stationary source fuel combustion.



Sulfur Dioxide and PM_{2.5} Emissions by source category:





HAZARDOUS AIR POLLUTANTS (HAPs)

In addition to ozone precursors, and particulate and its precursors, Delaware also has regulations that address the emissions of air toxics. The Permitting & Compliance group of the Division of Air Quality maintains air permits on various processes that emit air toxics. Specific toxic chemicals, called Hazardous Air Pollutants (HAPs), are regulated under these permits. The Clean Air Act mandates that EPA set national standards for HAPs. These standards are based on specific emission source types, and are called Maximum Achievable Control Technology (MACT) standards.

The EID Program developed a comprehensive air toxics inventory for 2002 in support of the Delaware Air Toxics Assessment Study. All sources (point, non-point, on-road mobile and off-road mobile) were included in the toxics inventory. Additional information on emissions of air toxics is contained in the annual Delaware Toxics Release Inventory Report (see References). These inventories can be used to track progress associated with implementing the MACT standards.



IV. POLLUTION CONTROL/PREVENTION

CLEAN AIR ACT AMENDMENTS OF 1990 AND OZONE NAAQS

The Clean Air Act Amendments of 1990 require EPA, states, and cities to implement a series of programs that will further reduce emissions of VOCs and NO_x from cars, fuels, industrial and chemical facilities, power plants, and consumer and commercial products among other sources, to attain the ozone NAAQS. Cleaner cars and fuels, new kinds of gasoline nozzles, enhanced vehicle inspection, and other programs along with new control strategies have been implemented in the past decade or so, and additional control measures will be phased in over the next decade.

The Philadelphia-Trenton-Wilmington Consolidated Metropolitan Statistical Area (CMSA) was classified as severe non-attainment area under the 1-hour ozone NAAQS (0.12 ppm).

Delaware's Kent and New Castle Counties fell into this severe non-attainment area, while Sussex County was designated separately as a marginal non-attainment area. To attain the 1-hour ozone standard, Delaware fulfilled the following strategies and control programs that were required by the 1990 CAAA:

- submission and implementation of an ozone air quality SIP;
- development of a periodic emissions inventory for ozone precursors every three years;
- a 15% net-of-growth reduction in VOC emissions by 1996 and a 3% reduction in VOC and/or NO_x emissions each year after 1996 until 2005;
- development of Rate-of-Progress Plans (RPPs) for 1996, 1999, 2002, and 2005 to achieve the above VOC and/or NO_x emission reductions;
- a demonstration that transportation plans conform to ozone air quality SIP;
- an enhanced vehicle inspection-and-maintenance program;
- reformulated gasoline;
- clean, alternatively fueled vehicles;
- demonstration using EPA-recommended modeling methods that the 1-hour ozone standard could be attained in 2005;
- collection of additional pollutant and meteorological data to support modeling efforts;
- a program to prevent the addition of new large sources of emissions from increasing total emissions;
- new emissions controls on small business;
- new controls on fugitive emissions;
- reasonably available control technology (RACT) for sources of VOC or NO_x emissions; and
- enhanced monitoring by industrial sources; and maximum achievable control technology on large sources of hazardous air pollutants, some of which are VOCs.

In 1997, EPA revised the 1-hour ozone NAAQS (0.12 ppm) to an 8-hour standard of 0.08 ppm. In June 2004, EPA designated all three counties in Delaware as moderate non-attainment area, as



a part of Philadelphia-Wilmington-Atlantic City PA-NJ-MD-DE moderate non-attainment area, under the 8-hour ozone NAAQS. In June 2005, EPA revoked the 1-hour ozone standard. However, the 1-hour ozone standard stays valid in Delaware as required by its Regulation 1103 Governing Control of Air Pollution. All control strategies and programs listed above stay in effect in Delaware, as required by the Clean Air Act (CAA) and Delaware's regulations.

PROGRESS TOWARD ATTAINMENT OF THE NAAQS FOR OZONE

The 1990 Clean Air Act Amendments (CAAA) contain provisions for the attainment and maintenance of the ozone NAAQS. State implementation plans (SIP) must be developed in designated nonattainment areas. Plan requirements vary depending on the severity of the individual area's air pollution problem. Under the 1-hour ozone standard, New Castle and Kent Counties have been designated to be in severe nonattainment while Sussex County has been placed in marginal nonattainment status.

One key requirement of the CAAA for moderate and above ozone nonattainment areas is the achievement of Reasonable Further Progress (RFP) toward the attainment of the NAAQS. States must demonstrate RFP by achieving at least a 15 percent reduction of VOC emissions from 1990 levels by 1996. In addition, states must offset any growth in emissions projected from 1990 to 1996. A three percent per year reduction of VOC and/or NO_x emissions is required between 1997 and 2005. The year 2005 is the year for which severe nonattainment areas must attain the 1-hour ozone standard.

Progress toward attainment of the NAAQS in the year 2005 is measured by periodic emission inventories conducted every three years, beginning in 1993. Actual air emission data are inventoried for reactive VOCs, NO_x, and CO from point, area and mobile sources.

Point sources, as defined for the 1990 base year and successive inventories, are those facilities/plants/activities that have actual emissions greater than or equal to at least one of the following: 10 tons per year VOC, 100 tons per year NO_x, or 100 tons per year CO. Detailed plant, point and process data is maintained by each point source. Area sources represent collections of many small air pollutant emitters existing within a specified geographical area. Because non-point sources are too small and/or too numerous to be surveyed and characterized individually, their emissions must be estimated collectively. Mobile sources are represented by all forms of transportation commercial/recreational/private, as well as portable implements and tools powered by internal combustion engines. Emissions for mobile sources are estimated through primary data, computer modeling and collective estimates.

In 1995, DNREC submitted its 15 percent VOC reduction SIP for 1996 to the EPA. It targeted reductions through multiple control strategies including gasoline vapor collection, low volatility coatings and solvents, and controlling leaks in manufacturing processes. To further reduce VOCs, Delaware implemented statewide use of reformulated gasoline and an open burning ban



in Kent and New Castle Counties during the months of June, July, and August.

Delaware submitted its 1999 RFP plan to the EPA in December 1997, and amended it in June 1999. In addition to continuing the VOC emissions controls in the 15 Percent Plan, the 1999 RFP (as amended) was designed to achieve significant NO_x reductions through implementing controls over a variety of NO_x sources, especially large industrial sources. Afterwards, Delaware submitted its 2002 RFP plan and 2005 RFP plan in February 2000 and December 2000, respectively, implementing additional control programs over a wide range of VOC and NO_x emission sources. Many of those control programs were implemented along with other states within the northeast Ozone Transport Region (OTR).

Delaware's efforts in controlling ozone problem have made remarkable progresses. Both VOC and NO_x emissions in Delaware have been reduced significantly since 1990. Delaware's 1993, 1996, 1999 and 2002 periodic emission inventories have demonstrated that all RFP emission reductions under the 1-hour ozone standard were achieved. In 2003, 2004 and 2005, ambient monitors in all three counties in Delaware recorded ozone concentrations in compliance with the 1-hour ozone standard, indicating that Delaware attained the 1-hour ozone standard in 2005. All VOC and NO_x emission control programs in Delaware stay in effect for maintaining this attainment status.

Now, Delaware, as well its neighboring states, is focusing on the new 8-hour ozone standard, which must be attained in 2010. In September 2006, Delaware submitted to EPA the Reasonably Available Control Technology (RACT) SIP revision. In June 2007, Delaware submitted to EPA the RFP and Attainment Demonstration SIP revision. Both SIP revisions were required by the CAAA under the 8-hour standard. In addition to continuing all control measures implemented under the 1-hour ozone standard, Delaware has committed to additional and/or improved (i.e., revised) control measures to further reduce VOC and NO_x emissions in the years to come. It is anticipated that all those efforts will further improve Delaware air quality with respect to ozone.



OTHER POLLUTANTS

The Clean Air Act Amendments of 1990 also include a number of sections devoted to air pollutants besides ozone. Requirements for other pollutants include:

- Reduction of sulfur dioxide (SO₂) emissions nationally to reduce acid deposition; the goal is a reduction of 10 million tons per year from 1980 levels. This represents a reduction of approximately 40% by the year 2000. There is also a national cap on major point-source emissions after the year 2000.
- Expansion of Maximum Available Control Technology standards to sources of toxic emissions not previously covered. The expanded standards will result in reduced emissions of benzene from wastewater treatment plants, chrome from cooling towers, and tetrachloroethylene from dry cleaning and chrome plating.
- Implementation of Title V of the Clean Air Act Amendments by establishing a new operating permit program for all major stationary sources of air pollutant emissions. This program will ensure that both industry and the public are knowledgeable as to the rules and regulations that all major stationary sources are required to meet.

Delaware has relevant control programs that fulfill the above requirements.



V. WHAT YOU CAN DO

Air pollution is a worldwide problem. No political boundaries stop the flow of polluted air. No humans have been able to retrieve pollutants once they have been released. Because air pollutants spread rapidly, almost instantaneously, polluters rarely feel affected by their decision to pollute.

By choosing to act, each person can reduce air pollution and make a difference in the environment. Since the primary sources of air pollution are from vehicular transportation and energy production, the main thing you can do is *conserve energy and use alternative forms of transportation*.

Reduce pollution in the following manner:

- Limit single passenger trips in the car, plan your trips, form a car pool.
- Use public transportation.
- Walk or bike whenever possible.
- Turn off lights and appliances not in use.
- Recycle everything you can and use products made from recycled materials.
- Use environmentally friendly household products.
- Keep your automobile well tuned and maintained.
- Be careful not to spill gasoline when filling up your car, boat, or lawn and garden equipment.
- Seal containers containing household cleaners, workshop chemicals and solvents, and garden chemicals to prevent volatile organic chemicals from evaporating into the air.

You can also stay informed by reading and listening for information on air quality data, legislation, and regulations. For more air quality information and what you can do, visit our website: <http://www.dnrec.delaware.gov/whs/awm/Pages/AirQuality.aspx>.



APPENDIX A - Monitoring Methods

Carbon Monoxide (CO)

Carbon monoxide is measured by infrared absorption photometry. Air is drawn continuously through a sample cell where infrared light passes through it. Carbon monoxide molecules in the air absorb part of the infrared light, reducing the intensity of the light reaching a light sensor. The light is converted into an electrical signal related to the concentration of carbon monoxide.

Nitrogen Dioxide (NO₂)

Nitrogen oxides are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone (O₃). Air is drawn into a reaction chamber where it is mixed with a high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the ozone to produce NO₂. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. Nitrogen dioxide (NO₂) must be measured indirectly. Total nitrogen oxides (NO_x) are measured by passing the air through a converter where any NO₂ in the air is reduced to NO before the air is passed to the reaction chamber. By alternately passing the air directly to the reaction chamber, and through the converter before the reaction chamber, the analyzer alternately measures NO and NO_x. The NO₂ concentration is equal to the difference between NO and NO_x.

Ozone (O₃)

Ozone is measured by ultraviolet absorption photometry. Air is drawn through a sample cell where ultraviolet light (254 nm wavelength) passes through it. Light not absorbed by the ozone is converted into an electrical signal proportional to the ozone concentration.

In Delaware, the ozone season runs from April 1 to October 31 during which monitors are in operation at six sites (see Delaware monitoring network description). Beginning in 2011, the ozone monitoring season will run from March 1 through October 31. Monitoring continues at Bellefonte and Summit Bridge year-round.

Particulate Matter - Fine (PM_{2.5})

PM_{2.5} is sampled by drawing air through a specially designed inlet that excludes particles larger than 2.5 microns in diameter. The particles are collected on a Teflon⁷ microfiber filter that is weighed to determine the particulate mass. The normal sampling schedule is 24 hours every third day, however, at one site (Wilmington-MLK) samples are collected for 24 hours every day.

Particulate Matter (PM₁₀)

PM₁₀ is sampled continuously using a tapered element oscillating microbalance (TEOM). Air is drawn through a specially designed inlet that excludes particles larger than 10 microns in diameter. Particle accumulation causes changes in the microbalance oscillation which are recorded by the instrument.



Sulfur Dioxide (SO₂)

Sulfur dioxide is measured with a fluorescence analyzer. Air is drawn through a sample cell where it is subjected to high intensity ultraviolet light. This causes the sulfur dioxide molecules in the air to fluoresce and release light. The fluorescence is detected with a photo multiplier tube and converted to an electrical signal proportional to the SO₂ concentration.

Lead

A large volume of air is drawn through a glass fiber filter (Hi-vol method). Part of the filter is removed and chemically extracted. This is followed by laboratory analysis using atomic absorption spectrometry to determine the lead concentration.

Acid Rain

Acidity is reported as pH, which is a measure of hydrogen ion concentration. The scale is logarithmic with a pH of 7.0 being neutral, pH 10.0 highly basic and pH 1.0 highly acidic. Clean precipitation is approximately pH 5.6.

Weekly precipitation samples are collected at the Ommelanden range. This monitor is for wet deposition only; dry deposition is not measured in Delaware. In the past, there was a second monitoring site in Georgetown. This site was terminated due to questions of site quality (too close to roadways) and restrictions on resources. Samples are analyzed for pH and conductivity at the Air Surveillance lab ("field" measurements). From 1983 through April 1995, the samples were mailed to a contractor for detailed chemical analysis for pH, conductivity, and ion species; this has been discontinued due to lack of financial support by the EPA.

Community Air Toxics

There are no EPA "reference" methods for monitoring ambient air for VOCs. In Delaware's program from 1991 through 1999, samples were taken on sorbent tubes once per week, rotating Monday through Thursday, for 24 hour intervals. The tubes were analyzed by the DNREC Environmental Services Laboratory using a gas chromatograph/mass spectrometer (GC/MS). Quality control measurements included collocated samplers, travel and laboratory blanks, spiked tubes, internal and various calibration standards. This method was replaced in 2000 by EPA Method TO15a, which collects 24-hour samples once every six days using stainless-steel canisters followed by GC/MS analysis.

Heavy metals are collected by drawing a large volume of air through a glass-fiber filter (Hi-vol method). The filters are extracted using method IO3.5. Samples are collected for 24 hours once every six days.

Carbonyls are collected by drawing low volume of air through a 2,4-Dinitrophenylhydrazine Coated trap for 24 hours. The samples are analyzed using method TO-11A. Samples are collected once every six days.



APPENDIX B - Definitions, References, and Contacts

Ambient Air: Generally, the atmosphere; usually refers to the troposphere.

Annual Arithmetic Mean: The numerical average of the data for the year.

Annual Geometric Mean: The geometric average of the data for the year (the nth root of the product of n numbers).

Attainment: EPA designation that an area meets the NAAQS.

24-hour Average: The average concentration for a 24-hour period.

CAA: Clean Air Act

CAAA: Clean Air Act Amendments of 1990.

CMSA: Consolidated Metropolitan Statistical Area

Chemiluminescence: Visible light produced by chemical reaction.

Exceedance: An incident occurring when the concentration of a pollutant in ambient air is higher than the NAAQS.

Fluorescence: The production of light in response to the application of radiant energy such as ultraviolet rays.

Infrared: Lying just beyond the red end of the visible electromagnetic spectrum.

MSA: Metropolitan Statistical Area

NAAQS: National Ambient Air Quality Standard, set by EPA to protect human health and welfare.

NAMS: National Air Monitoring Stations

Nonattainment: EPA designation that an area does not meet the NAAQS.

OTR: Ozone Transport Region.

PAMS: Photochemical Assessment Monitoring Stations



PEI: Periodical Emission Inventory

Photometry: The measurement of the intensity of light.

Photomultiplier: A device that converts light into an electrical current, amplifying it in the process.

ppb: Parts per billion by volume.

ppm: Parts per million by volume.

Precursor: A substance that is the source of, or aids in the formation of, another substance.

RACT: Reasonably Available Control Technology.

RFP: Reasonable Further Progress.

SIP: State Implementation Plan.

SLAMS: State and/or Local Air Monitoring Stations.

SPMS: Special Purpose Monitoring Stations.

Spectrometry: The measurement of electromagnetic wavelengths (spectra).

Troposphere: The region of the atmosphere nearest to the earth in which temperature generally decreases with height.

$\mu\text{g}/\text{m}^3$: Micrograms per cubic meter.

Ultraviolet: Lying just beyond the violet end of the visible electromagnetic spectrum.



References and Reports

Air Quality Index (AQI) - A Guide to Air Quality and Your Health, U.S. EPA,
<http://airnow.gov/index.cfm?action=aqibasics.aqi>

National air quality and emissions trends, U. S. EPA,
<http://www.epa.gov/airtrends/index.html>

Delaware Toxics Release Inventory Report, Delaware DNREC,
<http://www.dnrec.delaware.gov/serc/Pages/Default.aspx>

Delaware Final 2002 Ozone Precursor Emissions Inventory Report, Delaware DNREC,
<http://www.awm.delaware.gov/Info/Pages/2002OzoneReport.aspx>

Delaware rate of progress plans, SIP emissions inventories, and other reports, Delaware DNREC,
<http://www.awm.delaware.gov/AQM/Pages/AQMPublicationsandReports.aspx>

Delaware Annual Air Quality Reports, Delaware DNREC,
<http://www.awm.delaware.gov/AQM/Pages/AQMPublicationsandReports.aspx>

Air Quality Related World Wide Web Sites

AIRData - Access to national and state air pollution concentrations and emissions data
<http://www.epa.gov/airdata/>

American Lung Association
<http://lung.org>

Delaware State Climatologist
<http://climate.udel.edu/>

Delaware Valley Regional Planning Commission
<http://www.dvrpc.org/Environment/AirQuality>

Delaware Valley Air Quality Forecast
<http://www.airqualitypartnership.org/>

State of Delaware Division of Air Quality current hourly monitoring data
<http://apps.dnrec.delaware.gov/AirMonitoring/>



US National Oceanic and Atmospheric Administration, Environmental Research Laboratories,
www.arl.noaa.gov

USEPA Office of Air and Radiation, Air Trends reports
<http://www.epa.gov/airtrends/reports.html>

USEPA Office of Air Quality Planning and Standards “AirNow” - ozone maps, real-time data
<http://airnow.gov>

USEPA Office of Transportation and Air Quality (formerly Office of Mobile Sources)
www.epa.gov/oms

USEPA Region III Air Protection Division
www.epa.gov/reg3artd

USEPA Technology Transfer Network (TTN Web)
www.epa.gov/ttn



LIST OF CONTACTS

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Stationary Area Sources – Mark Prettyman, Dover Office

Mobile Sources (on- and off-road) – John Outten, Dover Office

State Implementation Plan (SIP) - Regulations and Planning

Ozone SIP Development - Frank Gao, New Castle Office

PM_{2.5} SIP Development - Jack Sipple, Dover Office

Mobile Source Controls - Phillip Wheeler, Dover Office

Air Monitoring Program

Program Manager - Chuck Sarnoski, New Castle Office