



# **DELAWARE ANNUAL AIR QUALITY REPORT**

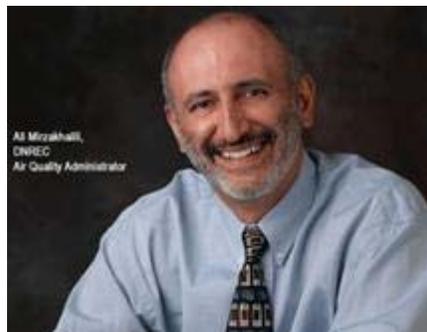
## **2006**

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Division of Air and Waste Management  
Department of Natural Resources and Environmental Control

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### **A word from Ali Mirzakhali, Delaware's Air Quality Administrator**

“Blue Skies Delaware; Clean Air for Life”, this is Air Quality Management’s vision for Delaware. Air Quality Management developed this new vision statement to guide us in our role as guardians of a precious natural resource, the air we breathe.

This report provides you with an outline of the Air Quality Management Section’s organizational structure and responsibilities; it provides you with the latest air quality data summary and makes available contact information in case you want additional information. This report also presents a summary of what we are doing to clean up Delaware’s air quality and keep it clean.

We look forward to a day when Delawareans have good air quality every day of the year, when our visibility is not blocked by haze and when we are no longer concerned with excessive amounts of toxics in our air. To reach this important goal we need your help. This report provides you with information on what you can do to help our clean air efforts, it is vital that you get involved.

**On the cover** – aerial photograph of Delaware’s Inland Bays. Photo by Joanna Wilson, cover design by John Thomas and Christy Shaffer.



## EXECUTIVE SUMMARY

Delaware's 2006 annual air quality report continues to document the changes and overall improvement in ambient air quality in the state. In 2006 only two pollutants, ozone and  $PM_{2.5}$ , exceed or are close to the national ambient air quality standards. Other pollutants monitored in Delaware ( $SO_2$ , CO,  $NO_2$ , and  $PM_{10}$ ) are well below the national standards.

As measured by the air quality index (AQI), there are fewer days that fall into the category of moderate or unhealthy for sensitive populations. There were more days with good air in 2006 than in past years.

For ozone, there were six exceedances of the 8-hour ozone standard in 2006; however, there were no exceedances of the 1-hour 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 (2004 - 2006) show concentrations that continue to be close to the level of the air quality standard. Kent and Sussex counties continue to record concentrations below the standard.

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. The most recent inventory was for 2002 and the next update will cover 2005.



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## **DELAWARE ANNUAL AIR QUALITY REPORT 2006**

### **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 (O<sub>3</sub>), carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), particulate matter less than 10 microns (PM<sub>10</sub>), particulate matter less than 2.5 microns (PM<sub>2.5</sub>) 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<sub>2.5</sub> 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**

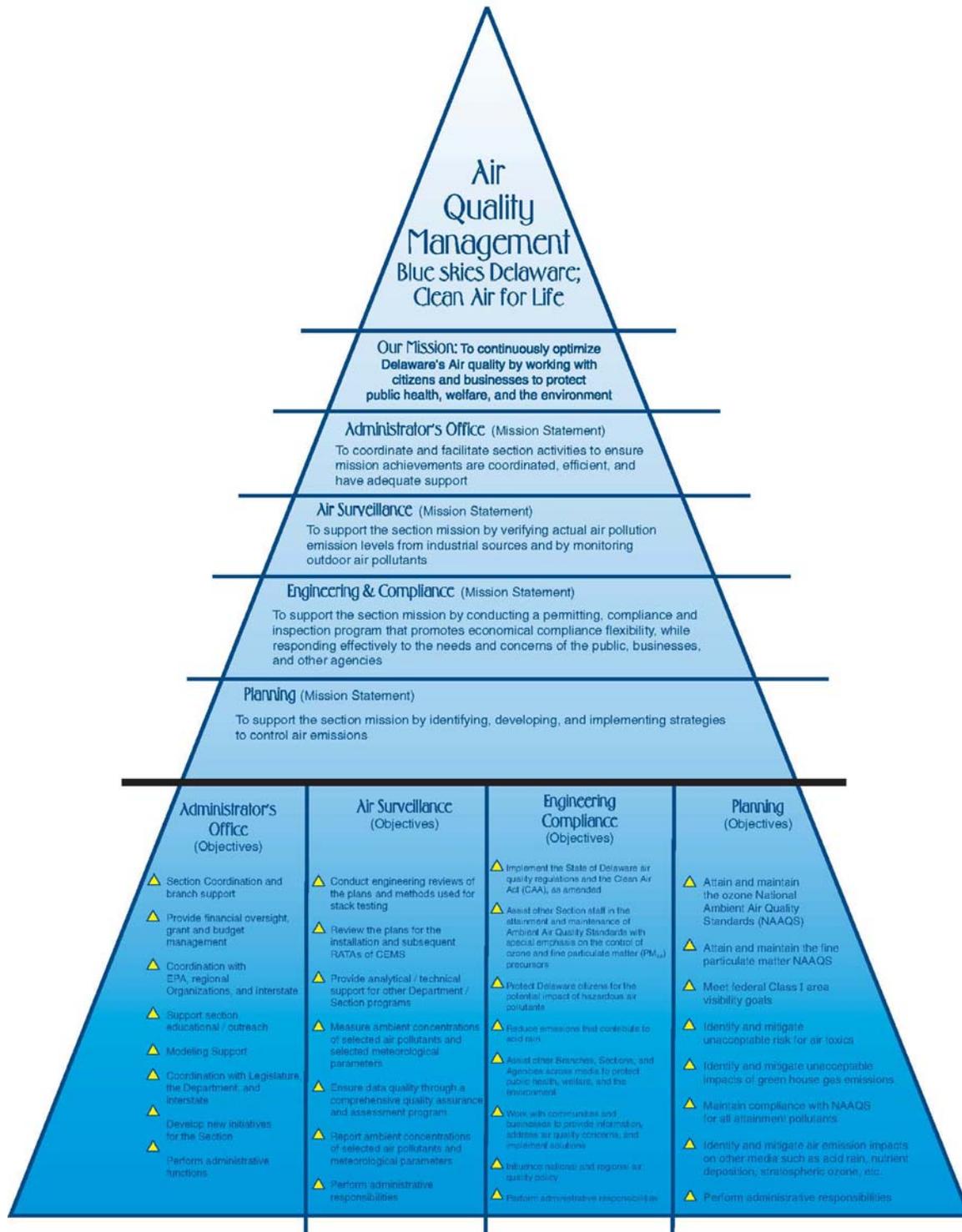
### **ABOUT DELAWARE'S AIR QUALITY MANAGEMENT SECTION**

Air Quality Management (AQM) Section is operated through an Air Quality Administrator and is organized by branches that are defined as:

- Air Surveillance
- Engineering and Compliance
- Planning

Each Branch in the AQM has created a mission statement. A mission statement defines in one or two sentences any entity's reason for existence. It embodies its philosophies, goals, ambitions and more. Consistent with these mission statements, branch-specific objectives have been developed. These objectives are brief, clear statements of outcomes that are related to and flow from the vision / mission. The vision/mission/branch-specific objectives are identified in the following pyramid.

Each branch has uniquely defined objectives that collectively support the AQM vision.





### **Engineering and Compliance Branch**

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. Compliance or enforcement actions are initiated for violation of regulations or permit conditions when warranted.

### **Air Surveillance Branch**

#### *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).

#### *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. 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.

### **Planning Branch**

#### *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 entitled State Implementation Plans. These are usually in the form of revisions to existing plans.

### *Area Sources Compliance Program*

The Areas 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. Compliance or 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 (PM<sub>10</sub>), and particulate matter less than 2.5 microns in diameter (PM<sub>2.5</sub>).

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 deciding 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 build up 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 Air Quality Management Section web page.

[http://www.dnrec.state.de.us/air/aqm\\_page/airmont/air.asp](http://www.dnrec.state.de.us/air/aqm_page/airmont/air.asp)

8. How can I get historical air quality data?

Historic air quality data for Delaware and other states is available on the internet at: [www.epa.gov/air/data/](http://www.epa.gov/air/data/)



### 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.

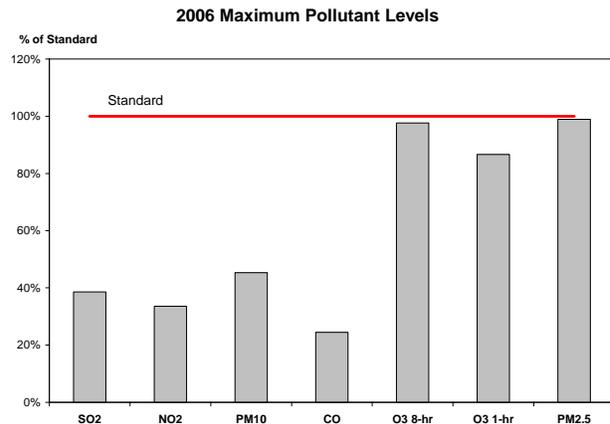
### 10. Who can I call about an indoor air quality problem?

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



## DELAWARE'S AIR QUALITY STATUS

Delaware is currently in attainment with all the National Ambient Air Quality Standards except ozone and PM<sub>2.5</sub>. 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 (PM<sub>10</sub>/PM<sub>2.5</sub>, SO<sub>2</sub>, CO, O<sub>3</sub>, and NO<sub>2</sub>) are used to calculate a health-related value or index. The data represents the previous 24 hours. For each pollutant, a subindex 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".

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"

### 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<sub>2.5</sub> for the first

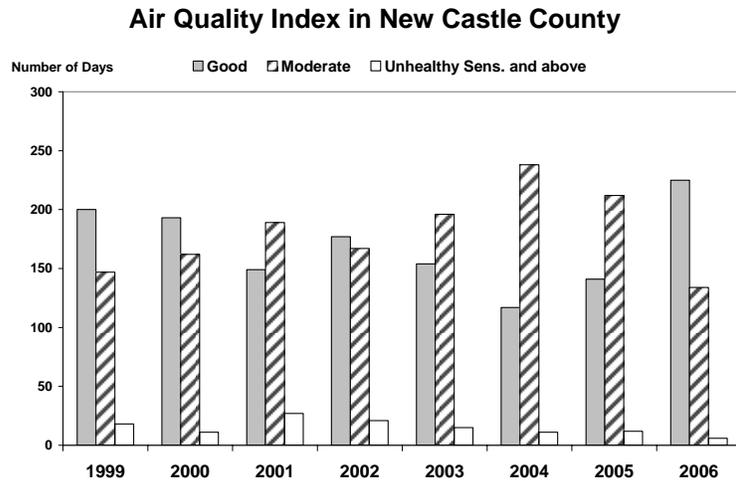
## Air Quality Management

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time. This 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 2006. 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

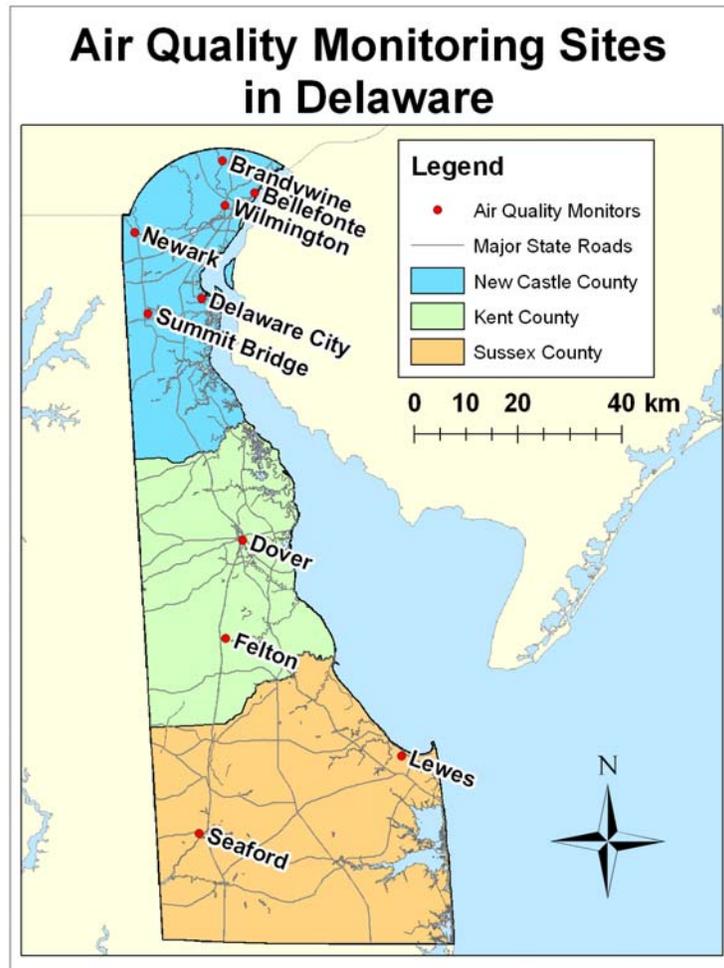
The State of Delaware has established an air monitoring network to determine the ambient levels of the pollutants for which NAAQS have been established. The Delaware Air Monitoring Network consists of the sites and monitors listed in the following table and figure. Although monitoring takes place statewide, 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 Air Quality Management Section, Division of Air and Waste Management, 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 AQM 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 2006

“X” indicates pollutant monitored

SITE	SO <sub>2</sub>	NO <sub>2</sub>	CO	O <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Wind Speed/ Direction	Acid Rain
Brandywine				X				
Bellefonte	X			X		X		
Wilm. - MLK Blvd	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 Air Quality Management Section's webpage as the [Delaware Ambient Air Monitoring Network Description](http://www.awm.delaware.gov/Info/PubComAmbientAir.htm) (<http://www.awm.delaware.gov/Info/PubComAmbientAir.htm>).



## AIR QUALITY - POLLUTANTS THAT EXCEED STANDARDS: OZONE AND PM<sub>2.5</sub>

### OZONE (O<sub>3</sub>)

#### Description

Ozone (O<sub>3</sub>) 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 = 0.08 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 0.08 ppm.

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 1-hour standard in its regulations (Regulation 3).*

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  $\mu\text{g}/\text{m}^3$ ) 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<sub>x</sub>) 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<sub>x</sub> 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 highest in New Castle County, longer-term 8-hour averages are above the standard throughout Delaware.

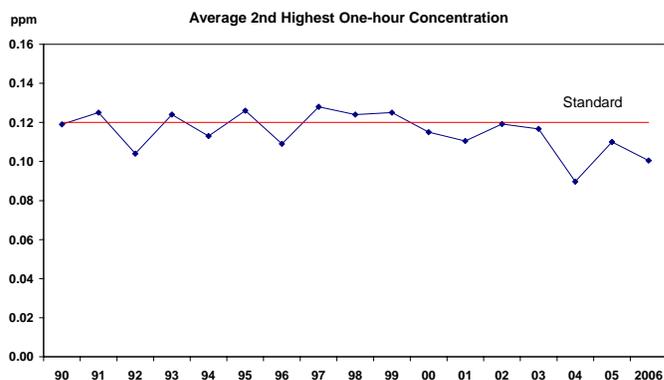
## Delaware Air Quality and Trends

Trends in ozone concentrations are often difficult to discern due to the effect of meteorology. Hot, dry weather and stagnant air favor the formation of ozone, and the greatest number of exceedance days typically occur during the hottest and driest summers. Ozone levels in the 1990's were better than in the 1980's and are continuing to show generally decreasing levels.

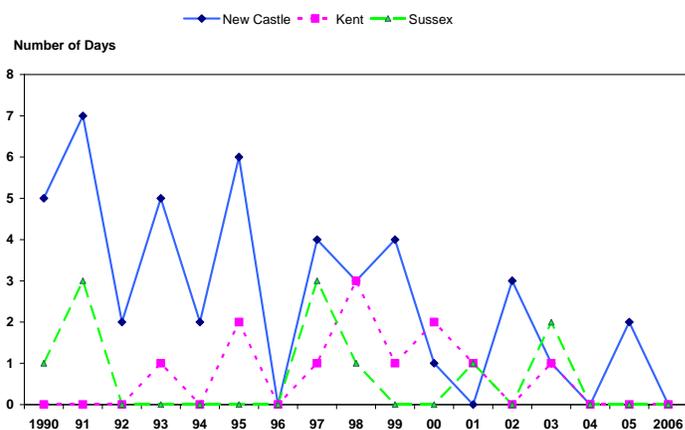
### One-hour Ozone Data and Trends

2006 was a relatively hot summer, which tends to favor high ozone concentrations; however, there were no days on which the one-hour NAAQS was exceeded in Delaware. This shows continuing improvement in air quality.

Ozone Trends



Number of Days Exceeding Ozone 1-hr NAAQS





**Delaware Exceedances of the One-Hour Ozone NAAQS**  
Total number of days at each site with a daily one-hour maximum  $\geq$  0.12 ppm

Year	Site								County			State
	Smt	Blfte	Clmt	Brnd	Dver	Fltn	Sfrd	Lws	NC	K	S	
1984	3	2	2		1		0		4	1	0	5
1985	5	4	2		2		1		8	2	1	10
1986	0	6	0		0		0		6	0	0	6
1987	3	6	6		3		1		9	3	1	12
1988	15	15	15		10		8		23	10	8	28
1989	2	1	2		0		0		4	0	0	4
1990	4	4	2		0		1		5	0	1	6
1991	6	3	2		*0		3		7	0	3	9
1992	1	1	0		0		0		2	0	0	2
1993	5	2	0		1		0		5	1	0	5
1994	2	0		<sup>a</sup> 0	0		0		2	0	0	2
1995	5	5		3		2	0		6	2	0	6
1996	0	0		0		0	0		0	0	0	0
1997	4	1		2		1	3	1	4	1	3	7
1998	2	1		1		3	1	0	3	3	1	6
1999	2	2		4		1	0	0	4	1	0	4
2000	1	1		1		2	0	0	1	2	0	3
2001	0	0		0		1	1	0	0	1	1	2
2002	1	2		3		0	0	0	3	0	0	2
2003	0	0		1		1	2	0	1	1	2	2
2004	0	0		0		0	0	0	0	0	0	0
2005	2	0		0		0	0	0	2	0	0	2
2006	0	0		0		0	0	0	0	0	0	0

\* No data May 22 - July 22, 1991

<sup>a</sup> Site became operational 8/1/94

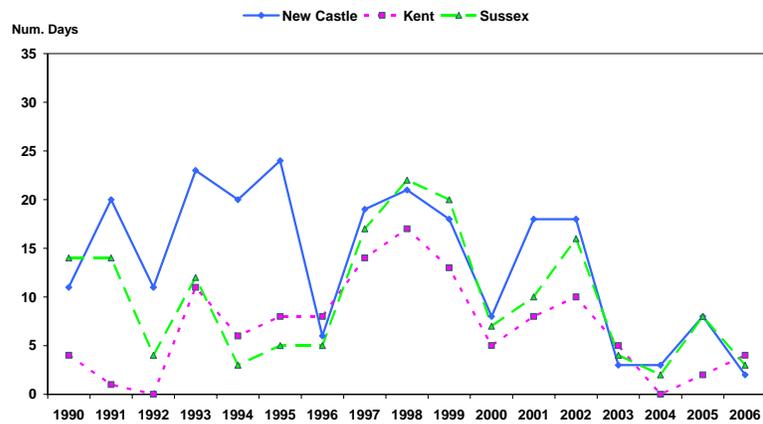
ND = no data



## *Eight-hour Ozone Data and Trends*

There were six days in Delaware that exceeded the 8-hour standard. There were two days in New Castle County, four days in Kent County, and three days in Sussex County. As with the 1-hour exceedances, weather plays a major role and makes it difficult to determine pollutant trends; however, 2003 and 2004 represent two consecutive years with relatively few days exceeding the 8-hour standard in New Castle County. Although there was a slight increase in the number of days with exceedances in 2005, 2006 continues to show an overall improving trend in air quality.

### Number of Days Exceeding Ozone 8-hr NAAQS





### 2006 Eight-hour Averages Exceedances and Maximum (ppm)

Site	Num. Exc.	1st Max.	2nd Max.	3rd Max.	4th Max.
Brandywine	2	0.093	0.090	0.081	0.081
Bellefonte	1	0.088	0.084	0.082	0.082
Summit Bridge	2	0.095	0.089	0.084	0.081
Felton	4	0.089	0.088	0.086	0.085
Seaford	1	0.089	0.083	0.083	0.082
Lewes	3	0.088	0.087	0.085	0.080

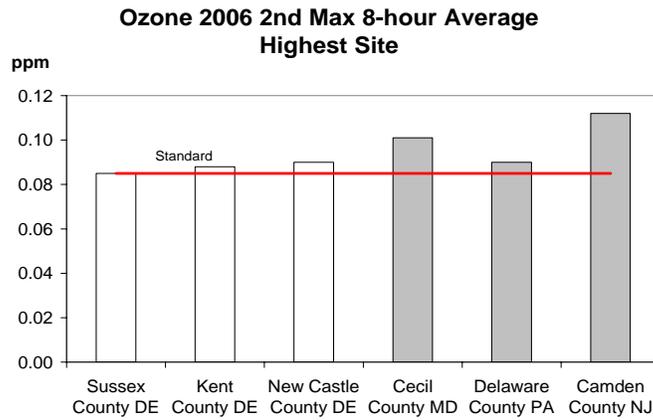
Num. Exceedances = Number of days with at least one 8-hour average  $\geq$  0.085 ppm.

### 3-Year Average of 4<sup>th</sup> Daily Max. Eight-hour Avg. NAAQS = 0.08 ppm

Site	1998-2000	1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006
Brandywine	0.096	0.096	0.096	0.093	0.089	0.082	0.082
Bellefonte	0.090	0.092	0.092	0.090	0.086	0.082	0.081
Summit Bridge	0.097	0.097	0.097	0.093	0.084	0.080	0.078
Felton	0.097	0.094	0.093	0.089	0.084	0.080	0.080
Seaford	0.098	0.095	0.094	0.091	0.086	0.082	0.080
Lewes	0.095	0.091	0.088	0.088	0.085	0.084	0.082



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





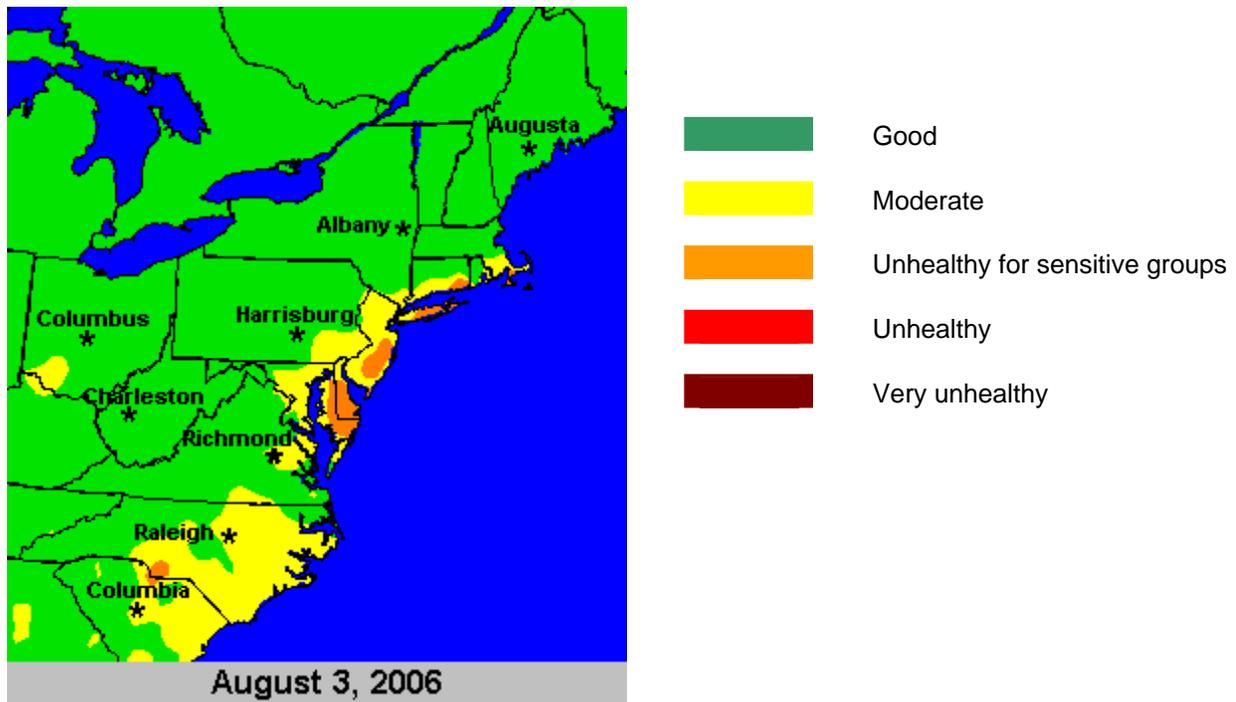
**Ozone Mapping Project**

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://www.epa.gov/airnow>.

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

**Air Quality Index Peak Values - August 3, 2006**



Source: EPA Ozone Mapping Project, AIRNOW website <http://www.epa.gov/airnow/>



## PARTICULATE MATTER - FINE (PM<sub>2.5</sub>)

### Description

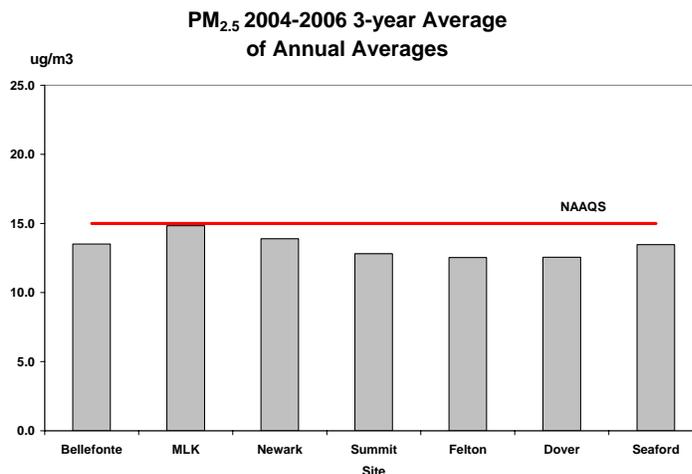
Fine particulate matter is made up of particles smaller than 2.5 microns in diameter. These fine particles, also called PM<sub>2.5</sub>, penetrate more deeply into the lungs than coarse particles (2.5 - 10 microns) and are more likely to contribute to health effects. Health effects of concern associated 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  $\mu\text{g}/\text{m}^3$  averaged over three years  
 24-Hour maximum = 65  $\mu\text{g}/\text{m}^3$  as the 98<sup>th</sup> percentile averaged over three years (A new 24-hour maximum standard of 35  $\mu\text{g}/\text{m}^3$  became effective on December 16, 2006. This new standard will be addressed in 2007 Air Quality Report.

### Sources

Fine particles (PM<sub>2.5</sub>) 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<sub>2.5</sub> can also form in the atmosphere from precursor compounds, such as SO<sub>2</sub> and NO<sub>x</sub>, 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.

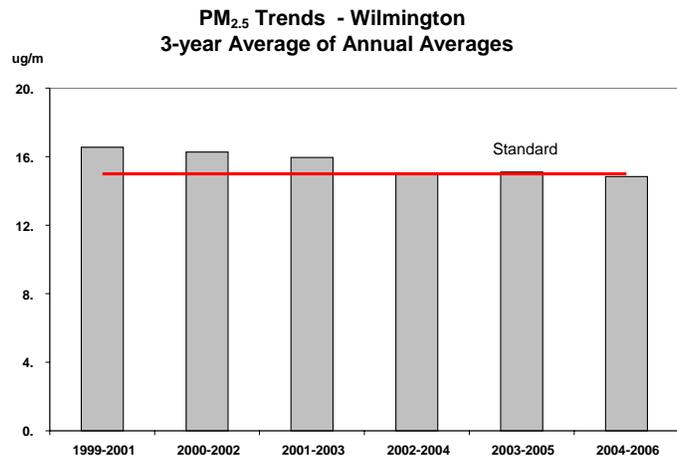
### Delaware Air Quality and Trends

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

New Castle County has been designated non-attainment for PM<sub>2.5</sub> based on the 16.0  $\mu\text{g}/\text{m}^3$  three-



year average of the annual averages for 2001 to 2003 at the urban Wilmington site. For the most recent three-year period (2004 - 2006), the highest average in New Castle County was 14.8 ug/m<sup>3</sup>, which is very close to the PM<sub>2.5</sub> annual standard, while Kent and Sussex counties were below the standard. The 98<sup>th</sup> percentile 24-hour average PM<sub>2.5</sub> standard is met in all three counties; however, this is expected to change with the implementation of the new PM<sub>2.5</sub> 98<sup>th</sup> percentile standard of 35 F g/m<sup>3</sup> in 2007. There will be more information on this in the 2007 Annual Air Quality Report.



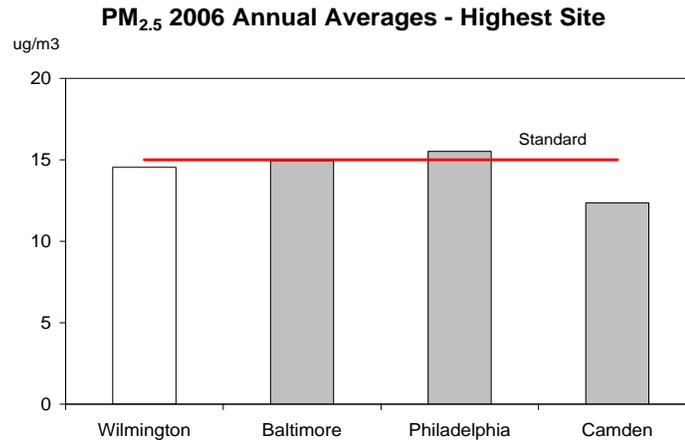
The highest concentrations continue to be at the urban Wilmington MLK site; however, there is significant correlation between all sites. For example, if high concentrations of PM<sub>2.5</sub> are recorded at one site, all other sites also record high concentrations on that day. Both local and regional sources of fine particulate matter and its precursors (a substance that is the source of another substance) contribute to concentrations seen in Delaware. Overall, there is a decreasing trend in the annual average concentrations at all sites.

**Delaware 2004 - 2006 PM<sub>2.5</sub> Data Summary**

Site	3-year Average of Annual Averages NAAQS = 15F g/m <sup>3</sup>	3-year Average of 98 <sup>th</sup> Percentiles NAAQS = 65F g/m <sup>3</sup>
Felton	12.6	32
Dover	12.5	31
Bellefonte	13.5	33
Summit Bridge	12.8	32
Wilmington MLK	14.8	36
Newark	13.9	32
Seaford	13.5	34



**How does Delaware's air quality compare to nearby areas?**  
Air quality in Delaware is similar to nearby areas.





## AIR QUALITY - POLLUTANTS THAT MEET STANDARDS: CO, NO<sub>2</sub>, PM<sub>10</sub>, SO<sub>2</sub>, 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 F g/m<sup>3</sup>)  
                           1-hour average = 35 ppm (40 F g/m<sup>3</sup>)  
                           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.

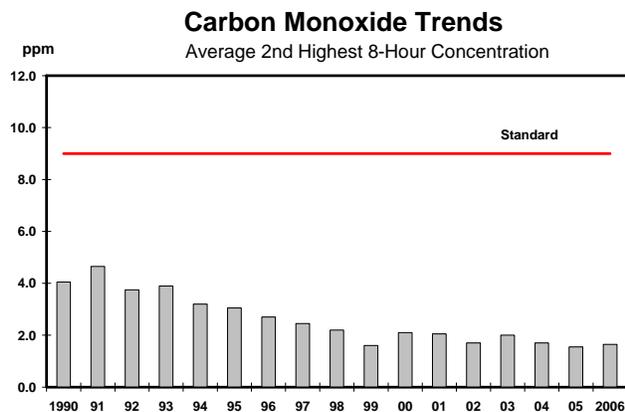
#### Locations

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 2006.



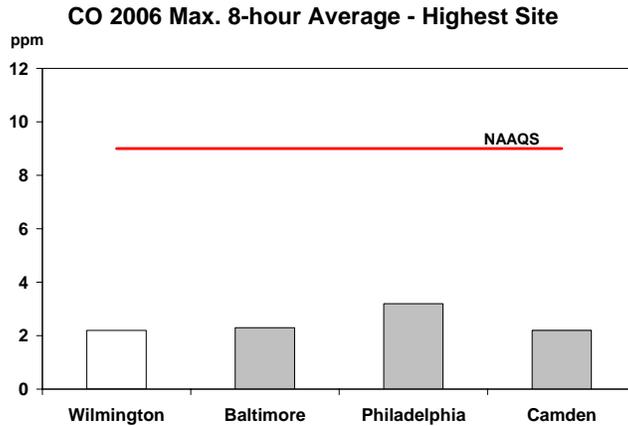


**Delaware Carbon Monoxide (CO) 2006 Max. Values**  
ppm

Site	1-Hour Avg. NAAQS = 35 ppm		8-Hour Avg. NAAQS = 9 ppm	
	1 <sup>st</sup> Max.	2 <sup>nd</sup> Max.	1 <sup>st</sup> Max.	2 <sup>nd</sup> Max.
Wilmington	3.0	2.9	2.2	2.2
Delaware City	1.5	1.4	1.2	1.1

**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 (NO<sub>2</sub>)

### Description

Nitrogen dioxide (NO<sub>2</sub>) is a reddish-brown toxic gas that is part of a group of gases containing nitrogen and oxygen called oxides of nitrogen or NO<sub>x</sub>. 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<sub>x</sub> is their ability to react with volatile organic compounds (VOCs) to form ozone. Air quality computer models have shown that control of NO<sub>x</sub> 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 = 0.053 ppm (100 F g/m<sup>3</sup>)

### Sources

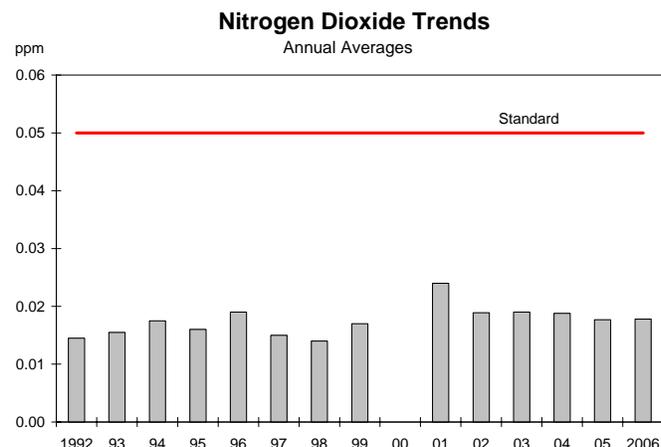
Oxides of nitrogen are produced during high-temperature burning of fuels. Sources of NO<sub>x</sub> include motor vehicles and stationary sources that burn fossil fuels such as power plants and industrial boilers.

### Locations

Since 2001, Delaware has monitored NO<sub>2</sub> 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 2006, levels continued to remain well below the standard.





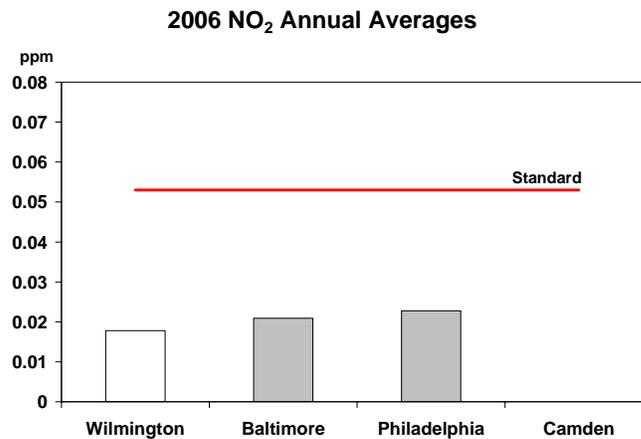
**Delaware Nitrogen Dioxide (NO<sub>2</sub>)**  
Annual Arithmetic Means in ppm

Site	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Wilmington					*	.024	.019	.019	.019	.018	.018
Bellefonte	.019	.018	.016	.017	*						
Summit	*	.012	.012								

\* Insufficient data to calculate annual average.

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

Most NO<sub>2</sub> monitors are located in urban areas. NO<sub>2</sub> concentrations monitored in Delaware are similar to those in nearby areas.





## PARTICULATE MATTER (PM<sub>10</sub>)

### Description

PM<sub>10</sub> 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 PM<sub>10</sub> 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:      Annual arithmetic mean = 50  $\mu\text{g}/\text{m}^3$   
                               24-Hour maximum = 150  $\mu\text{g}/\text{m}^3$  not to be exceeded more than once per year averaged over three years.

### Sources

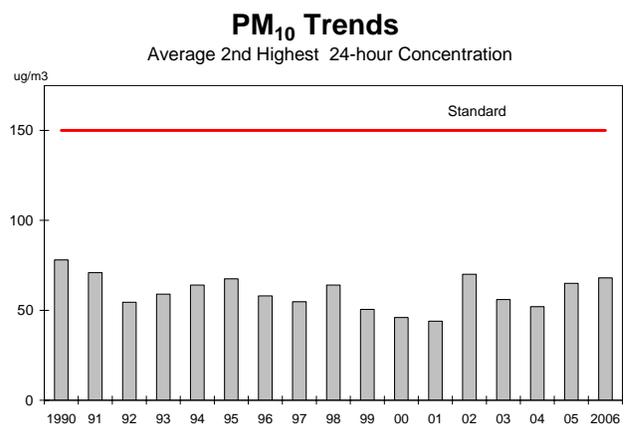
Major sources include steel mills, power plants, motor vehicles, industrial plants, unpaved roads, and agricultural tilling. The wide variety of PM<sub>10</sub> sources means that the chemical and physical composition of the particles are highly variable.

### Locations

Because resources were shifted to support PM<sub>2.5</sub> monitoring, and PM<sub>10</sub> concentrations have been consistently below the standard, PM<sub>10</sub> is currently monitored only at the urban Wilmington site.

### Delaware Air Quality and Trends

Delaware is in attainment with the PM<sub>10</sub> NAAQS. The increases in concentrations in 2005 and 2006 are related to nearby construction and road improvement projects in the Riverfront area.



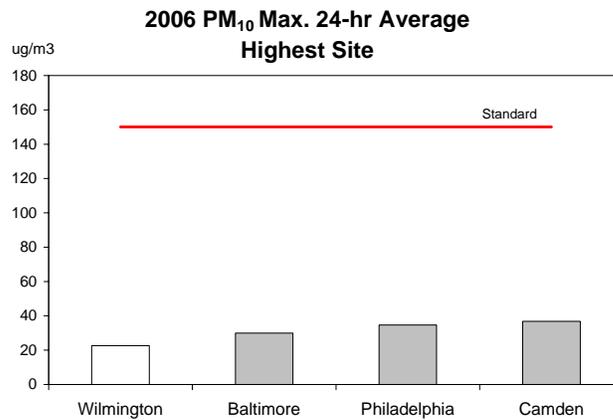


**Delaware PM<sub>10</sub> Trends**  
Annual Average  $\mu\text{g}/\text{m}^3$

Site	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Bellefonte	25.9	25.3	29.0	24.4	24.9						
Wilmington	32.1	31.9	28.4	27.8	26.4	23.0	23.0	20.3	19.8	22.5	22.6
Seaford	24.0	24.4									

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

PM<sub>10</sub> concentrations in Delaware are similar to nearby areas.





## SULFUR DIOXIDE (SO<sub>2</sub>)

### Description

Sulfur dioxide (SO<sub>2</sub>) 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 SO<sub>2</sub> 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 SO<sub>3</sub> 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 F g/m<sup>3</sup>)  
 24-hour average = 0.14 ppm (365 F g/m<sup>3</sup>)

Secondary NAAQS: 3-hour average = 0.5 ppm (1300 F g/m<sup>3</sup>)

### Sources

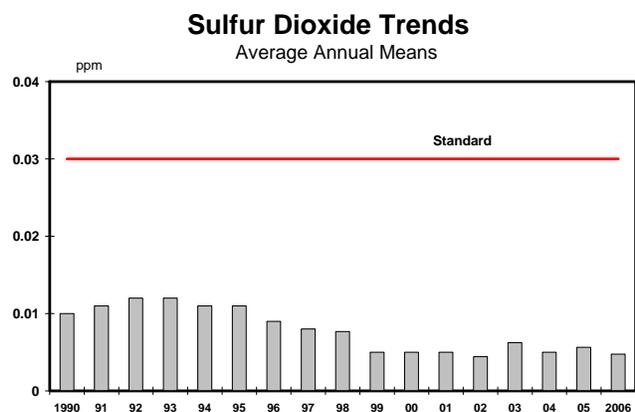
The main sources of SO<sub>2</sub> are combustion of coal and oil (mostly by power plants), refineries, smelters, and industrial boilers. Nationally, two-thirds of all sulfur dioxide emissions are from power plants, and coal-fired plants account for 95% of these emissions.

### Locations

Delaware's SO<sub>2</sub> monitors are located in Wilmington, Bellefonte, Summit Bridge, and Delaware City.

### Delaware Air Quality and Trends

Delaware is in attainment with the NAAQS for SO<sub>2</sub>. Levels declined rapidly in the 1970's due largely to the change to low or lower sulfur fuels in power plants and improved control technologies. 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 2006, SO<sub>2</sub> levels remained well below the standards.

**Delaware Sulfur Dioxide 2006**  
Max. Values ppm

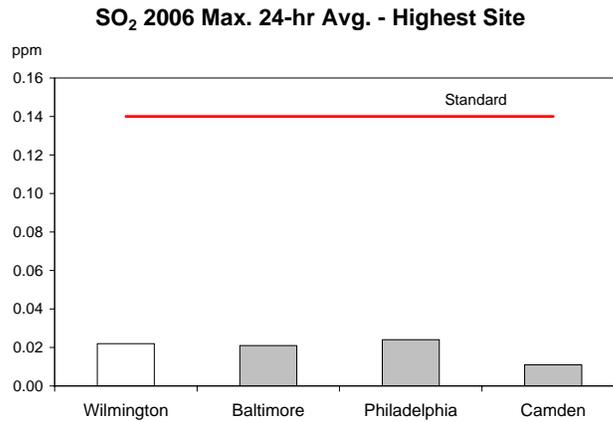
Site	24-Hour Averages NAAQS = 0.14 ppm		3-Hour Averages NAAQS = 0.5 ppm	
	1st Max	2nd Max	1st Max	2nd Max
Bellefonte	0.022	0.019	0.101	0.053
Wilm. - MLK	0.016	0.016	0.039	0.035
Del. City/Rte 9	0.063	0.054	0.158	0.119
Summit Bridge	0.015	0.012	0.040	0.034

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

Site	Year											
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Bellefonte	.008	.008	.007	.007	.005	.007	.005	.004	.007	.005	.007	.005
Wilmington	.012	.011	.008	.008								
Wilm.-MLK					.004	.005	.006	.005	.006	.005	.005	.005
Summit Br.							.003	.003	.004	.004	.004	.003
Del City	.013	.011	.011	.008	.007	.006	.006	.006	.008	.006	.007	.007
Seaford	.008	.008	.006									



**How does Delaware's air quality compare to nearby areas?**  
SO<sub>2</sub> concentrations in Delaware are similar to those in nearby areas.





**LEAD (Pb)** - no monitors currently active in Delaware

### 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

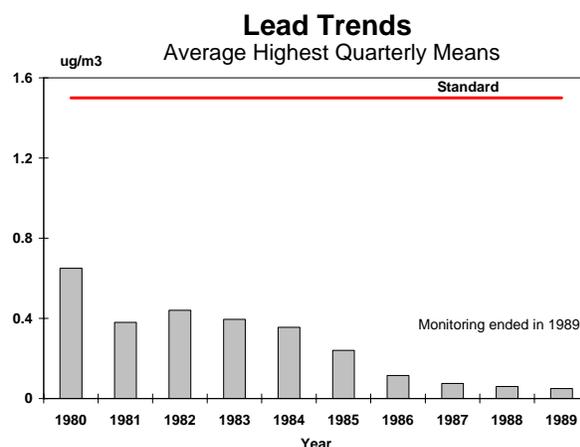
Primary NAAQS: 24-hour average (averaged over one calendar quarter) =  $1.5 \text{ } \mu\text{g}/\text{m}^3$

### Locations

Monitors were formerly located in Claymont and Wilmington.

### Delaware Air Quality and Trends

Delaware is in attainment with the 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.



Special note: Lead is included in the metals analysis performed on PM<sub>2.5</sub> “speciation” samples and total suspended particulate air toxics samples. This data will be addressed in the 2007 Annual Air Quality Report.



## 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. In 2000, the most acidic rain falling in the US had a pH of about 4.3.

#### Sources

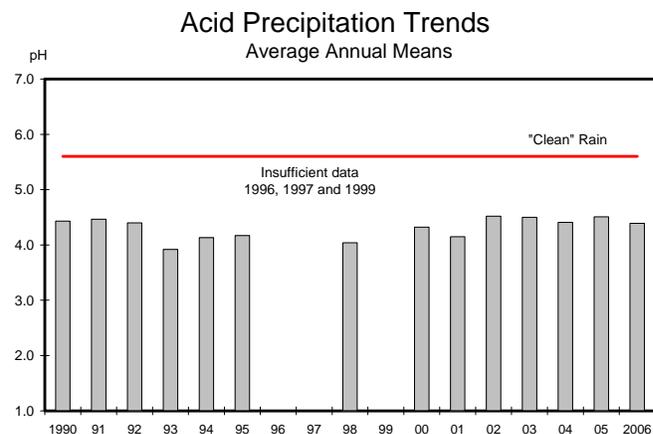
The largest sources of sulfur oxides are coal burning power plants, which are mainly located along the Ohio River valley. These plants are also significant sources of nitrogen oxides, as are motor vehicles. Prevailing winds carry these pollutants to the east and north, resulting in the most acidic precipitation 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 2006, precipitation remained acidic, with an average annual pH of 4.51.





## 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.

### Delaware Air Quality and Trends

Ambient VOC levels are consistently below 10 ppb for all monitored compounds, and most are below 1 ppb. Only VOCs are included in this year's report; carbonyls and metals will be added in the 2007 report.

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.



## 2006 Air Toxics Data in ppb - Wilmington

Compound Name	Average	Minimum	Maximum
Dichlorodifluoromethane	0.51	0.45	0.65
Chloromethane	0.62	0.48	0.86
1,2-Dichloro-1,1,2,2-Tetrafluoroethane	0.02	0.01	0.02
Chloroethene	0.01	0.00	0.05
1,3-Butadiene	0.08	0.00	0.30
Bromomethane	0.03	0.00	0.37
Chloroethane	0.01	0.00	0.07
Trichlorofluoromethane	0.28	0.23	0.33
Acetone	4.92	1.42	21.58
1,1-Dichloroethene	0.00	0.00	0.02
Methylene Chloride	0.17	0.05	2.13
Carbon Disulfide	0.03	0.00	0.26
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.08	0.07	0.10
Trans-1,2-Dichloroethene	0.00	0.00	0.00
1,1-Dichloroethane	0.00	0.00	0.01
2-Methoxy-2-Methyl-Propane	0.53	0.00	5.07
Methyl Ethyl Ketone (2-Butanone)	0.48	0.16	1.20
Cis-1,2-Dichloroethene	0.00	0.00	0.01
Hexane	0.30	0.05	1.42
Chloroform	0.02	0.01	0.06
Ethyl Acetate	0.07	0.00	0.53
Tetrahydrofuran	0.06	0.00	0.67
1,2-Dichloroethane	0.01	0.00	0.02
1,1,1-Trichloroethane	0.02	0.01	0.03
Benzene	0.36	0.13	1.13
Carbon Tetrachloride	0.08	0.06	0.10
Cyclohexane	0.07	0.00	0.34
1,2-Dichloropropane	0.00	0.00	0.01
Bromodichloromethane	0.00	0.00	0.03
Trichloroethene	0.01	0.00	0.03
Heptane	0.12	0.02	0.52
Cis-1,3-Dichloro-1-Propene	0.00	0.00	0.00
Methyl Isobutyl Ketone	0.03	0.00	0.20
Trans-1,3-Dichloro-1-Propene	0.00	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.01
Toluene	0.80	0.15	3.12
Dibromochloromethane	0.00	0.00	0.00
Methyl Butyl Ketone (2-Hexanone)	0.04	0.00	0.16
1,2-Dibromoethane	0.00	0.00	0.00
Tetrachloroethylene	0.07	0.01	0.28

## Air Quality Management

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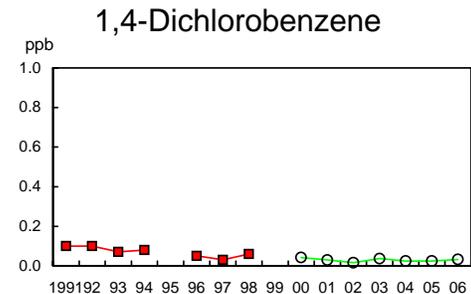
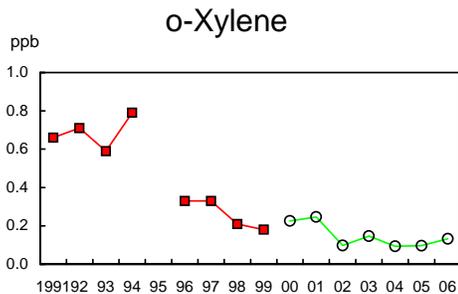
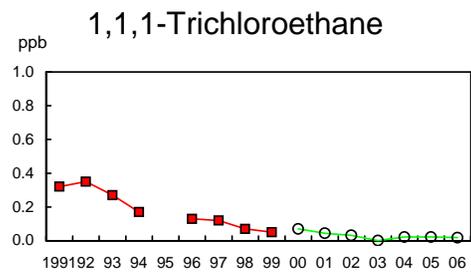
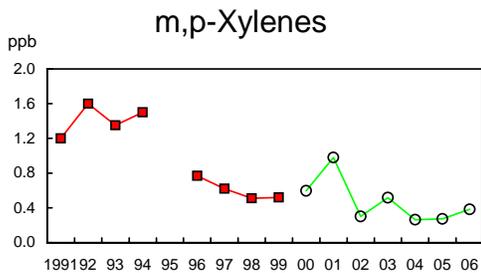
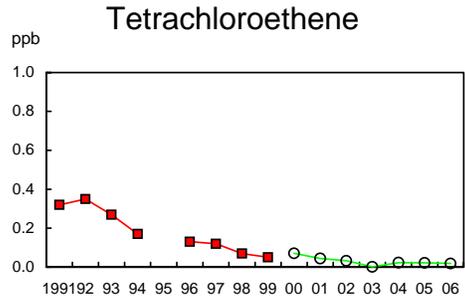
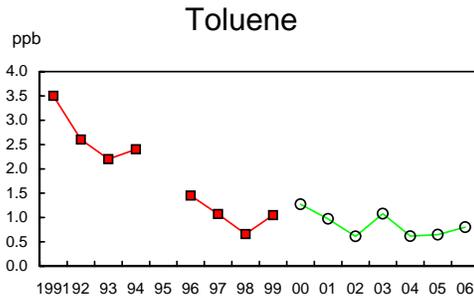
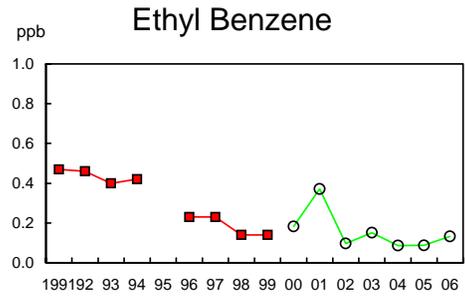
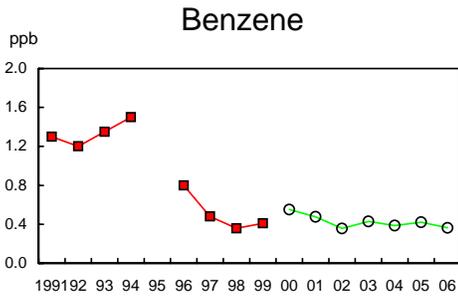


Compound Name	Average	Minimum	Maximum
Chlorobenzene	0.01	0.00	0.01
Ethylbenzene	0.13	0.03	0.61
m & p- Xylene	0.38	0.07	1.70
Bromoform (Tribromomethane)	0.00	0.00	0.01
Styrene	0.03	0.01	0.15
1,1,2,2-Tetrachloroethane	0.00	0.00	0.01
o-Xylene	0.13	0.03	0.52
1-Ethyl-4-Methylbenzene	0.05	0.01	0.19
1,3,5-Trimethylbenzene	0.04	0.01	0.19
1,2,4-Trimethylbenzene	0.14	0.03	0.56
Benzyl Chloride	0.00	0.00	0.05
1,3-dichlorobenzene	0.00	0.00	0.01
1,4-Dichlorobenzene	0.03	0.00	0.10
1,2-Dichlorobenzene	0.00	0.00	0.03
1,2,4-Trichlorobenzene	0.00	0.00	0.01
Hexachloro-1,3-Butadiene	0.00	0.00	0.01



**Wilmington Air Toxics Trends - Annual Averages Selected Compounds**

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





### **The Delaware Air Toxics Assessment Study (DATAS)**

The monitoring for Phase I of DATAS was completed as of June 30, 2005. It includes a full year of measured air toxic concentrations at five locations, a risk assessment of those concentrations, an emission inventory, and a prototype study of modeling performance.

The full report is available at <http://www.awm.delaware.gov/Info/Regs/DATAS.htm>

Currently, the modeling for Phase II of DATAS is projected to be completed in 2007 and the subsequent report will include results of the statewide modeling effort and a risk assessment of the modeled concentrations. Further analysis of the monitoring and inventory data will also be included in the Phase II report.

Whereas the monitored data represent only five sites in Delaware, the air dispersion modeling effort will generate ambient concentrations at a finer resolution throughout Delaware, providing a comprehensive picture of air toxics. In order to have confidence in the model's ability to accurately predict ambient concentrations, the modeling results will be compared to the monitored data. Adjustments to the model assumptions and inputs, including reassessment of the emission inventory, may be necessary based on comparability with the monitored results.

The AQM has proposed a Risk Management Plan (RMP) as part of its Air Toxics Strategic Plan that was submitted to EPA Region III in February 2005. The AQM proposes to establish a stakeholder process to develop (1) action levels based on risk and (2) a process for addressing risks that require action. Depending on the risk drivers and the sources contributing most to the risk, the process will develop a set of solutions, which may include regulatory and/or non-regulatory options to reduce risk. In addition, the results of DATAS will assist the permitting process base its decisions on cumulative impacts. The modeling tool developed through DATAS will be used with future inventories to periodically assess ambient concentrations of air toxics in the future.

### **Enhanced Delaware Air Toxics Assessment Study (E-DATAS)**

Through funding opportunities provided by the National Air Toxics Monitoring Program – Community Assessments, the AQM was able to expand the initial monitoring work that was performed during the 2003 DATAS effort.

During the development, implementation, and conclusion of this enhanced study, AQM strived to better understand the suite of pollutant sources that are impacting the air quality at the Martin Luther King Station (MLK), located in Wilmington, Delaware.

Through collaborative partnerships with University of Delaware and Duke University research



teams, an ambient air monitoring study, defined as the Enhanced Delaware Air Toxics Study (E-DATAS) was conducted at the MLK. The study began in April 2005 and continued through February 2006.

Specifically, E-DATAS was designed to:

- Characterize the seasonal ambient variability of ambient aerosols of aerodynamic diameters of 50, 110, 220, 440, and 770 nm at the MLK site. Real-time measurements were performed during four, one-month intensive efforts using the Rapid Single-particle Mass Spectrometer, version 3 (RSMS-3).
- Implement an approach in which selected industry within a 10-km radius of the MLK could be characterized according to their ambient aerosol contribution. Data obtained during this effort was vital to better identifying a source's contribution to the ambient air composition at the MLK.
- Study the spatial and seasonal variability of target ambient compounds (formaldehyde, chromium species, particulate matter, and ozone) using both research-specific and commercially available technology to perform mobile, real-time ambient measurements within the Wilmington area. These measurements were performed during four, one-week intensive efforts that were coordinated with the aerosol measurements.
- Utilize and integrate into E-DATAS many of the federal- and state-run ambient measurements being performed at the MLK. For this study, particulate, carbon monoxide, nitric oxide, and wind measurements were incorporated into E-DATAS.
- Develop efficient, effective, and long-term partnerships with the research community, which will provide value-added data to enhance AQM' and the public's understanding of the state of Delaware's air quality. E-DATAS clearly signifies the importance of developing these partnerships, as this field application would not have been performed otherwise.

### Project Conclusions

At the conclusion of the E-DATAS field monitoring efforts an enormous dataset was established for ambient aerosol characterization at the MLK with over 500,000 ambient aerosol particles being analyzed with the RSMS-3. Additionally over 61,000 aerosol size distributions were collected via the mobile monitoring effort with 42,426 data points being collected for formaldehyde, and 26,843 data points collected for chromium.

The project conclusions that are summarized below are organized by monitoring activity, (fixed-site aerosol monitoring vs. mobile monitoring)

#### Fixed-Site Aerosol Monitoring

With over 500,000 ambient aerosol particles, data had to be analyzed in clusters of 40,000



particles. Data collected from each of the four monitoring intensives was kept separate from other intensives. For the MLK, data were separated into 16 chemical composition classes: OCANS (organic carbon, ammonium nitrate, ammonium sulfate secondary aerosol), ammonium nitrate, potassium, EOC, amine, sodium, potassium with sodium, iron, iron with cerium/lanthanum, lead, zinc, zinc with lead, tin/antimony, lithium, vanadium, and other metals.

From the analysis of this dataset, AQM has the following understanding of the source contributions at the MLK.

- Air quality at the MLK has a regional characteristic.
- The MLK is impacted by wood and biomass burning. There is a slight bias toward wind directions for the northwest where the greatest nearby residential population exits. There is also a slight bias toward the nighttime, consistent with residential wood burning.
- The MLK is impacted by diesel vehicle exhaust, as indicated by the EOC measurements. The slight enhancement of EOC when the wind is from the east may indicate a contribution from industrial combustion sources. Also, diesel emissions from the nearby DART depot impact the MLK.
- The MLK measurements have signatures from stack emissions where aliphatic amines have been added during the scrubbing process used to remove SO<sub>2</sub> from the effluent.
- Multiple local industrial combustion processes to the east and southwest contribute to the MLK signature.
- Signatures from the Delaware City Refinery, and the Delmarva Edgemoor Power Plant were detected in the ambient air sampled at the MLK.
- CitiSteel emissions impact the MLK. Bag sampling at the CitiSteel site confirm this signature and association.
- Emissions from oil powered boilers impact the MLK. There is a strong time of day preference for these impacts, strongest during the early morning hours, as oil powered boilers are firing at the start of the day.
- Signatures from particles emitted from large ships were measured at the MLK. Wind dependence ( $110^\circ$ ) indicates that the Port of Wilmington impacts the MLK ambient measurements.
- In broad estimates, the Wilmington aerosol is characterized as follows:
  - Secondary aerosol of regional origin constitutes about 38% of PM<sub>1</sub>.
  - Secondary aerosol of local origin constitutes about 27% of PM<sub>1</sub>.
  - Biomass burning contributes about 14% of PM<sub>1</sub>.
  - Primary particulate emissions from vehicular traffic contribute about 8% of PM<sub>1</sub>.
  - Primary particulate emissions from local industrial sources contribute about 13% of PM<sub>1</sub>.

### Mobile Monitoring

Through implementation of the Duke University Mobile Laboratory, over 130,000 data points



were measured during the E-DATAS to characterize the spatial, temporal and seasonal variability of water-soluble hexavalent and trivalent chromium, formaldehyde, ozone, and particulate matter.

The analysis of these data indicate the following significant conclusions:

- Aerosol number concentration, chromium IV, and particulate matter less than or equal to 0.27 micron diameter, varied significantly by location.
- The variability in formaldehyde and ozone concentrations during the summer 2005 campaign was lower in comparison to the aerosol concentration. Since both formaldehyde and ozone are either partially or fully produced by photochemistry, this result is expected.
- Only formaldehyde showed a seasonal trend with concentrations being highest during the spring and summer, while the winter campaign had the lowest concentration.
- PM<sub>0.27</sub> shows a seasonal trend similar to that of formaldehyde, but the trend is largely obscured by the strong variability in the data.
- Comparison of the mobile data to the federal- / state-run network indicates:
  - Comparisons with CO and NO<sub>x</sub> concentrations measured at the central site do not correlate well with the mobile results for formaldehyde, PM<sub>0.27</sub>, or chromium IV.
  - Both formaldehyde and PM<sub>0.27</sub> correlate well with the PM<sub>10</sub> and PM<sub>2.5</sub> measured at the central site. This suggests that PM<sub>0.27</sub> and formaldehyde are influenced by long-range sources.
  - Formaldehyde and PM<sub>0.27</sub> show a positive correlation with temperature, suggesting the photochemical activity.



### III. SOURCES OF POLLUTION

#### OZONE

##### EMISSIONS INVENTORY

In 1997, the U.S. Environmental Protection Agency (EPA) promulgated a revised National Ambient Air Quality Standard (NAAQS) for ground-level ozone at a concentration of 0.08 ppm averaged over eight hours. The new standard went into effect on June 15, 2004 and supersedes the 1-hour ozone standard of 0.12 ppm. All three of Delaware's counties (Kent, New Castle, and Sussex) have been designated non-attainment for the 8-hour standard based on 2000-2002 monitoring data. All three counties are included in the Philadelphia-Wilmington-Atlantic City non-attainment area which is listed as a "moderate" area with an attainment date of June 15, 2010.

EPA established calendar year 2002 as the base year inventory for the new 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 (NOx), and carbon monoxide (CO).

##### What is an emissions inventory?

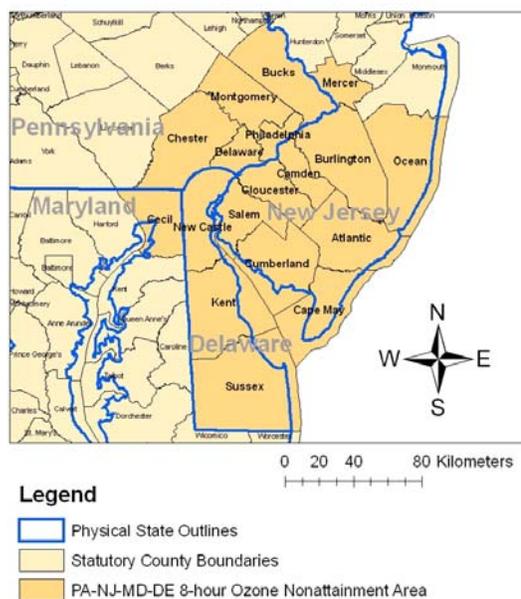
The emission inventory is a tool used to determine the amount of air pollution released from various air emission sources in a given geographic area. The inventory identifies the source types present in an area, the amount of each pollutant emitted, the types of processes and control devices employed,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

##### How are these inventories used?

**PA-NJ-MD-DE  
8-Hour Ozone Nonattainment Area**





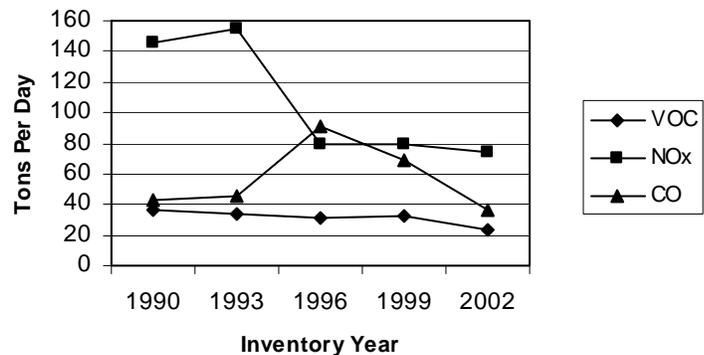
Emission inventories can serve many purposes. They are the basis of overall air quality management planning, and are used in ambient dispersion modeling and analysis, control strategy development, and in screening sources for compliance investigations. Together with ambient monitoring data, inventory 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 2002 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 NOx or CO emissions of 25 TPY or greater. Owners or operators of about 100 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.

Point Source Emissions by Inventory Year



Stationary Non-Point Source Emissions by Inventory Year



**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.

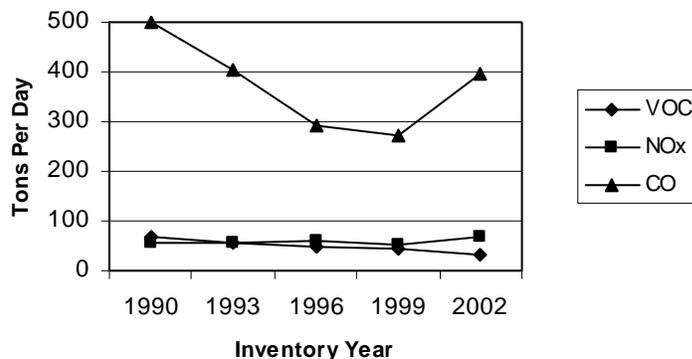
**Mobile sources** are usually divided into two sectors: on-road and off-road.

**On-road mobile sources** consist of automobiles, trucks, motorcycles, and other vehicles traveling on roadways in the nonattainment area. The MOBILE6 model developed by EPA estimates emission rates for VOCs, NO<sub>x</sub>, and CO; these rates combined with vehicle miles traveled, are then used to develop estimates of the quantity of emissions produced by this source. Emissions from the tailpipe of vehicles, as well as emissions due to evaporation of gasoline and other fluids, are estimated.

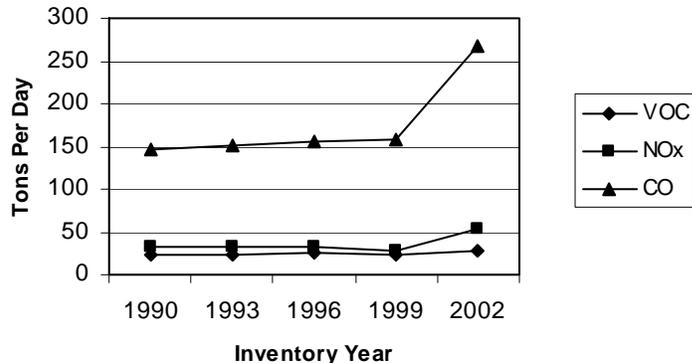
**Off-road mobile sources** include commercial, military, and general aircraft, marine vessels, recreational boats, railroad locomotives, and a very broad subcategory that includes everything from construction equipment, forklifts, and farm tractors to lawn mowers, chain saws, and leaf blowers. Most 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<sub>x</sub> and CO. The BEIS3.12 model is used to estimate the quantity and type of emissions from

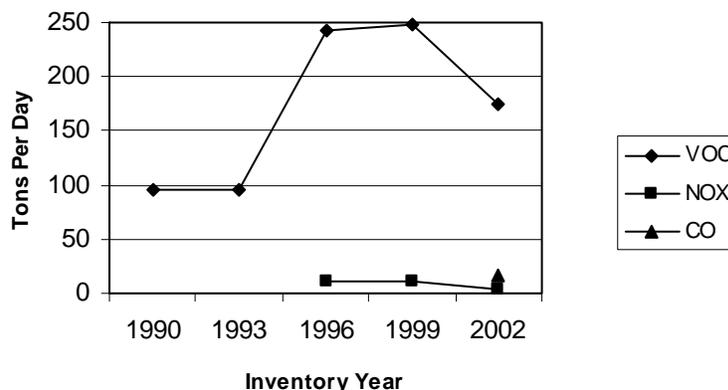
On-road Mobile Source Emissions by Inventory Year



Off-road Mobile Source Emissions by Inventory Year



Natural Source Emissions by Inventory Year



\* Nox Emissions not estimated for 1990 and 1993  
 \* CO Emissions not estimated for 1990 thru 1999



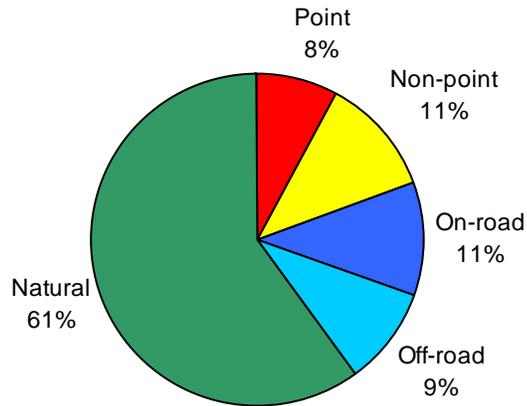
vegetation making use of tools such as satellite imaging to develop county specific land use data. While biogenic sources do emit VOCs into the atmosphere that may contribute to ozone formation, they also remove significant amounts of CO, SO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub>, and PM<sub>10</sub> from the air, and cool the air through shade and transpiration, thus reducing pollution from other sources. Finally, lightning is a source of NO<sub>x</sub>.

2002 Statewide Peak Ozone Season Daily Emissions			
Source Category	Pollutant Emissions (TPD)		
	VOC	NO <sub>x</sub>	CO
Point	23.3	74.1	36.8
Non-point	33.0	3.2	7.2
Mobile on-road	32.4	69.0	396.9
Mobile off-road	26.8	52.8	267.1
Natural	173.9	3.9	16.1

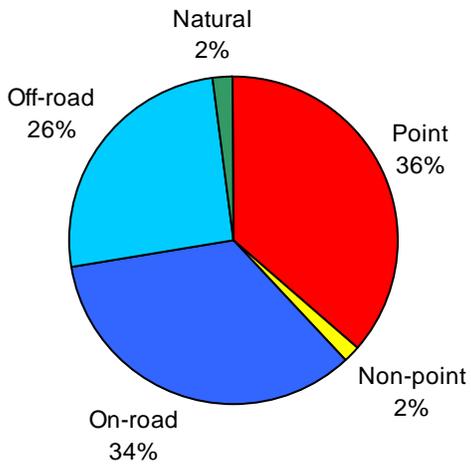


Emissions by Source Category.

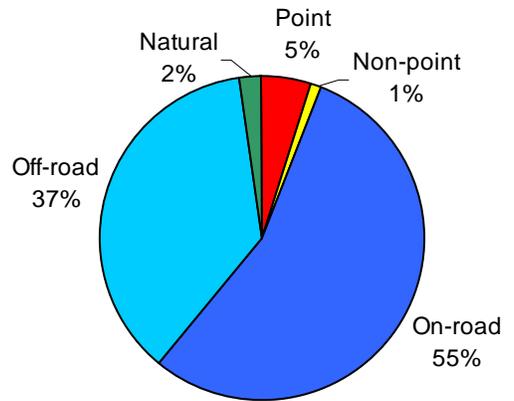
2002 Statewide VOC Emissions by Source Category



2002 Statewide NO<sub>x</sub> Emissions by Source Category



2002 Statewide CO Emissions by Source Category





## **SULFUR DIOXIDE (SO<sub>2</sub>) AND PARTICULATE MATTER (PM<sub>10</sub> and PM<sub>2.5</sub>)**

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<sub>2.5</sub>, which designates particles with a diameter of 2.5 microns or less. PM<sub>10</sub> defines particles with a diameter of 10 microns or less, and thus includes PM<sub>2.5</sub> 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<sub>2.5</sub>, 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 (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), ammonia, and certain organic and inorganic compounds. Since NO<sub>x</sub> and VOCs are already inventoried due to their contribution to ground-level ozone formation, the inventory program only adds SO<sub>2</sub> and ammonia to its list of pollutants to be inventoried from all sources.

The majority of PM<sub>10</sub> 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<sub>2.5</sub> is significantly different, with the vast majority of emissions being secondary emissions. Sulfates and nitrates, which are secondary compounds of PM<sub>2.5</sub>, are expected to comprise almost two-thirds of the total inventory. Roughly one-third of the PM<sub>2.5</sub> 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 SO<sub>2</sub> emission sources. Motor vehicle fuel combustion is also a significant source of SO<sub>2</sub>, although on a much smaller scale than stationary source fuel combustion.



### **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 Air Quality Management Section 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.

For the first time, the EID Program developed a comprehensive air toxics inventory for 2002 in support of the Delaware Air Toxics Assessment Study (see page 36). 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<sub>x</sub> 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 Statistic 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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 3 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<sub>x</sub> 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<sub>x</sub>, 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<sub>x</sub>, 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<sub>x</sub> reductions through implementing controls over a variety of NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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 (SO<sub>2</sub>) 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.awm.delaware.gov/AirQuality.htm>.



## 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 in the sample cell.

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

Nitrogen oxides are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone (O<sub>3</sub>). 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 NO<sub>2</sub>. 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 (NO<sub>2</sub>) must be measured indirectly. Total nitrogen oxides (NO<sub>x</sub>) are measured by passing the air through a converter where any NO<sub>2</sub> 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<sub>x</sub>. The NO<sub>2</sub> concentration is equal to the difference between NO and NO<sub>x</sub>.

### Ozone (O<sub>3</sub>)

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). Monitoring continues at Bellefonte and Summit Bridge year-round.

### Particulate Matter - Fine (PM<sub>2.5</sub>)

PM<sub>2.5</sub> 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 Teflon® 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 (PM<sub>10</sub>)

PM<sub>10</sub> 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 (SO<sub>2</sub>)**

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 SO<sub>2</sub> 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 WWW Addresses

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### **Some Air Quality Related World Wide Web Sites**

AIRSDATA - Access to national and state air pollution concentrations and emissions data  
[www.epa.gov/air/data/index.html](http://www.epa.gov/air/data/index.html)

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

Delaware State Climatologist  
[www.udel.edu/leathers/stclim.html](http://www.udel.edu/leathers/stclim.html)

Delaware Valley Regional Planning Commission (daily ozone forecasts)  
<http://www.dvrpc.org/AQPartnership/index.htm>

Mid-Atlantic/Northeast Visibility Union - Regional Planning for Improved Visibility  
[www.manevu.org](http://www.manevu.org)

State of Delaware Air Quality Management Section current hourly monitoring data  
[www.dnrec.state.de.us/air/aqm\\_page/airmont/air.asp](http://www.dnrec.state.de.us/air/aqm_page/airmont/air.asp)

US National Oceanic and Atmospheric Administration, Environmental Research Laboratories,  
[www.arl.noaa.gov](http://www.arl.noaa.gov)

USEPA Emission Factor and Inventory Group  
[www.epa.gov/ttn/chief](http://www.epa.gov/ttn/chief)

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  
[www.epa.gov/airnow/](http://www.epa.gov/airnow/)

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

USEPA Region III Air Protection Division  
[www.epa.gov/reg3artd](http://www.epa.gov/reg3artd)

USEPA Technology Transfer Network (TTN Web)  
[www.epa.gov/ttn](http://www.epa.gov/ttn)



### LIST OF CONTACTS

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Program Manager	David Fees
Point Sources	John Outten
Stationary Area Sources	David Fees
Mobile Sources	David Fees
(on- and off-road)	
State Implementation Plan (SIP) - Regulations and Planning	
Program Manager	Ron Amirikian
Ozone SIP Development	Frank Gao
PM <sub>2.5</sub> SIP Development	Jack Sipple
Mobile Source Controls	Phillip Wheeler