

# Delaware Ambient Air Monitoring Network Description



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## Introduction

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

Seven pollutants currently have NAAQS: ozone (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.

## Requirements for Monitoring Network Descriptions

In October 2006, the U.S. EPA issued final regulations concerning state and local agency ambient air monitoring networks. These regulations require periodic assessments of the monitoring networks including the information described below.

§58.10 Annual monitoring network plan and periodic network assessment.

(b) The annual monitoring network plan must contain the following information for each existing and proposed site:

- (1) The Air Quality System (AQS) site identification number.
- (2) The location, including street address and geographical coordinates.
- (3) The sampling and analysis method(s) for each measured parameter.
- (4) The operating schedules for each monitor.
- (5) Any proposals to remove or move a monitoring station within a period of 18 months following plan submittal.
- (6) The monitoring objective and spatial scale of representativeness for each monitor.
- (7) The identification of any sites that are suitable and sites that are not suitable for comparison against the annual PM<sub>2.5</sub> NAAQS as described in §58.30.
- (8) The Metropolitan Statistical Area (MSA), Core Based Statistical Area (CBSA), Combined Statistical Area (CSA) or other area represented by the monitor.

## 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 this document. 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.

## General Information

The following tables include information required as part of the monitoring network description. Table 1 includes sites specific information, Table 2 includes information for each parameter monitored at a specific site, and Table 3 contains information on specific method codes for AQS.

Table 1. Delaware Monitoring Sites - General Information

Site Name & AQS ID	Address Lat/Long	Land Use	Setting	Nearest St	Traffic Count	Count Year	Metropolitan Statistical Area
Killens Pond 10-001-0002	State Rd 384, Killens Pond Rd +38:59:05, -75:33:20	Agricultural	Rural	Rte 384	3175	1994	NA
Dover 10-001-0003	E. Water St. +39:09:18, -75:31:05	Residential	Suburban	Water St.	6861	2000	Dover
Brandywine 10-003-1010	Brandywine Creek St. Park +39:49:02, -75:33:50	Agricultural	Rural	Thompson Bridge Rd.	6272	2000	Philadelphia - Wilm.
Bellefonte2 10-003-1013	Bellevue St. Park +39:46:26, -75:29:47	Residential	Suburban	Philadelphia Pike, US13b	14053	2001	Philadelphia - Wilm.
Bellefonte 10-003-1003	River Rd. Park +39:45:40, -75:29:31	Residential	Suburban	Gov. Printz Blvd, US13	10729	2004	Philadelphia - Wilm.
MLK 10-003-2004	Justison St. & MLK Blvd, Wilm. +39:44:22, -75:33:29	Commercial	Urban	MLK Blvd	28046	1995	Philadelphia - Wilm.
Newark 10-003-1012	UD North Campus +39:41:31, -75:45:42	Residential	Suburban	New London Rd, Rte 896	18566	2001	Philadelphia - Wilm.
Lums Pond 10-003-1007	Lums Pond State Park +39:33:04, -75:43:51	Agricultural	Rural	Red Lion Rd	4551	2004	Philadelphia - Wilm.
Delaware City 10-003-1008	Rte 9, Delaware City +39:34:40, -75:36:40	Agricultural	Rural	Rte 9	7657	2001	NA
Seaford 10-005-1002	450 Virginia Ave, Seaford +38:38:40, -75:36:47	Residential	Suburban	Virginia Ave	1827	1996	Seaford - Micropolitan
Lewes 10-005-1003	Univ. Delaware campus +38:46:45, -75:09:47	Agricultural	Rural	unamed	NA	NA	NA

Table 2. Delaware Monitoring Sites – Parameter Information

Site Name & AQS ID	Parameter	Start Date	Probe Ht	Scale of Rep	Objective	Comments
Killens Pond 10-001-0002	Ozone - seasonal	4/1/1995	4m	Neighborhood	General/Background	
	PM2.5	1/1/1999	4m	Neighborhood	General/Background	
	WS/WD	4/1/1995		N/A		
Dover 10-001-0003	PM2.5	1/1/1999	2m	Neighborhood	Population Exposure	
	PM2.5 speciation	6/1/2001	2m	N/A		
Brandywine 10-003-1010	Ozone - seasonal	7/1/1994	4m	Neighborhood	Population Exposure	Secondary downwind of Wilm.
Bellefonte2 10-003-1013	Ozone	4/1/2001	4m	Neighborhood	Population Exposure	Primary downwind of Wilm.
	SO2	3/1/2003	4m	Neighborhood		
Bellefonte 10-003-1003	PM2.5	1/1/1999	2m	Neighborhood	Population Exposure	
MLK 10-003-2004	SO2	1/1/1999	4m	Neighborhood		Urban site
	CO	1/1/1999	4m	Middle	Maximum concentration	
	NO2	1/1/2001	4m	Neighborhood	Maximum concentration	
	PM10	1/1/2000	4m	Neighborhood	Maximum concentration	
	PM2.5	1/1/1999	4m	Neighborhood	Maximum concentration	
	PM2.5 speciation	6/1/2001	4m	N/A		
	BC	1/1/2001	4m	N/A		
	VOCs	1/1/1999	4m	N/A		
	Carbonyls	1/1/2003	4m	N/A		
	Metals	1/1/2003	4m	N/A		
	WS/WD	6/1/2000		N/A		
Newark 10-003-1012	PM2.5	12/15/1999	2m	Neighborhood	Population Exposure	
Lums Pond 10-003-1007	Ozone	1/1/1992	4m	Neighborhood	Upwind/Background	
	SO2	3/1/2000	4m	Neighborhood		
	PM2.5	1/1/1999	4m	Neighborhood	Transport/Background	
Delaware City 10-003-1008	SO2	2/1/1992	4m	Neighborhood		Point source dominated site
	CO	1/1/1994	4m	Middle		
	VOCs	1/1/2001	4m	N/A		
	WS/WD			N/A		
Seaford 10-005-1002	Ozone - seasonal	3/1/1990	4m	Neighborhood	Population Exposure	
	PM2.5	1/1/1999	4m	Neighborhood	Population Exposure	
	WS/WD			N/A		
Lewes 10-005-1003	Ozone - seasonal	5/1/1997	4m	Neighborhood	Population Exposure	Coastal site
	WS/WD	6/1/1997		N/A		

All PM<sub>2.5</sub> sites are eligible for comparison to the annual NAAQS of 15 ug/m<sup>3</sup>.  
All sites operate year-round except ozone where noted; Ozone season is April through October.

### Monitoring method information

Table 3. Monitoring methods and associated AQS codes used in the Delaware ambient air monitoring network:

Parameter	AQS Method Code	Method Description
O <sub>3</sub>	047, 091	UV Absorption
SO <sub>2</sub>	092	UV Fluorescence
CO	054	Non-dispersive Infrared
NO <sub>2</sub>	074	Chemiluminescence
PM <sub>2.5</sub>	155	Gravimetric
PM <sub>10</sub>	079	TEOM Gravimetric
WS/WD	050	Ultrasonic

#### 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.

#### 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.

#### 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 ( $\text{NO}_x$ ) are measured by passing the air through a converter where any  $\text{NO}_2$  in the air is reduced to  $\text{NO}$  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  $\text{NO}$  and  $\text{NO}_x$ . The  $\text{NO}_2$  concentration is equal to the difference between  $\text{NO}$  and  $\text{NO}_x$ .

**Particulate Matter - Fine ( $\text{PM}_{2.5}$ )**

$\text{PM}_{2.5}$  is sampled by drawing air through a specially designed inlet that excludes particles larger than 2.5 microns in diameter. The particles are collected on a 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 ( $\text{PM}_{10}$ )**

$\text{PM}_{10}$  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.

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## Specific Pollutant Monitor Descriptions and Requirements

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

#### Monitoring Requirements

Within an O<sub>3</sub> network, at least one O<sub>3</sub> site for each MSA, or CSA if multiple MSAs are involved, must be designed to record the maximum concentration for that particular metropolitan area.

More than one maximum concentration site may be necessary in some areas. The appropriate spatial scales for O<sub>3</sub> sites are neighborhood, urban, and regional. Since O<sub>3</sub> requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring small scale spatial variability.

The prospective maximum concentration monitor site should be selected in a direction from the city that is most likely to observe the highest O<sub>3</sub> concentrations, more specifically, downwind during periods of photochemical activity. Since O<sub>3</sub> levels decrease significantly in the colder parts of the year in many areas, O<sub>3</sub> is required to be monitored only during the “ozone season” as designated in the 40 CFR Part 58 Appendix D, which in Delaware is April 1 through October 31.

#### Delaware Ozone Monitoring Network

##### Sites

- Bellefonte2 – Primary downwind direction from Wilmington
- Brandywine – Secondary downwind direction from Wilmington
- Lums Pond – Transport (from west) and background
- Killens Pond – Background (rural area, no nearby sources)
- Seaford – Population exposure
- Lewes – Population exposure, coastal area

##### 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 O<sub>3</sub>” can travel for miles before chemical reactions in the atmosphere form O<sub>3</sub>.

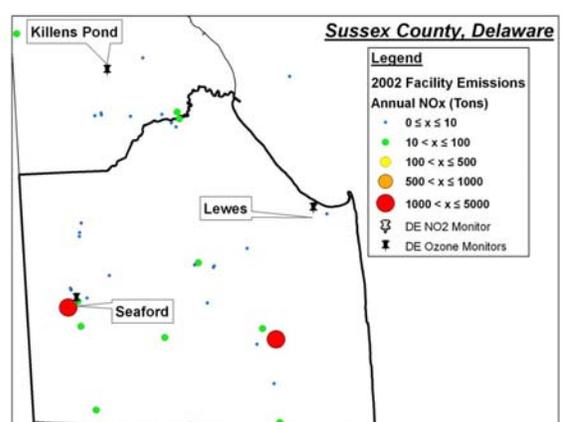
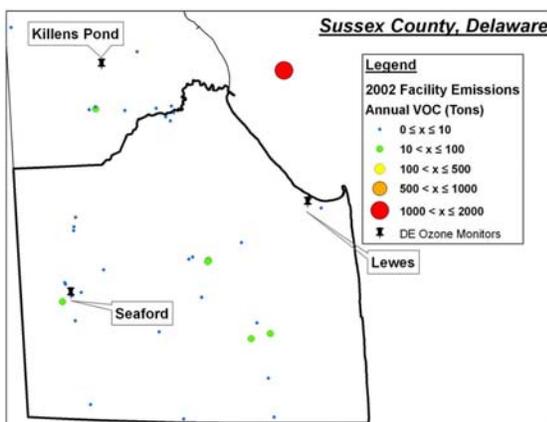
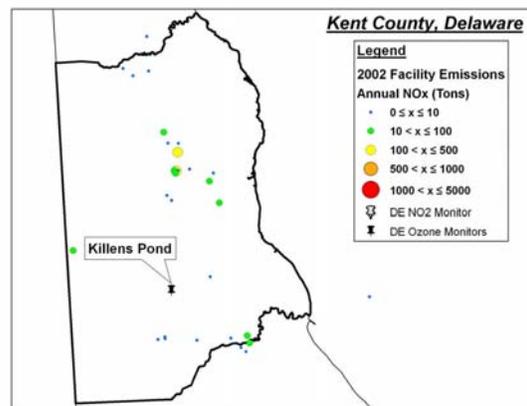
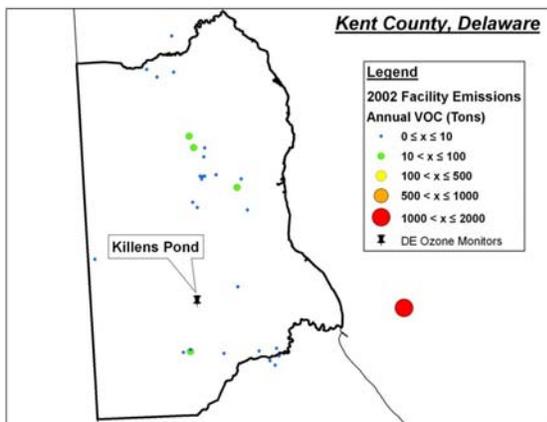
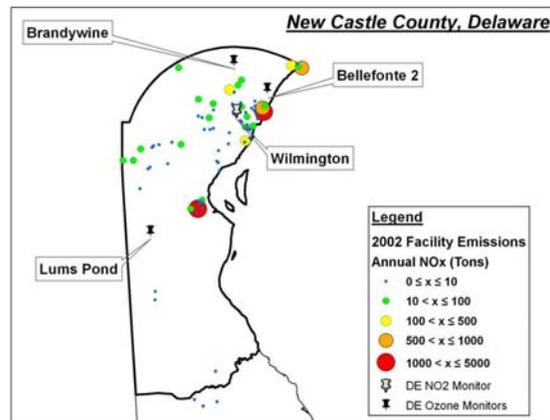
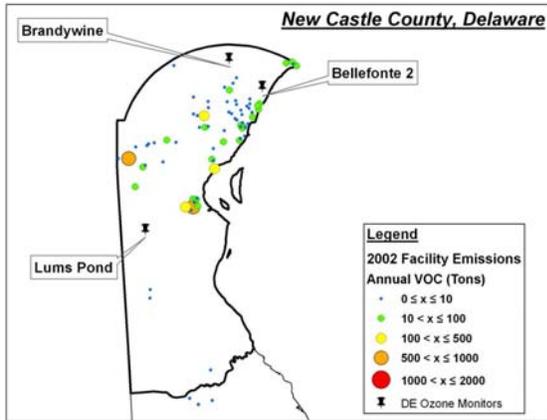
##### Monitor Locations

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 O<sub>3</sub> by NO emissions. Exceedances of the 8-hour O<sub>3</sub> standard occur throughout Delaware.

**Maps of O<sub>3</sub> monitoring sites and major emission (VOC and NO<sub>x</sub>) sources**

VOC Emissions

NO<sub>x</sub> Emissions



**Changes Planned for 2007 - 2008**

There are no changes planned for the number or location of O<sub>3</sub> monitors in Delaware.

**Carbon Monoxide (CO)**

**Monitoring Requirements**

There are no minimum requirements for the number of CO monitoring sites. Continued operation of existing CO sites is required until discontinuation is approved by the EPA Regional Administrator. Where CO monitoring is ongoing, at least one site must be a maximum concentration site for that area under investigation.

**Delaware CO Monitoring Network**

**Sites:**

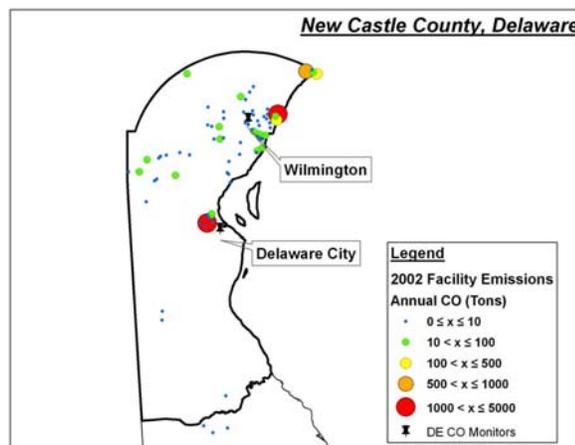
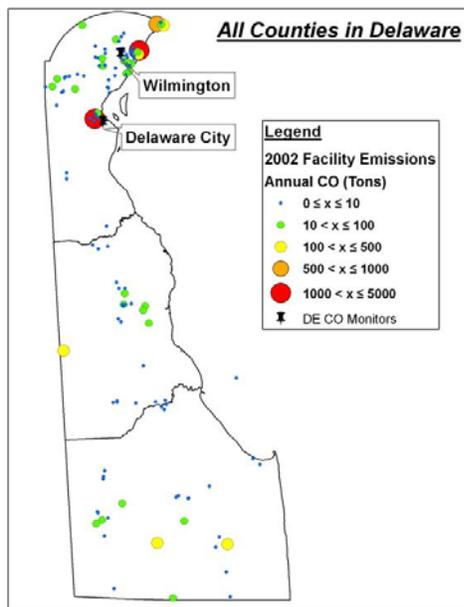
MLK – Mobile sources, middle scale

Delaware City – Downwind from major point source (oil refinery), middle scale

**Sources:**

Carbon monoxide is formed when carbon in fuels is not completely burned. The 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.

**Maps of CO monitoring sites and major CO sources**



**Changes Planned for 2007 - 2008**

There are no changes planned for the number or location of CO monitors in Delaware.

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

### Monitoring Requirements

There are no minimum requirements for the number of NO<sub>2</sub> monitoring sites. Continued operation of existing NO<sub>2</sub> sites using is required until discontinuation is approved by the EPA Regional Administrator. Where NO<sub>2</sub> monitoring is ongoing, at least one NO<sub>2</sub> site in the area must be located to measure the maximum concentration of NO<sub>2</sub>.

### Delaware NO<sub>2</sub> Monitoring Network

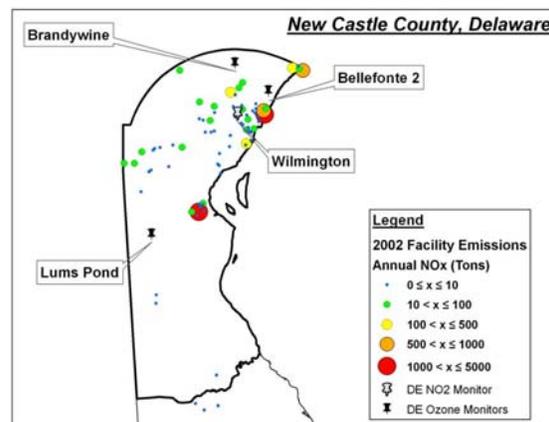
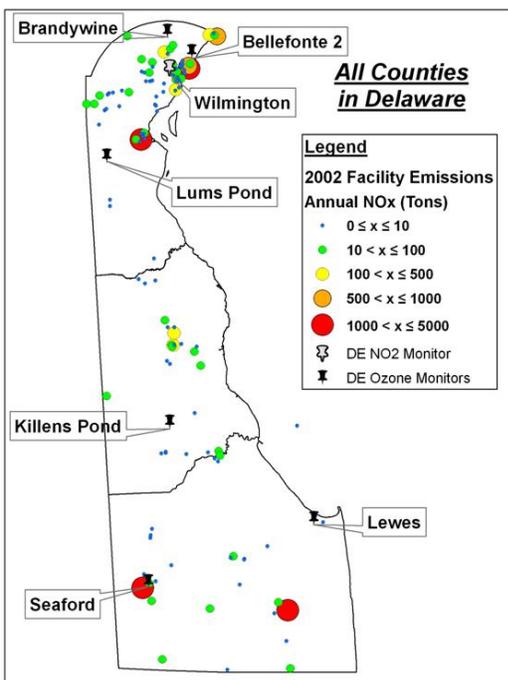
#### Sites

MLK – Maximum concentration

#### 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.

### Map of NO<sub>2</sub> monitoring site and major NO<sub>x</sub> sources.



### Changes Planned for 2007 - 2008

There are no changes planned for the number or location of NO<sub>2</sub> monitors in Delaware.

## Sulfur Dioxide (SO<sub>2</sub>)

### Monitoring Requirements

There are no minimum requirements for the number of SO<sub>2</sub> monitoring sites. Continued operation of existing SO<sub>2</sub> sites is required until discontinuation is approved by the EPA Regional Administrator. Where SO<sub>2</sub> monitoring is ongoing, at least one of the SO<sub>2</sub> sites must be a maximum concentration site for that specific area.

The appropriate spatial scales for SO<sub>2</sub> monitoring are the microscale, middle, and possibly neighborhood scales.

### Delaware SO<sub>2</sub> Monitoring Network

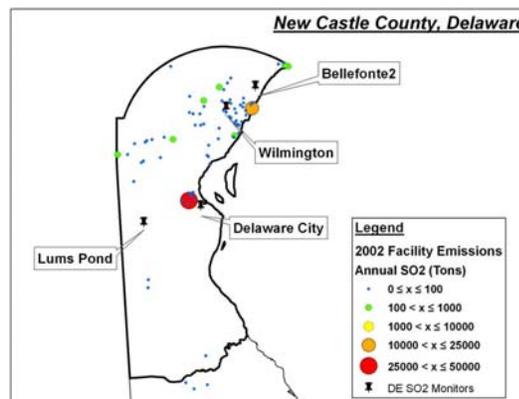
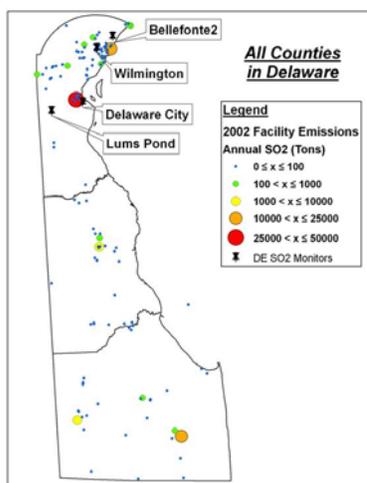
#### Sites:

- MLK – Neighborhood
- Bellefonte2 – Neighborhood
- Lums Pond – Neighborhood
- Delaware City – Neighborhood, stationary point-source impacted

#### 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.

### Maps of SO<sub>2</sub> monitoring sites and major point sources



### Changes Planned for 2007 - 2008

There are no changes planned for the number or location of SO<sub>2</sub> monitors in Delaware.

## Particulate Matter (PM<sub>10</sub>)

### Monitoring Requirements

State, and where applicable local, agencies must operate the minimum number of required PM<sub>10</sub> monitoring sites listed in Table D-4 of 40 CFR Part 58 Appendix D. For Delaware this requires at least one site in the urban Wilmington area.

Although microscale monitoring may be appropriate in some circumstances, the most important spatial scales to effectively characterize the emissions of PM<sub>10</sub> from both mobile and stationary sources are the middle scales and neighborhood scales.

### Delaware PM<sub>10</sub> Monitoring Network

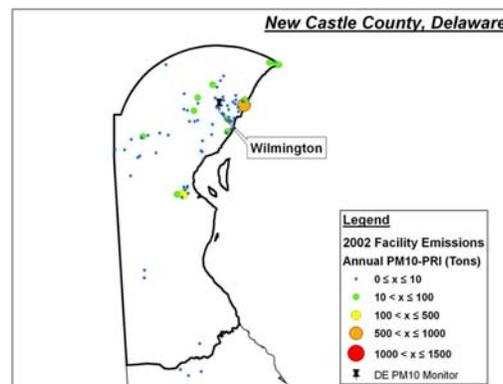
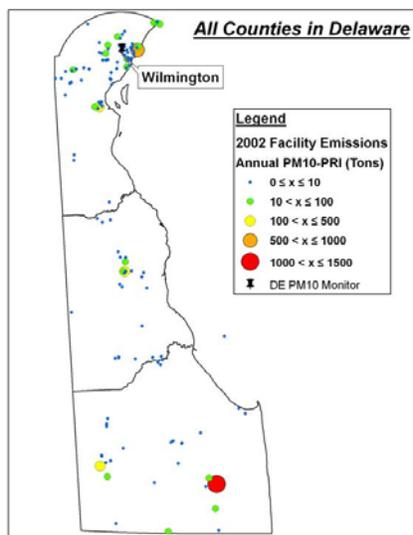
#### Sites

Because resources have been 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 at MLK. The monitoring method used was a Federal Reference Method from 2000-2002, then a continuous Federal Equivalent Method (TEOM) from 2003 to the present.

#### Sources

Major sources of PM<sub>10</sub> 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.

### Maps of PM<sub>10</sub> monitoring sites and major point sources



### Changes Planned for 2007 - 2008

There are no changes planned for the number or location of PM<sub>10</sub> monitors in Delaware.

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

### Monitoring Requirements

State agencies must operate at least the minimum number of required PM<sub>2.5</sub> sites listed in 40 CFR Part 58 Appendix D Table D-5. These required monitoring stations or sites must be sited to represent community-wide air quality. In addition, the following specific criteria also apply:

- (1) At least one monitoring station is to be sited in a population-oriented area of expected maximum concentration.
- (2) For areas with more than one required station, a monitoring station is to be sited in an area of poor air quality.
- (3) Each State shall install and operate at least one PM<sub>2.5</sub> site to monitor for regional background and at least one PM<sub>2.5</sub> site to monitor regional transport.

Delaware is also required to operate continuous fine particulate analyzers at two monitoring sites, and one of those sites must be collocated.

Chemical speciation is encouraged at sites where the chemically resolved data would be useful in developing State implementation plans and supporting atmospheric or health effects related studies. These sites in Delaware are MLK in Wilmington and Dover in Kent County. The PM<sub>2.5</sub> chemical speciation sites include analysis for elements, selected anions and cations, and carbon.

### Delaware PM<sub>2.5</sub> Monitoring Network

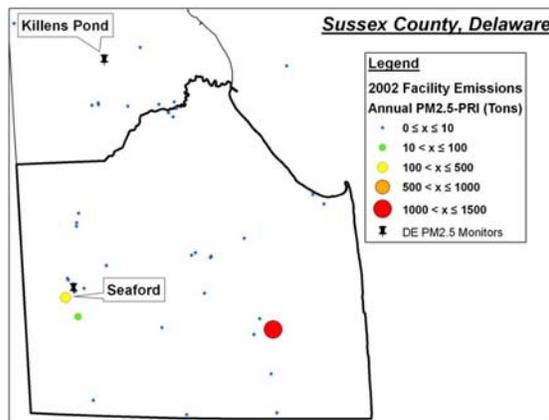
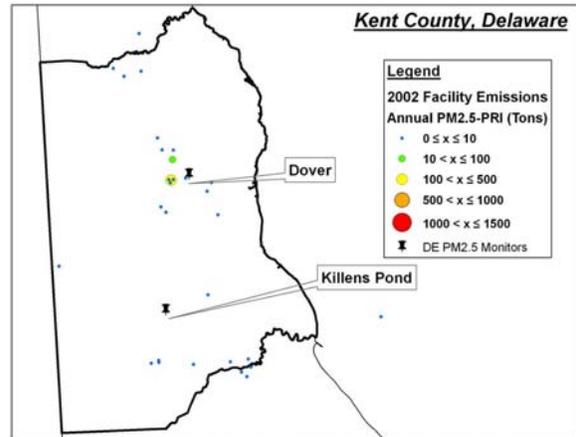
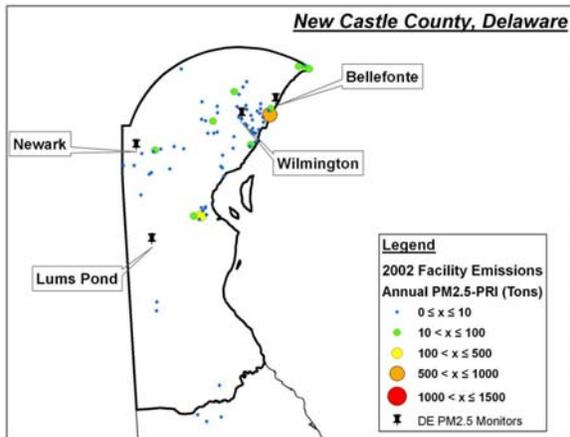
#### Sites:

Bellefonte	- Population
MLK	- Population, Maximum Concentration, Speciation
Newark	- Population
Lums Pond	- Transport, Population
Dover	- Population, Speciation
Killens Pond	- Background
Seaford	- Population

#### 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 through various physical and chemical processes.

**Maps of PM<sub>2.5</sub> monitoring sites and major PM<sub>2.5</sub> sources**



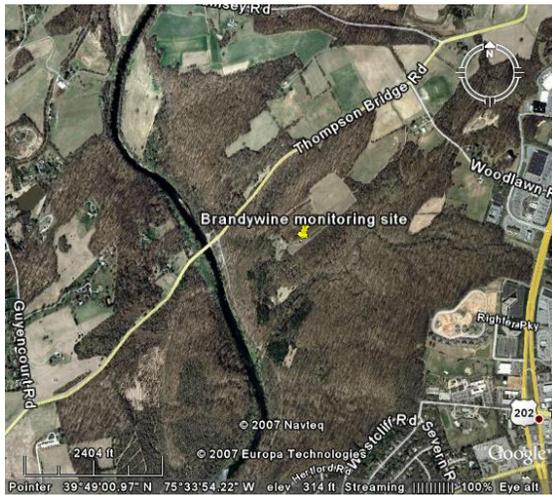
**Changes Planned for 2007 - 2008**

There are no changes planned for the number or location of PM<sub>2.5</sub> monitors in Delaware.

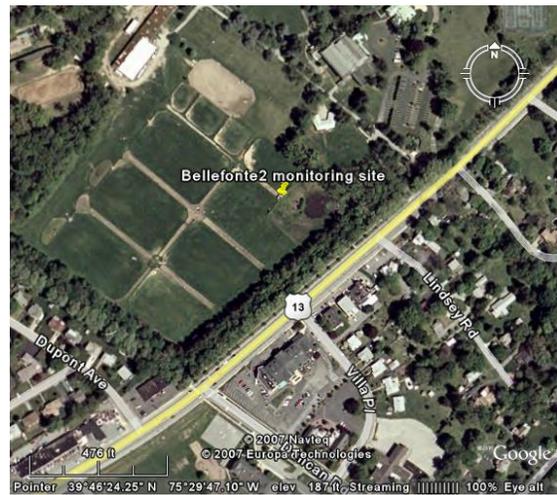
## **Appendix A - Aerial Photographs**

The next section contains aerial photographs of the air monitoring stations in Delaware. Please refer to Tables 1 and 2 for specific information about monitored parameters and areas of representation.

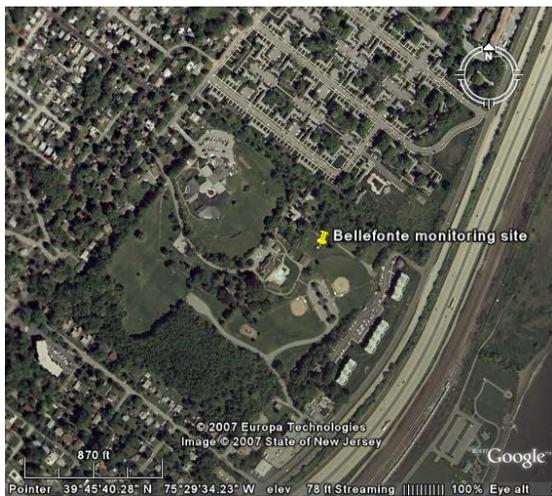
Aerial Photographs of Air Monitoring Sites - New Castle County Monitoring Sites



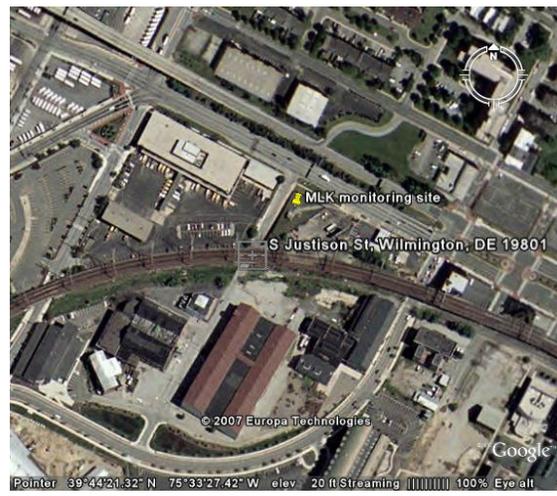
**Brandywine**



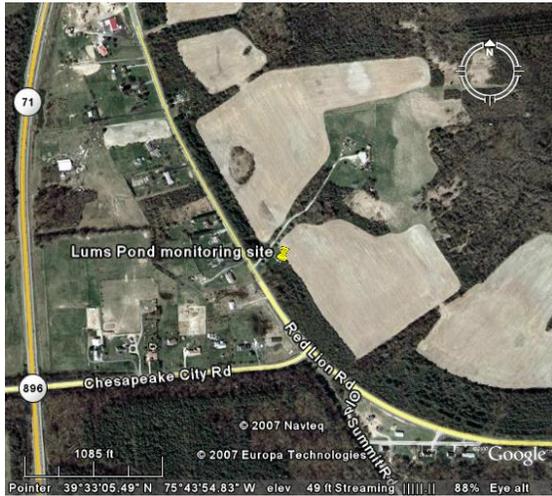
**Bellefonte2**



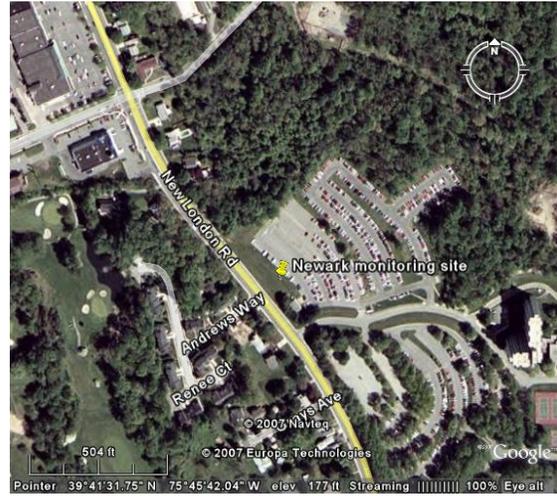
**Bellefonte**



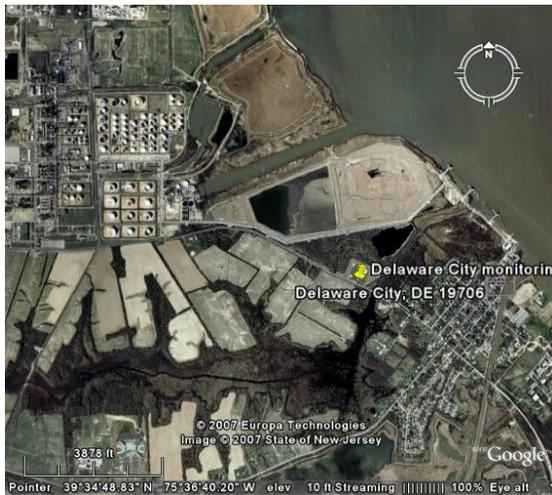
**MLK**



**Lums Pond (Summit)**

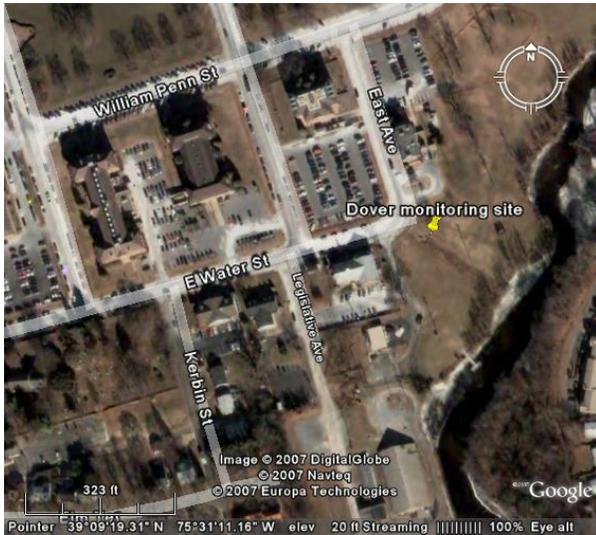


**Newark**



**Delaware City**

Aerial Photographs of Air Monitoring Sites - Kent County monitoring sites

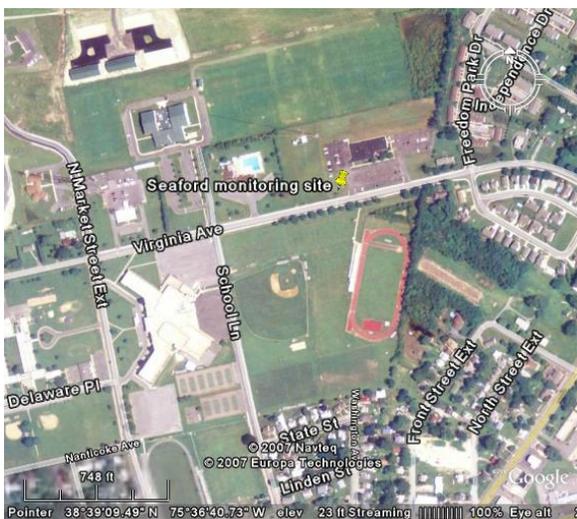


**Dover**



**Killens Pond (Felton)**

Aerial Photographs of Air Monitoring Sites - Sussex county monitoring sites



**Seaford**



**Lewes**