

# Delaware Ambient Air Monitoring Network Description for Criteria Pollutants



Division of Air Quality  
Department of Natural Resources and Environmental Control

715 Grantham Lane  
New Castle, DE 19720  
(302) 323-4542

And

655 S. Bay RD  
Suite 5N  
Dover, DE 19901  
(302) 739-9402

May 20, 2013

**List of Acronyms**

AQS – Air Quality System  
CAA – Clean Air Act  
CFR – Code of Federal Regulations  
CO – carbon monoxide  
CSA – combined statistical area  
DNREC – Department of Natural Resources and Environmental Control  
EPA – Environmental Protection Agency  
FEM – Federal Equivalent Method  
FRM – Federal Reference Method  
MSA – metropolitan statistical area  
NAAQS – National Ambient Air Quality Standards  
NO – nitric oxide  
NO<sub>2</sub> – nitrogen dioxide  
NO<sub>x</sub> – nitrogen oxides  
O<sub>3</sub> – ozone  
Pb - lead  
PM<sub>2.5</sub> – fine particulate matter (2.5 microns)  
PM<sub>10</sub> – respirable particulate matter (10 microns)  
PM<sub>10-2.5</sub> – coarse particulate matter (PM<sub>10</sub> – PM<sub>2.5</sub>)  
SLAMS – state and local monitoring stations  
SO<sub>2</sub> – sulfur dioxide  
SPM – Special Purpose Monitor  
UFP – ultrafine particles  
WS/WD – wind speed/wind direction

- 9) The identification of required NO<sub>2</sub> monitors as either near-road or area-wide sites in accordance with Appendix D to 40 CFR Part 58.

All proposed changes of SLAMS monitors in annual monitoring network plans and periodic network assessments are subject to EPA Regional approval according to 40 CFR Part 58.14

---

existed for several years. The final network plan was submitted to EPA on July 1, 2009 and station was fully operational on January 1, 2011.

The NCore Network addresses the following monitoring objectives:

- timely reporting of data to the public through AIRNow, air quality forecasting, and other public reporting mechanisms
- support development of emission strategies through air quality model evaluation and other observational methods
- accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors
- support long-term health assessments that contribute to ongoing reviews of the National Ambient Air Quality Standards (NAAQS)
- compliance through establishing nonattainment/attainment areas by comparison with the NAAQS
- support multiple disciplines of scientific research, including; public health, atmospheric and ecological

The NCore sites must measure, at a minimum, PM<sub>2.5</sub> particle mass using continuous and integrated/filter-based samplers, speciated PM<sub>2.5</sub>, PM<sub>10-2.5</sub> particle mass, O<sub>3</sub>, SO<sub>2</sub>, CO, NO<sub>2</sub>, NO<sub>y</sub>, lead, wind speed, wind direction, relative humidity, and ambient temperature.

Each State is required to operate at least one NCore site. The objective is to locate sites in broadly representative urban (about 50 sites) and rural or regional (about 20 sites) locations throughout the country to help characterize urban- and regional-scale patterns of air pollution. Monitoring agencies are encouraged by EPA to collocate NCore sites with existing sites already measuring ozone precursors, air toxics, or PM<sub>2.5</sub> speciation components. By combining these monitoring programs at a single location, stakeholders can maximize the multi-pollutant information available. This approach not only leverages existing resources but notably enhances the foundation for future health studies and NAAQS revisions.

In 2009, EPA provided funding to begin the process of establishing an NCore station in Delaware. After evaluating the existing network, historical data, census data, meteorology, and topography, Delaware's proposal for the existing MLK monitoring site as Delaware's NCore site was accepted by EPA.

Delaware's NCore monitoring, including PMcoarse, Ozone, and NO<sub>y</sub>, became operational on January 1, 2011. The lead monitoring began on January 1, 2012.

Site Name & AQS ID	Parameter	Start Date	Scale of Rep	Objective	Comments
Killens Pond 10-001-0002	Ozone	4/1/1995	Neighborhood	General/Background	Rural site
	PM2.5	1/1/1999	Neighborhood	General/Background	
	WSWD	4/1/1995	N/A		
Dover 10-001-0003	PM2.5	1/1/1999	Neighborhood	Population Exposure	
	PM2.5 speciation	6/1/2001	N/A		
Brandywine 10-003-1010	Ozone	7/1/1994	Neighborhood	Population Exposure	Secondary downwind of Wilmington
	<b>NO2</b>	<b>5/1/2013</b>	<b>Neighborhood</b>	<b>Special purpose monitor</b>	
Bellefonte2 10-003-1013	Ozone	4/1/2001	Neighborhood	Population Exposure	Primary downwind of Wilmington
	SO2	3/1/2003	Neighborhood	Population Exposure	
Bellefonte 10-003-1003	PM2.5	1/1/1999	Neighborhood	Population Exposure	
MLK 10-003-2004	SO2	1/1/1999	Neighborhood	Population Exposure	Urban NCore site
	CO	1/1/1999	Middle	Population Exposure	
	NO2	1/1/2001	Neighborhood	Population Exposure/ Maximum Concentration	
	NOy	1/1/2011	Neighborhood	Population Exposure/ NCore	
	Ozone	1/1/2011	Neighborhood	Population Exposure/ NCore	
	PM10	1/1/2000	Neighborhood	Population Exposure/ Maximum Concentration	
	PM2.5	1/1/1999	Neighborhood	Population Exposure/ Maximum Concentration	
	PMcoarse & PM10	1/1/2011	Neighborhood	Population Exposure/ NCore	
	Lead	1/1/2012	Neighborhood	Population Exposure/ NCore	
	PM2.5 speciation	6/1/2001	N/A		
	BC	1/1/2001	N/A		
	VOCs	1/1/1999	N/A		
	Carbonyls	1/1/2003	N/A		
	Metals	1/1/2003	N/A		
WSWD	6/1/2000	N/A			

## Criteria Pollutant Network Description by Parameter

### 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.

#### *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. Other types of monitoring sites are needed to determine maximum population exposure, background concentrations, and concentrations being transported into an area (boundary conditions). 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 for 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. In 2013 the monitoring season will be increased to cover March 1 through October 31 in Delaware.



Delaware operates seven ozone monitoring sites, including sites for population exposure, background concentrations, upwind and downwind directions for the Wilmington area, and NCore monitoring. The monitors began operating year-round in 2011 although the official EPA ozone monitoring season for Delaware runs from April through October. Hourly data is sent to the AirNow website to generate the daily Air Quality Index and to be used in mapping ozone concentrations throughout the region.

#### *Ozone Design Values*

The table below shows the most recent (2010 – 2012) design values for each ozone monitor in Delaware. Ozone design values are calculated by taking the 3-year average of the annual 4th maximum daily maximum 8-hr ozone averages. The 2008 8-hr ozone standard is 0.075 ppm. The most recent design values are shown in the table below.

SO2 design values for 2010 – 2012: 3-year average of 98<sup>th</sup> percentile 1-hour averages

Site	Design Value in ppb
Bellefonte2	18*
MLK NCore	18*
Delaware City	19*
Lums Pond	No complete years

\*Less than 4 complete calendar quarters in one or more year.

**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.

**Monitoring Requirements**

EPA has not established requirements for the minimum 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 operates two CO monitoring sites; monitors operate year-round.

**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. NO<sub>2</sub> must be measured indirectly. NO<sub>x</sub> is 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>.



alternately measures NO and NO<sub>y</sub>. The NO<sub>(Diff)</sub> concentration is equal to the difference between NO and NO<sub>y</sub>.

On January 1, 2011 NO<sub>y</sub> monitoring began at the MLK site as part of the NCore program.

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

The federal reference method (FRM) monitors for PM<sub>2.5</sub> operate 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 7 microfiber filter that is weighed to determine the particulate mass.

Delaware operates PM<sub>2.5</sub> monitors at seven sites throughout the state. All monitors operate year-round. There is one collocated site at MLK in Wilmington. The normal sampling schedule is 24 hours every third day, however, at MLK samples are collected every day.



### **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 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.

### **PM<sub>2.5</sub> Speciation**

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.

### **Continuous PM<sub>2.5</sub>**

Delaware operates a designated FEM continuous PM<sub>2.5</sub> monitor for hourly and 24-hour data at the MLK site. This monitor operates year-round, and is collocated with an FRM PM<sub>2.5</sub> monitor. Continuous PM<sub>2.5</sub> data had formerly been collected at Newark, Killens Pond, and Seaford using different monitoring methodology. The data collected with that instrumentation did not consistently compare well with the FRM data. Consequently, operation of these monitors was temporarily suspended for monitor upgrades and repairs, and has since been re-instated at Killens Pond and Seaford in order to generate data for the daily Air Quality Index in each county.

Site	Annual Design Value $\mu\text{g}/\text{m}^3$	Daily Design Value $\mu\text{g}/\text{m}^3$
Bellefonte	9.6*	23*
MLK – Wilmington	10.4	26
Newark	10.1*	23*
Lums Pond	9.1*	23*
Dover	9.0	23
Killens Pond	8.7*	22*
Seaford	9.0	24
<b>NAAQS</b>	<b>15</b>	<b>35</b>

\*At least one year has less than 75% data completeness.

Currently, all Delaware monitors are measuring attainment for both the annual and daily  $\text{PM}_{2.5}$  standards. However, New Castle County is currently designated nonattainment for the annual and daily standards as part of the Philadelphia nonattainment area.

### Particulate Matter ( $\text{PM}_{10}$ )

$\text{PM}_{10}$  is sampled using the federal reference method (FRM) monitor similar to  $\text{PM}_{2.5}$  that operates by drawing air through a specially designed inlet that excludes particles larger than 10 microns in diameter. The particles are collected on a Teflon<sup>®</sup> microfiber filter that is weighed to determine the particulate mass.

### Monitoring Requirements

State, and where applicable local, agencies must operate the minimum number of required  $\text{PM}_{10}$  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  $\text{PM}_{10}$  from both mobile and stationary sources are the middle scales and neighborhood scales.



Delaware operates one  $\text{PM}_{10}$  monitor at MLK in Wilmington. The same monitor is used to calculate the  $\text{PM}_{\text{coarse}}$  concentrations; therefore the  $\text{PM}_{10}$  data is reported at Local, not Standard, temperature and pressure for consistency with the  $\text{PM}_{2.5}$  collocated data.

**Site: Bellefonte and Bellefonte2**

County:	New Castle	Latitude:	Bellefonte 39.7611 Bellefonte2 39.7739
Address:	Bellefonte: River Road Park Bellefonte2: Bellevue State Park	Longitude:	Bellefonte -75.4919 Bellefonte2 - 75.4964
AQS site ID:	Bellefonte: 10-003-1003 Bellefonte2: 10-003-1013	Year	Bellefonte 1969
Spatial Scale:	Neighborhood	Established:	Bellefonte2 2001
		Area Represented:	Wilmington area



Bellefonte and Bellefonte2 locations



Bellefonte2



**Monitored Parameters**

	Ozone	SO <sub>2</sub>	CO	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>2.5</sub> speciation	PM <sub>2.5</sub> continuous	PM <sub>10</sub>	Wind Speed	Wind Direction
Bellefonte					X					
Bellefonte2	X	X								

**Site Description:** Bellefonte was originally established in 1969 to monitor O<sub>3</sub> and SO<sub>2</sub>. PM<sub>2.5</sub> was added in 1999. When changing site characteristics began to interfere with ozone monitoring, a new site (Bellefonte2) was established in 2001, less than a mile to the north. The O<sub>3</sub> and SO<sub>2</sub> monitors were relocated to the new site, while the PM<sub>2.5</sub> monitor remained at the original site to provide data continuity. Both sites meet all EPA siting criteria.

**Monitoring Objectives:** Both monitoring sites are neighborhood scale, and collect data to determine compliance with the NAAQS, to determine population exposures, and to track trends. Bellefonte2 is the O<sub>3</sub> maximum downwind concentration site for Wilmington. The SO<sub>2</sub> monitor is sited for general population exposure and trends, with major point sources located to the northeast in Marcus Hook, PA and to the south in Edgemoor.

**Planned Changes through 2013:** No changes planned.

**Site: Delaware City**

County:	New Castle	Latitude:	39.5778
Address:	Route 9, Delaware City	Longitude:	-75.6111
AQS site ID:	10-003-1008	Year Established:	1992
Spatial Scale:	Neighborhood	Area Represented:	Delaware City



**Monitored Parameters**

Ozone	SO <sub>2</sub>	CO	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>2.5</sub> speciation	PM <sub>2.5</sub> continuous	PM <sub>10</sub>	Wind Speed	Wind Direction
	X	X				New SPM		X	X

**Site Description:** The Delaware City site was established at a location along Route 9 that is between the Delaware City industrial complex and the nearest populated area (Delaware City) in the predominant downwind direction. This site meets all EPA siting criteria.

**Monitoring Objectives:** This monitoring site is a stationary source-impacted site for SO<sub>2</sub>. The monitoring objectives are compliance with the NAAQS, population exposure, and trends.

**Planned Changes through 2013:** Continuous PM<sub>2.5</sub> SPM monitoring is planned for this site in 2013.

**Site: MLK**

County:	New Castle	Latitude:	39.7394
Address:	Justison St. and MLK Blvd	Longitude:	-75.5581
AQS site ID:	10-003-2004	Year Established:	1999
Spatial Scale:	Neighborhood	Area Represented:	Wilmington



**Monitored Parameters**

Ozone	SO <sub>2</sub>	CO	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>2.5</sub> speciation	PM <sub>2.5</sub> continuous	PM <sub>10</sub>	Wind Speed	Wind Direction	NO/NO <sub>y</sub>	Lead	PM <sub>10-2.5</sub>	Temp & Rel. Hum.
X	X	X	X	X	X	X	X	X	X	X	New	X	X

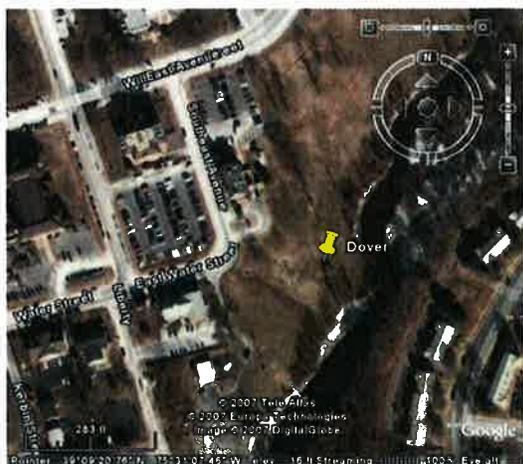
**Site Description:** The MLK site is located in Wilmington at the intersection of Justison St. and MLK Blvd. It replaced another urban site at 12<sup>th</sup> and King Streets that had operated at that location for over 20 years. The MLK site represents urban population exposure to multiple pollution sources. The site meets all EPA siting criteria.

**Monitoring Objectives:** Monitoring objectives are compliance with the NAAQS, maximum population exposure, and trends.

**Planned Changes through 2013:** No changes planned for 2013.

**Site: Dover**

County:	Kent	Latitude:	39.155
Address:	Water St.	Longitude:	-75.5181
AQS site ID:	10-001-0003	Year Established:	1999
Spatial Scale:	Neighborhood	Area Represented:	Dover



**Monitored Parameters**

Ozone	SO <sub>2</sub>	CO	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>2.5</sub> speciation	PM <sub>2.5</sub> continuous	PM <sub>10</sub>	Wind Speed	Wind Direction
				X	X				

**Site Description:** The Dover site is a platform only. It is a neighborhood scale site representative of the Dover area, and is impacted by a combination of source types including mobile, large and small point sources. The site meets all EPA siting criteria.

**Monitoring Objectives:** The monitoring objectives are NAAQS compliance, population exposure, and trends.

**Planned Changes through 2013:** No changes planned.

**Site: Lewes**

County:	Sussex	Latitude:	38.7792
Address:	University of Delaware College of Marine Studies	Longitude:	-75.1631
AQS site ID:	10-005-1003	Year Established:	1997
Spatial Scale:	Neighborhood	Area Represented:	Lewes



**Monitored Parameters**

Ozone	SO <sub>2</sub>	CO	NO <sub>2</sub>	PM <sub>2.5</sub>	PM <sub>2.5</sub> speciation	PM <sub>2.5</sub> continuous	PM <sub>10</sub>	Ultrafine Particles	Wind Speed	Wind Direction
X	New SLAMS		New SPM					New SPM	X	X

**Site Description:** The Lewes site is neighborhood scale. It is near the University of Delaware College of Marine Studies campus in Lewes, and is representative of the coastal Sussex County area. The site meets all EPA siting criteria.

**Monitoring Objectives:** The objectives include NAAQS compliance, population exposure, and trends.

**Planned Changes through 2013:** An expanded SPM project began in 2012 and included the addition of SO<sub>2</sub>, NO<sub>2</sub>/NO<sub>x</sub>, and ultrafine particle monitoring. The SO<sub>2</sub> monitor was designated as SLAMS as of January 1, 2013. No further changes are planned for 2013.

### Monitoring method information

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, 560	UV Fluorescence
CO	054, 554	Non-dispersive Infrared
NO <sub>2</sub> and NO <sub>y</sub>	074, 574	Chemiluminescence
PM <sub>2.5</sub>	155	Gravimetric
PM <sub>10</sub>	127	Gravimetric
PMcoarse	176	Calculated from paired samplers
Lead	811	X-ray fluorescence, low-volume PM10 sampler
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>) and NO<sub>y</sub>

Nitrogen oxides are measured using the chemiluminescence reaction of NO with 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