

Delaware Ambient Air Monitoring Network Description for Criteria Pollutants



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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
NO₂ – nitrogen dioxide
NO_x – nitrogen oxides
O₃ – ozone
Pb - lead
PM_{2.5} – fine particulate matter (2.5 microns)
PM₁₀ – respirable particulate matter (10 microns)
PM_{10-2.5} – coarse particulate matter (PM₁₀ – PM_{2.5})
SLAMS – state and local monitoring stations
SO₂ – sulfur dioxide
SPM – Special Purpose Monitor
UFP – ultrafine particles
WS/WD – wind speed/wind direction

Introduction

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

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

Requirements for Monitoring Network Descriptions

In October 2006, the EPA issued final regulations concerning state and local agency ambient air monitoring networks (see 71 FR 61298). These regulations are codified at 40 CFR Part 58, and require periodic assessments of the monitoring networks including the information described below.

§58.10 Annual monitoring network plan and periodic network assessment, Section §58.10 (a) requires for each existing and proposed monitoring site:

- 1) A statement of purpose for each monitor.
- 2) Evidence that siting and operation of each monitor meets the requirements of appendices A, C, D, and E of 40 CFR Part 58, where applicable.
- 3) Proposals for any State and Local Air Monitoring station (SLAMS) network modifications.

Section §58.10 (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 as defined in Appendix D to 40 CFR Part 58.
- 7) The identification of any sites that are suitable and sites that are not suitable for comparison against the annual PM_{2.5} 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.

- 9) The identification of required NO₂ 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

Delaware Air Monitoring Network

History of air monitoring in Delaware

Air pollution monitoring in Delaware began in the 1950s, prior to the establishment of the US EPA. The first monitors were simple mechanisms or passive collectors such as dust-fall buckets and tape samplers. These were followed in the 1960s by wet-chemistry instruments, which were soon replaced by more advanced electronic instruments. The addition of computer technology in operating monitoring systems and air pollution data collection in the late 1970s and early 1980s was critical to the development of the core monitoring network that exists today.

The earliest monitors were placed near pollution sources to measure direct impact of pollution emissions. As ambient air pollution standards became established and monitoring methods standardized, the monitoring network expanded to include monitors in both urban and suburban areas. Monitoring goals shifted to include measuring high pollution concentrations in population centers, detecting trends, and determining compliance with the new national and state air quality standards, as well as establishing background levels and measuring pollution transported from areas outside of Delaware.

With the passage of the Clean Air Act in 1970, and the Clean Air Act Amendments in 1990, various control measures implemented by the federal and state governments resulted in major improvements in air quality, particularly regarding major industrial sources. Pollutants of concern today come from a variety of sources including mobile (both on road and off road vehicles) sources, large industrial facilities, and smaller industries and business. Delaware continues to use its ambient monitoring network to track changes in air quality across the state and evaluate compliance with ambient air quality standards.

Network Overview

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 throughout the state, which are listed and described in this document. This network is maintained and operated by the Air Surveillance Group of the Division of Air Quality, DNREC.

National Core Monitoring Strategy – NCore

In October 2006 the United States Environmental Protection Agency (EPA) issued final amendments to the ambient air monitoring regulations for criteria pollutants. These amendments are codified in 40 CFR parts 53 and 58. The purpose of the amendments was to enhance ambient air quality monitoring to better serve current and future air quality needs. One of the most significant changes in the regulations was the requirement to establish National Core (NCore) multi-pollutant monitoring stations. These stations provide data on several pollutants at lower detection limits and replace the National Air Monitoring Station (NAMS) networks that have

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_{2.5} particle mass using continuous and integrated/filter-based samplers, speciated PM_{2.5}, PM_{10-2.5} particle mass, O₃, SO₂, CO, NO/NO_y, 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_{2.5} 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 PM_{coarse}, ozone, and NO_y, became operational on January 1, 2011. The lead monitoring began on January 1, 2012.

Monitoring Site Network Map and Information

Below is the Delaware ambient air monitoring site network map as of June 2014.



Below is a table with summary information on every SLAMS site in Delaware. Information includes site name and AQS ID, active parameters as of June 2014, the date when each monitor began collecting information, the scale of representativeness for each parameter, the monitoring objective, and any other comments relating to the site or monitor.

Changes from the 2013 Monitoring Plan are highlighted.

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	
	PM2.5 Continuous FEM	9/1/2012	Neighborhood	General/Background	
	WS/WD	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
	NO2	5/1/2013	Neighborhood	Special purpose monitor	
	WS/WD	11/1/2013	N/A		
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		

Site Name & AQS ID	Parameter	Start Date	Scale of Rep	Objective	Comments
	PM2.5 Continuous FEM		Neighborhood	Air Quality Index/Population Exposure	
	Carbonyls	1/1/2003	N/A		
	Metals	1/1/2003	N/A		
	WS/WD	6/1/2000	N/A		
	Temp/RH	1/1/2011	N/A		
Newark 10-003-1012	PM2.5	12/15/1999	Neighborhood	Population Exposure	
Lums Pond 10-003-1007	Ozone	1/1/1992	Neighborhood	Upwind Background/ Population Exposure	Rural/suburban, upwind of Wilmington during ozone season
	SO2	1/1/2000	Neighborhood	General Background/ Population Exposure	
	PM2.5	1/1/1999	Neighborhood	Regional Transport/ Population Exposure	
	WS/WD	6/1/2013	N/A		
Delaware City 10-003-1008	SO2	2/1/1992	Neighborhood	Population Exposure/ Source Oriented	Point source dominated site
	CO	1/1/1994	Middle	Population Exposure/ Source Oriented	
	PM2.5 Continuous FEM	6/1/2013	Neighborhood	Population Exposure/ Source Oriented	
	VOCs	1/1/2001	N/A		
	WS/WD	5/1/2011	N/A		
Seaford 10-005-1002	Ozone	3/1/1990	Neighborhood	Population Exposure	
	PM2.5	1/1/1999	Neighborhood	Population Exposure	
	PM2.5 Continuous FEM	1/1/2013	Neighborhood	Population Exposure	
	WS/WD	5/1/2011	N/A		
Lewes 10-005-1003	Ozone	5/1/1997	Neighborhood	Population Exposure	Coastal site
	SO2	1/1/2013	Neighborhood	Population Exposure	
	NO2	8/1/2012	Neighborhood	Special Purpose Monitor	
	WS/WD	6/1/1997	N/A		

N/A – not applicable

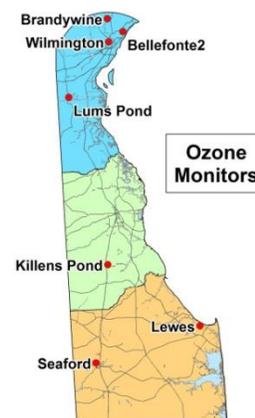
Criteria Pollutant Network Description by Parameter

Ozone (O₃)

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

Monitoring Requirements

Within an O₃ network, at least one O₃ 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 O₃ sites are neighborhood, urban, and regional. Since O₃ 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 O₃ concentrations, more specifically, downwind during periods of photochemical activity. Since O₃ levels decrease significantly in the colder parts of the year in many areas, O₃ 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 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 (2011 – 2013) design value 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 current 8-hr ozone standard is 0.075 ppm.

Ozone 8-hour design values in ppm, 2011 – 2013.

Site	Design Value in ppm
Brandywine	0.073
Bellefonte2	0.076
Lums Pond	0.074
Killens Pond	0.074
Seaford	0.075
Lewes	0.077
MLK NCore	0.075

Sulfur Dioxide (SO₂)

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

Monitoring Requirements

On June 2, 2010, EPA strengthened the primary National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO₂). The primary SO₂ standard was revised by establishing a new 1-hour standard at a level of 75 parts per billion (ppb). The new form of the standard is the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations.



EPA also revised the ambient air monitoring requirements for SO₂. For Delaware, the new standard requires one additional monitoring site be established in Sussex County. New monitors needed to meet the network design regulations for the new 1-hour SO₂ standard must be sited and operational by January 1, 2013 in accordance with the requirements of 40 CFR Part 58 Appendix D and Delaware will comply with this requirement by adding a monitor in Sussex County to fulfill the requirement for monitoring in the Seaford micropolitan statistical area.

EPA also made changes to data reporting requirements for SO₂. State and local agencies are now required to report two data values for every hour of monitoring conducted:

- the 1-hour average SO₂ concentration; and
- the maximum 5-minute block average SO₂ concentration of each hour.

More detailed information on the new SO₂ standard and monitoring requirements can be found on the EPA website at <http://www.epa.gov/air/sulfurdioxide/actions.html#jun10>

Delaware currently operates four SO₂ monitoring sites, all in New Castle County, which operate year-round. The fifth site in Sussex County became operational as a SPM in late summer 2012 and a SLAMS on January 1, 2013.

SO2 design values for 2011 – 2013: 3-year average of 98th percentile 1-hour averages

Site	Design Value in ppb
Bellefonte2	11*
MLK NCore	12*
Delaware City	19*
Lums Pond	10*
Lewes (2 years)	9*

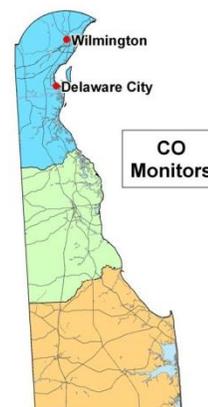
*Less than 4 complete calendar quarters in one or more year.

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 (NO₂)

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



Monitoring Requirements

On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide (NO₂). EPA set a new 1-hour NO₂ standard at the level of 100 parts per billion (ppb). The form for the 1-hour NO₂ standard is the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations. EPA also retained, with no change, the current annual average NO₂ standard of 53 ppb.

The 2011-2013 one hour NO₂ design value based on the MLK monitor data is 46 ppb.

To determine compliance with the new standard, EPA established new ambient air monitoring and reporting requirements for NO₂:

- In large urban areas, monitors are required near major roads as well as in other locations where maximum concentrations are expected.
- Additional monitors are required in large urban areas to measure the highest concentrations of NO₂ that occur more broadly across communities.
- Working with the states, EPA will site a subset of monitors in locations to help protect communities that are susceptible and vulnerable to NO₂-related health effects. These monitors are referred to as RA-40 monitors.

In Delaware, the new requirement for a community-wide NO₂ monitor will apply, and the existing NO₂ monitor at the MLK site will fulfill the requirement. EPA is in the process of designating the RA-40 monitors, and it is expected that the MLK site will be included.

More detailed information on the new NO₂ standard and monitoring requirements can be found on the EPA website at <http://www.epa.gov/air/nitrogenoxides/actions.html#jan10>.

In 2012 Delaware added a special purpose monitor (SPM) for NO₂ at the Lewes site for research and model development purposes. It is anticipated that this monitor will operate for approximately two years.

In 2013 Delaware added a SPM for NO₂ at the Brandywine site for research and model development purposes. It is anticipated that this monitor will operate for approximately two years.

Total Reactive Oxides of Nitrogen (NO_y)

Oxides of Nitrogen are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone (O₃). Air is drawn into a reaction chamber where it is mixed with a high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the ozone to produce NO₂. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. NO_(Diff) must be measured indirectly. NO_y is measured by passing the air through a converter that is mounted 10 meters from ground level. Reactive Oxides of Nitrogen in the air are reduced to NO in the convertor 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_y. The NO_(Diff) concentration is equal to the difference between NO and NO_y.

On January 1, 2011 NO_y monitoring began at the MLK site as part of the NCore program.

Particulate Matter - Fine (PM_{2.5})

The federal reference method (FRM) monitors for PM_{2.5} 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_{2.5} 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_{2.5} 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_{2.5} site to monitor for regional background and at least one PM_{2.5} site to monitor regional transport.

PM_{2.5} 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. The sites in Delaware are MLK in Wilmington and Dover in Kent County. The PM_{2.5} chemical speciation sites include analysis for elements, selected anions and cations, and carbon.

Continuous PM_{2.5}

Delaware operates a designated FEM continuous PM_{2.5} monitor for hourly and 24-hour data at the MLK, Killens Pond, and Seaford sites. These monitors operate year-round, and are collocated with an FRM PM_{2.5} monitor. In 2013 Delaware added another FEM continuous PM_{2.5} monitor to the Delaware City site as a SPM monitor which will operate for approximately two years, at which time the data will be evaluated to determine if monitoring should continue as a SLAMS.

Correlation of continuous PM_{2.5} FEM data with collocated FRM data: Under the most recent revisions to the 40 CFR, Part 50, Appendix N data handling requirements, data capture for annual

and daily Design Values is 75% of scheduled samples per quarter. The “Creditable” data from “suitable” monitors includes both FRMs and appropriate FEMs. This does not include specific continuous FEMs disqualified by the monitoring agency in annual network plan and approved by the EPA Regional Administrator.

The PM_{2.5} from scheduled days, valid make-ups and collocated suitable monitors are “credible” for the annual and daily NAAQS and computations are based on a “combined site record”. The PM_{2.5} data from the designated “primary” monitor is therefore supplemented with the average of daily data from all collocated “suitable” monitors, including continuous FEM monitors, for any missing primary monitor days.

Although Delaware is using designated FEM methods for continuous PM_{2.5} monitoring collocated with FRMs, the actual data do not always meet the bias and correlation comparability tests from 40 CFR Part 58 Appendix C. For the most recent complete year of monitoring, the three sites in Delaware all show correlation statistics that failed to meet the goal of 0.9500 or higher while the slope and intercept meet the criteria.

Because the data are close to meeting the equivalency criteria, Delaware at this time is NOT requesting exclusion of the continuous FEM PM_{2.5} data under 40 CFR, Part 50, Appendix N data handling requirements.

PM_{2.5} Design Values (2011 – 2013)

Below are the design values for PM_{2.5} using 2011 through 2013 FRM data. PM_{2.5} annual design values are calculated using the 3-year average of the respective annual averages. The current annual PM_{2.5} standard is 15 µg/m³. PM_{2.5} daily design values are calculated using the 3-year average of the annual 98th percentile values. As of 2006, the new, more stringent daily PM_{2.5} standard is 35 µg/m³.

Site	Annual Design Value µg/m ³	Daily Design Value µg/m ³
Bellefonte	9.1	23*
MLK – Wilmington	10.0	25
Newark	9.7	24*
Lums Pond	8.4	21*
Dover	8.4	23
Killens Pond	8.2	22*
Seaford	8.5	23
NAAQS	15	35

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

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

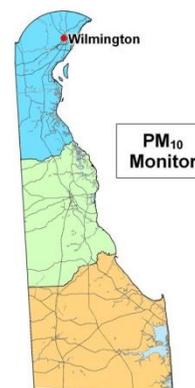
Particulate Matter (PM_{10})

PM_{10} is sampled using the federal reference method (FRM) monitor similar to $PM_{2.5}$ 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 Teflon⁷ 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 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 PM_{10} from both mobile and stationary sources are the middle scales and neighborhood scales.



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

Particulate Matter (PM_{coarse})

PM_{coarse} is calculated as the difference between concentrations of PM_{10} and $PM_{2.5}$ at collocated monitors. PM_{coarse} is part of the NCore monitoring at the Wilmington MLK site. Monitoring began on January 1, 2011.

Lead (Pb)

Lead is sampled as PM_{10} with the Teflon filters sent to a laboratory for analysis by XRF after they have been weighed for mass. The method is considered a federal equivalent method (FEM) and complies with the EPA requirements of 40 CFR Part 50 Appendix Q.

Monitoring Requirements

Lead monitoring in Delaware is required as part of the NCore network, and takes place at the NCore site at MLK in Wilmington. The samples are collected on a 1 in 6 day schedule beginning on January 4, 2012.

Summary of Changes from 2013

Following are the changes from the monitoring network in 2013:

- Continuous PM_{2.5} monitor was added as a SPM at Delaware City
- Wind speed and wind direction monitoring were added at Brandywine
- Wind speed and wind direction monitoring were added at Lums Pond

Changes anticipated for 2014

Following are the changes anticipated to occur in 2014:

PM_{2.5} Chemical Speciation changes - EPA is in the process of completing an assessment of the national speciation network. The purpose of the assessment is to create a network that is sustainable going forward with the current situation of reduced federal funding by redistributing resources to new or high priorities from those of low-priority or low-benefit. As part of this process EPA developed a scoring metric to identify existing speciation sites of lower value for defunding, and has issued a preliminary list of those sites that includes the Dover Delaware site. The list is not yet final and may change. When the list is finalized, funds for analyzing speciation samples from those sites will be discontinued beginning in January 2015. Delaware will work with EPA Region 3 in reviewing the assessment and will include any changes in the next annual monitoring network plan.

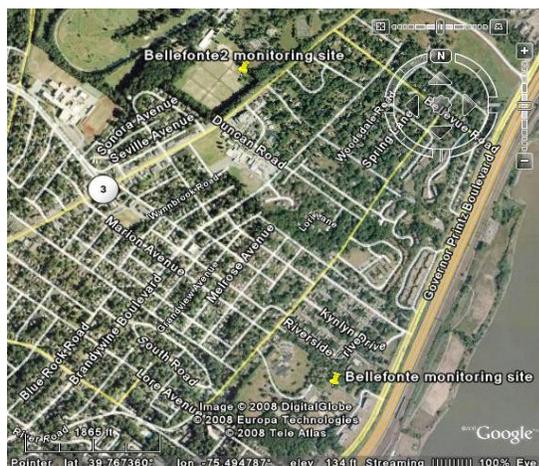
The following pages contain additional site specific information on all active SLAMS monitoring sites in Delaware. Sites are shown in alphabetical order for New Castle, Kent, and Sussex Counties.

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 Established:	Bellefonte 1969 Bellefonte2 2001
Spatial Scale:	Neighborhood	Area Represented:	Wilmington area



Bellefonte and Bellefonte2 locations



Bellefonte2



Monitored Parameters

	Ozone	SO ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction
Bellefonte					X					
Bellefonte2	X	X								

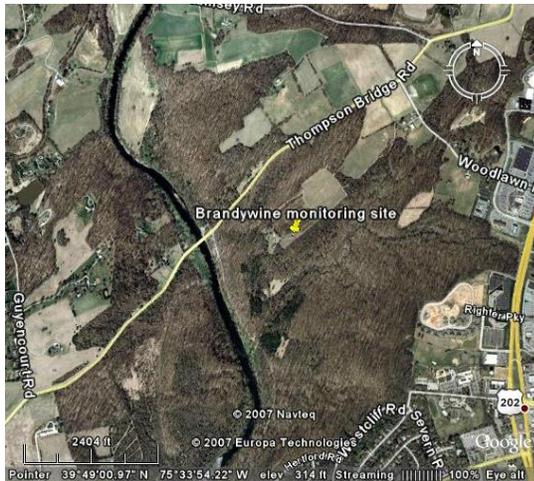
Site Description: Bellefonte was originally established in 1969 to monitor O₃ and SO₂. PM_{2.5} was added in 1999. When changing site characteristics began to interfere with ozone monitoring, a new site (Bellefonte2) was established in 2001, less than a mile to the north. The O₃ and SO₂ monitors were relocated to the new site, while the PM_{2.5} 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 O₃ maximum downwind concentration site for Wilmington. The SO₂ 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 2014: No changes planned.

Site: Brandywine

County:	New Castle	Latitude:	39.8172
Address:	Brandywine Creek State Park	Longitude:	-75.5639
AQS site ID:	10-003-1010	Year Established:	1994
Spatial Scale:	Neighborhood	Area Represented:	Wilmington area



Monitored Parameters

Ozone	SO ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction
X			New SPM					X	X

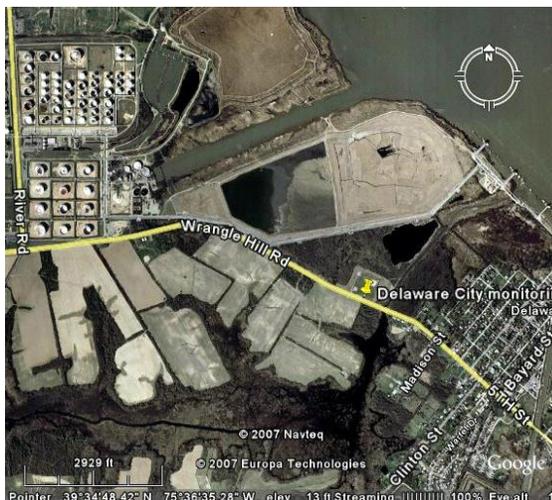
Site Description: The Brandywine site is located in Brandywine Creek State Park. This is a neighborhood scale site for O₃ monitoring. The site meets all EPA siting requirements.

Monitoring Objectives: The Brandywine site is in the secondary downwind direction from Wilmington. The objectives are compliance with the O₃ NAAQS, population exposure, and trends.

Planned Changes through 2014: Upgrades to the monitor shelter were in 2013. NO₂ SPM monitoring began in 2013. No other 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 ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction
	X	X				New SPM		X	X

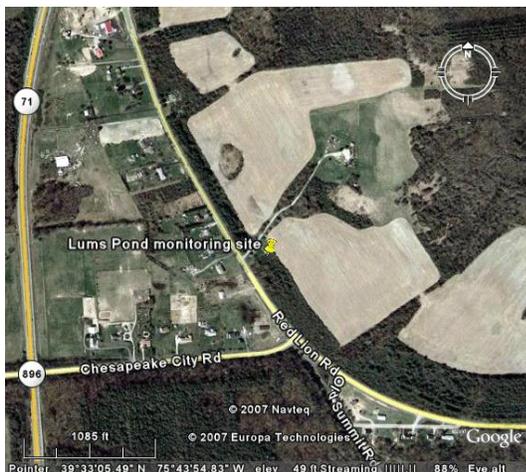
Site Description: The Delaware City site was established at a location along Route 9 that is between the Delaware City industrial complex and the nearest populated area (Delaware City) in the predominant downwind direction. This site meets all EPA siting criteria.

Monitoring Objectives: This monitoring site is a stationary source-impacted site for SO₂. The monitoring objectives are compliance with the NAAQS, population exposure, and trends.

Planned Changes through 201:

Site: Lums Pond

County:	New Castle	Latitude:	39.5511
Address:	Lums Pond State Park	Longitude:	-75.7308
AQS site ID:	10-003-1007	Year Established:	1991
Spatial Scale:	Neighborhood	Area Represented:	Wilmington area



Monitored Parameters

Ozone	SO ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction
X	X			X				X	X

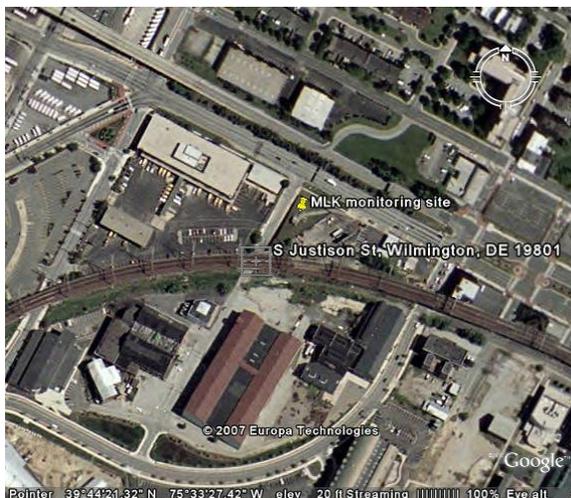
Site Description: The Lums Pond site is a neighborhood scale site located in a general upwind direction from Wilmington. The immediate area is rural. The site meets all EPA siting criteria.

Monitoring Objectives: The site objectives for O₃ are NAAQS compliance, upwind background for the Wilmington area, population exposure, and trends. This site was originally planned to monitor O₃ transported into Delaware from the Baltimore/Washington area, and continues to serve this purpose. The SO₂ monitor was added 2000 to detect impacts from major point sources directly to the east. PM_{2.5} monitoring began in 1999 as both a transport and general population exposure site, as well as for NAAQS compliance. All parameters are neighborhood scale.

Planned Changes through 2014: No changes planned.

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 ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction	NO/NO _y	Lead	PM _{10-2.5}	Temp & Rel. Hum.
X	X	X	X	X	X	X	X	X	X	X	New	X	X

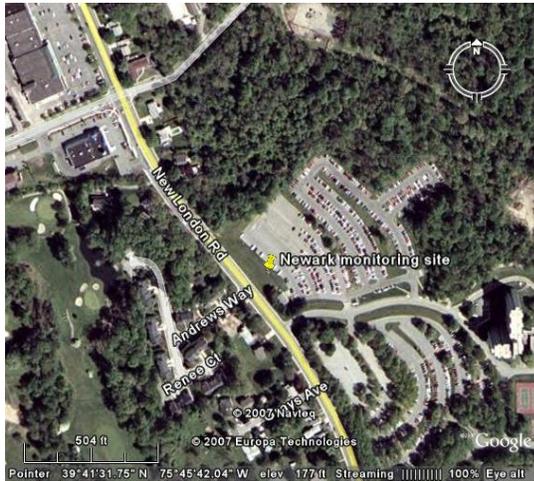
Site Description: The MLK site is located in Wilmington at the intersection of Justison St. and MLK Blvd. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years. The MLK site represents urban population exposure to multiple pollution sources. The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

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

Planned Changes through 2014: No changes planned for 2014.

Site: Newark

County:	New Castle	Latitude:	39.6919
Address:	University of Delaware North Campus	Longitude:	-75.7617
AQS site ID:	10-003-1012	Year Established:	1999
Spatial Scale:	Neighborhood	Area Represented:	Newark



Monitored Parameters

Ozone	SO ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction
				X					

Site Description: The Newark site is a platform only. It is a PM_{2.5} neighborhood scale site. The location is suburban and generally impacted by mobile sources and regional transport. The site meets all EPA siting criteria.

Monitoring Objectives: The objectives are NAAQS compliance, regional transport, population exposure, and trends.

Planned Changes through 2014: No changes planned.

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 ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	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 2014: No changes planned.

Site: Killens Pond

County:	Kent	Latitude:	38.9847
Address:	Killens Pond Rd.	Longitude:	-75.5555
AQS site ID:	10-001-0002	Year Established:	1995
Spatial Scale:	Neighborhood	Area Represented:	Not in an urban area



Monitored Parameters

Ozone	SO ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Wind Speed	Wind Direction
X				X		X		X	X

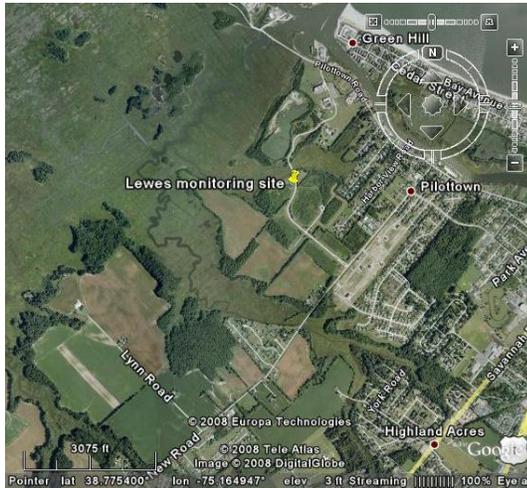
Site Description: The Killens Pond site is located in a rural area that is part of Killens Pond State Park. The site meets all EPA siting criteria.

Monitoring Objectives: The objectives for this site are background concentrations, NAAQS compliance, and trends.

Planned Changes through 2014: 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 ₂	CO	NO ₂	PM _{2.5}	PM _{2.5} speciation	PM _{2.5} continuous	PM ₁₀	Ultrafine Particles	Wind Speed	Wind Direction
X	X		New SPM						X	X

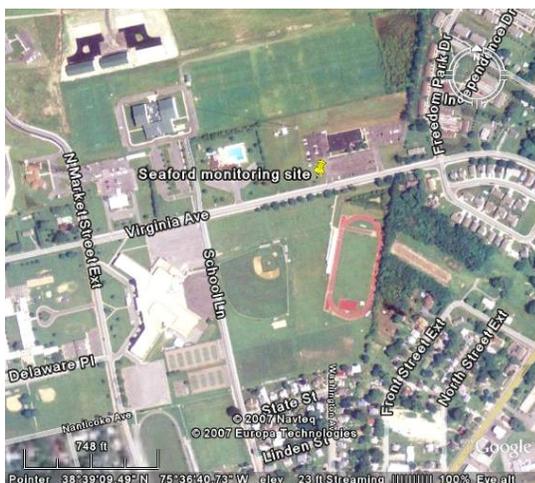
Site Description: The Lewes site is neighborhood scale. It is near the University of Delaware College of Marine Studies campus in Lewes, and is representative of the coastal Sussex County area. The site meets all EPA siting criteria.

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

Planned Changes through 2014: No changes planned.

Site: Seaford

County:	Sussex	Latitude:	38.6444
Address:	350 Virginia Ave.	Longitude:	-75.6131
AQS site ID:	10-005-1002	Year Established:	1990
Spatial Scale:	Neighborhood	Area Represented:	Seaford



Monitored Parameters

Ozone									
SO ₂									
CO									
NO ₂									
PM _{2.5}	X								
PM _{2.5} speciation									
PM _{2.5} continuous	X								
PM ₁₀									
Wind Speed	X								
Wind Direction	X								

Site Description: The Seaford site was originally located further south, near the Seaford water tower. It was relocated to the present location in 1990 due to deteriorating conditions at the original site. The current site is neighborhood scale and is suburban. The site is impacted by local point sources, mobile sources, and regional transport. The site meets all EPA siting criteria.

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

Planned Changes through 2014: No changes planned.

Monitoring method information

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

Parameter	AQS Method Code	Method Description
O ₃	047, 091	UV Absorption
SO ₂	092, 560	UV Fluorescence
CO	054, 554	Non-dispersive Infrared
NO ₂ and NO _y	074, 574	Chemiluminescence
PM _{2.5}	145	Gravimetric
PM ₁₀	127	Gravimetric
PMcoarse	176	Calculated from paired samplers
Lead	811	X-ray fluorescence, low-volume PM10 sampler
WS/WD	050	Ultrasonic

Ozone (O₃)

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

Sulfur Dioxide (SO₂)

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

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 (NO₂) and NO_y

Nitrogen oxides are measured using the chemiluminescence reaction of NO with O₃. Air is drawn into a reaction chamber where it is mixed with a high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the ozone to produce NO₂. Light

emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. NO₂ must be measured indirectly. NO_x are measured by passing the air through a converter where any NO₂ in the air is reduced to NO before the air is passed to the reaction chamber. By alternately passing the air directly to the reaction chamber, and through the converter before the reaction chamber, the analyzer alternately measures NO and NO_x. The NO₂ concentration is equal to the difference between NO and NO_x.

NO_y is measured by the same method as NO_x with the exception that the converter is at the sample inlet instead of at the reaction chamber. This position is used because the NO_y compounds are too unstable to be measured when taken in through the entire length of the typical ambient air sampling inlet system. Placing the converter at the inlet allows the catalytic reaction to convert most of the NO_y species (approximately 30 nitroxyl compounds) to NO very close to the point where ambient air is sampled. The more stable NO can then be detected as described previously.

Particulate Matter - Fine (PM_{2.5}), PM₁₀, and PM_{coarse}

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

PM₁₀ samples are collected every third day. PM_{coarse} is calculated by subtracting the PM_{2.5} concentration from the collocated PM₁₀ concentration for the same day.

Lead

Lead is sampled on PM₁₀ filters collected as described above every 6th day beginning on January 4, 2012. The filters are first weighed for particulate mass, then submitted to a contract laboratory for analysis by x-ray fluorescence (XRF) according to Appendix Q to 40 CFR Part 50, "Reference Method for the Determination of Lead in Particulate Matter as PM₁₀ Collected from Ambient Air".