2017 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
NOx – nitrogen oxides
O_3 – ozone
Pb - lead
$PM_{2.5}$ – fine particulate matter (2.5 microns)
PM_{10} – respirable particulate matter (10 microns)
$PM_{10-2.5}$ – coarse particulate matter (PM10 – PM2.5)
SLAMS – state and local monitoring stations
SO_2 – 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 (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter less than 10 microns (PM_{10}), 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 that the operation of each monitor meets the requirements of appendices A, C, D, and E of 40 CFR Part 58, where applicable.
2) 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 Ambient Air Monitoring Network Assessment 2015

Executive Summary

40 CFR Part 58.10(d) requires Delaware to perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in Appendix D of this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and where new technologies are appropriate for incorporation in the ambient air monitoring network.

The 2015 network assessment report served as Delaware's most recent assessment under this requirement. For the 2015 5-Year Monitoring Network Assessment (Assessment), the Division of Air Quality (DAQ) performed a technical review of the data collected in the ambient monitoring network including the following:

1. Population data was summarized for all three counties in Delaware. This information was used to determine the appropriateness of monitoring for population exposure.
2. Meteorological parameters were reviewed to establish upwind / downwind relationships between a monitor site and surrounding emission sources.
3. Emission inventory summary data was reviewed. This information was used to determine if a monitor is sited appropriately to represent maximum pollution concentrations or specific ambient source impacts quantification.
4. Historical data collected at each site was reviewed for trends and comparison to the current National Ambient Air Quality Standards. This is helpful to determine if Delaware is achieving air quality improvements and meeting air quality standards.
5. Site by site correlation analysis was performed using tools supplied by EPA. Currently, EPA has provided this tool for O_3, $PM_{2.5}$, and PM_{10}. This information is used to determine if information collected at sites is redundant and if the site may be considered for elimination.
6. A bias calculation was performed to determine impacts that may occur if a monitor is removed from the network.

DAQ evaluated the data from this technical review according to defined performance measures. We also expanded performance measures beyond application of this technical information. Performance measures were organized into the following categories:

a) Data Criteria
b) Statistical Criteria
c) Situational Criteria
d) Future Needs and Special Considerations

Specific performance measures used in the Assessment were detailed in the Delaware Air

Monitoring Network – Current Network Description section. Not all performance measures were applicable to every monitor / site.

Based upon the evaluation of these performance measures, DAQ determined the importance (critical, credible, marginal, new site required) of each monitor in the network. Critical sites are of high value and will be continued. Credible sites are expected to continue, but may not be the design value location at or above the NAAQS. Marginal sites or monitors are subject for removal or movement. New site required represent potential areas of investment.

Results

The results of this Assessment indicated that the network contains only critical or credible sites. Issues that may impact future network design include new monitoring requirements associated with new or revised NAAQS, aging equipment/maintenance issues, and resource availability. When any future monitoring rules are promulgated, Delaware will work closely with EPA Region 3 to ensure that all new monitoring requirements are met.

The annual network plan for 2017 incorporates the results of the 2015 Assessment. Since all monitors are rated critical or credible, no changes were recommended for 2017.

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 ambient 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 the 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 $PM_{2.5}$, $PM_{10\text{-}2.5}$ particle mass, O_3, SO_2, CO, NO/NOy, lead, wind speed, wind direction, relative humidity, and ambient temperature.

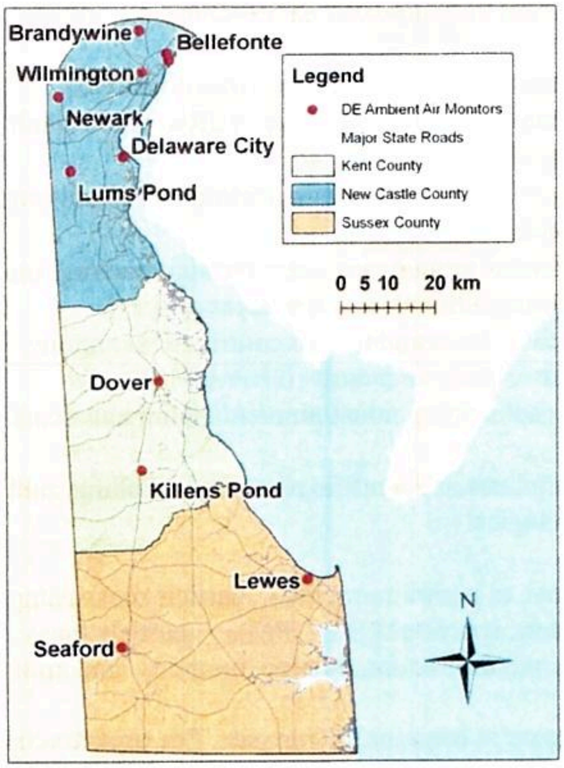
Each State is required to operate at least one NCore site. The objective is to locate sites in broadly representative urban (about 50 sites) and rural or regional (about 20 sites) locations throughout the country to help characterize urban- and regional-scale patterns of air pollution. Monitoring agencies 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 PMcoarse, ozone, and NOy, became operational on January 1, 2011. The lead monitoring began on January 1, 2012.

Monitoring Site Network Map and Information

Following is the Delaware ambient air monitoring site network map as of June 2017.



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 2017, 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. Street address and geographic coordinates are included for each site in Appendix A.

All monitoring sites that are part of a CBSA/MSA meet the minimum monitoring requirements specified in 40 CFR Part 58 Appendix D.

Actual changes from the 2016 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	Urban	General/Background	Rural site
	PM2.5	1/1/1999	Urban	General/Background	
	PM2.5 Continuous FEM	9/1/2012	Urban	General/Background	
	WS/WD	4/1/1995	N/A	N/A	
Dover 10-001-0003	PM2.5	1/1/1999	Neighborhood	Population Exposure	
Brandywine 10-003-1010	Ozone	7/1/1994	Neighborhood	Population Exposure	Secondary downwind of Wilmington
	WS/WD	11/1/2013	N/A	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	
	PM2.5 Continuous FEM	7/1/2007	Neighborhood	Air Quality Index/Population Exposure	
	PMcoarse	1/1/2011	Neighborhood	Population Exposure/ NCore	
	Lead	1/1/2012	Neighborhood	Population Exposure/ NCore	Lead discontinued June 2016
	PM2.5 speciation	6/1/2001	N/A	Population Exposure	
	BC	1/1/2001	N/A	Population Exposure	

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

N/A – not applicable

Changes from 2016 are highlighted in yellow.

Criteria Pollutant Network Description by Parameter

Ozone (O_3)

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_3 network, at least one O_3 site for each MSA, or CSA if multiple MSAs are involved, must be designed to record the maximum concentration for that 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). In Delaware, New Castle County is part of the larger Philadelphia CSA, Kent County is covered by the Dover MSA, and Sussex County is part of the Salisbury MSA.

Number of Ozone SLAMS Sites Required (based on Table D–2 , Appendix D to 40 CFR Part 58, Ozone minimum monitoring requirements)

MSA Name	County in Delaware	Population	DE Monitors	Total Required Monitors
Philadelphia-Camden-Wilmington- Newark, PA-DE-MD		6,018,800		3
	New Castle	538,479	**4**	
Dover, DE	Kent	162.310	**1**	1
Salisbury, MD-DE		381,868		1
	Sussex	197,145	**2**	
Total in DE			**7**	

The appropriate spatial scales for O_3 sites are neighborhood, urban, and regional. Since O_3 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_3 concentrations, more specifically, downwind during periods of photochemical activity. Since O_3 levels decrease significantly in the colder parts of the year in many areas, O_3 is required to be monitored only during the "ozone season" as designated in the 40 CFR Part 58 Appendix D, which in Delaware is March 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. Monitoring objectives for each site are included in the detailed site description section of this document. 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.

Operation of all ozone monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

Ozone Design Values

The table below shows the most recent (2014 – 2016) 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 8-hr ozone standard established in 2015 is 0.070 ppm.

Ozone 8-hour design values in ppm, 2014 – 2016.

Site	Design Value in ppm
Brandywine	0.074
Bellefonte2	0.070
Lums Pond	0.068
Killens Pond	0.066
Seaford	0.065
Lewes	0.069
MLK NCore	0.071

Sulfur Dioxide (SO_2)

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_2 concentration.

Monitoring Requirements

On June 2, 2010, EPA strengthened the primary National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2). The primary SO_2 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 SO_2. 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 SO_2 standard had to be sited and operational by January 1, 2013 in accordance with the requirements of 40 CFR Part 58 Appendix D. Delaware complied with this requirement by adding a monitor in Sussex County to fulfill the requirement for monitoring in the Sussex County portion of the Salisbury metropolitan statistical area (MSA).

On August 10, 2015, the U.S. Environmental Protection Agency initialized requirements for air agencies to monitor or model ambient sulfur dioxide (SO_2) levels in areas with large sources of SO_2 emissions to help implement the 1-hour SO_2 National Air Ambient Quality Standard (NAAQS). This final rule established that, at a minimum, air agencies must characterize air quality around sources that emit 2,000 tons per year (tpy) or more of SO2. Delaware has determined that there are no sources within the state above this threshold emissions total.

EPA also made changes to data reporting requirements for SO_2. State and local agencies are now required to report two data values for every hour of monitoring conducted:

- the 1-hour average SO_2 concentration; and
- the maximum 5-minute block average SO_2 concentration of each hour.

More detailed information on the new SO_2 standard and monitoring requirements can be found on the EPA website at http://www3.epa.gov/airquality/sulfurdioxide/implement.html

Delaware currently operates four SO_2 monitoring sites 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. Operation of all SO_2 monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

SO_2 design values for 2014 – 2016: 3-year average of 98th percentile 1-hour averages

Site	Design Value in ppb
Bellefonte2	9*
MLK NCore	10
Delaware City	12
Lums Pond	9*
Lewes	5

*Does not meet completeness criteria

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 revised the minimum number of required CO monitoring sites on August 12, 2011. Since Delaware does not operate a near-road urban monitoring site with a population of 1 million or more and does not have a Photochemical Air Monitoring Site (PAMS), Delaware is only required to monitor CO at its urban NCore MLK monitoring site in Wilmington. For the larger Philadelphia-Camden-Wilmington-Newark, PA-DE-MD MSA, the requirements are met by monitors installed in the urban Philadelphia area.

Operation of all CO monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

Nitrogen Dioxide (NO_2)

Nitrogen oxides are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone (O_3). 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_2. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. NO_2 must be measured indirectly. NO_X is measured by passing the air through a converter where any NO_2 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 NO_2 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 (NO_2). EPA set a new 1-hour NO_2 standard at the level of 100 parts per billion (ppb). The form for the 1-hour NO_2 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 NO_2 standard of 53 ppb.

On March 14, 2013, EPA published revised monitoring requirements for NO_2. Monitoring for NO_2 is now required at near road sites in CBSAs with populations greater than 500,000, in CBSAs with populations greater than 1 million, and at NCore sites. In accordance with the new rule, Delaware is required to monitor NO_2 only at its NCore MLK site in Wilmington. For the larger Philadelphia-Camden-Wilmington-Newark, PA-DE-MD MSA, the requirements are met by monitors installed by the Pennsylvania Department of Environmental Protection (PADEP).

The 2013-2015 one hour NO_2 design value based on the MLK monitor data is 46 ppb.

Operation of all NO_2 monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

More detailed information on the new NO_2 standard and monitoring requirements can be found on the EPA website at http://www3.epa.gov/airquality/nitrogenoxides/actions.html#oct12

Total Reactive Oxides of Nitrogen (NO_Y)

Oxides of Nitrogen are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone (O_3). 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_2. 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. Operation of all NO_Y monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

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 Teflon7 microfiber filter that is weighed to determine the particulate mass.

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.

Number of $PM_{2.5}$ SLAMS Sites Required (based on Table D–5 , Appendix D to 40 CFR Part 58, $PM_{2.5}$ minimum monitoring requirements)

MSA Name	County in Delaware	Population	Design Value Daily/Annual NAAQS: 35/15.0	DE Monitors	Total Required Monitors
Philadelphia-Camden-Wilmington-Newark, PA-DE-MD		6,018,800	29/12.3		3
	New Castle	538,479	**25/9.6**	**4**	
Dover, DE	Kent	162.310	**21/8.1**	**2**	
Salisbury, MD-DE		381,868			0
	Sussex	197,145	**21/8.4**	**1**	
Total in DE				7	

Based on tables available at http://www.epa.gov/airtrends/values.html.

Delaware operates more than the minimum number of required $PM_{2.5}$ 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.

Operation of all $PM_{2.5}$ monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

$PM_{2.5}$ Chemical 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 were established at MLK in Wilmington and Dover in Kent County.

In 2014 EPA completed the process of assessing the national speciation network. The purpose of the assessment was 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 the Dover site was identified as low-value due to redundancy. Speciation monitoring at the Dover site therefore ended in 2014 in response to termination of support from the EPA. Speciation monitoring continues at the MLK site in Wilmington on a 1-in-three day schedule.

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 which operated as a SPM monitor through 2015, and was designated as a SLAMS beginning on January 1, 2016.

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, the data capture requirement for annual and daily Design Values is 75% of scheduled samples per quarter. "Creditable" data includes all $PM_{2.5}$ data from scheduled sampling days, valid make-ups and collocated suitable monitors. This data is acceptable for comparison to the annual and daily NAAQS and computations are based on a "combined site record". "Suitable" monitors are all monitors designated as either FRM or FEM. (Note: This does not include specific continuous FEMs disqualified by the monitoring agency in the annual network plan and approved by the EPA Regional Administrator. Delaware has not disqualified any continuous FEM monitors.) 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.

$PM_{2.5}$ Design Values (2014 – 2016)

Below are the design values for $PM_{2.5}$ using 2014 through 2016 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 12 $\mu g/m^3$. $PM_{2.5}$ daily design values are calculated using the 3-year average of the annual 98th percentile values. The daily $PM_{2.5}$ standard is 35 $\mu g/m^3$.

Site	Annual Design Value $\mu g/m^3$	Daily Design Value $\mu g/m^3$
Bellefonte	8.4*	22*
MLK – Wilmington	9.1*	23*
Newark	9.0*	23*
Rte 9/Delaware City	8.9*	23*

Lums Pond	8.1*	19*
Dover	7.8*	19*
Killens Pond	7.7*	20*
Seaford	8.0*	19*
NAAQS	**12**	**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.

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 the Philadelphia-Camden-Wilmington-Newark, PA-DE-MD MSA, the requirements are met by monitors installed in the Philadelphia urban area. No other PM_{10} monitors are required in Delaware.

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 to calculate the PMcoarse 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 (PMcoarse)

PMcoarse is calculated as the difference between concentrations of PM_{10} and $PM_{2.5}$ at collocated monitors. PMcoarse is part of the NCore monitoring at the Wilmington MLK site. Monitoring began on January 1, 2011. There are no ambient air quality standards for PMcoarse.

Operation of all PM_{10} and PMcoarse monitors in Delaware meet the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

Air Toxics Pollutant Monitors

Toxic air pollutants, also called air toxics or hazardous air pollutants are pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.

As part of the EPA Region III Cooperative Toxic Monitoring Program, Delaware operates one air toxic monitoring station to assess general urban levels. Toxics are sampled every sixth day year-round at the MLK site in Wilmington. The compounds measured are shown in the Monitoring Method table.

The two main classes of air toxics compounds currently monitored in Delaware are volatile organic compounds (VOCs) and heavy metals. VOC samples are collected for 24 hours in canisters with a XonTech 910A canister sampler. The canisters are returned to the Maryland Department of the Environment laboratory for analysis on an Entech/Agilent gas chromatograph mass spectrometer system.

The heavy metals are collected for 24 hours on a total suspended particulate quartz filter which is sent to the West Virginia Department of Environmental Protection laboratory for analysis using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). Results of the monitoring are submitted to the national Air Quality System (AQS) database.

Delaware previously included carbonyl monitoring as part of the EPA Region III program but monitoring ended in 2015 due to problems with data quality and aging monitoring equipment.

No changes to the program are planned for 2017.

Photochemical Assessment Monitoring System (PAMS) Monitors

The Clean Air Act (CAA) of 1990, Section 182 (c)(1), required the EPA to promulgate rules for enhanced monitoring of O_3, NOx, and volatile organic compounds (VOCs) for O_3 nonattainment areas based on their classification with the goal of obtaining more comprehensive and representative data on O_3 air pollution.

The following information is taken (and condensed) from the document "PAMS Required Quality Assurance Implementation Plan", U.S. Environmental Protection Agency, October 2016.

> In 2011, the EPA initiated an effort to re-evaluate the PAMS requirements in light of changes in the needs of PAMS data users and the improvements in monitoring technology. The EPA consulted with the Clean Air Science Advisory Committee (CASAC), Air Monitoring and Methods Subcommittee (AMMS) to seek advice on potential revisions to the technical and regulatory aspects of the PAMS program, including changes to required measurements and associated network design requirements. The EPA also requested advice on appropriate technology, sampling frequency, and overall program objectives in the context of the most recently revised O_3 NAAQS and changes to atmospheric chemistry that have occurred over the previous 10 to 15 years in the significantly impacted areas.
>
> Based on the findings of the PAMS evaluation and the consultations with the CASAC AMMS and NACAA MSC, the EPA proposed to revise several aspects of the PAMS monitoring requirements. The current objective of the PAMS air monitoring program is to provide data to evaluate and support the development of air quality models and track trends in ozone precursor concentrations so as to aid ongoing efforts to attain the ozone NAAQS.
>
> **Network Design** - The first part of the network design change involved EPA requiring PAMS measurements minimally during the PAMS (summer) sampling season, which is June 1 through August 31, at all NCore sites in Core-Based Statistical Areas (CBSAs) with a population of 1,000,000 people or more. The final network design will result in approximately 40 "Required" PAMS sites,
>
> The new regulations specify that the following parameters will be measured at PAMS Required sites:
>
> - **Volatile organic compounds (VOCs)** – It is strongly suggested that all Required PAMS sites take hourly speciated VOC measurements with auto-gas chromatographs (GCs).
> - **Carbonyls** - All Required PAMS sites will conduct carbonyl sampling with a frequency of three 8-hour samples on a one-in-three-day basis (~90 samples per PAMS sampling season).
> - **Nitrogen Oxides** - All Required PAMS sites must monitor for NO and NO_y (total oxides of nitrogen) in addition to true NO_2, where the latter must be measured with a cavity attenuated phase shift (CAPS) spectroscopy direct-reading NO_2 instrument or a photolytic-converter NO_x analyzer.

- **Meteorology Measurements** - All Required PAMS sites must measure wind speed and direction, temperature, humidity, atmospheric pressure, precipitation, solar radiation, ultraviolet radiation, and mixing height.

As part of the Philadelphia CBSA and OTR Delaware is required to establish a PAMS site at the NCore site in Wilmington (MLK AQS ID 10-003-2004). As part of the PAMS network, the following measurements are required:

1. Hourly speciated VOC measurements with auto-GCs
2. Carbonyl sampling (three 8-hour samples on a one-in-three-day sampling frequency)
3. NO, true NO_2, and NO_y measurements
4. Surface meteorology measurements including mixing height

Planned equipment is included in Appendix ___ . Purchasing of equipment will begin in 2017 in order to meet the goal of initial installation and data collection by July 2018.

Summary of Changes from 2016

Following are the changes from the monitoring network in 2016:

- The lead monitoring at MLK was discontinued per approval by the EPA Region 3 Office and in compliance with 58.14(c). §58 Appendix D Section 4.5(b) and 4.5(c). Lead continues to be monitored at MLK as part of the PM2.5 chemical speciation network and the TSP heavy metals air toxics program.

Changes anticipated for 2017

Following are the changes anticipated to occur in 2017:

The $PM_{2.5}$ FRM monitors are aging. Delaware plans to replace some of the FRM monitors with continuous FEM monitors at selected sites. This was expected to take place sometime in 2016, but problems with monitor reliability and mechanical failures have caused delays in the implementation schedule. Delaware is actively attempting to resolve the technical issues and there is currently no specific timeline for replacement of the FRMs. When Delaware proceeds with the FRM replacement, Delaware will comply with all relevant EPA collocation and other siting and data handling requirements for the FEM continuous monitors. FRM monitoring will continue at the NCore site at MLK in Wilmington.

Detailed Site Descriptions

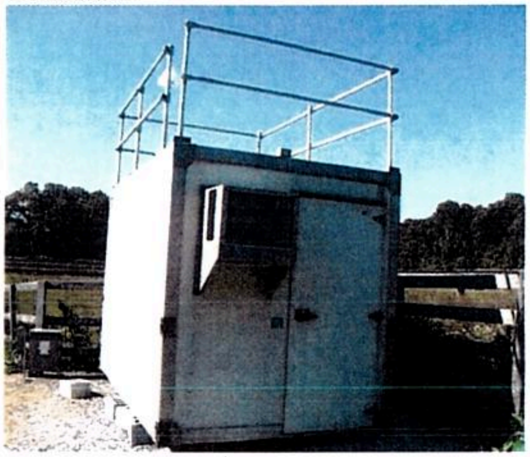
The following pages contain additional site specific information on all active SLAMS monitoring sites in Delaware. Sites are shown in alphabetical order for New Castle, Kent, and Sussex Counties.

Site: Bellefonte and Bellefonte2

County:	New Castle	Latitude:	Bellefonte 39.7613 Bellefonte2 39.7739	
Address:	Bellefonte: River Road Park Bellefonte2: Bellevue State Park	Longitude:	Bellefonte -75.4920 Bellefonte2 -75.4965	
AQS site ID:	Bellefonte: 10-003-1003 Bellefonte2: 10-003-1013	Year Established:	Bellefonte 1969 Bellefonte2 2001	
Spatial Scale:	Neighborhood	Area Represented (MSA):	Philadelphia-Camden-Wilmington PA-NJ-DE-MD	

Bellefonte and Bellefonte2 locations

Bellefonte2



Monitored Parameters

	Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$	PM_{10}	Wind Speed	Wind Direction
Bellefonte					X					
Bellefone2	X	X								

Site Description: Bellefonte was originally established in 1969 to monitor O_3 (primary downwind direction from Wilmington) and SO_2. $PM_{2.5}$ 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 O_3 and SO_2 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 O_3 maximum downwind concentration site for Wilmington. The SO_2 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 2017: 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 (MSA):	Philadelphia-Camden-Wilmington PA-NJ-DE-MD	

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

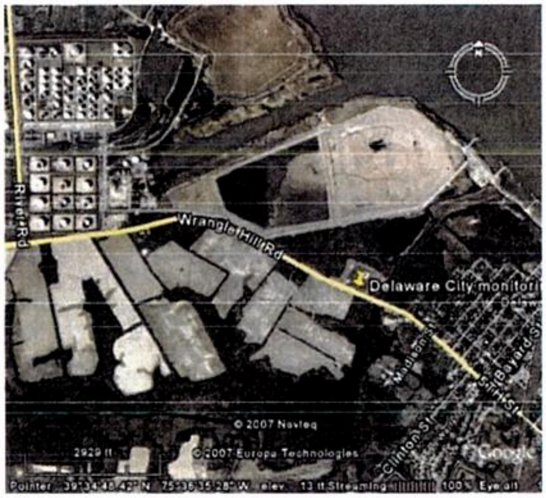
Site Description: The Brandywine site is located in Brandywine Creek State Park, and was established when a secondary downwind site in Claymont was discontinued to changes in nearby land use and ownership. This is a neighborhood scale site for O_3 monitoring. The site meets all EPA siting requirements. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives: The Brandywine site is in the secondary downwind direction from Wilmington. The objectives are population exposure, compliance with the O_3 NAAQS, and trends.

Planned Changes through 2017: No changes planned.

Site: Delaware City

County:	New Castle	Latitude:	39.5777	
Address:	Route 9, Delaware City	Longitude:	-75.6036	
AQS site ID:	10-003-1008	Year Established:	1992	
Spatial Scale:	Neighborhood	Area Represented (MSA):	Philadelphia-Camden-Wilmington PA-NJ-DE-MD	



Monitored Parameters

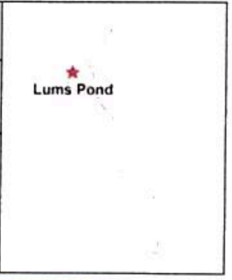
Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$ continuous	PM_{10}	Wind Speed	Wind Direction
	X					X		X	X

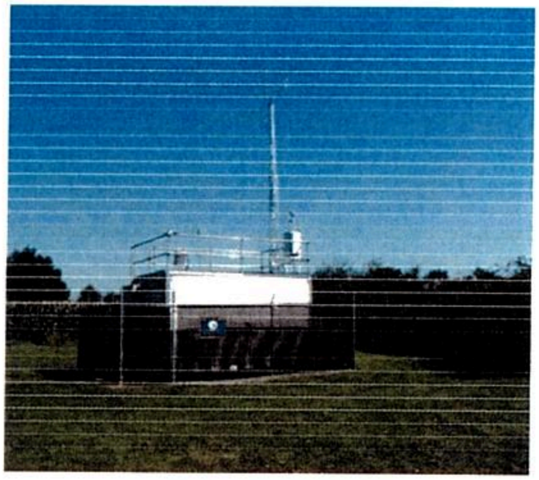
Site Description: The Delaware City site was established at a location along Route 9 that is between the Delaware City industrial complex and the nearest populated area (Delaware City) in the predominant downwind direction. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives: This monitoring site is a stationary source-impacted site for SO_2. The monitoring objectives are population exposure, compliance with the NAAQS, and trends.

Planned Changes through 2017: No changes planned.

Site: Lums Pond

County:	New Castle	Latitude:	39.5513	 Lums Pond
Address:	Lums Pond State Park	Longitude:	-75.7320	
AQS site ID:	10-003-1007	Year Established:	1991	
Spatial Scale:	Urban	Area Represented (MSA):	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

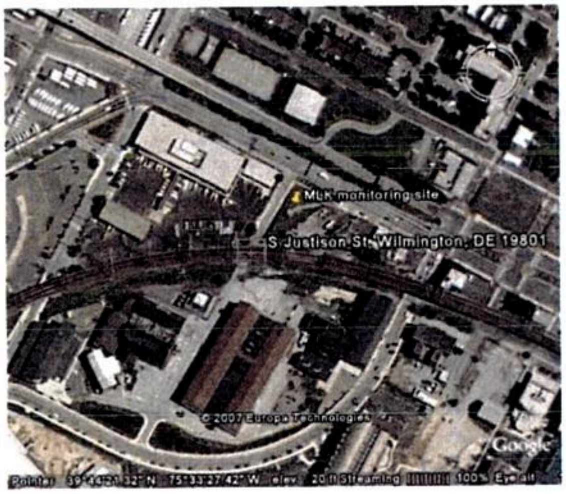
Site Description: The Lums Pond site is a neighborhood scale site located in a general upwind direction from Wilmington. The immediate area is rural. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives: The site objectives for O_3 are upwind background for the Wilmington area, population exposure, NAAQS compliance, and trends. This site was originally planned to monitor O_3 transported into Delaware from the Baltimore/Washington area, and continues to serve this purpose. The SO_2 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 regional transport and general population exposure site, as well as for NAAQS compliance. The scale of representation was changed to Urban (4 – 50 km) to reflect the background and transport monitoring objectives.

Planned Changes through 2017: No changes planned.

Site: MLK

County:	New Castle	Latitude:	39.7395	
Address:	Justison St. and MLK Blvd	Longitude:	-75.5575	
AQS site ID:	10-003-2004	Year Established:	1999	
Spatial Scale:	Neighborhood	Area Represented (MSA):	Philadelphia- Camden- Wilmington PA- NJ- DE-MD	



Monitored Parameters

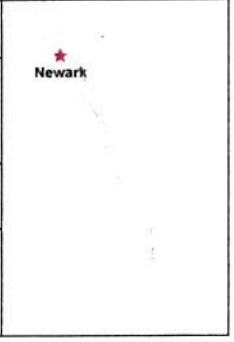
Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$ continuous	PM_{10}	Wind Speed	Wind Direction	NO/NO_y	Lead	$PM_{10-2.5}$	VOCs	Metals	Black Carbon	Temp & Rel. Hum.
X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X

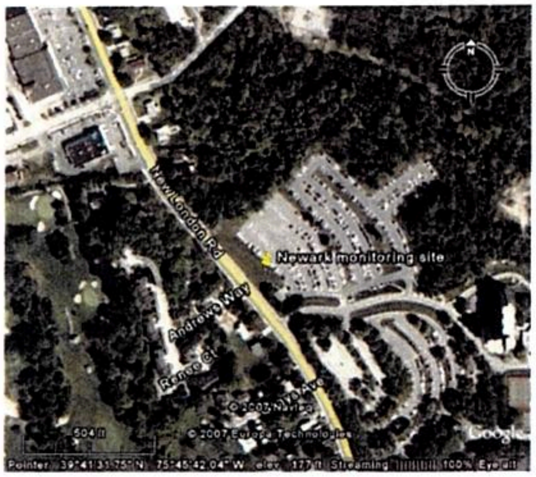
Site Description: The MLK site is located in Wilmington at the intersection of Justison St. and MLK Blvd. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years and was discontinued due to a change in land ownership. The MLK site is the state NCore site and represents urban population exposure to multiple pollution sources. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives: Monitoring objectives are population exposure, maximum concentration, NAAQS compliance, NCore, and trends.

Planned Changes through 2017: End NCore Pb monitoring, continue Pb as part of $PM_{2.5}$ speciation and metals.

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 (MSA):	Philadelphia- Camden- Wilmington PA- NJ-DE-MD	



Monitored Parameters

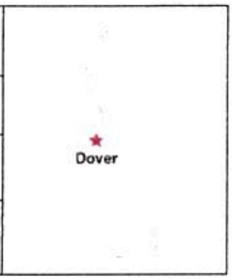
Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$ continuous	PM_{10}	Wind Speed	Wind Direction
				X					

Site Description: The Newark site is a platform only and was established to understand $PM_{2.5}$ concentrations in the Newark area and potentially transported $PM_{2.5}$ from upwind areas to the west. It is a $PM_{2.5}$ neighborhood scale site. The location is suburban and generally impacted by mobile sources and regional transport. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

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

Planned Changes through 2017: No changes planned.

Site: Dover

County:	Kent	Latitude:	39.1556	
Address:	Water St.	Longitude:	-75.5182	
AQS site ID:	10-001-0003	Year Established:	1999	
Spatial Scale:	Neighborhood	Area Represented (MSA):	Dover	

Monitored Parameters

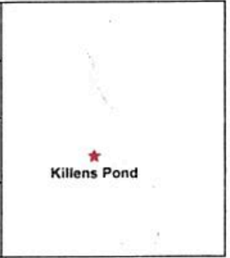
Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$ continuous	PM_{10}	Wind Speed	Wind Direction
				X					

Site Description: The Dover site is a platform only and was established to understand fine particulate concentrations in the Dover area as well as speciated components of fine particulate. It is a neighborhood scale site representative of the Dover MSA, and is impacted by a combination of source types including mobile, large and small point sources. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

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

Planned Changes through 2017: No changes planned.

Site: Killens Pond

County:	Kent	Latitude:	38.9867	
Address:	Killens Pond Rd.	Longitude:	-75.5568	
AQS site ID:	10-001-0002	Year Established:	1995	
Spatial Scale:	Urban	Area Represented (MSA):	Not in an urban area	

Monitored Parameters

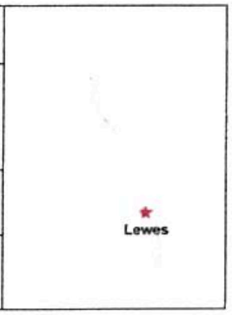
Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$ continuous	PM_{10}	Wind Speed	Wind Direction
X				X		X		X	X

Site Description: The Killens Pond site is located in a rural area that is part of Killens Pond State Park. It was established to understand background concentrations of ozone and $PM_{2.5}$. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives: The objectives for this site are background concentrations, NAAQS compliance, and trends. The scale of representation was changed to Urban (4 – 50 km) to reflect the background monitoring objective.

Planned Changes through 2017: No changes planned.

Site: Lewes

County:	Sussex	Latitude:	38.7791	
Address:	University of Delaware College of Marine Studies	Longitude:	-75.1632	
AQS site ID:	10-005-1003	Year Established:	1997	
Spatial Scale:	Neighborhood	Area Represented (MSA):	Salisbury MD-DE	

Monitored Parameters

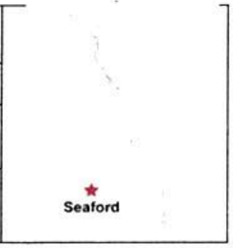
Ozone	SO_2	CO	NO_2	$PM_{2.5}$	$PM_{2.5}$ speciation	$PM_{2.5}$ continuous	PM_{10}	Wind Speed	Wind Direction
X	X							X	X

Site Description: The Lewes site is neighborhood scale, and was established to understand ozone concentrations in the coastal area where population increases significantly in the summer months. SO2 was added in 2012 in response to the new SO2 NAAQS monitoring requirements. It is near the University of Delaware College of Marine Studies campus in Lewes, and is representative of the coastal Sussex County area. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

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

Planned Changes through 2017: No changes planned.

Site: Seaford

County:	Sussex	Latitude:	38.6539	
Address:	350 Virginia Ave.	Longitude:	-75.6106	
AQS site ID:	10-005-1002	Year Established:	1990	
Spatial Scale:	Neighborhood	Area Represented (MSA):	Salisbury MD-DE	

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 Seaford site was originally located to monitor pollutant concentrations in the Seaford area. The original site was 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. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

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

Planned Changes through 2017: No changes planned.

Monitoring method information

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

Parameter AQS code	AQS Method Code	Method Description/ Analysis Method
O3 - 44201	047 – TE 49i 087 – API T400 Teledyne	UV Absorption
SO2 - 42401	560 - TE 43i-TLE	UV Fluorescence
CO - 42101	554 – TE 48i-TLE 593 – TAPI Trace CO	Non-dispersive Infrared
NO2 - 42602	574 – TE 42i-TL 599 –TAPI T200 NO, NOx 600 –TAPI T200 NO2	Chemiluminescence
NOy - 42600	674 – TE 42i-Y NOy	Chemiluninescence
PM2.5 - 88101	145 – TE Partisol 2025 VSCC Inlet 184 – TE SHARP 5030i FEM (continuous)	Gravimetric Beta-attenuation/Nephalometer
$PM_{2.5}$ Speciation – Ions*	812 – Met One SASS	Nylon filter, Ion chromatography
$PM_{2.5}$ Speciation – Carbon*	839 – URG 3000N	Quartz filer and cyclone inlet; IMPROVE carbon Thermal Optical Reflectance (TOR) analysis method
$PM_{2.5}$ Speciation – Metals*	811 – Met One SASS	Teflon filter, energy dispersive XRF
PM10 – 85129 local conditions	127 – TE Partisol 2025 Sequential	Gravimetric
PMcoarse – 86101 PM10-2.5 local conditions	176 – TE Partisol 2025 Sequential Pair	Calculated from paired samplers
Lead – 85129 PM10 local conditions	811 – TE Partisol 2025 Sequential	X-ray fluorescence, low-volume PM10 sampler
Air Toxics – VOCs*	150 – SS 6L – Pressurized Canister	Cryogenic pre-concentration: GC/MS
Air Toxics – Metals *	089 – High-Volume TSP	ICP/MS Quartz filters
WS/WD	020 – Vaisala vector method	Ultrasonic

* Multiple parameters in this group; see next table for list of compounds.

Group	Compounds
VOCs	Dichlorodifluoromethane, Chloromethane, 1,2-Dichloro-1,1,2,2,tetrafluoroleth, Chloroethene, 1,3-Butadiene, Trichlorofluoromethane, Acetone, Methylene Chloride, 1,1,2-Trichloro-1,2,2-trifluoroethane, 2-methoxy-2-methyl-Propane, Hexane, Chloroform, Tetrahydrofuran, 1,2-Dichloroethane, 1,1,1-Trichloroethane, Benzene, Carbon tetrachloride, Cyclohexane, 1,2-Dichloropropane, Trichloroethene, Heptane, Cis-1,3-Dichloro-1-Propene, Trans-1,3-Dichloro-1-Propene, Toluene, 1,2-Dibromoethane, Tetrachloroethylene, Chlorobenzene, Ethylbenzene, m & p- Xylene, Styrene, 1,1,2,2-Tetrachloroethane, o-Xylene, 1-Ethyl-4-Methylbenzene, 1,3,5-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,4-Dichlorobenzene
Metals	Arsenic (12103), Cadmium (12110), Chromium (12112), Lead (12128), Manganese (12132), Nickel (12136)
$PM_{2.5}$ Speciation – ions, carbon, and metals	Ammonium, Nitrate, Sulfate, Potassium, Sodium Elemental carbon (E1 IMPROVE, E2 IMPROVE, E3 IMPROVE, EC IMPROVE TOR, EC IMPROVE TOT) Organic carbon (O1 IMPROVE, O2 IMPROVE, O3 IMPROVE, O4 IMPROVE, OC IMPROVE TOR, OC IMPROVE TOT, OP IMPROVE TOR), OP IMPROVE TOT, TC IMPROVE Aluminum, Antimony, Arsenic, Barium, Bromine, Cadmium, Calcium, Cerium, Cesium, Chlorine, Chromium, Cobalt, Copper, Europium, Gallium, Gold, Hafnium, Indium, Iridium, Iron, Lanthanum, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Niobium, Phosphorus, Potassium, Rubidium, Samarium, Scandium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Tantalum, Terbium, Tin, Titanium, Vanadium, Wolfram, Yttrium, Zinc, and Zirconium

Ozone (O_3)
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_2)
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_2 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_2) and NOy
Nitrogen oxides are measured using the chemiluminescence reaction of NO with O_3. 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_2. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. NO_2 must be measured indirectly.

NO_2 is measured by passing the air through a converter where any NO_2 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 NO_2 concentration is equal to the difference between NO and NO_X.

NOy is measured by the same method as NOx 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 detected as described previously.

Particulate Matter - Fine ($PM_{2.5}$), PM_{10}, and PMcoarse
$PM_{2.5}$ 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.

$PM_{2.5}$ continuous is measured by time-averaged measurements of an integral beta attenuation mass sensor which also incorporates a nephalometer signal to ensure that the measured mass concentration remains independent of changes in the particle population being sampled.

PM_{10} samples are collected using the same general method as $PM_{2.5}$ with a specially designed inlet that excludes particles larger than 10 microns in diameter. Samples are collected every third day.

PMcoarse is calculated by subtracting the $PM_{2.5}$ concentration from the collocated PM_{10} concentration for the same day.

$PM_{2.5}$ Speciation

Some of the gravimetric $PM_{2.5}$ monitors are specially equipped to collect $PM_{2.5}$ samples which are later analyzed into concentrations of the samples' chemical constituents or species. MetOne Super SAAS samplers, URG 3000N, and IMPROVE samplers are used for the collection of samples for the chemical speciation of $PM_{2.5}$. The samplers collect 3 samples simultaneously every third day for a period of 24 hours. These samples are then sent to an EPA contract laboratory for chemical analyses. There are over 50 species consisting of ions, metals and carbon species quantified by the analyses.

VOCs

Air toxics samples are collected for 24 hours in canisters with a XonTech 910A or Atec 2200 canister sampler on an every sixth day schedule. The canisters are returned to the Maryland Department of the Environment laboratory for analysis on an Entech/Agilent gas chromatograph mass spectrometer system.

Metals

Metals are collected for 24 hours with a high-volume TSP sampler on a quartz filter. The filter is sent to the West Virginia Division of Air Quality laboratory for analysis using ICP/MS.

Ozone (O_3)

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_2)

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_2 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_2) and NOy

Nitrogen oxides are measured using the chemiluminescence reaction of NO with O_3. 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_2. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. NO_2 must be measured indirectly.

NO_2 is measured by passing the air through a converter where any NO_2 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 NO_2 concentration is equal to the difference between NO and NO_X.

NOy is measured by the same method as NOx 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 detected as described previously.

Particulate Matter - Fine ($PM_{2.5}$), PM_{10}, and PMcoarse

$PM_{2.5}$ 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.

1. The TO-11A test method, as used in the National Air Toxics Trends (NATTS) program[1] will be used.

- **Nitrogen Oxides –** Will monitor for NO and NO_y (total oxides of nitrogen) in addition to true NO_2. The true NO_2 is required to be measured with a direct reading NO_2 analyzer, cavity attenuated phase shift (CAPS) spectroscopy or photolytic-converter NO_x analyzer. We have elected to use Model *T500U CAPS NO2* Analyzer for the true NO2 measurement. NO and NOy will be measured using a *Thermo Environmental 42i-Y*

Table 1 PAMS Target Compound List

Priority Compounds				Optional Compounds			
1	1,2,3-trimethylbenzene [a]	19	n-hexane [b]	1	1,3,5-trimethylbenzene	19	m-diethlybenzene
2	1,2,4-trimethylbenzene [a]	20	n-pentane	2	1-pentene	20	methylcyclohexane
3	1-butene	21	o-ethyltoluene [a]	3	2,2-dimethylbutane	21	methylcyclopentane
4	2,2,4-trimethylpentane [b]	22	o-xylene [a,b]	4	2,3,4-trimethylpentane	22	n-decane
5	acetaldehyde [b,c]	23	p-ethyltoluene [a]	5	2,3-dimethylbutane	23	n-heptane
6	acetone [c,d]	24	Propane	6	2,3-dimethylpentane	24	n-nonane
7	benzene [a,b]	25	propylene	7	2,4-dimethylpentane	25	n-octane
8	c-2-butene	26	styrene [a,b]	8	2-methylheptane	26	n-propylbenzene [a]
9	ethane [d]	27	toluene [a,b]	9	2-methylhexane	27	n-undecane
10	ethylbenzene [a,b]	28	t-2-butene	10	2-methylpentane	28	p-diethylbenzene
11	Ethylene			11	3-methylheptane	29	t-2-pentene
12	formaldehyde [b,c]			12	3-methylhexane	30	α/β-pinene
13	Isobutane			13	3-methylpentane	31	1,3 butadiene [b]
14	Isopentane			14	Acetylene	32	benzaldehyde [c]
15	Isoprene			15	c-2-pentene	33	carbon tetrachloride [b]
16	m&p-xylenes [a,b]			16	cyclohexane	34	Ethanol
17	m-ethyltoluene [a]			17	cyclopentane	35	Tetrachloroethylene [b]
18	n-butane			18	isopropylbenzene [b]		

Source: Revisions to the Photochemical Assessment Monitoring Stations Compound Target List.
U.S. EPA, November 20, 2013

[a] Important SOAP (Secondary Organic Aerosols Precursor) Compounds
[b] HAP (Hazardous Air Pollutant) Compounds
[c] Carbonyl compounds
[d] Non-reactive compounds, not considered to be VOC for regulatory purposes

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[1] See NATTS Technical Assistance Document for TO-11A method.

Attachment 1 Equipment Inventory

Region	3		
State	Delaware		
AQS ID	10-003-2004		
CBSA	Philadelphia-Camden-Wilmington		
	Parameter	**Category**	**Detail**
	Site	Is the AQS site listed above the expected PAMS Core site?	**Yes**
		What is the status of the decision for the expected PAMS Core site location (not started, draft, or final)?	**Final**
		Is there an alternate PAMS Core site location selected?	**No**
		Identify type of alternative site (existing PAMS, NATTS, etc.)	
		Alternate site AQS ID (if known)	
	Mixing Height	Is there an existing functional ceilometer o other similar instrument available for use?	**No**
		Current location (at future PAMS Core site, at other site, not applicable)	
		Instrument type (ceilometer, radar profiler, etc.)	
		Manufacturer	
		Model	
		Date purchased	
		Comments	
	Auto GC	Is there an existing Auto GC available for use?	**No**
		Current location (at future PAMS Core site, at other site, not applicable)	
		Manufacturer	
		Model	
		Date purchased	
		Does it have a service contract?	
		Comments	
	True NO2	Is there an existing true NO2 instrument available for use?	**No**
		Current location (at future PAMS Core site, at other site, not applicable)	
		Instrument type (photolytic conversion, cavity ringdown, CAPS, etc.)	
		Manufacturer	
		Model	
		Date purchased	
		Comments	
	Carbonyls Sampling	Is there an existing sequential carbonyls sampling unit or similar instrument available for use?	**No**
		Current location (at future PAMS Core site, at other site, not applicable)	
		Instrument type (photolytic conversion, cavity ringdown, CAPS, etc.)	
		Manufacturer	
		Model	
		Date purchased	
		Comments	
	Carbonyls Analysis	Does the site currently have a support laboratory for carbonyls or plans to use a support laboratory?	**Yes**
		Laboratory name	**City of Philadelphia AMS**
		Comments	
	Barometric Pressure	Instrument type (aneroid barometer, etc.)	**capacitive silicon**
		Manufacturer	**Vaisala**
		Model	**WXT 520**
		Date purchased	**12/2011**
		Comments	
	UV Radiation	Instrument type (UV radiometer, etc.)	
		Manufacturer	
		Model	
		Date purchased	

		Comments	
	Solar Radiation	Instrument type (pyranometer, etc.)	
		Manufacturer	
		Model	
		Date purchased	
		Comments	
	Precipitation	Instrument type (tipping bucket, weighing, etc.)	**piezoelectrical sensor**
		Manufacturer	**Vaisala**
		Model	**WXT 520**
		Date purchased	**12/2011**
		Comments	