2014 Photochemical Assessment Monitoring Station (PAMS) Summary

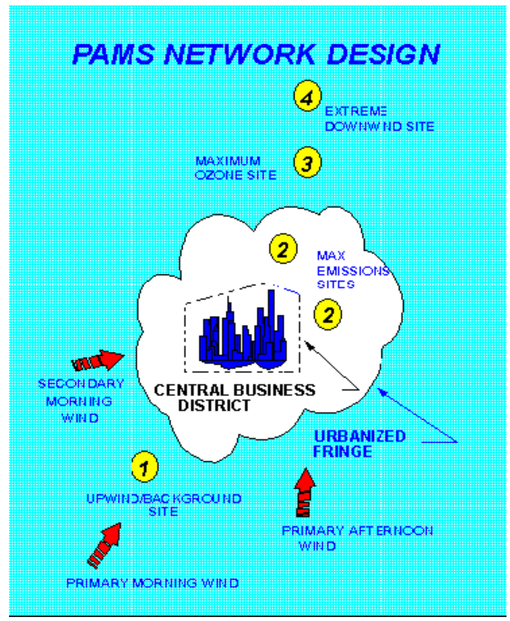
New Jersey Department of Environmental Protection

Photochemical Assessment Monitoring Stations (PAMS)

Most ground-level ozone (O_3) is formed from oxides of nitrogen (NOx) and volatile organic compounds (VOCs) reacting in the presence of sunlight. Therefore, to effectively evaluate strategies for reducing ozone levels, it is necessary to measure these ozone-forming pollutants, also known as precursor pollutants. The Photochemical Assessment Monitoring Stations (PAMS) network was established by the U.S. Environmental Protection Agency (USEPA) for this purpose. Data from the PAMS network is used to better characterize the nature and extent of the O_3 problem, track VOC and NOx emission inventory reductions, assess air quality trends, and make attainment/nonattainment decisions. PAMS monitor both criteria and non-criteria pollutants, including ozone, NOx, nitric oxide (NO), nitrogen dioxide (NO_2), as well as specific VOCs, including several carbonyls that are important in ozone formation. In addition, the measurement of specific weather parameters (wind speed, wind direction, temperature) is required at all PAMS, and upper air weather measurements are required in certain areas. The VOC and carbonyl measurements are only taken during peak ozone season, from June 1st to August 31st each year.

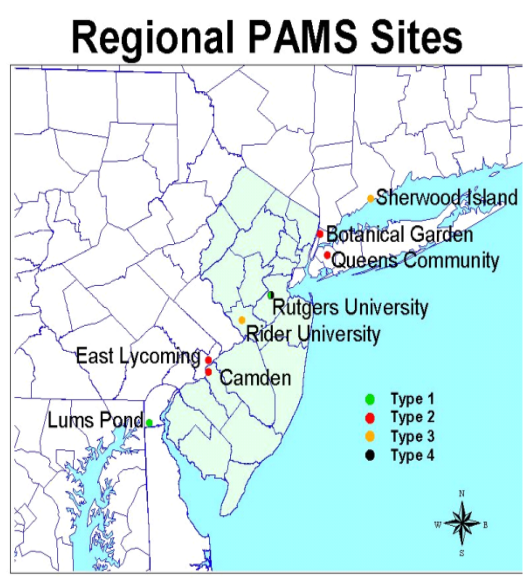
The PAMS network is designed around metropolitan areas where ozone is a significant problem. Each site in the network has a specific purpose, as shown in Figure 1. New Jersey is part of both the Philadelphia and New York Metropolitan areas and has historically operated a total of three PAMS sites. A Type 3 maximum ozone site for the Philadelphia area was located at Rider University in Mercer County. A secondary Type 2 (or Type 2A) maximum emissions site was located downwind of the Philadelphia Metropolitan urban area in Camden. The site at Rutgers University in New Brunswick has been designated both a PAMS Type 1 upwind site for the New York urban area, as well as a Type 4 downwind site for the Philadelphia Metropolitan urban area. An upper air weather monitoring station is also located at the Rutgers University site. All of the PAMS sites for the Philadelphia and New York City areas are shown in Figure 2.

Figure 1



[5] USEPA , PAMS General Information

Figure 2

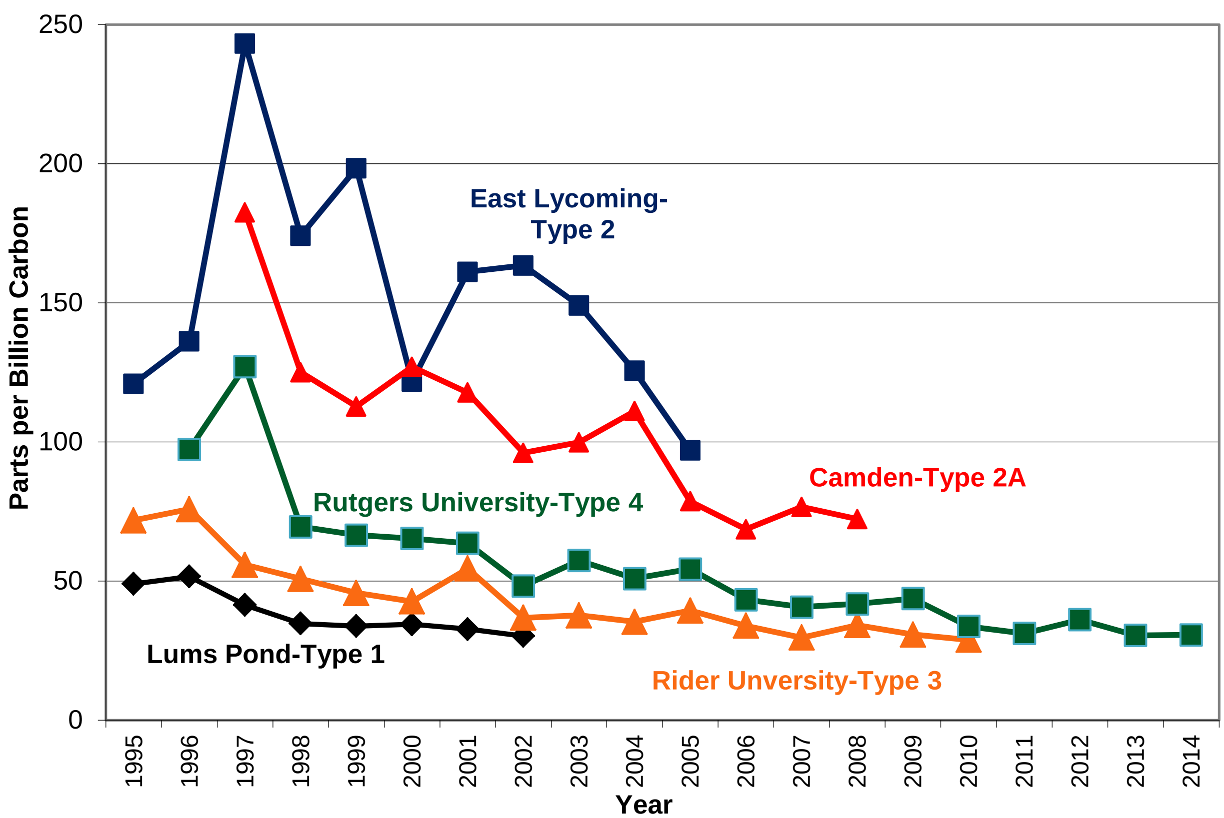


Note: Rutgers University PAMS site is both Type 4 for Philadelphia and Type 1 for New York City.

PHILADELPHIA REGION

Figure 3 shows VOC trends for the PAMS sites for the Philadelphia Metropolitan area. In general, at the Lums Pond (upwind - Type 1), Rider University (maximum ozone concentration - Type 3) and Rutgers University (downwind - Type 4), VOCs have declined over the measurement period. The improvements were initially more dramatic, with more level, though still discernibly declining concentrations, over the last several years. The maximum emissions -Type 2 sites (Camden and East Lycoming) for this area show more variation from year to year, though the trend at both sites is downward since 1997. This greater variability may be due to the fact that Type 2 sites are typically impacted by varied sources, whereas the other sites are mostly impacted by transportation sources.

Figure 3
Philadelphia Region
Total Non-Methane Organic Carbon (TNMOC)
Seasonal Average 1995-2014



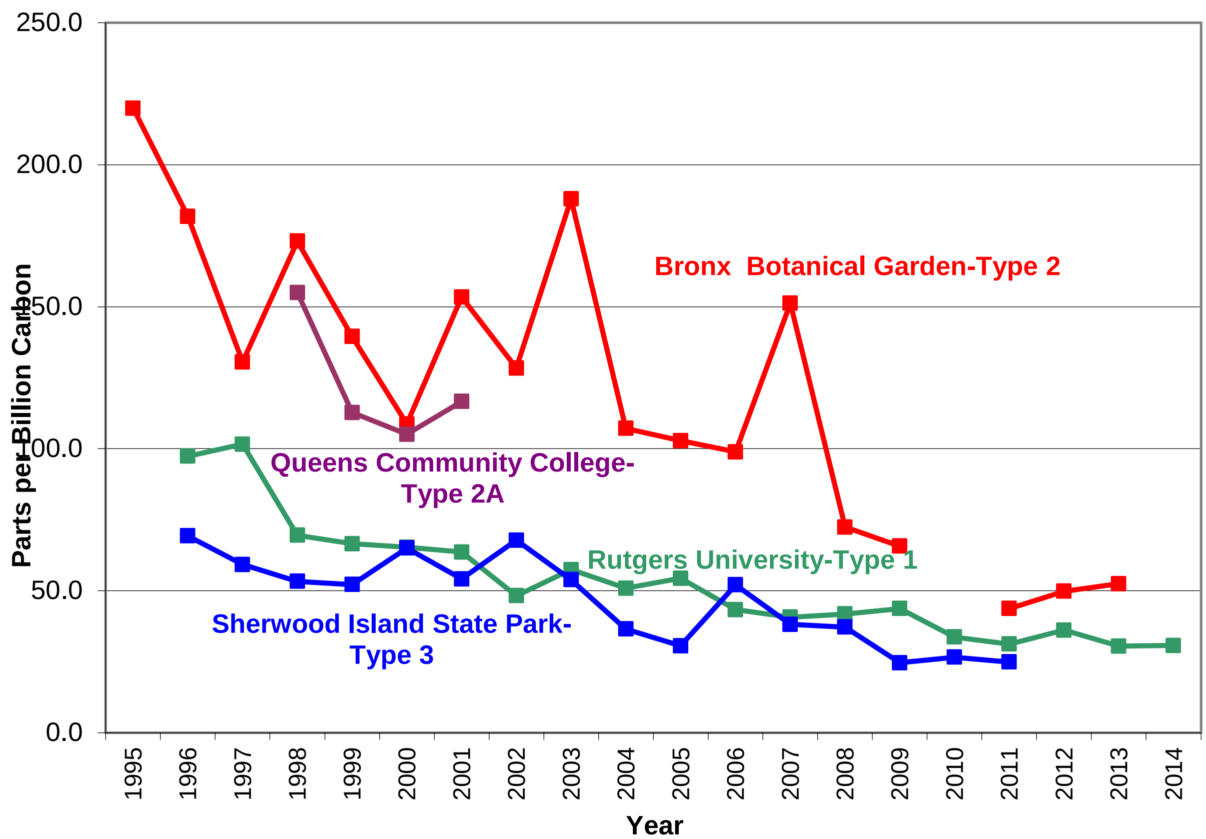
NOTE: Delaware's Department of Natural Resources and Environmental Control (DNREC) discontinued operation of the Lums Pond site after the 2002 season. Philadelphia's Air Management Services Laboratory still operates the PAMS site at their East Lycoming lab, but as of 2006 they no longer report Total Non-Methane Organic Carbon (TNMOC). Our Camden site was shut down in 2008 when we lost access to the site. The Rider University site was removed from the PAMS network following the 2010 season. An evaluation of the site showed this data was not significantly different from the Rutgers University site and it was discontinued as part of an overall restructuring of the monitoring network.

NEW YORK REGION

Figure 4 shows VOC trends for the PAMS sites in the New York City metropolitan area. In general, observations in the NYC area are similar to those for the Philadelphia area. The Type 2 site in the NY area at the Bronx Botanical Gardens shows even more year to year variability than does the Philadelphia Type 2 site at East Lycoming.

NOTE: Operation of the Queens Community College site was discontinued after the 2001 season. No data was reported for the Bronx Botanical Garden site for 2010 due to equipment problems. The Sherwood Island site began using new equipment in 2012 which doesn't allow for a measure of TNMOC.

Figure 4
New York City Region
Total Non-Methane Organic Carbon (TNMOC)
Seasonal Average 1995-2014



SUMMARY

Trends for VOC values measured at all PAMS sites in the Philadelphia and New York City areas show an impressive decline over the time period during which these measurements have been made. Some of these reductions can be attributed to mandated changes in gasoline formulation over the period, as well as cleaner vehicles replacing older vehicles in the automotive fleet. Type 2 sites, though impacted by vehicle emissions, are also affected by stationary sources. Emission trends for these sources over the measurement period are less clear, and Type 2 sites seem to show more year-to-year variability. All sites are also impacted by naturally-occurring VOCs such as isoprene, which is emitted by trees. All VOCs are not equal in their contribution to ozone formation; while isoprene levels are generally lower than many other VOCs, isoprene can account for a significant amount of ozone-forming potential, especially in non-urban areas. Isoprene levels are highest during the middle of the day, when photochemical conditions are most conducive to ozone formation. Isoprene emissions are thought to be influenced by factors that affect tree health and growth, such as rainfall and severe temperatures.

Results for all of the VOCs measured at the New Jersey PAMS sites can be found in Table 1.

Table 1
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July and August 2014

Parts per Billion (Volume) – ppbv
Parts per Billion (Carbon) – ppbC

	Rutgers University			
	ppbv		**ppbC**	
	Average	**Maximum**	**Average**	**Maximum**
Acetylene	0.11	5.57	0.23	11.14
Benzene	0.05	0.63	0.33	3.80
n-Butane	0.44	8.06	1.74	32.23
1-Butene	0.02	0.32	0.08	1.26
cis-2-Butene	0.01	0.72	0.05	2.87
trans-2-Butene	0.02	0.46	0.07	1.83
Cyclohexane	0.03	0.53	0.16	3.16
Cyclopentane	0.02	0.50	0.10	2.48
n-Decane	0.01	0.27	0.11	2.66
m-Diethylbenzene	0.01	0.09	0.12	0.94
p-Diethylbenzene	0.01	0.26	0.11	2.62
2,2-Dimethylbutane	0.01	0.20	0.07	1.19
2,3-Dimethylbutane	0.03	0.70	0.17	4.19
2,3-Dimethylpentane	0.02	0.29	0.14	2.06
2,4-Dimethylpentane	0.03	0.98	0.18	6.85
Ethane	1.99	10.39	3.97	20.77
Ethylbenzene	0.02	0.29	0.13	2.33
Ethylene (Ethene)	0.20	5.29	0.39	10.57
m-Ethyltoluene	0.01	0.25	0.09	2.28
o-Ethyltoluene	0.01	0.12	0.05	1.08
p-Ethyltoluene	0.02	0.46	0.17	4.13

Table 1 (Continued)
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July and August 2014

Parts per Billion (Volume) – ppbv
Parts per Billion (Carbon) – ppbC

	Rutgers University			
	ppbv		**ppbC**	
	Average	**Maximum**	**Average**	**Maximum**
n-Heptane	0.09	1.05	0.63	7.37
Hexane	0.06	1.30	0.33	7.78
1-Hexene	0.01	0.30	0.08	1.82
Isobutane	0.16	1.80	0.65	7.19
Isopentane	0.38	14.90	1.90	74.50
Isoprene	0.16	2.89	0.79	14.45
Isopropylbenzene	0.01	0.08	0.06	0.73
Methylcyclohexane	0.03	0.43	0.18	3.03
Methylcyclopentane	0.03	0.45	0.19	2.67
2-Methylheptane	0.01	0.21	0.07	1.23
3-Methylheptane	0.01	0.23	0.07	1.37
2-Methylhexane	0.02	0.35	0.17	2.77
3-Methylhexane	0.03	0.39	0.21	3.13
2-Methylpentane	0.06	1.80	0.45	12.63
3-Methylpentane	0.04	1.04	0.29	7.28
n-Nonane	0.01	0.25	0.11	2.26
n-Octane	0.01	0.34	0.12	2.74
n-Pentane	0.22	6.85	1.09	34.23
1-Pentene	0.01	1.00	0.06	5.02
cis-2-Pentene	0.01	0.94	0.04	4.68
trans-2-Pentene	0.01	1.85	0.07	9.25
Propane	0.93	18.83	2.79	56.50
n-Propylbenzene	0.01	0.07	0.05	0.61
Propylene (Propene)	0.15	1.86	0.44	5.58
Styrene	0.01	0.09	0.09	0.73
Toluene	0.15	1.60	1.07	11.23
1,2,3-Trimethylbenzene	0.03	0.99	0.28	8.92
1,2,4-Trimethylbenzene	0.03	0.45	0.25	4.01
1,3,5-Trimethylbenzene	0.01	0.19	0.06	1.73
2,2,4-Trimethylpentane	0.03	0.46	0.23	3.65
2,3,4-Trimethylpentane	0.02	0.30	0.19	2.41
n-Undecane	0.01	0.25	0.09	2.70
m/p-Xylene	0.05	1.17	0.41	9.35
o-Xylene	0.02	0.43	0.18	3.43

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