2.0 AIR QUALITY AMBIENT AND EMISSION INVENTORY DATA

This chapter provides an analysis of the fine particulate matter and precursor ambient air quality data for the entire State of New Jersey, as well as for both the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas. The data was obtained from the United States Environmental Protection Agency's (USEPA's) online database, AirData,[1] which provides data summaries using the Air Quality System (AQS) data subsystem. AirData was also used to obtain data for the other states that share a nonattainment area with New Jersey. This USEPA data was updated with data provided by the other state agencies, where available.[2] In general, the pollutant concentrations presented in this chapter are expressed as micrograms per cubic meter (µg/m^3) unless otherwise stated.

2.1 Measuring Fine Particle Pollution in the Atmosphere – An Introduction to PM$_{2.5}$ Monitoring

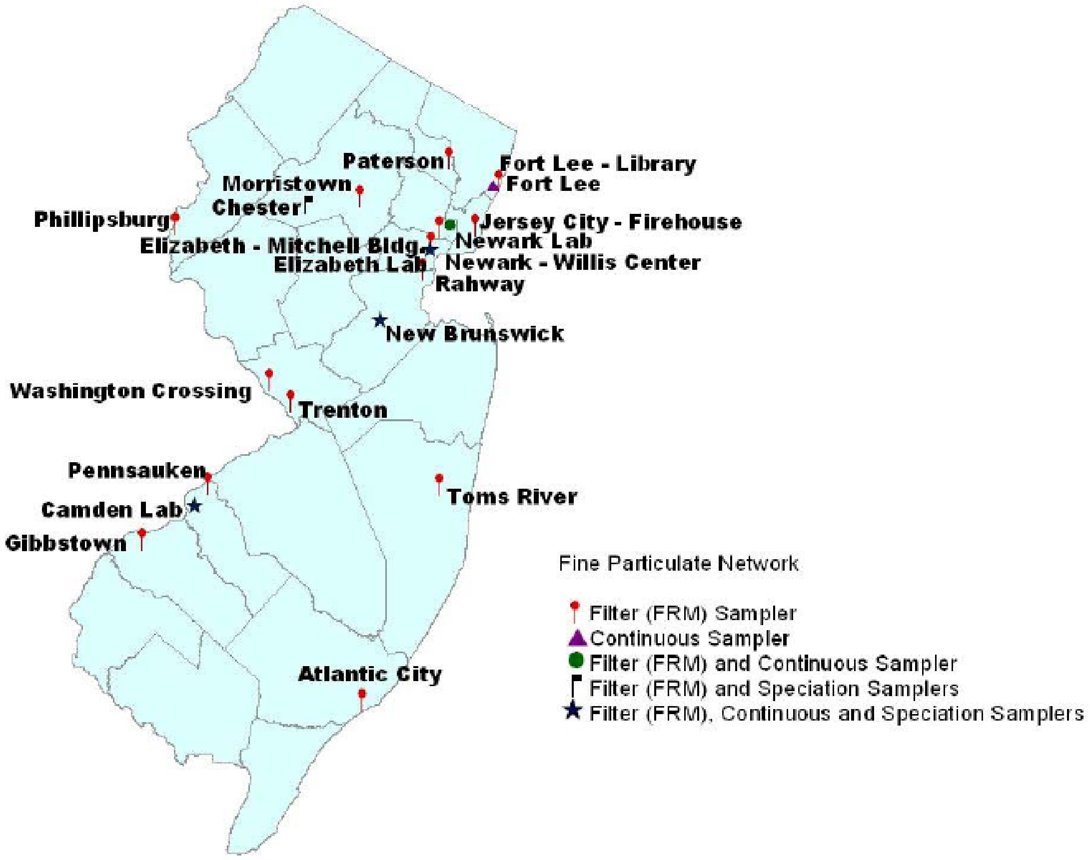
In order to monitor the levels of PM$_{2.5}$ and compare those levels to the National Ambient Air Quality Standards (NAAQS), the USEPA established criteria for ambient air quality networks for PM$_{2.5}$ at 40 C.F.R. Pt. 58. Figure 2.1 shows the New Jersey Fine Particulate Monitoring Network. Some locations have multiple samplers. There are 19 monitoring sites in New Jersey where the Federal Reference Method sampler (FRM) routinely collects 24-hour PM$_{2.5}$ samples. All sites collect a sample once every three days, with the exception of Elizabeth Lab which samples daily. Ambient air quality monitoring of PM$_{2.5}$ began in 1999. As of 2006, nine sites also continuously monitor fine particle concentrations and transmit the data every minute to the Bureau of Air Monitoring's (BAM's) central computer, where the data is made available on the BAM's public website (www.state.nj.us/dep/airmon). In addition, the NJDEP has a Speciation Network which consists of four sites at which filters are collected and analyzed to determine their chemical characteristics. Speciation monitoring is conducted to determine the chemical characteristics of the fine particles. Samples are collected once every three days concurrent with FRM sampling.

---

[1] USEPA. AirData: Access to Air Pollution Data, United States Environmental Protection Agency, http://www.epa.gov/air/data/index.html.

[2] The New Haven/Stiles St., CT monitor was designated as a "special purpose" monitor, and as such cannot be used to make an attainment or nonattainment designation. The site was found to be overly influenced by micro-scale phenomena, including heavy duty truck exhaust from trucks leaving the New Haven Terminal area and accelerating uphill on the Interstate-95 on-ramp. The monitor was less than twenty feet from the traffic lane. Following a special, multi-site monitoring study conducted by CTDEP, the Stiles Street monitor was deemed unrepresentative of population exposure in the City of New Haven. In 2006, it was shut down as part of the I-95 bridge reconstruction project. The information on this site, therefore, is for informational purposes only and should not be used to assess attainment of the standard.

Figure 2.1: **Particulate Monitoring Network in New Jersey**



2.2 USEPA NAAQS for Fine Particle Pollution: Annual $PM_{2.5}$

2.2.1 Annual $PM_{2.5}$ Mean Concentrations and Design Values

A nonattainment area demonstrates compliance with the 1997 annual $PM_{2.5}$ standard when the 3-year average of the exceeding sites' annual arithmetic mean $PM_{2.5}$ concentrations from a monitor is 15.0 µg/m^3 or less. Each 3-year average is commonly referred to as the design value for that monitoring site. The design value for the nonattainment area is the highest value from all the sites in the nonattainment area. A design value is only valid if minimum data completeness criteria for the monitoring site are met. With regard to the annual $PM_{2.5}$ standard, a site meets National Ambient Air Quality Standard (NAAQS) completeness criteria if it registered 75 percent or more data capture each quarter of the three year period in question.[3] $PM_{2.5}$ annual means are calculated from the four calendar quarterly averages at each monitoring site. Refer to the USEPA guidance issued in 1999 for more details on calculations and data handling for

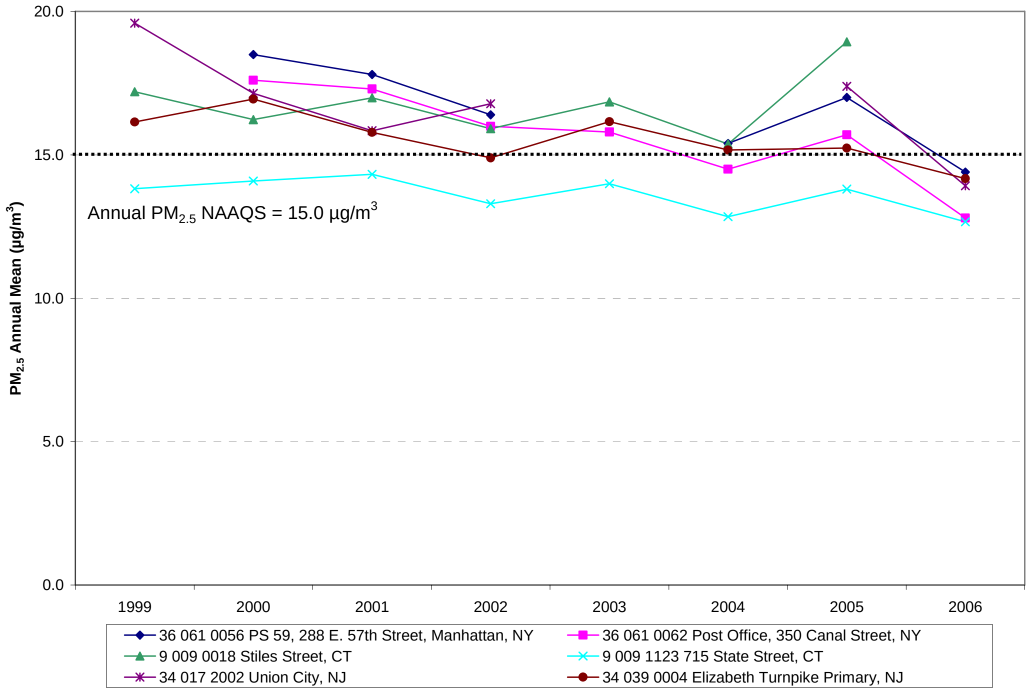
---

[3] For the purposes of presenting the current state of air quality in New Jersey, data that did not meet the 75 percent completeness requirement were included in this chapter and should not be used to make formal determinations about meeting the NAAQS.

$PM_{2.5}$.[4] In the multi-state 1997 $PM_{2.5}$ Southern New Jersey/Philadelphia nonattainment area, there are three New Jersey monitors, and all are plotted in the figures for this section.

Figures 2.2 and 2.3 show the annual $PM_{2.5}$ mean concentrations for the two consistently highest monitoring sites in each of the states that make up the multi-state Northern New Jersey/New York/Connecticut and the Southern New Jersey/Philadelphia nonattainment areas.[5] In 2006, all the monitors in both annual $PM_{2.5}$ nonattainment areas were below the NAAQS level of 15.0 µg/m^3 in 2006,[6] as seen in Tables 2.1 and 2.2.

<u>Figure 2.2</u>: Northern New Jersey/New York/Connecticut Nonattainment Area Annual $PM_{2.5}$ Mean Concentrations for the Two Consistently Highest Monitors in Each Associated State, 1999-2006[7]



---

[4] USEPA. Guidance on Data Handling Conventions for the PM NAAQS. United States Environmental Protection Agency, Office of Air Quality, Planning and Standards, Research Triangle Park, NC, EPA-454/R-99-008, April 1999.

[5] The monitoring data used to develop this chapter include periods when the monitors were shut down. Monitoring problems that occurred with the monitor that was used to designate the Northern New Jersey/New York/Connecticut nonattainment area, monitor # 360610056, invalidated the data collected for 2003 and were not included in this analysis. Monitoring problems that occurred with the monitor that was used to designate the Southern New Jersey/Philadelphia nonattainment area, i.e., monitor # 421010047, invalidated the data collected for 2005 and 2006 and were not included in this analysis.

[6] 2007 data were undergoing quality assurance and not available for inclusion in this proposal. The preliminary data indicates the ambient air quality data in the two multi-state nonattainment areas is below the NAAQS threshold of 15.0 µg/m^3.

[7] See note 2.

Figure 2.3: Southern New Jersey/Philadelphia Nonattainment Area Annual $PM_{2.5}$ Mean Concentrations for the Consistently Highest Monitors in Each Associated State, 1999-2006[8]

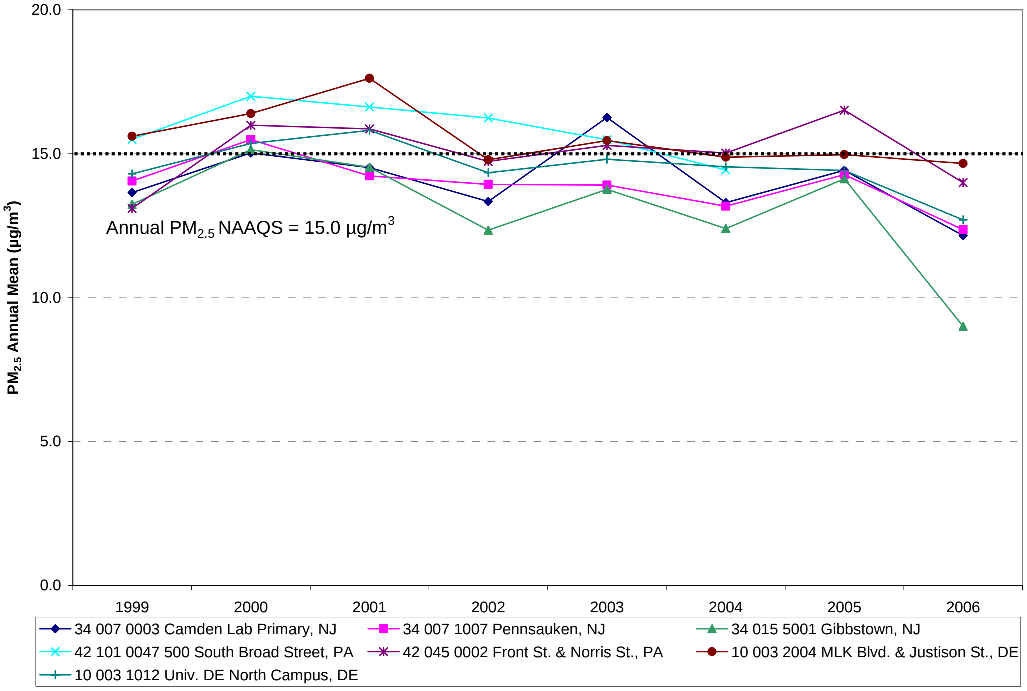


Table 2.1: Northern New Jersey/New York/Connecticut Nonattainment Area Annual $PM_{2.5}$ Means for the Two Consistently Highest Monitors by State, 1999-2006[9]

	New York		Connecticut		New Jersey	
	1st Highest	2nd Highest	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	36-061-0056 PS 59, New York City	36-061-0062 Canal Street, New York City	9-009-0018 Stiles Street, New Haven	9-009-1123 715 State Street, New Haven	34-017-2002 Union City	34-039-0004 Elizabeth Turnpike Primary
Year of Highest	2000	2000	2005	2001	1999	2000
Concentration of Highest (µg/m^3)	18.5	17.6	18.9	14.3	19.6	16.9
Below 1997 Annual $PM_{2.5}$ NAAQS in 2006?	Yes	Yes	No data available	Yes	Yes	Yes

---

[8] See note 2.

[9] See note 2.

Table 2.2: Southern New Jersey/Philadelphia Nonattainment Area Annual $PM_{2.5}$ Means for the Two Consistently Highest Monitors by State, 1999-2006

	New Jersey		Pennsylvania		Delaware	
	1st Highest	2nd Highest	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	34-007-0003 Camden Lab Primary, Camden	34-007-1007 Pennsauken Township, Pennsauken	42-101-0047 500 South Broad Street, Philadelphia	42-045-0002 Front Street & Norris Street, Chester	10-003-2004 MLK Blvd. & Justison Street, Wilmington	10-003-1012 University of Delaware, Newark
Year of Highest	2003	2000	2000	2005	2001	2001
Concentration of Highest (µg/m^3)	16.3	15.5	17.0	16.5	17.6	15.8
Below 1997 Annual $PM_{2.5}$ NAAQS in 2006?	Yes	Yes	No data available[a]	Yes	Yes	Yes

[a] Monitoring problems that occurred with the monitor that was used to designate the Southern New Jersey/Philadelphia nonattainment area, i.e., monitor # 421010047, invalidated the data collected for 2005 and 2006 and were not included in this analysis.

Three years of annual mean concentrations for $PM_{2.5}$ are used to calculate the design value at a monitor.[10] Figures 2.4 and 2.5 show the $PM_{2.5}$ design values for the two consistently highest monitoring sites in each of the states that make up the multi-state Northern New Jersey/New York/Connecticut and the Southern New Jersey/Philadelphia nonattainment areas.[11] They show much progress has been made to attain the 2007 annual $PM_{2.5}$ NAAQS, but more reductions are necessary to attain the NAAQS as some sites remain out of compliance. Tables 2.3 and 2.4 show the maximum $PM_{2.5}$ design values at these sites, which were included in Figures 2.4 and 2.5, respectively.

---

[10] The design value for a nonattainment area is the maximum monitor design value for all monitors for each 3-year period.

[11] See note 5.

Figure 2.4: Northern New Jersey/New York/Connecticut Nonattainment Area Annual $PM_{2.5}$ Design Values for the Two Consistently Highest Monitors in each Associated State, 2001-2006[12]

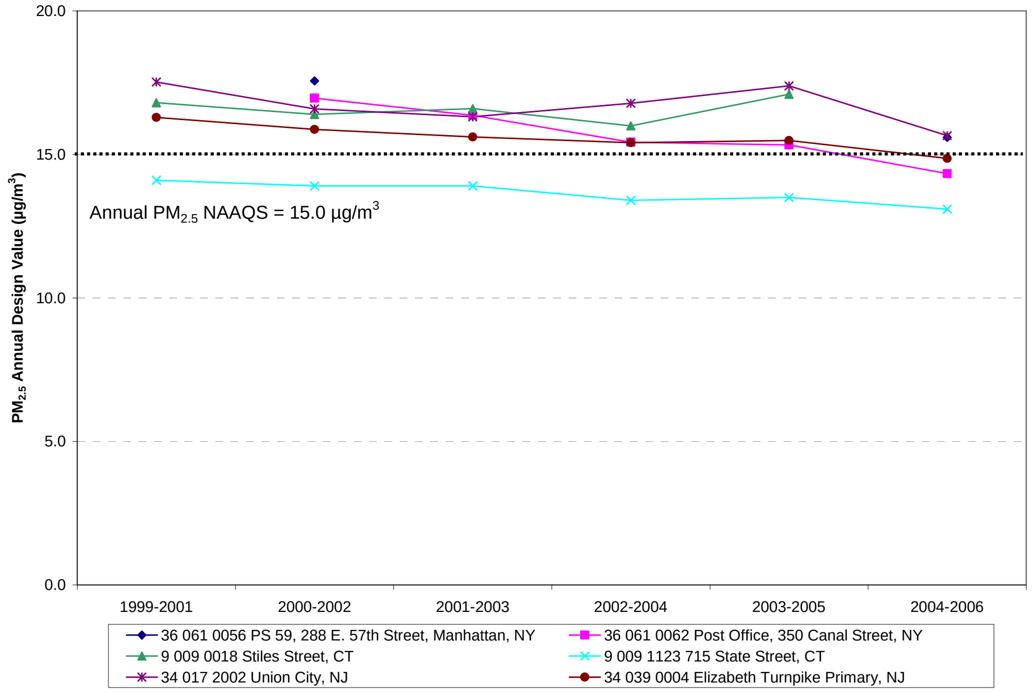
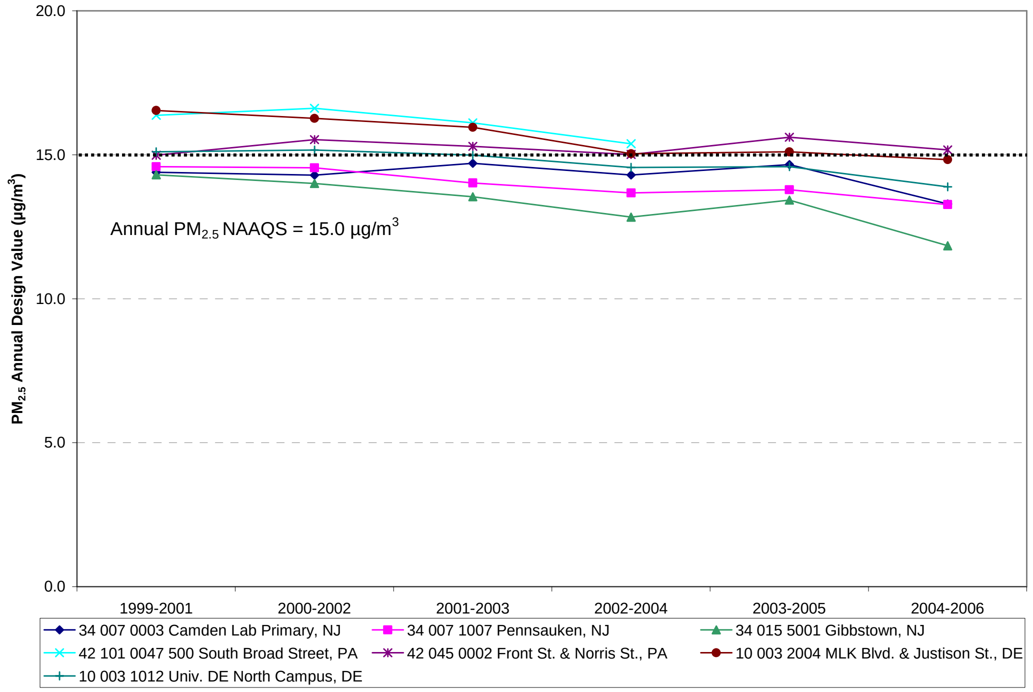


Figure 2.5: Southern New Jersey/Philadelphia Nonattainment Area Annual $PM_{2.5}$ Design Values for the Consistently Highest Monitors in each Associated State, 2001-2006



---

[12] See note 2.

Table 2.3: Northern New Jersey/New York/Connecticut Nonattainment Area Annual $PM_{2.5}$ Design Values for the Two Consistently Highest Monitors by State, 2001-2006[13]

	New York		Connecticut		New Jersey	
	1st Highest	2nd Highest	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	36-061-0056 PS 59, New York City	36-061-0062 Canal Street, New York City	9-009-0018 Stiles Street, New Haven	9-009-1123 715 State Street, New Haven	34-017-2002 Union City	34-039-0004 Elizabeth Turnpike Primary
Year of Highest	2002	2002	2005	2001	2001	2001
Concentration of Highest (µg/m^3)	17.6	17.0	17.1	14.1	17.5	16.3
Below 1997 Annual $PM_{2.5}$ NAAQS in 2006?	No	Yes	2006 data not available	Yes	No	Yes

Table 2.4: Southern New Jersey/Philadelphia Nonattainment Area Annual $PM_{2.5}$ Design Values for the Two Consistently Highest Monitors by State, 2001-2006

	New Jersey		Pennsylvania		Delaware	
	1st Highest	2nd Highest	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	34-007-0003 Camden Lab Primary, Camden	34-007-1007 Pennsauken Township, Pennsauken	42-101-0047 500 South Broad Street, Philadelphia	42-045-0002 Front Street & Norris Street, Chester	10-003-2004 MLK Blvd. & Justison Street, Wilmington	10-003-1012 University of Delaware, Newark
Year of Highest	2003 and 2005	2001	2002	2005	2001	2002
Concentration of Highest (µg/m^3)	14.7	14.6	16.6	15.6	16.5	15.2
Below 1997 Annual $PM_{2.5}$ NAAQS in 2006?	Yes	Yes	Not available[a]	No	Yes	Yes

[a] Monitoring problems that occurred with the monitor that was used to designate the Southern New Jersey/Philadelphia nonattainment area, i.e., monitor # 421010047, invalidated the data collected for 2005 and 2006 and were not included in this analysis.

2.3 USEPA NAAQS for Fine Particle Pollution: Daily (24-Hour) $PM_{2.5}$

2.3.1 Daily $PM_{2.5}$ 98th Percentile Average Concentrations and Design Values

The former 24-hour (daily) NAAQS for $PM_{2.5}$ was 65 µg/m^3 and the current daily $PM_{2.5}$ standard is 35 µg/m^3. To attain these standards, the 3-year average of the 98th percentile of 24-hour concentrations at each monitor within an area must not exceed 65 µg/m^3 or 35

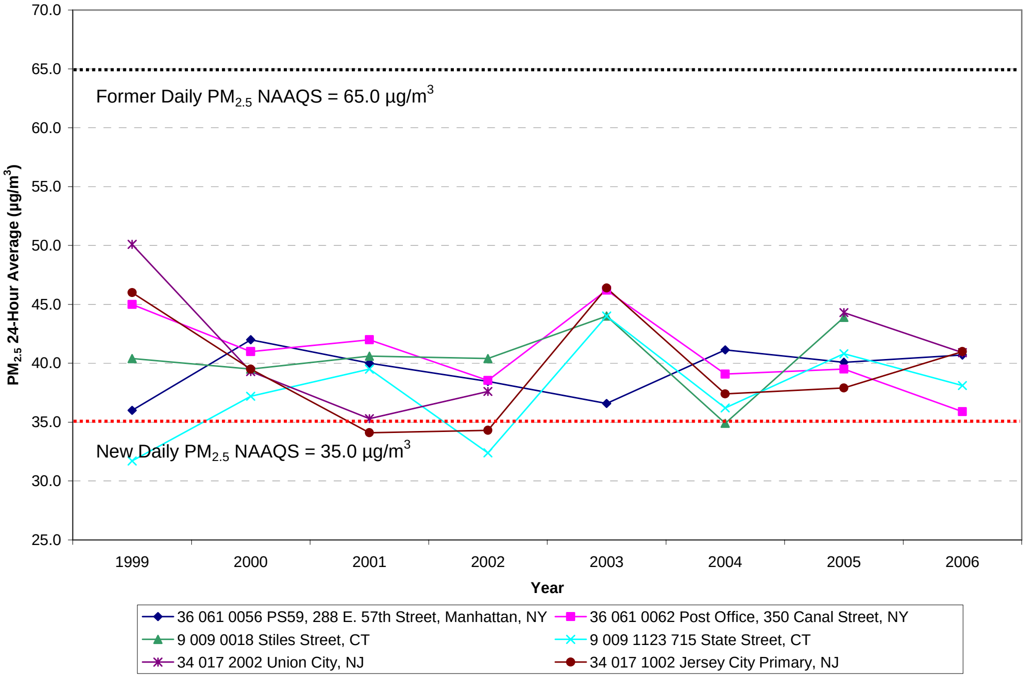
---

[13] See note 2.

µg/m^3.[14] Refer to the USEPA guidance issued in 1999 for more details on calculations and data handling for $PM_{2.5}$.[15] In the Southern New Jersey/Philadelphia nonattainment area, there are three New Jersey monitors, and all are plotted in the figures for this section.

Figures 2.6 and 2.7 show that the concentrations in the multi-state nonattainment areas are well below the former 65 µg/m^3 standard, but near and above the newer 35 µg/m^3 NAAQS. New Jersey and the other states that share New Jersey's 1997 $PM_{2.5}$ multi-state nonattainment areas have always met and are in attainment with the 1997 daily $PM_{2.5}$ health-based standard of 65 µg/m^3.[16]

Figure 2.6: $PM_{2.5}$ 98th Percentile 24-Hour Averages for the Two Consistently Highest Monitors in each Associated State in the 1997 $PM_{2.5}$ Northern New Jersey/New York/Connecticut Nonattainment Area, 1999-2006[17]



---

[14] The entire state of New Jersey was in attainment of the 24-hour $PM_{2.5}$ standard of 65 µg/m^3 in 2004 when USEPA finalized designations.

[15] USEPA. Guidance on Data Handling Conventions for the PM NAAQS. United States Environmental Protection Agency, Office of Air Quality, Planning and Standards, Research Triangle Park, NC, EPA-454/R-99-008, April 1999.

[16] The attainment demonstration in this proposed SIP revision addresses the 1997 annual $PM_{2.5}$ standard. According to the USEPA's modeling guidance (USEPA. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/B-07-002, April 2007, pg. 56), since these levels are well below the standard and have continued to improve since 2001, the modeled attainment test for the 1997 daily $PM_{2.5}$ standard is not needed nor is included in the attainment demonstration.

[17] See note 2.

Figure 2.7: $PM_{2.5}$ 98th Percentile 24-Hour Averages for the Consistently Highest Monitors in each Associated State in the 1997 $PM_{2.5}$ Southern New Jersey/Philadelphia Nonattainment Area, 1999-2006

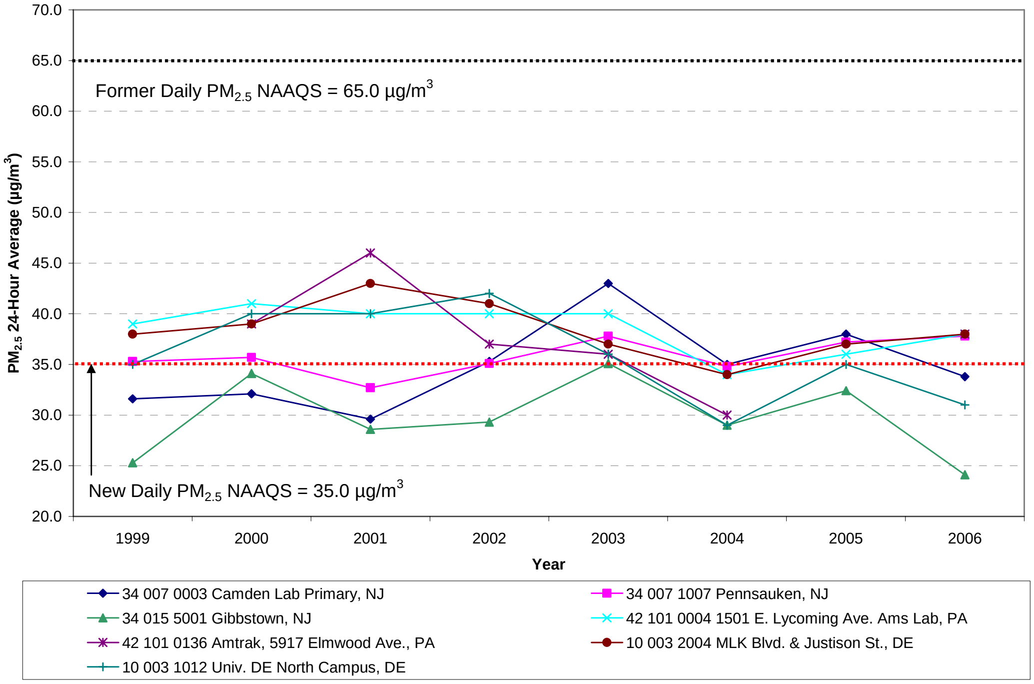


Table 2.5: $PM_{2.5}$ 98th Percentile 24-Hour Averages for the Two Consistently Highest Monitors in the 1997 $PM_{2.5}$ Northern New Jersey/New York/Connecticut Nonattainment Area, 1999-2006[18]

	New York		Connecticut		New Jersey	
	1st Highest	2nd Highest[a]	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	36-061-0056 PS 59, New York City	36-061-0062 Canal Street, New York City	9-009-0018 Stiles Street, New Haven	9-009-1123 715 State Street, New Haven	34-017-2002 Union City	34-017-1002 Jersey City Primary
Year of Highest	2000	2003	2003 and 2005	2003	1999	1999 and 2003
Concentration of Highest (µg/m^3)	42	46	44	44	50	46
Below 1997 Daily $PM_{2.5}$ NAAQS in 2006?	Yes	Yes	2006 data not available	Yes	Yes	Yes
Below 2006 Daily $PM_{2.5}$ NAAQS in 2006?	No	No	2006 data not available	No	No	No

---

[18] See note 2.

[a] Monitors #36-061-0010 and #36-085-0055 also had high 98th percentile 24-hour averages twice during the 1999-2006 time period but were not shown, as monitor #36-061-0062 had the highest average in 2006 and was chosen to be highlighted in this analysis.

Table 2.6: PM$_{2.5}$ 98th Percentile 24-Hour Averages for the Two Consistently Highest Monitors in the 1997 PM$_{2.5}$ Southern New Jersey/Philadelphia Nonattainment Area, 1999-2006

	New Jersey		**Pennsylvania**		**Delaware**	
	1st Highest	**2nd Highest**	**1st Highest**	**2nd Highest**	**1st Highest**	**2nd Highest**
AQS Monitor ID, Site Name and Location	34-007-0003 Camden Lab Primary, Camden	34-007-1007 Pennsauken Township, Pennsauken	42-101-0004 AMS Lab, Philadelphia	42-101-0136 Amtrak, Philadelphia	10-003-2004 MLK Blvd. & Justison Street, Wilmington	10-003-1012 University of Delaware, Newark
Year of Highest	2003	2006	2000	2001	2001	2002
Concentration of Highest (µg/m^3)	43	38	41	46	43	42
Below 1997 Annual PM$_{2.5}$ NAAQS in 2006?	Yes	Yes	Yes	Yes	Yes	Yes
Below 2006 Daily PM$_{2.5}$ NAAQS in 2006?	No	No	No	No	No	No

The design value for the 24-hour NAAQS for a monitor is calculated by taking the three year average of the 98th percentile of 24-hour concentrations for PM$_{2.5}$.[19] Figures 2.8 and 2.9 show the multi-state nonattainment areas are well below the former 65 µg/m^3 NAAQS, and above the newer 35 µg/m^3 NAAQS. Tables 2.7 and 2.8 show the maximum daily PM$_{2.5}$ design values at these sites, which were included in Figures 2.8 and 2.9, respectively.

---

[19] The design value for a nonattainment area is the maximum monitor design value for all monitors for each 3-year period.

Figure 2.8: Daily $PM_{2.5}$ Design Values for the Two Consistently Highest Monitors in each Associated State in the Northern New Jersey/New York/Connecticut Area, 2001-2006[20]

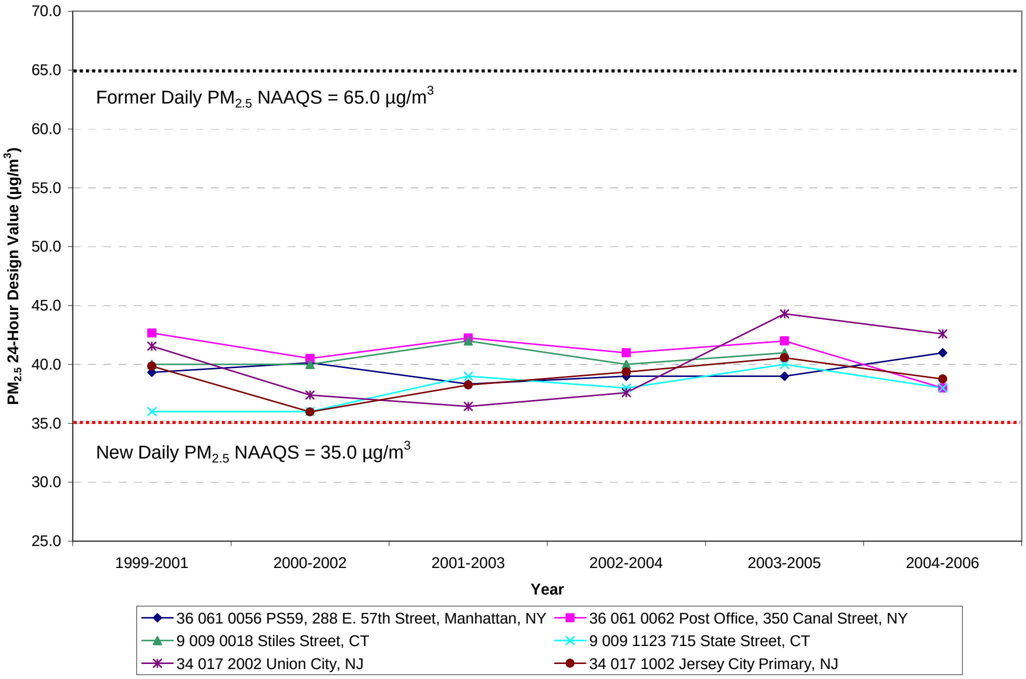
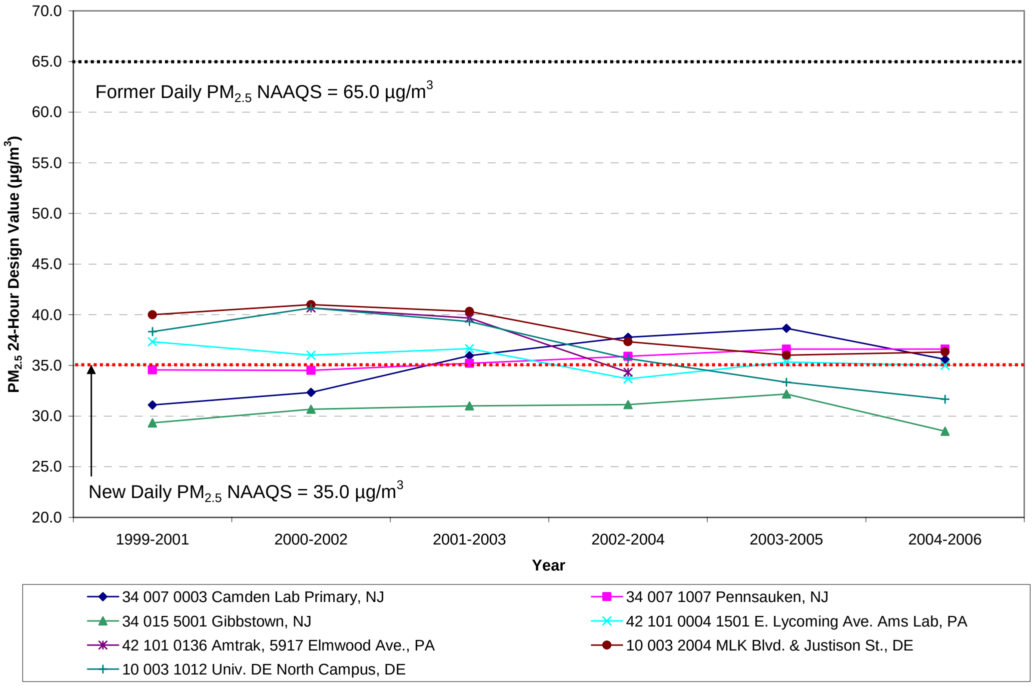


Figure 2.9: Daily $PM_{2.5}$ Design Values for the Consistently Highest Monitors in each Associated State in the Southern New Jersey/Philadelphia Area, 2001-2006



---

[20] See note 2.

Table 2.7: Northern New Jersey/New York/Connecticut Nonattainment Area Daily $PM_{2.5}$ Design Values for the Two Consistently Highest Monitors by State, 2001-2006[21]

	New York		Connecticut		New Jersey	
	1st Highest	2nd Highest	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	36-061-0056 PS 59, New York City	36-061-0062 Canal Street, New York City	9-009-0018 Stiles Street, New Haven	9-009-1123 715 State Street, New Haven	34-017-2002 Union City	34-017-1002 Jersey City Primary
Year of Highest	2006	2001	2003	2005	2005	2005
Concentration of Highest (μg/m^3)	41	43	42	40	44	41
Below 1997 Annual $PM_{2.5}$ NAAQS in 2006?	Yes	Yes	2006 data not available	Yes	Yes	Yes
Below 2006 Daily $PM_{2.5}$ NAAQS in 2006?	No	No	2006 data not available	No	No	No

Table 2.8: Southern New Jersey/Philadelphia Nonattainment Area Daily $PM_{2.5}$ Design Values for the Two Consistently Highest Monitors by State, 2001-2006

	New Jersey		Pennsylvania		Delaware	
	1st Highest	2nd Highest	1st Highest	2nd Highest	1st Highest	2nd Highest
AQS Monitor ID, Site Name and Location	34-007-0003 Camden Lab Primary, Camden	34-007-1007 Pennsauken Township, Pennsauken	42-101-0004 AMS Lab, Philadelphia	42-101-0136 Amtrak, Philadelphia	10-003-2004 MLK Blvd. & Justison Street, Wilmington	10-003-1012 University of Delaware, Newark
Year of Highest	2005	2005 and 2006	2001-2003	2002	2002	2002
Concentration of Highest (μg/m^3)	39	37	40	41	41	41
Below 1997 Annual $PM_{2.5}$ NAAQS in 2006?	Yes	Yes	Yes	2006 data not available	Yes	Yes
Below 2006 Daily $PM_{2.5}$ NAAQS in 2006?	No	No	No	2006 data not available	No	Yes

---

[21] See note 2.

2.4 Composition of Fine Particle Pollution – Speciated Monitoring Data and Trends

New Jersey has four monitoring sites that collect $PM_{2.5}$ speciated data. Speciation is the process of separating $PM_{2.5}$ particle mass into individual chemical species components or groups of species. These sites are located in Camden, Chester, Elizabeth, and New Brunswick, New Jersey. The first full year of speciated data collection was 2002. Data were collected in 2001 but only for part of the year. The data for each monitor, including each monitoring site's speciation profile for the eight highest $PM_{2.5}$ components from 2002 through 2006, is presented in Figures 2.10 through 2.14. The total mass is presented in the figures and does not equate to the sum of all of the components.[22] The trends for each monitor consistently show that sulfate, organic carbon, nitrate, ammonium, sulfur, and elemental carbon are the largest components of total $PM_{2.5}$ mass. These charts show that organic carbon and sulfate comprise the majority of the $PM_{2.5}$ mass measured at all four sites in both 2002 and 2006. Since the signatures of both organic carbon and sulfate are the highest compounds measured at each monitoring site from 2002 through 2006, the NJDEP is confident that these signatures are regional, rather than local, in nature.

---

[22] Data are collected on three different filters that run independently of each another. The flow rates may vary slightly between the three sample channels. The total mass that is reported is measured from the Teflon filter. There are also some redundancies in data reporting. For example, sodium and potassium are measured both by X-Ray Fluorescence (XRF) and Ion Chromatography. The XRF results were used in this analysis. Carbon is reported as Elemental Carbon, Organic Carbon, and total Carbon (sum of organic and elemental). If redundancies are removed, the reported total mass and sum of all species are relatively close.

<u>Figure 2.10</u>: $PM_{2.5}$ Species that Recorded the Highest Concentrations for 2002 and 2006 in New Jersey

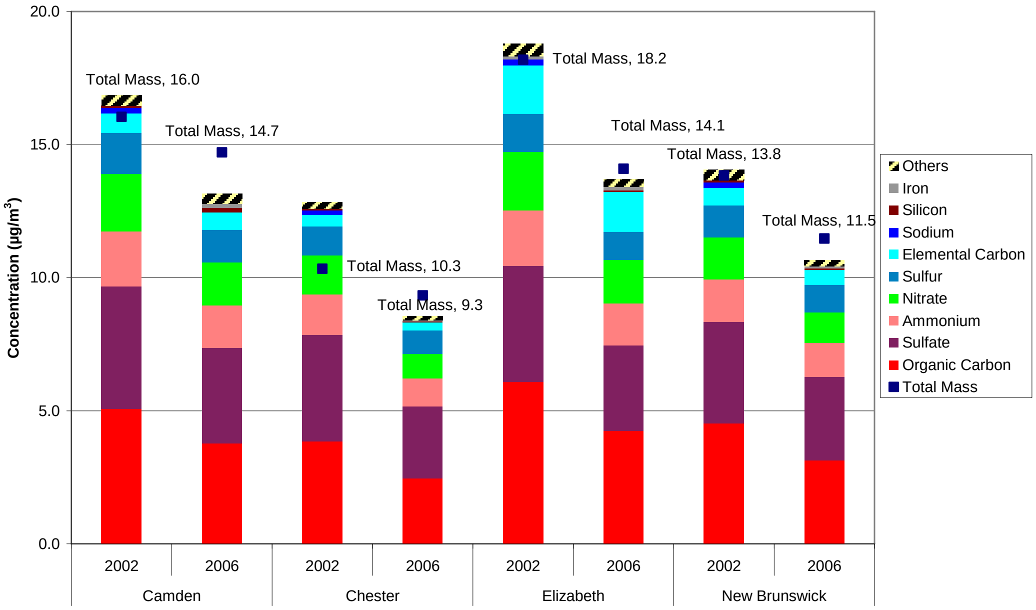


Figure 2.11: Speciated Data from 2002-2006 with the Highest Concentrations at Camden, New Jersey

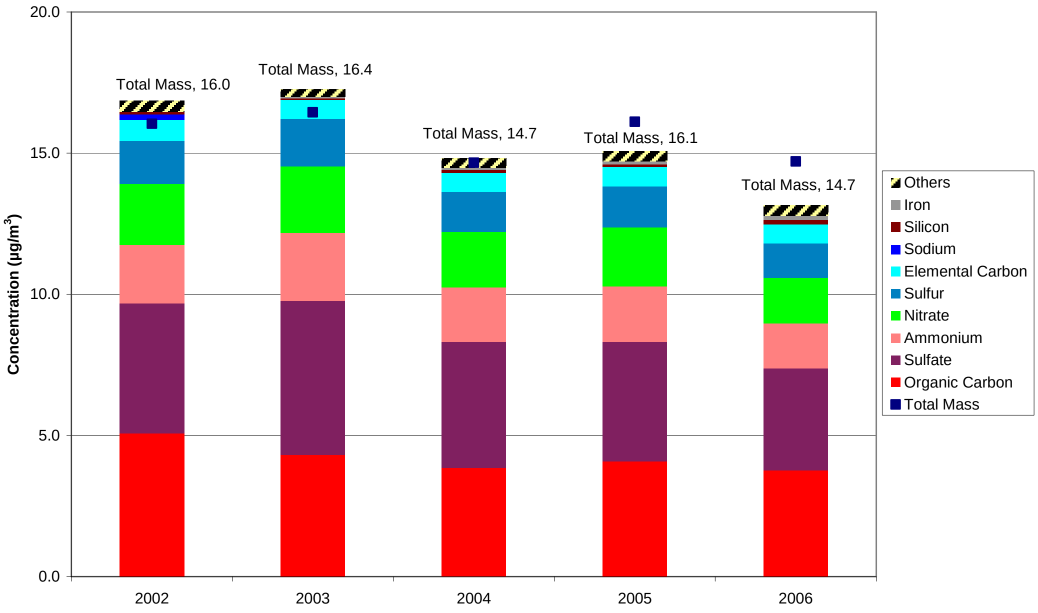


Figure 2.12: Speciated Data from 2002-2006 with the Highest Concentrations at Chester, New Jersey

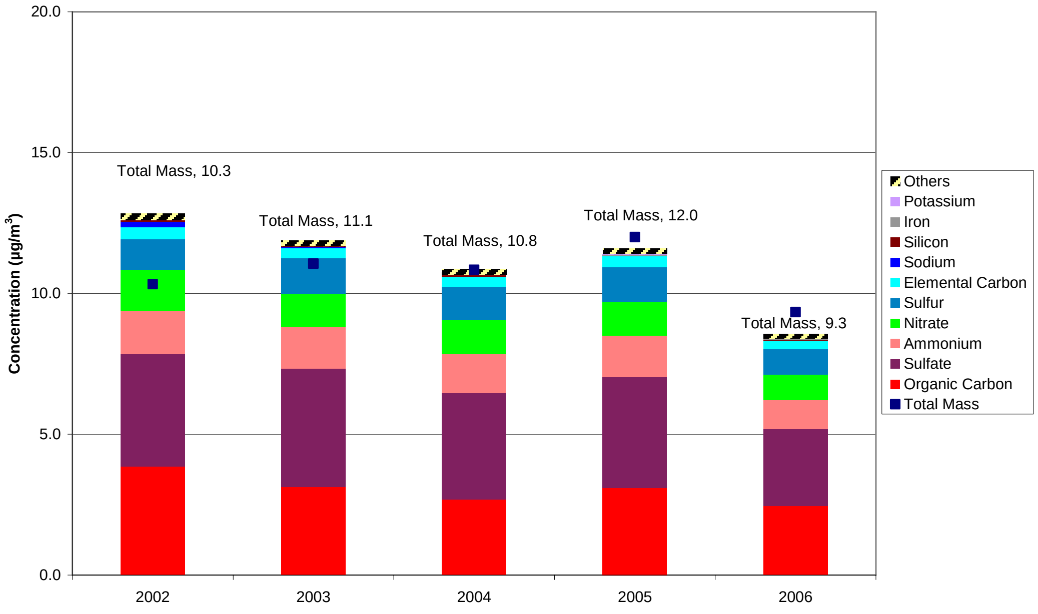


Figure 2.13: Speciated Data from 2002-2006 with the Highest Concentrations at Elizabeth, New Jersey

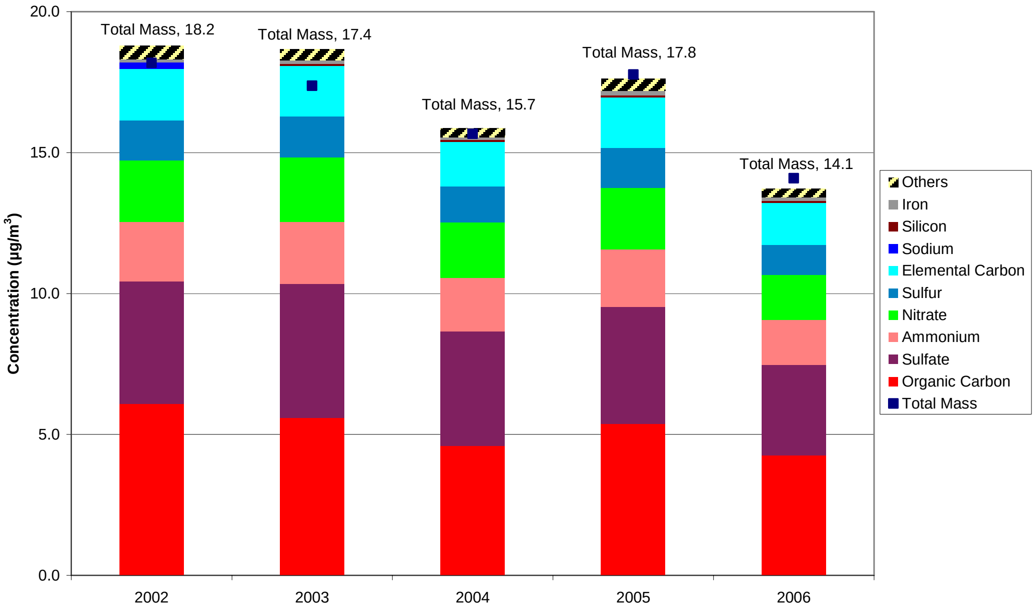
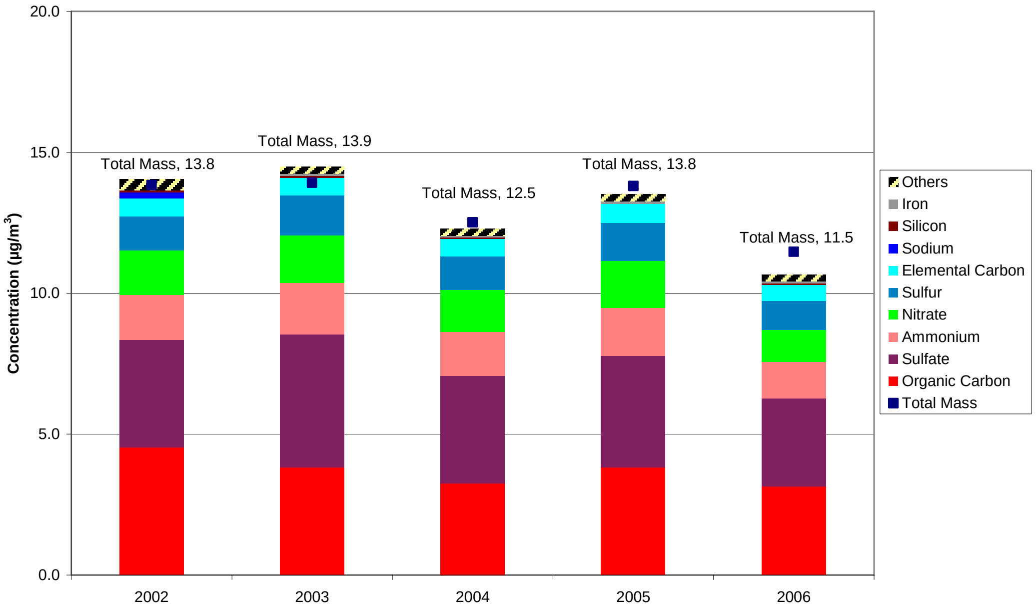


Figure 2.14: Speciated Data from 2002-2006 with the Highest Concentrations at New Brunswick, New Jersey



2.5 $PM_{2.5}$ Source Apportionment

Another way to look at the data is to attribute the composition of the particle mass to its source. This is accomplished using "source apportionment" modeling.[23] For air quality management purposes, source apportionment is complimentary to photochemical modeling and other air quality analyses. In this proposed SIP revision, one rural and one urban source apportionment study for New Jersey were selected to highlight major sources of $PM_{2.5}$.

Using the Brigantine monitoring site (a rural location and Class I area), Kim and Hopke (2004)[24,25] showed that over 60 percent of the $PM_{2.5}$ mass was associated with sulfate aerosol formation from electric generating units outside of New Jersey, 13 percent of the mass was from gasoline vehicles, and 4 percent was from diesel vehicles for sources in New Jersey or the nearby Philadelphia metropolitan area. Results are presented in Figure 2.15. Table 2.9 summarizes the results of additional analyses conducted in this study that provide an estimation of the geographic location/pathway and/or origin of the $PM_{2.5}$ sources identified through the positive matrix factorization (PMF) analysis.

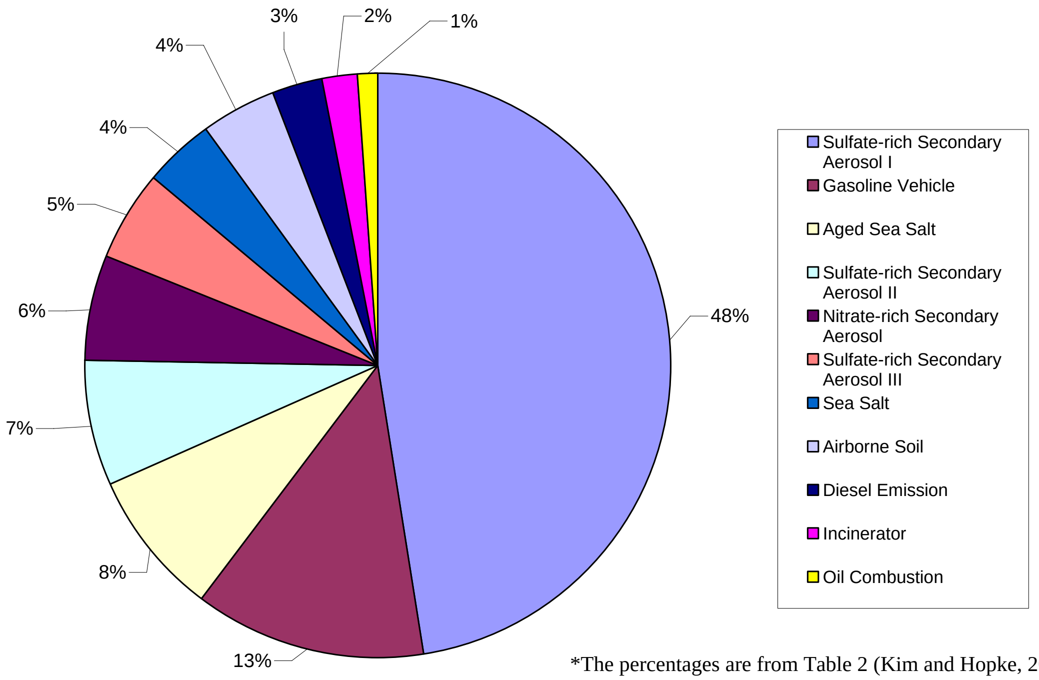
---

[23] USEPA. Receptor Modeling, Air Quality Management Online Portal, United States Environmental Protection Agency, http://www.epa.gov/air/aqmportal/management/modeling/receptor.htm, accessed October 22, 2007.

[24] Kim, E. and Hopke, P. K. Improving Source Identification of Fine Particles in a Rural Northeastern U.S. Area Utilizing Temperature-resolved Carbon Fractions. *Journal of Geophysical Research*, 109, D09201, doi: 10.1029/2003JD004199, 2004.

[25] Data from March 1992 - May 2001 was used in the positive matrix factorization (PMF) model, conditional probability function (CPF), and potential source contribution function (PSCF) analyses to identify sources of $PM_{2.5}$ and their locations contributing to concentrations at the Brigantine monitoring site.

<u>Figure 2.15</u>: $PM_{2.5}$ Sources Identified at the Monitoring Site in Brigantine, New Jersey Contributing to the Mean Daily $PM_{2.5}$ Mass Concentrations Averaged over 1992 – 2001 using PMF*



Source: Kim and Hopke, 2004

*The percentages are from Table 2 (Kim and Hopke, 2004) and are the estimated average source contribution (percent) to $PM_{2.5}$ mass (11.24 $\mu g/m^3$, measured over the 1992-2001 time period) using PMF. The relative contributions in $\mu g/m^3$ were not provided in the paper.

Table 2.9: Study Results from the Potential Source Contribution Function (PSCF) and Conditional Probability Function (CPF) Analyses, Kim and Hopke (2004)

Analysis	$PM_{2.5}$ Source(s) Identified[a]	Source Contributor(s)[b]	Source Location(s)/Pathway(s) (with respect to the Brigantine monitor)
PSCF[c]	Sulfate-rich secondary aerosols I and III	Coal-fired power plants	• Midwest (i.e., Ohio River Valley) • Southern Indiana • Northern Kentucky
		Petrochemical industry	• Louisiana
		Not identified	• Southern Mississippi
	Sulfate-rich secondary aerosol II	Biogenic emissions from Canadian forest fires	• Hudson Bay, Canada region
		Volatile organic carbon (VOC) emissions from biogenic sources	• Eastern Tennessee • Northeastern Georgia • Western South Carolina
		Sulfur emissions	• Southern Louisiana • Mississippi • Alabama
	Airborne soil	Dust storms	• Asia • Africa (Sahara)
CPF[d]	Organic carbon	Gasoline vehicles	North and southwest: close to Highway 9 in New Jersey
	Elemental carbon	Diesel vehicles	Northwest: an area containing Philadelphia, Pennsylvania and major highway traffic between Washington, D.C. and New York City.
	Nitrate-rich secondary aerosol	Not identified	West and Northwest – Philadelphia, Pennsylvania
	Aged and fresh sea salt	N/A	Atlantic Ocean
	Airborne soil	Crustal particles from onroad traffic	Northwest and southwest
		Dust storms	• Asia • Africa (Sahara)
	Municipal solid waste incinerator emissions	N/A	West and northwest
	Oil combustion	Utilities and industries	• New York City (north) • Atlantic City (southeast)
			• Northeastern urban corridor between Washington, D.C. and Boston, Massachusetts

[a] For clarification, researchers also sometimes refer to sources as factors and these terms may be used interchangeably in some instances. A factor could be associated with a source, source type, or source region (Lee, J. H., Poirot, R. L., Lioy, P. J., and Oxley, J. C. Identification of Sources Contributing to Mid-Atlantic Regional Aerosol. Journal of Air and Waste Management, 52, 1186-1205, 2002.).

[b] A ‘source contributor’ identifies the specific category or source type that is the assumed cause of the pollution.

[c] The PSCF analysis was performed only for the sulfate-rich secondary aerosols using the PMF estimations and backward trajectories using the HYSPLIT model.

[d] The CPF analysis combined the PMF results with wind direction values measured at the Brigantine monitoring site.

Building on the PMF analysis conducted in 2004,[26] Hopke and Gildemeister (2006) used PSCF and back trajectory analyses to determine the seasonal variation in source contributions to $PM_{2.5}$ mass measured at the four speciation monitors in New Jersey from 2001-2005.[27] These monitors are in urban areas compared to the rural location of the Brigantine monitor discussed in the previous study. Figure 2.16 shows the results of the study by monitor and by season. Significant findings of the study were as follows:

- Similar types of transported aerosols were seen amongst all four sites, notably, secondary sulfate and nitrate, biomass burning, and aged sea salt.
- Secondary sulfate was the largest contributor to $PM_{2.5}$, especially during the summer.
- Secondary nitrate concentrations reach their highest in the winter.
- Secondary sulfate and nitrate were transported from sources in other states.
- The sulfate factor was estimated to be from regions with large coal-fired power plants.
- Elevated nitrate concentrations were shown to be from areas with increased ammonia and some oxides of nitrogen (NO_x) emissions.
- Automotive emissions were the second highest contributor among most of the sites.
- Biomass burning was thought to be due to transport of wood smoke from Canadian boreal forest fires during the summers.
- Railroad traffic was estimated to be the source of iron and steel at New Brunswick.
- Compared to the summer source contributions, the automotive, nitrate, mixed industrial/Fe and steel, and sea salt factors increase during the winter.

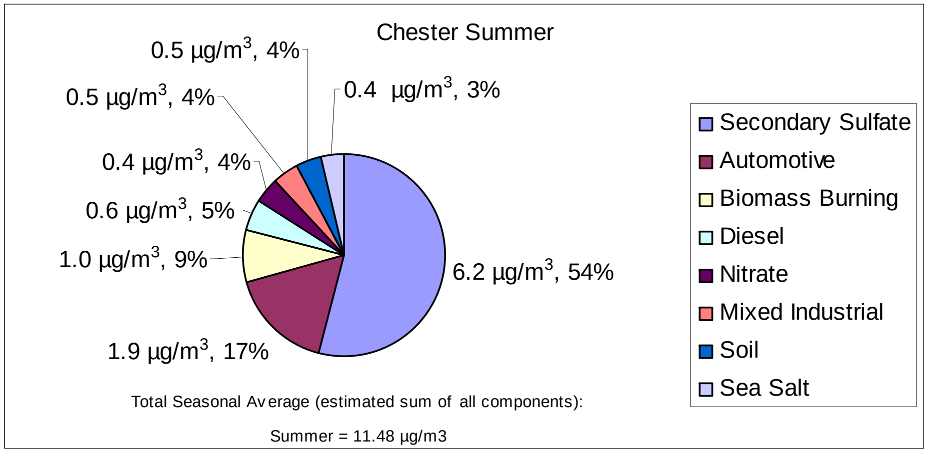
---

[26] Hopke, P. K. and Kim, E. Application of Advanced Factor Analysis Modeling to Apportion $PM_{2.5}$ in New Jersey. Center for Air Resources Engineering and Science, Clarkson University, March 2005.

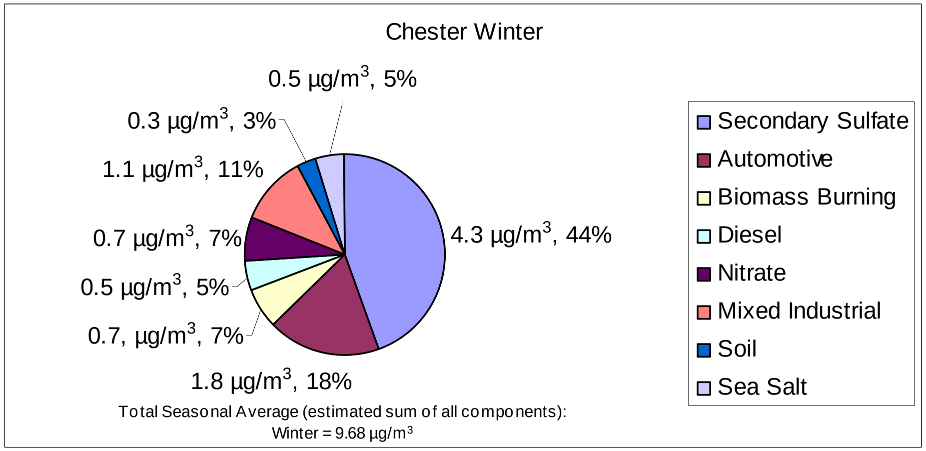
[27] Hopke, P. K. and Gildemeister, A. Application of Trajectory Ensemble Analysis to Locate $PM_{2.5}$ Sources. Center for Air Resources Engineering and Science, Clarkson University, November 2006.

Figure 2.16: Seasonal Variations in Source Contributions to Average Seasonal $PM_{2.5}$ Mass Concentrations from 2001-2004 at Four Speciation Monitors in New Jersey, Hopke and Gildemeister (2006)

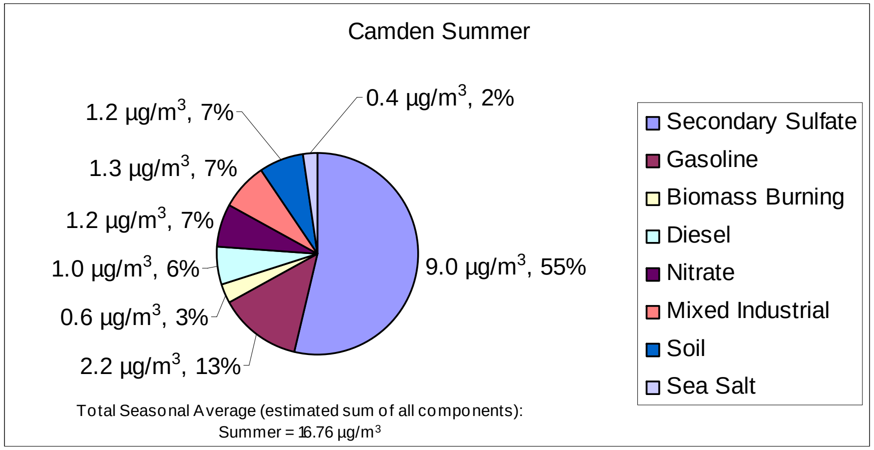
Chester, Summer



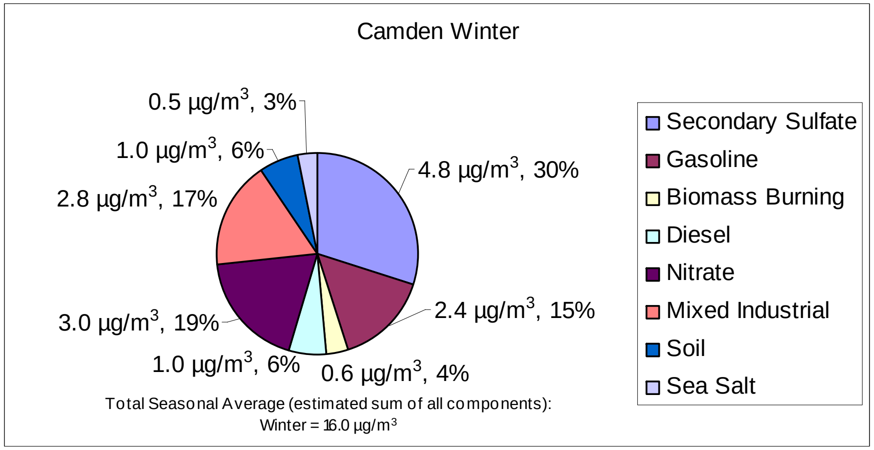
Chester, Winter



Camden, Summer

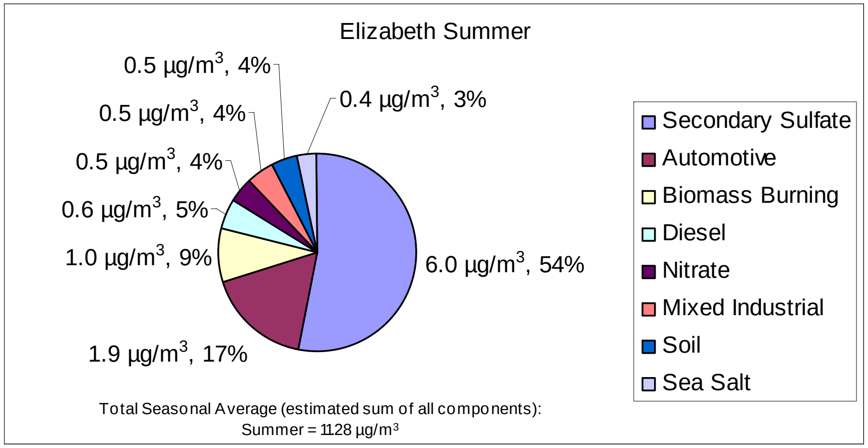


Camden, Winter



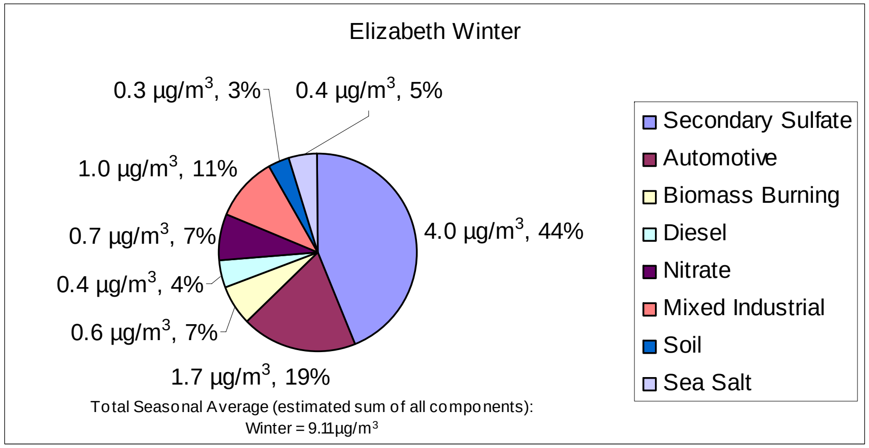
(continued) Figure 2.16: Seasonal Variations in Source Contributions to Average Seasonal $PM_{2.5}$ Mass Concentrations from 2001-2004 at Four Speciation Monitors in New Jersey, Hopke and Gildemeister (2006)

Elizabeth, Summer



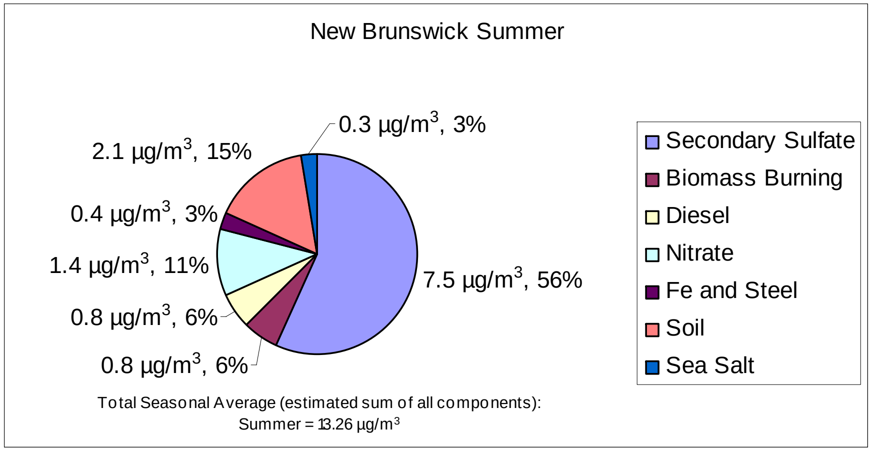
Total Seasonal Average (estimated sum of all components):
Summer = 11.28 µg/m³

Elizabeth, Winter



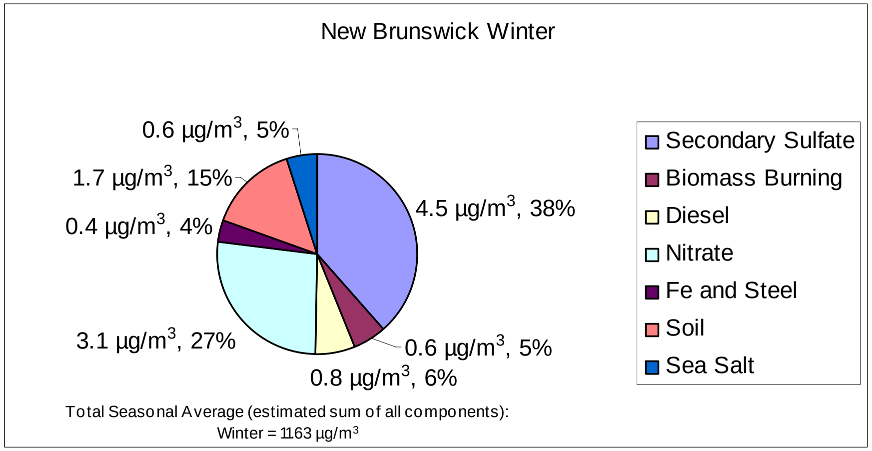
Total Seasonal Average (estimated sum of all components):
Winter = 9.11µg/m³

New Brunswick, Summer



Total Seasonal Average (estimated sum of all components):
Summer = 13.26 µg/m³

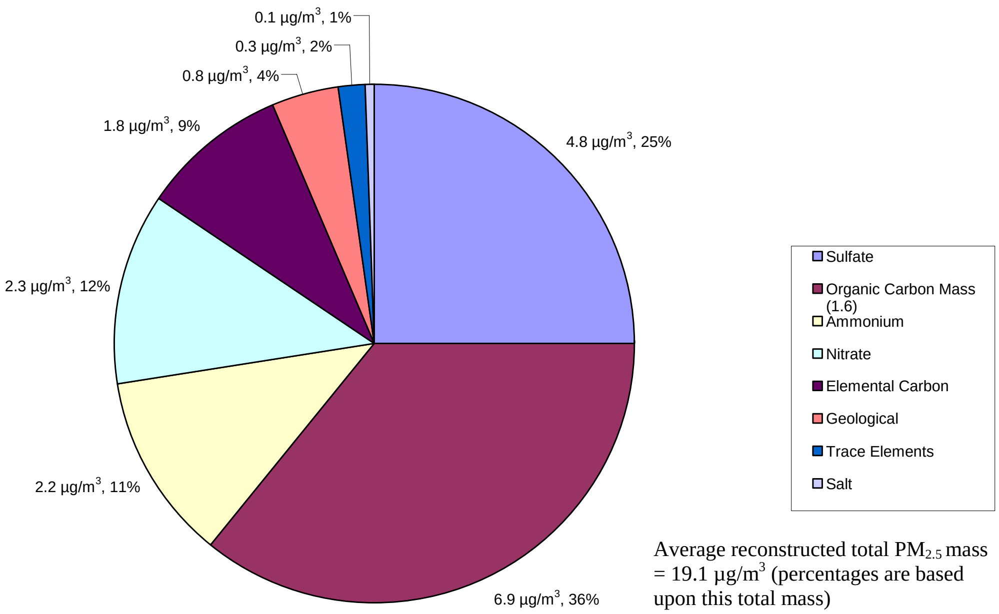
New Brunswick, Winter



Total Seasonal Average (estimated sum of all components):
Winter = 11.63 µg/m³

In a regional analysis[28] of $PM_{2.5}$, the chemical composition measured at the monitor in Elizabeth, New Jersey is shown in Figure 2.17. This analysis was not a source apportionment study but an analysis of the ambient data, which also showed that organic carbon (identified as gasoline emissions in Hopke and Gildemeister (2006)) and sulfate were the largest contributors to the total $PM_{2.5}$ mass with sulfate concentrations significantly higher in the summer compared to the winter. Back trajectories used in the Mid-Atlantic Regional Air Management Association (MARAMA) (2006) analysis showed air parcels on the cleanest days (i.e., lowest $PM_{2.5}$ concentrations) originating from western Canada, Ontario, Canada, and the ocean. On the dirtiest days showed air trajectories mostly from U.S. regions in the South, Midwest, or Northeast and Mid-Atlantic states.

Figure 2.17: Major Constituents of $PM_{2.5}$ Mass at the Elizabeth, New Jersey Monitoring Site from 2001-2003[29]



Average reconstructed total $PM_{2.5}$ mass = 19.1 µg/m³ (percentages are based upon this total mass)

Average gravimetric total $PM_{2.5}$ mass = 18.0 µg/m³

The ambient data analyses consistently show a fairly large sulfate contribution to the $PM_{2.5}$ mass collected at the speciation monitors throughout New Jersey, demonstrating that these signatures are regional, rather than local, in nature. The source apportionment modeling studies demonstrate that the major source of this sulfate is primarily from coal-fired electric generating units in regions west of New Jersey. The contribution of local sources from gasoline and diesel-powered vehicles and industries in the area are also important contributors to the $PM_{2.5}$ mass in New Jersey.

---

[28] MARAMA. An Analysis of Speciated $PM_{2.5}$ Data in the MARAMA Region. Prepared by Gillepsie, W G. and Davis, P of the Mid-Atlantic Regional Air Management Association, Baltimore, MD, May 31, 2006.

[29] Figure 5-65 modified from MARAMA, 2006 (see note 17).

2.6 Emission Inventory

An emission inventory is an estimate of the emissions from anthropogenic (human-made) and biogenic (natural) sources. New Jersey developed an emission inventory for 2002, which is defined as the base year for future attainment planning purposes with respect to 8-hour ozone, $PM_{2.5}$, and regional haze State Implementation Plans (SIPs), as required by the USEPA.[30] The 2002 base year inventory included the pollutants: VOC, NO_x, carbon monoxide, particulate matter less than 10 micrometers in diameter (PM_{10}), $PM_{2.5}$, sulfur dioxide (SO_2),[31] and ammonia (NH_3). The inventory divided the sources into five sectors, each making up one component of the inventory: point sources, area sources, onroad sources, nonroad sources, and biogenic sources. The emission inventories from all the states in the Northeastern and Mid-Atlantic states were compiled by the Mid-Atlantic/Northeast Visibility Union (MANE-VU), which then created a regional inventory. MANE-VU consists of the District of Columbia and 11 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. This regional inventory was used to perform the regional modeling analysis used in the State's air quality management planning efforts to attain the 8-hour ozone NAAQS, the $PM_{2.5}$ NAAQS, and the regional haze plans. MANE-VU, through its contractor, MARAMA, projected the 2002 base year emission inventory to various future years. For the purposes of this proposed $PM_{2.5}$ SIP revision, the 2009 future projections were used in the regional modeling exercises to demonstrate attainment of the 1997 annual $PM_{2.5}$ NAAQS.[32] The regional 2002 and 2009 emission inventories were used as the basis of this proposed SIP revision.

Comparisons of the 2002 and 2009 $PM_{2.5}$, SO_2, and NO_x inventories developed by MANE-VU are discussed in this section. Detailed information about the emission inventories is included in the attainment demonstration summary in Chapter 5. Figures 2.18 and 2.19 compare the total emissions of direct $PM_{2.5,}$ NO_x, and SO_2 from 2002 and 2009 for each state in the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas, respectively. Figures 2.20 through 2.26 compare the direct $PM_{2.5,}$ NO_x, and SO_2 emissions from each sector (i.e., point, area, onroad, and nonroad) in all the states associated with New Jersey's $PM_{2.5}$ nonattainment areas from 2002 and 2009. The top 15 direct $PM_{2.5,}$ NO_x, and SO_2 emitting categories in the 2002 and 2009 inventories for the MANE-VU region are compared in Figures 2.27 through 2.31. In general, for both nonattaiment areas, total emissions for each pollutant are projected to decrease, with emissions from the area source sector increasing while emissions from the other sectors are projected to decrease. Stationary source emissions

---

[30] NJDEP. State Implementation Plan (SIP) Revisions for the Attainment and Maintenance of the 8-Hour Carbon Monoxide National Ambient Air Quality Standard, 1-Hour Ozone National Ambient Air Quality Standard, and Fine Particulate Matter National Ambient Air Quality Standard; and the 2002 Periodic Emission Inventory. New Jersey Department of Environmental Protection, May 2006.

[31] SO_2 has been reported in the inventory instead of SO_x as required in the Consolidated Emissions Reporting Rule because the USEPA MOBILE and NON-ROAD models and the majority of USEPA guidance on emission factors is based on SO_2, not SO_x. In addition, the USEPA National Emissions Inventory reports SO_2.

[32] While New Jersey did complete a state-specific 2002 inventory (submitted to the USEPA February 28, 2006, and approved by the USEPA May 2006), this inventory was not used for this analysis, as a comparable 2009 inventory was not grown in state.

are projected to increase for direct $PM_{2.5}$. The 2009 projections assume the implementation of BOTW measures (see Chapter 4).

Figure 2.18: **Comparison of Total PM$_{2.5}$, NO$_x$, and SO$_2$ Emissions by State in the Northern New Jersey/New York/Connecticut Nonattainment Area 2002-2009**

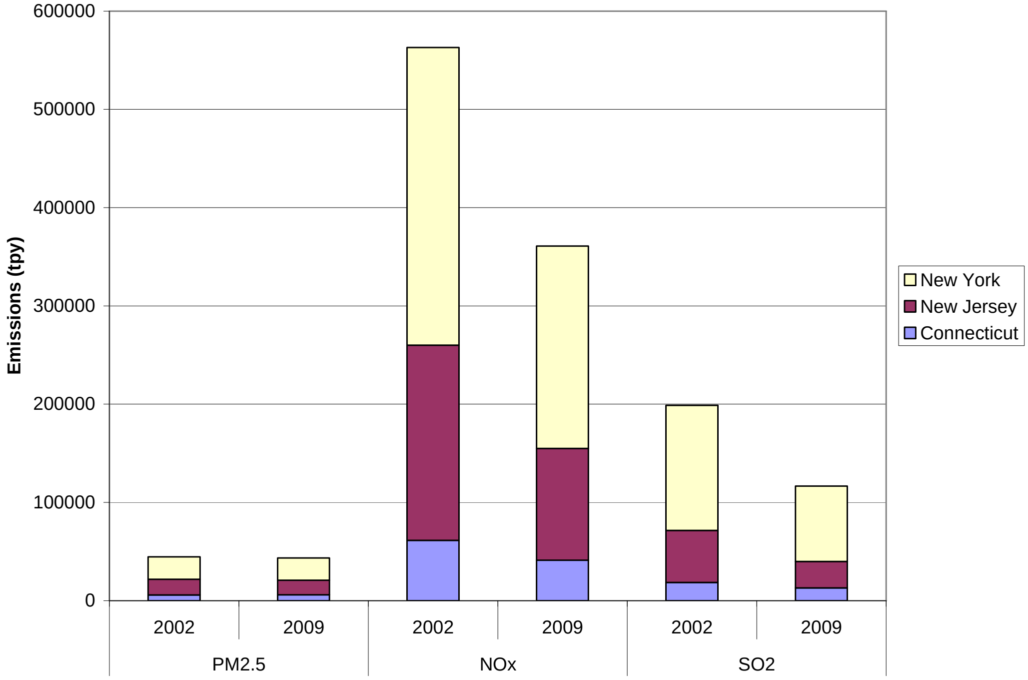


Figure 2.19: **Comparison of Total PM$_{2.5}$, NO$_x$, and SO$_2$ Emissions by State in the Southern New Jersey/Philadelphia Nonattainment Area 2002-2009**

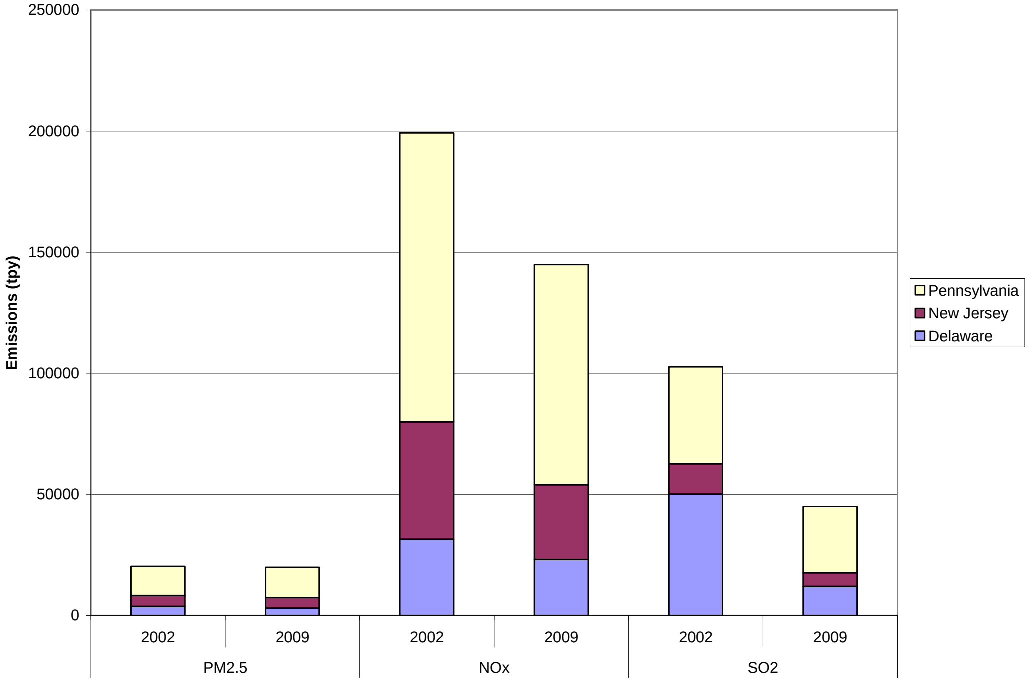


Figure 2.20: Comparison of $PM_{2.5}$ Emissions by Sector in the Northern New Jersey/New York/Connecticut Nonattainment Area 2002-2009

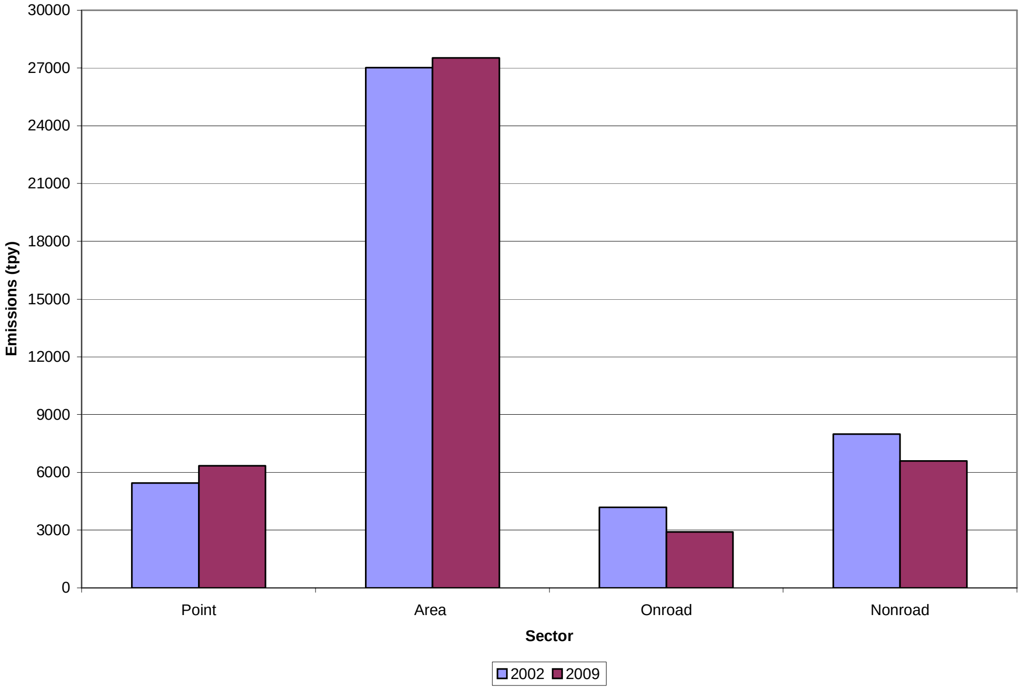


Figure 2.21: Comparison of $PM_{2.5}$ Emissions by Sector in the Southern New Jersey/Philadelphia Nonattainment Area 2002-2009

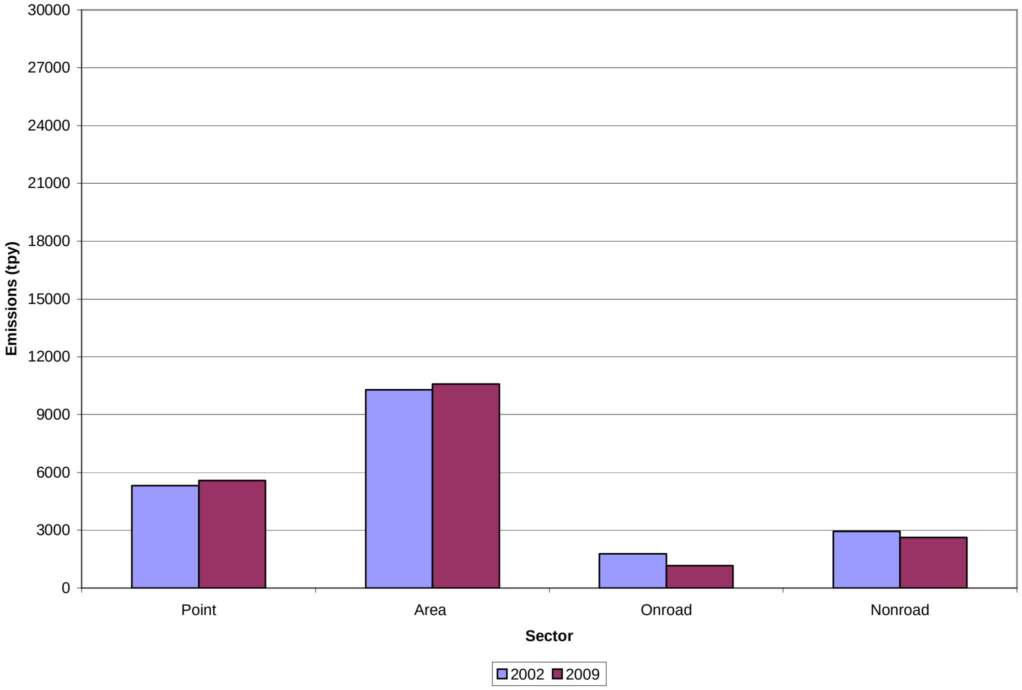


Figure 2.22: Comparison of NO_x Emissions by Sector in the Northern New Jersey/New York/Connecticut Nonattainment Area 2002-2009

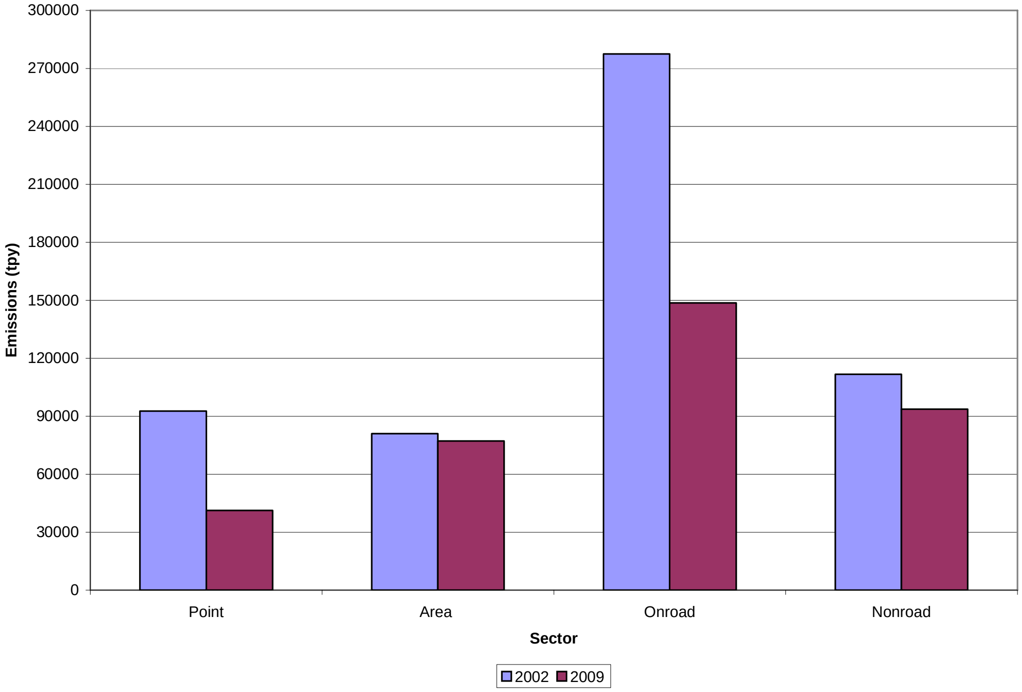


Figure 2.23: Comparison of NO_x Emissions by Sector in the Southern New Jersey/Philadelphia Nonattainment Area 2002-2009

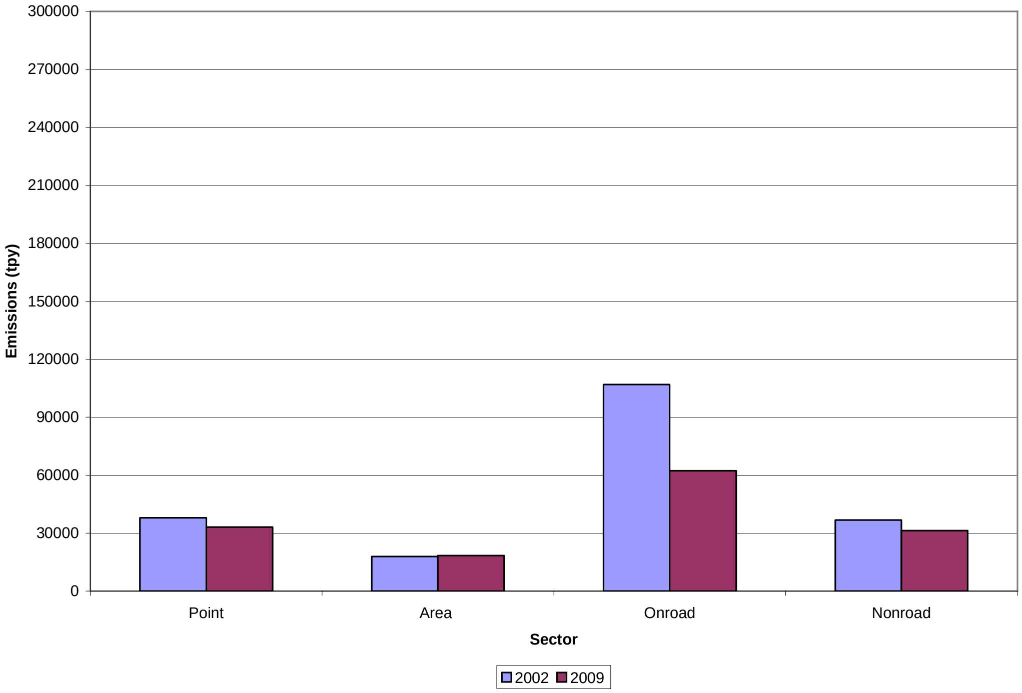


Figure 2.24: Comparison of SO_2 Emissions by Sector in the Northern New Jersey/New York/Connecticut Nonattainment Area 2002-2009

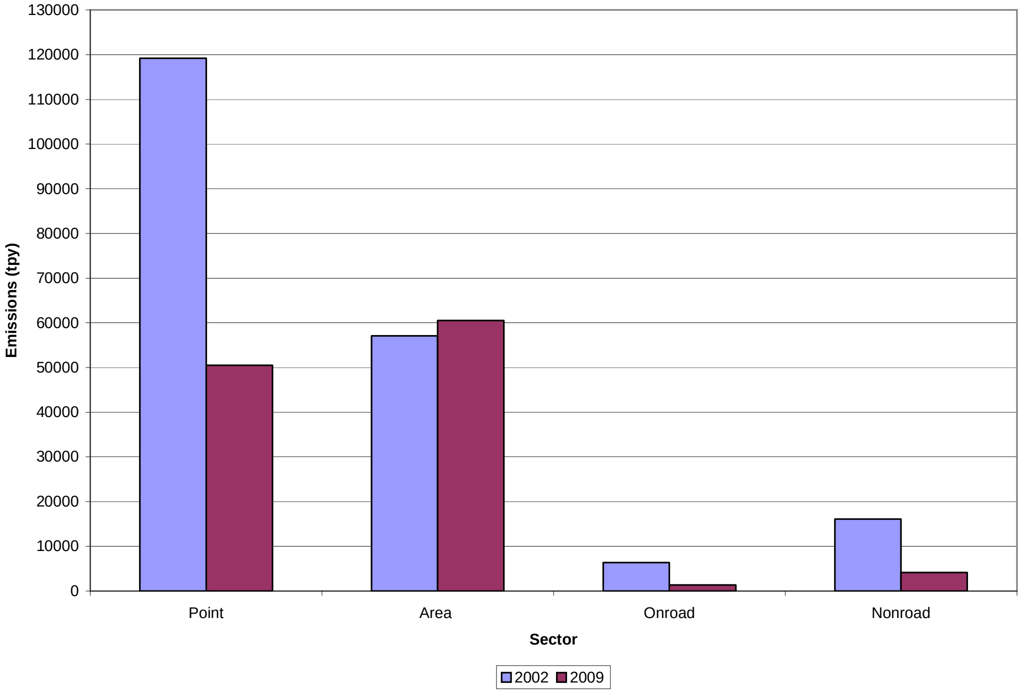


Figure 2.25: Comparison of SO_2 Emissions by Sector in the Southern New Jersey/Philadelphia Nonattainment Area 2002-2009

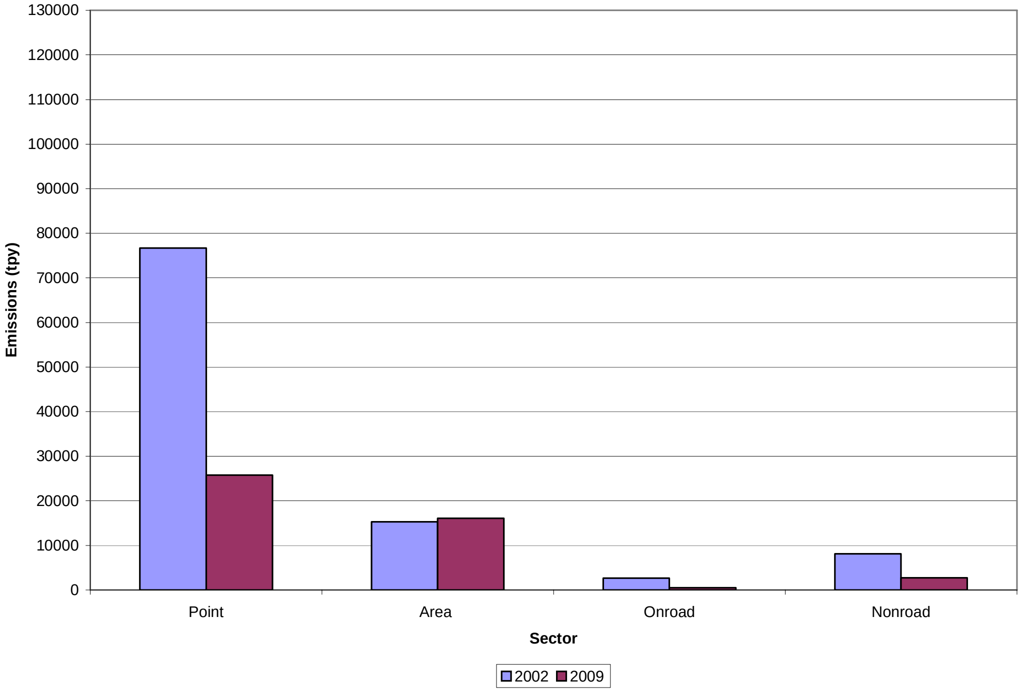


Figure 2.26: **2002 MANE-VU Region PM$_{2.5}$ Inventory Top 15**

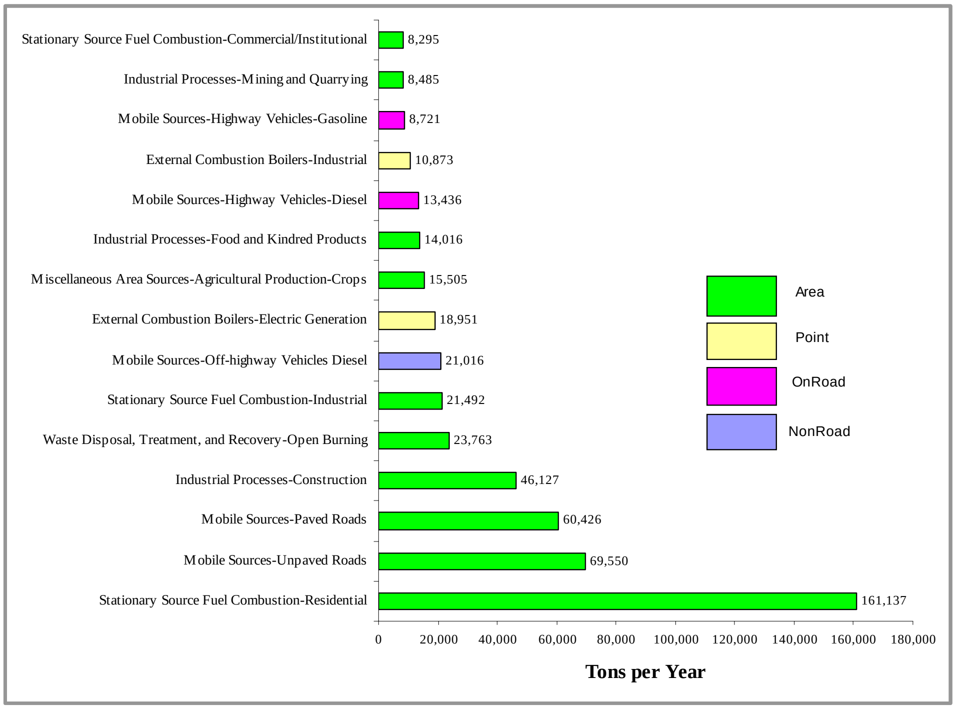


Figure 2.27: **2009 MANE-VU Region PM$_{2.5}$ Inventory Top 15**

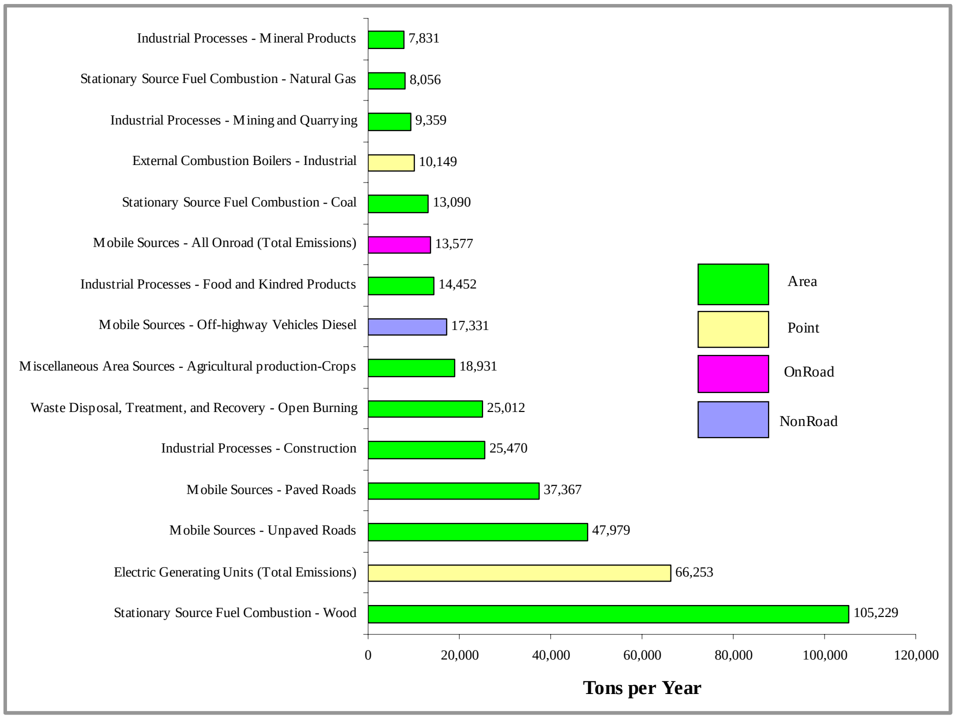


Figure 2.28: 2002 MANE-VU Region NO$_x$ Inventory Top 15

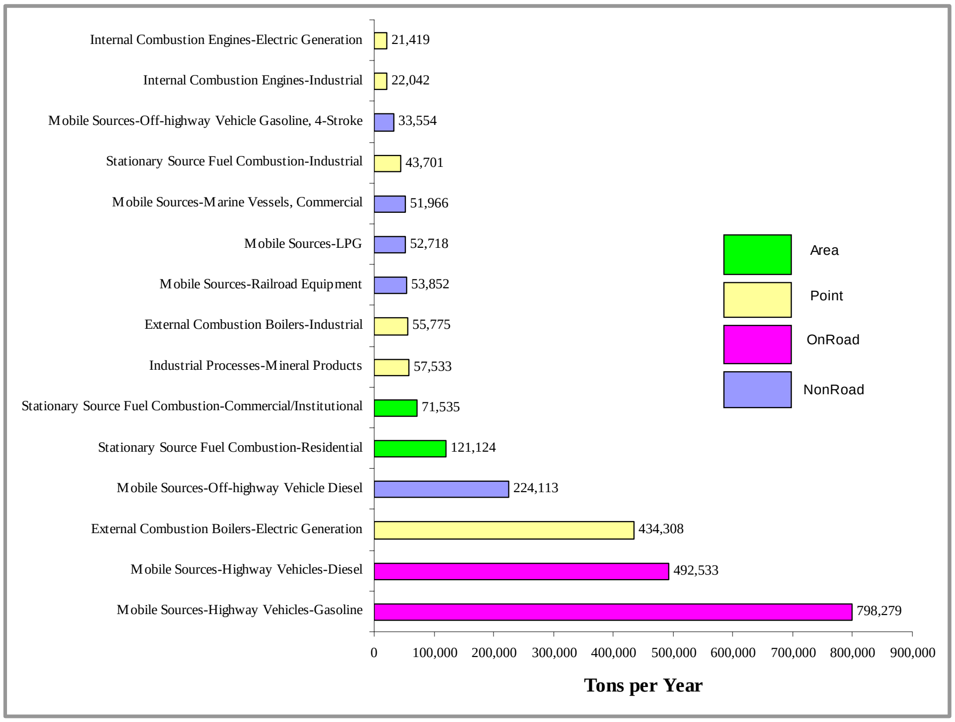


Figure 2.29: 2009 MANE-VU Region NO$_x$ Inventory Top 15

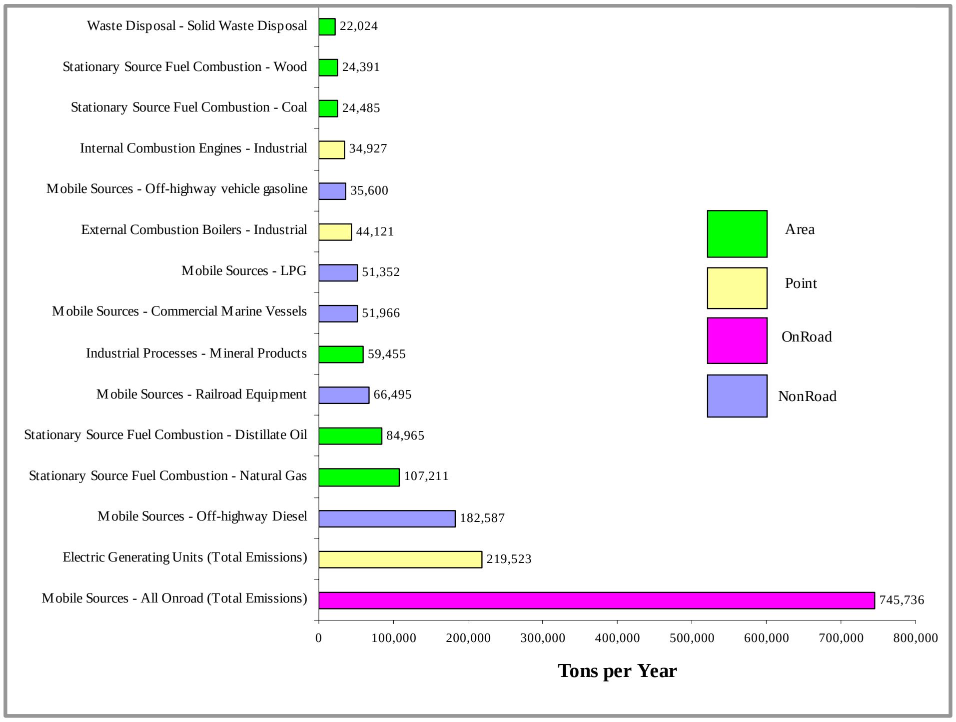


Figure 2.30: 2002 MANE-VU Region SO_2 Inventory Top 15

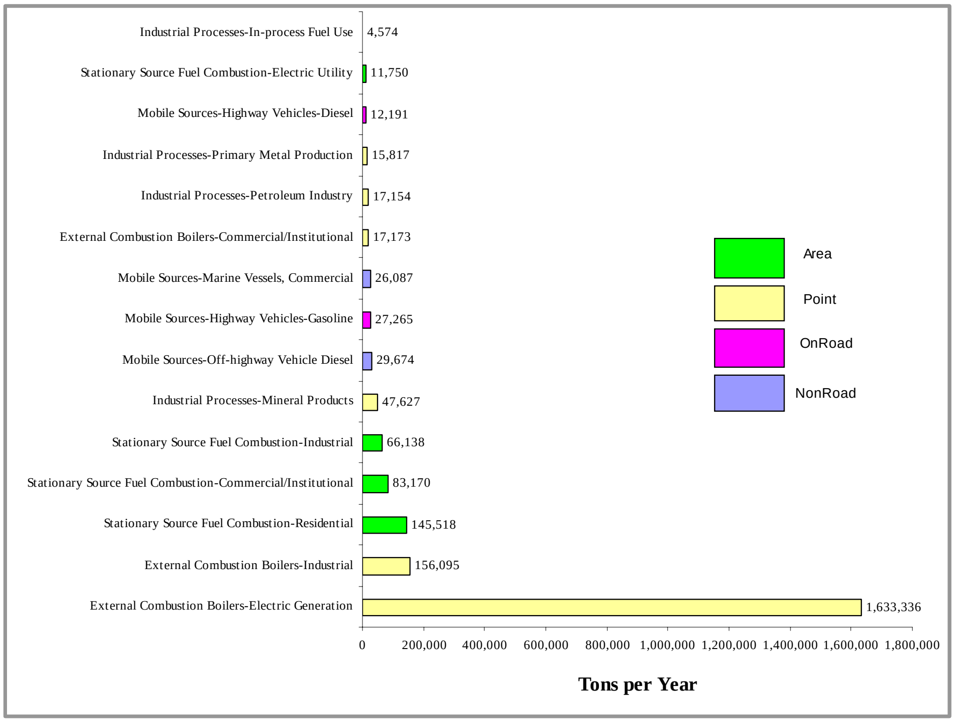
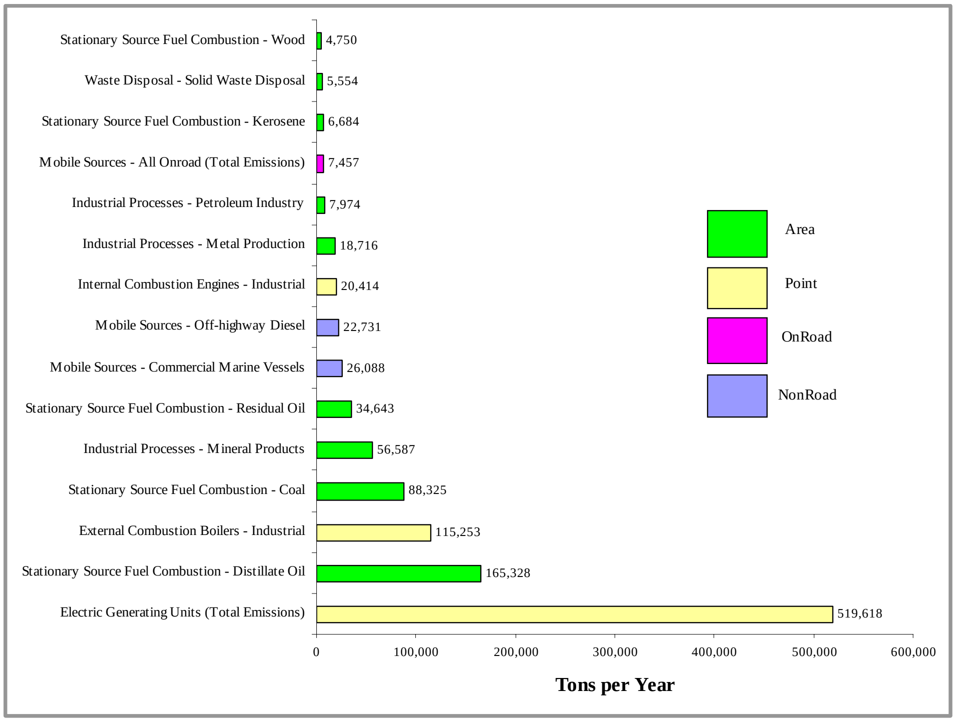


Figure 2.31: 2009 MANE-VU Region SO_2 Inventory Top 15



Addressing Condensables

Certain commercial or industrial activities involving high temperature processes (fuel combustion, metal processing, cooking operations, etc.) emit gaseous pollutants into the ambient air which rapidly condense into particle form. The constituents of these condensed particles include, but are not limited to, organic material, sulfuric acid, and metals.[33] States are required under the consolidated emissions reporting rule (CERR)[34] to report condensable emissions in each inventory revision. For New Jersey's 2002 $PM_{2.5}$ inventory, filterable $PM_{2.5}$ and condensable $PM_{2.5}$ emissions were calculated, and then these emissions were added together to produce the final $PM_{2.5}$ emissions.[35]

Addressing Fugitive Dust

There has been some controversy over state inventory estimates for fugitive dust sources, which primarily consist of dust from paved and unpaved roadways, stock/storage piles, landfill activity, quarry/mining activity, raw material handling, construction and agricultural tilling. Fugitive dusts are directly released air contaminants that do not pass through an exhaust pipe, stack, flue, vent, or chimney. Specifically, the concern is that the estimated numbers are significantly higher than is evidenced by the ambient data. This discrepancy is supported by a study of fine particle matter near urban roadways which found that emissions of resuspended particulate matter near urban roads calculated using the prescribed guidance would result in fine particle levels 9 to 20 times higher than those observed.[36] Further, the USEPA and other regional air quality modeling work have found it necessary to reduce calculated dust-related emissions by 75-90 percent in order to have the modeling results match monitored $PM_{2.5}$ speciated data. In the regional inventory, the states each submitted unadjusted fugitive dust emission numbers to the National Emissions Inventory (NEI)/MARAMA. However, these numbers were adjusted prior to modeling, as documented in the inventory section of the Technical Support Document for modeling (see Appendix B9). In order for the calculated inventory values to more closely match the actual measured levels in New Jersey air quality monitors, and match their true proportional impacts to human health, New Jersey multiplied its estimated fugitive dust emissions by a dust adjustment factor of 20 percent in its State-generated base inventory (submitted to USEPA on February 28, 2006, and approved by the USEPA May 2006).[37]

---

[33] 72 Fed. Reg. 20586 (April 25, 2007).

[34] 67 Fed. Reg. 39602 (June 10, 2002).

[35] NJDEP. State Implementation Plan (SIP) Revisions for the Attainment and Maintenance of the 8-Hour Carbon Monoxide National Ambient Air Quality Standard, 1-Hour Ozone National Ambient Air Quality Standard, and Fine Particulate Matter National Ambient Air Quality Standard; and the 2002 Periodic Emission Inventory. New Jersey Department of Environmental Protection. May 2006.

[36] NJDEP. Attachment 2: Fugitive Dust Inventory Discussion and Summary, State Implementation Plan (SIP) Revisions for the Attainment and Maintenance of the 8-Hour Carbon Monoxide National Ambient Air Quality Standard, 1-Hour Ozone National Ambient Air Quality Standard, and Fine Particulate Matter National Ambient Air Quality Standard; and the 2002 Periodic Emission Inventory. New Jersey Department of Environmental Protection. May 2006.

[37] See note 32.

2.7 Conclusions

Ambient air monitoring networks are in place to measure the levels of fine particulate matter in order to communicate the quality of the air to the public and to track the progress toward meeting the NAAQS. $PM_{2.5}$ has been measured in New Jersey and its associated multi-state nonattainment areas since 1999. A summary of the observations and conclusions from the analyses in this Chapter are as follows:

1) The air quality data in New Jersey and surrounding states indicates attainment of the former daily $PM_{2.5}$ standard (65 $\mu g/m^3$) and nonattainment of the new daily standard (35 $\mu g/m^3$).
2) $PM_{2.5}$ levels are decreasing.

3) Ambient $PM_{2.5}$ speciated data from the New Jersey speciation monitors in Camden, Chester, Elizabeth, and New Brunswick show that sulfate and organic carbon are the largest components of total $PM_{2.5}$ mass.

4) Analyses of the $PM_{2.5}$ speciated data collected at ambient monitors using source apportionment techniques demonstrate that common sources that contribute to $PM_{2.5}$ mass included a combination of local and regional sources and biogenic and anthropogenic sources, specifically coal-fired power plants in regions west of New Jersey, crustal matter, oil combustion sources in Northeast urban areas, sea salt, and motor vehicles (diesel/gasoline and local/highway).

5) In addition to the ambient monitoring network, emission inventories quantify the sources of $PM_{2.5}$. In general, for both nonattaiment areas associated with New Jersey, total emissions for each pollutant are projected to decrease, with emissions from the area source sector increasing, direct $PM_{2.5}$ emissions from stationary sources are increasing, and emissions from the other sectors are decreasing by 2009.