



# 2008 Particulate Summary

New Jersey Department of Environmental Protection

## NATURE AND SOURCES

Particulate air pollution is a complex mixture of organic and inorganic substances present in the atmosphere as either liquids or solids. Particulates may be as large as 70 microns in diameter or smaller than 1 micron in diameter. Most particulates are small enough that individual particles are undetectable by the human eye. Also, particulates may travel hundreds of miles suspended in the atmosphere from their sources before reaching ground level.

Generally particulate pollution is categorized by size. Particulates with diameters less than 2.5 microns are considered Fine Particulates, often referred to as PM<sub>2.5</sub> (Figure 1). Particulates with diameters greater than 2.5 microns are considered to be Coarse Particulates. Coarse Particulates are further divided into Total Suspended Particulates (TSP) and Inhalable Particulates (PM<sub>10</sub>). TSP consists of all suspended Particulates including the largest ones. PM<sub>10</sub> consists of particulates that are 10 microns in diameter or less. Particulates smaller than 10 microns are considered to be inhalable and are a greater health risk, but particulates of all sizes have an impact on the environment.

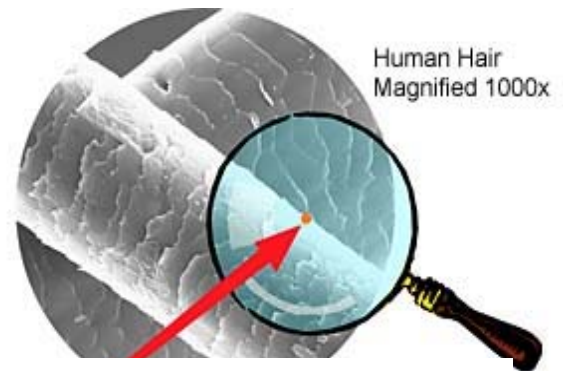
Particulates can occur naturally or be man made. Examples of naturally occurring particulates are windblown dust and sea salt. Man made particulates come from sources such as fossil fuel combustion and industrial processes. Man made sources can be divided into two categories: Primary Particulates and Secondary Particulates. Primary Particulates are directly emitted from their sources while Secondary Particulates are created in the atmosphere through reactions of gaseous emissions.

## ENVIRONMENTAL EFFECTS

Particulate matter is the major cause of reduced visibility in many parts of the United States. Figure 2a provides an example of reduced visibility due to particulate pollution recorded by the New Jersey Department of Environmental Protection's (NJDEP) visibility camera in Newark that shows the New York City skyline. Figure 2b is an example of a day with low particulate pollution and good visibility. Airborne

particles can also impact vegetation and aquatic ecosystems, and can cause damage to paints and building materials. More information regarding NJDEP's visibility efforts is provided in the Regional Haze section of this report.

**Figure 1**  
**Size of PM<sub>2.5</sub> Particulate Compared to a Human Hair**



**PM<sub>2.5</sub> Particulate**  
Graphics Courtesy of the US Department of Energy

**Figure 2a**



**Figure 2b**



## HEALTH EFFECTS

Inhalable particulates (PM<sub>10</sub>) and especially Fine Particulates (PM<sub>2.5</sub>) are a health concern because they are easily breathed into the lungs. Various health problems are associated with both long and short-term exposures. When inhaled, these particles can accumulate in the respiratory system and are responsible for heart and lung conditions, such as asthma, bronchitis, cardiac arrhythmias, heart attacks, and can even be attributed to premature death. Groups that appear to be at the greatest risk from particulates include children, the elderly, and individuals with heart and lung diseases, such as asthma (US EPA, 2001).

## STANDARDS

In 1971, Environmental Protection Agency (EPA) set primary (health based) and secondary (welfare based) standards for total suspended particulate matter (TSP). These standards, known as the National Ambient Air Quality Standards (NAAQS), were based on maximum 24-hour and annual concentrations. The annual standards were based on the geometric mean concentrations over a calendar year, and the 24-hour standards were based on the arithmetic average concentration from midnight to midnight. The primary 24-hour average standard for TSP was set at 260 micrograms per cubic meter (µg/m<sup>3</sup>) and the annual geometric mean health standard was set at 75 µg/m<sup>3</sup>. The 24-hour secondary standard was set at 150

µg/m<sup>3</sup>. While EPA did not establish a secondary annual standard for TSP they did set a guideline of 60 µg/m<sup>3</sup> to be used to ensure that the secondary 24-hour standard was being met throughout the year. Although New Jersey still maintains state standards for TSP, the national standards have been replaced with standards for smaller particles as described below. As a result, the monitoring effort for TSP has steadily diminished. NJDEP's sole TSP sampler was discontinued in early 2008.

In 1987, EPA replaced the TSP standards with standards that focused only on Inhalable Particulates. Inhalable particles are defined as particles less than 10 microns in diameter (PM<sub>10</sub>). The 24-hour PM<sub>10</sub> primary and secondary standards were set at 150 µg/m<sup>3</sup>, and the annual primary and secondary standards were set at 50 µg/m<sup>3</sup>. The annual standard for PM<sub>10</sub> is based on the arithmetic mean, as opposed to the geometric mean that was used for TSP.

In 1997, EPA promulgated new standards for fine particulates, while maintaining the existing standards for PM<sub>10</sub> as well. The PM<sub>2.5</sub> annual primary and secondary standards were set at 15.0 µg/m<sup>3</sup> and the 24-hour standard was set at 65 µg/m<sup>3</sup>. In October 2006, the EPA revised the 24-hour Standard. It currently is set at 35 µg/m<sup>3</sup>. Table 1 provides a summary of the Particulate Matter standards.

**Table 1  
National and New Jersey  
Ambient Air Quality Standards for Particulate Matter**

Micrograms Per Cubic Meter (µg/m<sup>3</sup>)

Standard	Averaging Period	Type	New Jersey	National
Total Suspended Particulates (TSP)	12-Month <sup>‡</sup>	Primary	75 µg/m <sup>3</sup>	---
	24-Hour	Primary	260 µg/m <sup>3</sup>	---
	12-Month <sup>‡</sup>	Secondary	60 µg/m <sup>3</sup>	---
	24-Hour	Secondary	150 µg/m <sup>3</sup>	---
Inhalable Particulates (PM <sub>10</sub> )	Annual <sup>†</sup>	Primary & Secondary	---	50 µg/m <sup>3</sup>
	24-Hour Average	Primary & Secondary	---	150 µg/m <sup>3</sup>
Fine Particulates (PM <sub>2.5</sub> )	Annual <sup>†</sup>	Primary & Secondary	----	15.0 µg/m <sup>3</sup>
	24-Hour Average	Primary & Secondary	----	35 µg/m <sup>3</sup>

<sup>‡</sup> Annual Geometric Mean

<sup>†</sup> Annual Arithmetic Mean

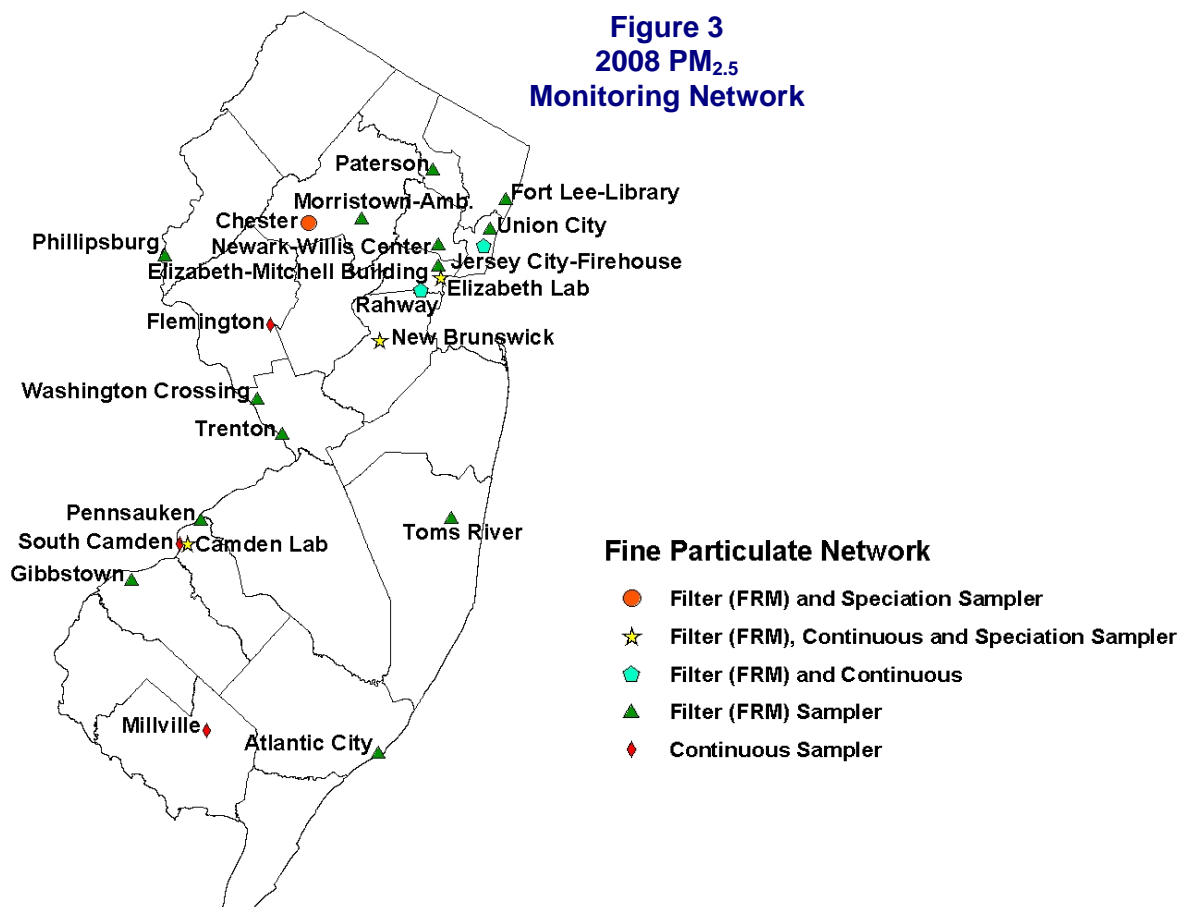
## PARTICULATE MONITORING NETWORK

New Jersey's Particulate Monitoring Network consists of 24 PM<sub>2.5</sub> monitoring sites, 6 PM<sub>10</sub> monitoring sites, and 9 sites where smoke shade is monitored.

20 samplers that comply with strict EPA guidelines are used for collecting data that is submitted to a national database maintained by the EPA. Samplers that meet these guidelines are called Federal Reference Method (FRM) samplers. These samplers pull a predetermined amount of air through a filter for a 24-hour period capturing particles on the filter. Different sample inlets determine what size particles will be captured. The filters are weighed before and after sampling under controlled environmental conditions to determine the concentration. The data is then used by the NJDEP and EPA to determine whether the state, or portions of the state, meets the federal health and welfare standards for particulate matter. Because these samplers are required to run for 24-hour period and can not provide data in real time the NJDEP employs additional monitors that

continuously measure particulate concentrations. These monitors are used by the NJDEP to report current air quality to the public through the Air Quality Index ([www.njaqinow.net](http://www.njaqinow.net)). The NJDEP uses Tapered Element Oscillating Microbalance (TEOM) analyzers and smoke shade instruments for real-time particle reporting. The TEOM analyzers collect a sample of fine particles on an oscillating filter, and determine the concentration based on the change in the frequency at which the filter oscillates. Smoke shade instruments collect a sample of particles on a paper tape for one hour. At the end of each hour the amount of light that will pass through the spot that has formed on the tape is measured, the tape advanced, and the cycle started over. The amount of light transmittance measured is used as an estimate of actual particulate concentrations.

**Figure 3**  
**2008 PM<sub>2.5</sub>**  
**Monitoring Network**



# FINE PARTICLE SUMMARY

## FINE PARTICLE MONITORING SITES

There are 20 monitoring sites in New Jersey where a filter-based sampler routinely collects 24-hour PM<sub>2.5</sub> samples (see Figure 3). At 10 sites, continuous particulate monitors (TEOMs) measure the concentration of fine particles every minute and transmit the data to the Bureau of Air Monitoring's central computer, where it is made available on the Bureau's public website ([www.njaqinow.net](http://www.njaqinow.net)).

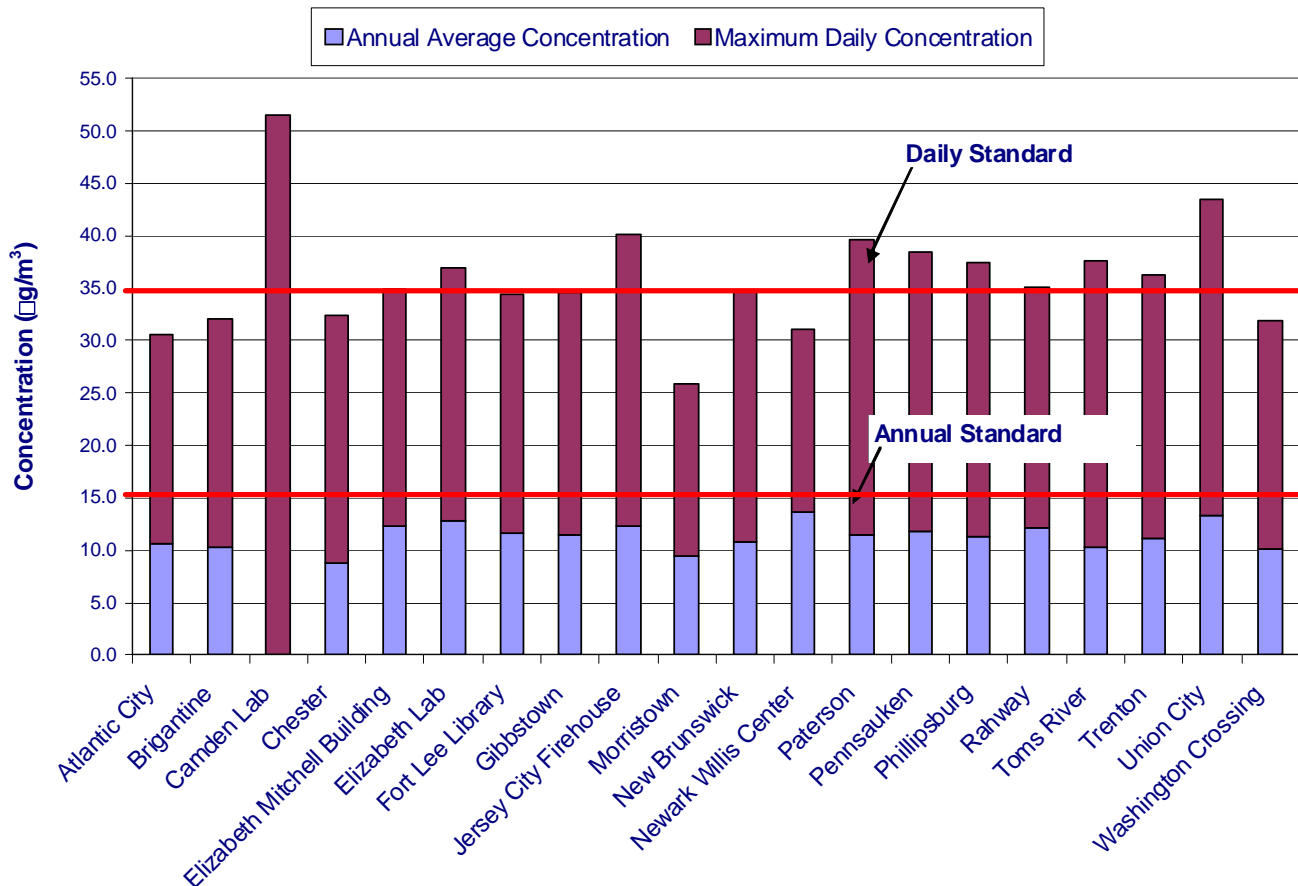
Additionally, at four of these locations, a separate 24-hour filter based sampler collects fine particles on three types of filter media which are subsequently analyzed using ion chromatography (IC), X-ray fluorescence (XRF), and Thermal Optical Analysis (TOA) to determine the concentrations of the chemical analytes that constitute the sample. (The Camden monitoring station was shut down on September 29, 2008 because the NJDEP lost access to the site).

## FINE PARTICLE CONCENTRATION SUMMARY

The annual mean concentration of PM<sub>2.5</sub> ranged from 8.8 µg/m<sup>3</sup> at Chester to 13.7 µg/m<sup>3</sup> at the Newark Willis Center. The highest daily concentration ranged from 25.8 µg/m<sup>3</sup> at Morristown to 51.5 µg/m<sup>3</sup> at Camden. Figure 4 and Table 2 depict the mean and maximum concentrations at each site. Table 2 also shows the 2008 annual design value for each site. An annual design value is calculated by averaging the average concentration from 12 consecutive quarters (3 years), in this case 2006-2008. Design values are used to determine attainment status.

No sites were in violation of the annual standard of 15.0 µg/m<sup>3</sup>. Nine monitoring sites measured exceedences of the 24-hour standard of 35 micrograms.

**Figure 4**  
**2008 Fine Particulate (PM<sub>2.5</sub>) Concentrations**



**Table 2**  
**2008 Summary of PM<sub>2.5</sub> Sampler Data**  
**Concentration in Micrograms Per Cubic Meter (µg/m<sup>3</sup>)**

Monitoring Site	Number of Samples	Annual Mean Concentration	Highest Daily Concentration	Second Highest Daily Concentration	2008 Annual Average Design Values
Atlantic City	96	10.6	30.6	27.2	11.1
Brigantine*	97	10.3	32.1	31.3	---
Camden Lab**	214	---	51.5	39.0	13.2
Chester	109	8.8	32.4	25.0	9.4
Elizabeth Lab	290	12.9	37.0	37.0	13.7
Elizabeth Mitchell Building	118	12.4	35.0	34.2	12.6
Fort Lee Library	106	11.6	34.4	32.6	12.2
Gibbstown	109	11.5	34.6	27.0	11.3
Jersey City Firehouse	324	12.2	40.1	38.1	12.8
Morristown	106	9.4	25.8	25.4	10.3
New Brunswick	112	10.9	34.8	29.1	11.3
Newark Willis Center	63	13.7	31.0	28.7	13.1
Paterson	115	11.4	39.6	31.1	12.3
Pennsauken	109	11.9	38.5	30.5	12.7
Phillipsburg	112	11.2	37.4	30.6	11.8
Rahway	111	12.0	35.1	31.7	12.4
Toms River	343	10.2	37.6	36.7	10.2
Trenton	341	11.1	36.2	36.0	11.9
Union City	110	13.3	43.5	37.7	14.1
Washington Crossing	107	10.0	31.9	28.0	10.1

\* Site does not have sufficient amount of data to calculate annual average design value.

\*\* Station was shut down on September 29, 2008 because the NJDEP lost access to the station. Site does not have sufficient amount of data to calculate annual mean concentration.

**Table 3**  
**2008 Summary of Continuous PM<sub>2.5</sub> Data**  
**Concentration in Micrograms Per Cubic Meter (µg/m<sup>3</sup>)**

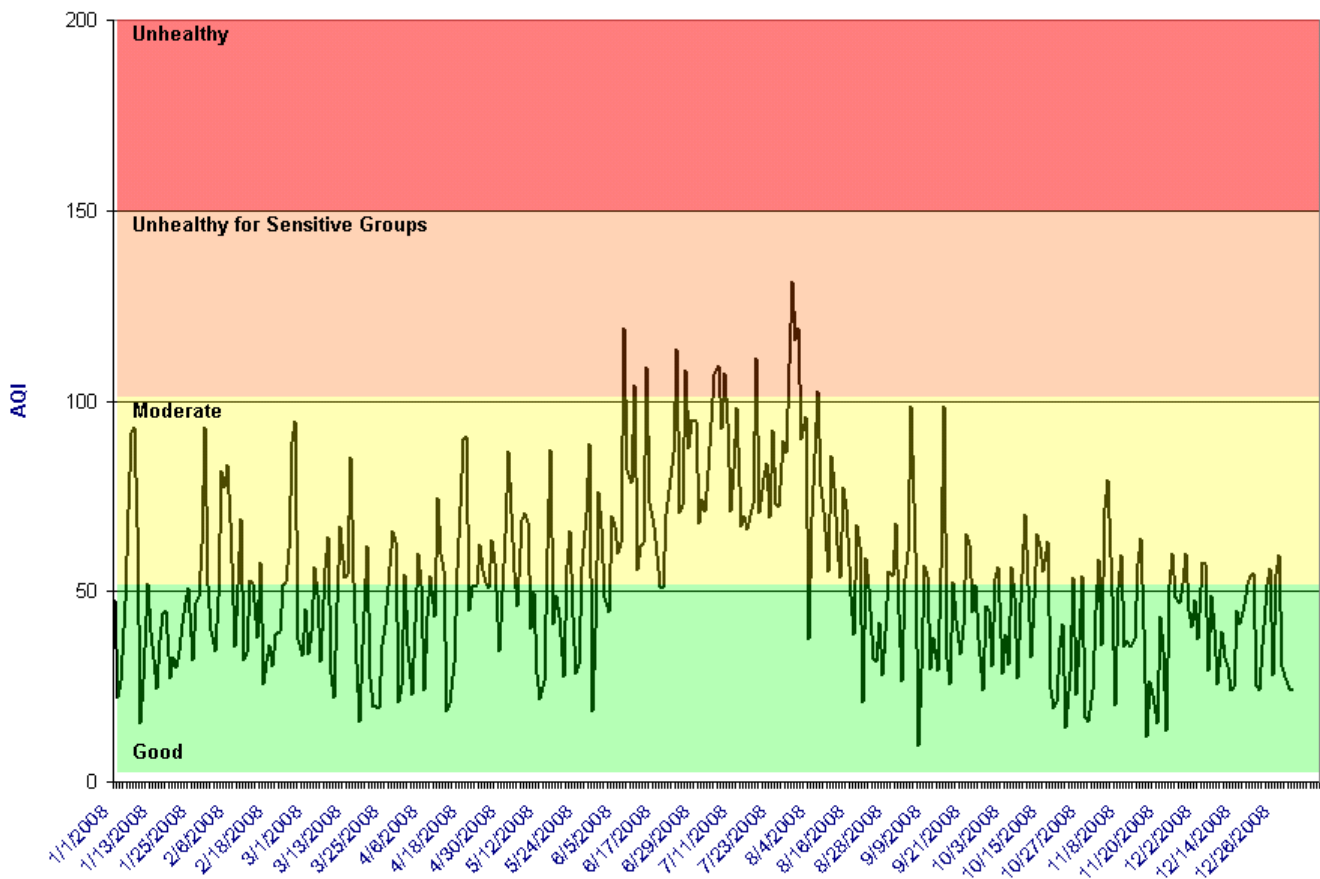
Monitoring Site	Annual Mean Concentration	Highest Daily Concentration	Second Highest Daily Concentration
Brigantine	9.8	37.7	37.5
Camden Lab*	---	29.8	28.7
Elizabeth Lab	11.6	33.3	33.1
Flemington	9.7	37.1	33.6
Fort Lee	15.0	47.0	40.0
Jersey City Firehouse	14.5	42.4	41.4
Millville	10.9	35.0	30.4
New Brunswick	8.4	35.8	31.1
Rahway	11.8	35.9	35.8
South Camden	15.1	55.9	49.8

\* Station was shut down September 29, 2008 because the NJDEP lost access to the station. Site does not have sufficient amount of data to calculate annual mean concentration.

## PM<sub>2.5</sub> REAL-TIME MONITORING

New Jersey's continuous PM<sub>2.5</sub> monitoring network consists of 10 sites: Brigantine, Camden Lab, Elizabeth Lab, Flemington, Fort Lee, Jersey City Firehouse, Millville, New Brunswick, Rahway and South Camden. The data is transmitted once a minute to a central computer in Trenton, where it is averaged and automatically updated on the bureau's website every hour. Table 3 provides a summary of the data from these sites, and Figure 5 depicts the health level associated with the maximum daily fine particulate concentration recorded in the state each day for the entire year. Only days in which 23 hours of valid data was collected are used for summaries.

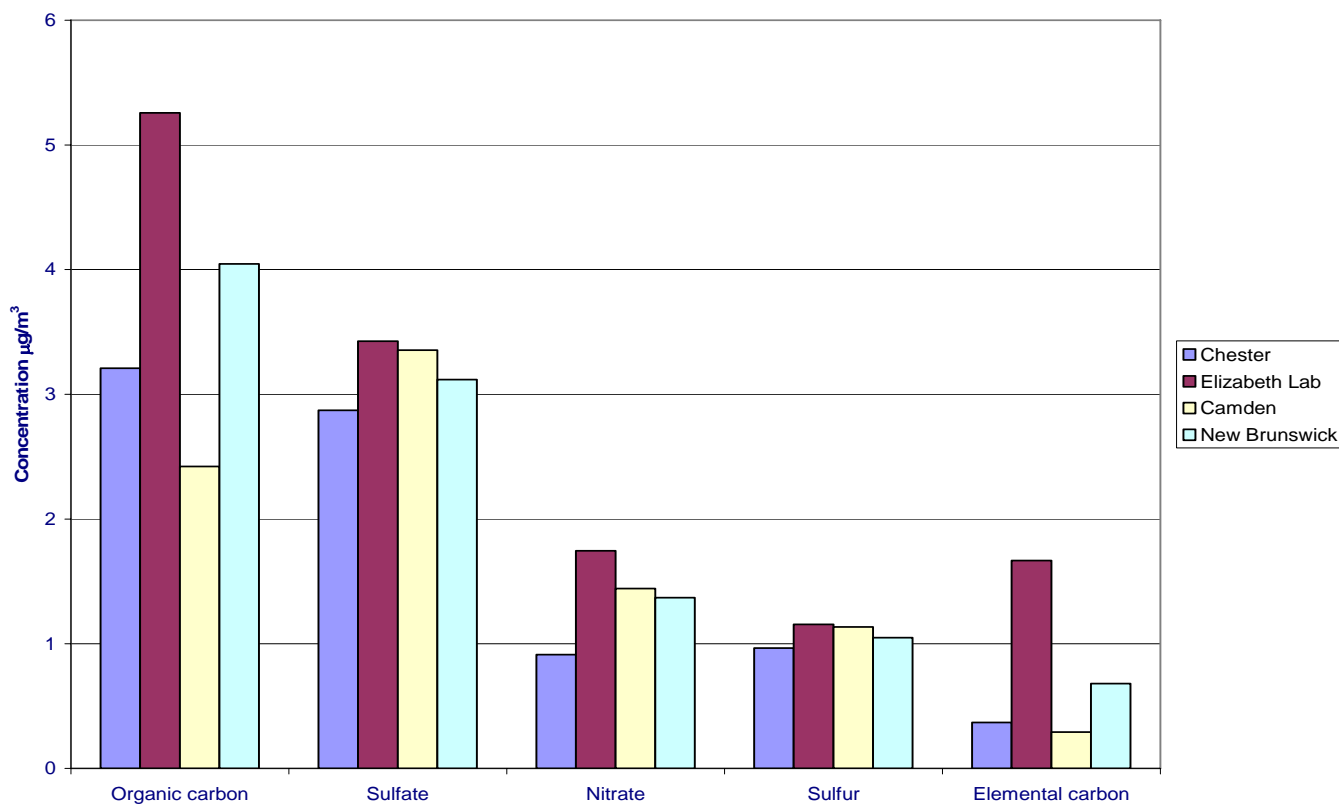
**Figure 5**  
**2008 Maximum Daily Fine Particulate Concentration**  
**(Highest site)**  
**Air Quality Index (AQI)**



## FINE PARTICULATE SPECIATION SUMMARY

New Jersey's Fine Particulate Speciation Network consists of 4 monitoring sites: Camden Lab, Elizabeth Lab, New Brunswick, and Chester. Samplers run every third day on a schedule concurrent with the Federal Reference Method sampling network. Of the 55 measured analytes, organic carbon, sulfate, nitrate, sulfur and elemental carbon are the most prevalent species. Combined, they create the majority of the particulates total mass. Figure 6 depicts the average concentration of the five most prevalent species. Organic and Elemental carbon samples at Camden are collected and analyzed using a different method than the other sites. High organic and elemental carbon concentrations at Elizabeth Lab are due to the sites' proximity to high traffic volume, and motor vehicles are the primary source for those species. Appendix B shows the average, maximum, and 2<sup>nd</sup> highest daily average concentrations for each species for 2008.

**Figure 6**  
**2008 Fine Particulate Analyte Composition**  
**Annual Average**  
**(Highest 5 Analytes Depicted)**



## FINE PARTICULATE NON-ATTAINMENT AREAS

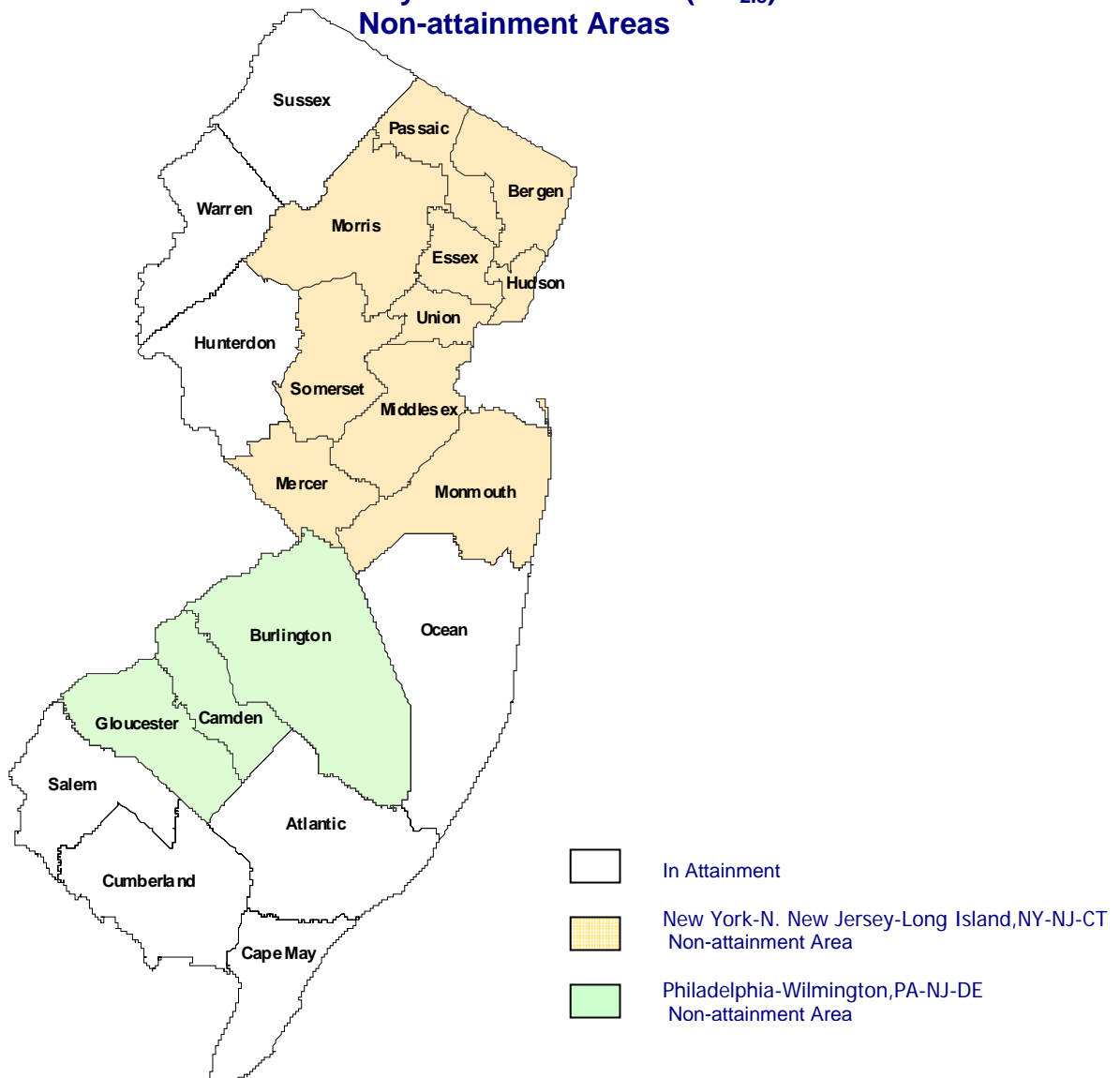
On April 5, 2005, thirteen New Jersey counties were classified as non-attainment areas. Non-attainment classification is given to an area that exceeds the air quality standard or contributes to the exceedance of that standard. In order to determine if the PM<sub>2.5</sub> annual standard is met, the average of 12 consecutive quarters of valid data within 3 calendar years is compared to 15 µg/m<sup>3</sup>.

While the Elizabeth Lab was the only site to record a violation of the annual standard, 10 counties in the northeast and central region of the state were designated

as non-attainment due to their potential PM<sub>2.5</sub> contribution to the Elizabeth Lab monitor and additional sites in New York City that recorded violations of the PM<sub>2.5</sub> Standards.

Similarly, 3 counties in the southwestern part of the state have been classified as non-attainment due to their contribution to PM<sub>2.5</sub> violations in the city of Philadelphia. DEP is currently devising a strategy to lower PM<sub>2.5</sub> levels in these affected areas.

**Figure 7**  
**New Jersey Particulate Matter (PM<sub>2.5</sub>)**  
**Non-attainment Areas**





## 2008 COARSE PARTICLE SUMMARY

### COARSE PARTICLE MONITORING SITES

The coarse particulate monitoring network is composed of 6 PM<sub>10</sub> sampling sites. New Jersey's last TSP monitoring site was discontinued in early 2008 due to low lead concentrations. PM<sub>10</sub> samples, taken once every six days are collected on a filter that is weighed before and after sampling to determine the concentration. Figure 8 depicts the PM<sub>10</sub> particulate monitoring network in New Jersey.

### PM<sub>10</sub> CONCENTRATION SUMMARY

In 2008, the annual mean concentration of PM<sub>10</sub> ranged from 20.1 µg/m<sup>3</sup> at Trenton to 40.9 µg/m<sup>3</sup> at Atlantic City. Table 4 and Figure 9 show the annual mean and 24-hour maximum PM<sub>10</sub> concentrations throughout the state. All areas of the state are in attainment for the both the annual PM<sub>10</sub> standards of 50 µg/m<sup>3</sup> and the 24-hour standard of 150 µg/m<sup>3</sup>.

**Figure 8**  
**2008 PM<sub>10</sub>**  
**Monitoring Network**

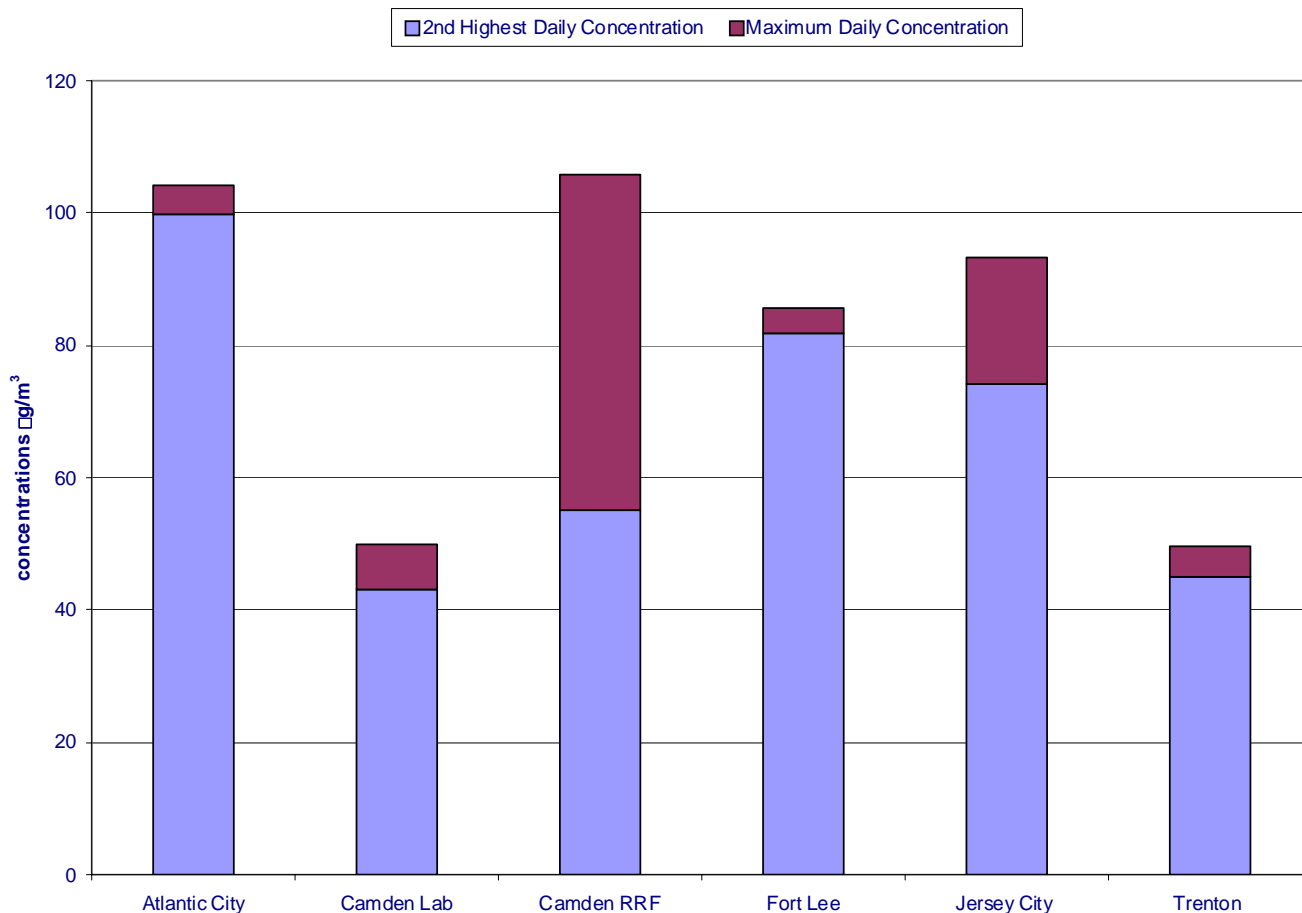


**Table 4**  
**PM<sub>10</sub> Data - 2008**  
**Daily and Annual Averages**

Micrograms Per Cubic Meter ( $\mu\text{g}/\text{m}^3$ )  
 Daily Standard = 150 ( $\mu\text{g}/\text{m}^3$ )  
 Annual Standard = 50 ( $\mu\text{g}/\text{m}^3$ )

Monitoring Site	Number of Samples	Highest Daily Concentration	Second Highest Daily Concentration	Annual Mean
Atlantic City	51	104.2	99.9	40.9
Camden Lab	39	49.9	43.0	23.1
Camden RRF	55	106.0	55.2	28.3
Fort Lee	49	85.5	81.9	37.8
Jersey City-Firehouse	59	93.4	74.1	29.0
Trenton	59	49.6	45.1	20.1

**Figure 9**  
**Summary of PM<sub>10</sub> Concentrations, New Jersey 2008**



## SMOKE SHADE SUMMARY

### SMOKE SHADE MONITORING SITES

In addition to fine and coarse particulate monitoring, smoke shade is also monitored at 9 stations around the state. The Elizabeth site resumed operation on July 1, 2008 after major renovations were completed at the site, while Camden Lab was shut down September 29, 2008 because the NJDEP lost access to the site. Smoke shade, which is an indirect measurement of particles in the atmosphere, has been monitored in New Jersey for over 40 years. Smoke shade is primarily used for the daily reporting of particulate levels in the Air Quality Index. The sites monitoring smoke shade are shown in Figure 10.

### SMOKE SHADE CONCENTRATION SUMMARY

In 2008, the annual mean concentration of smoke shade ranged from 0.15 Coefficient of Haze units (COH) at Freehold to 0.46 COH at Elizabeth Lab. COH are units of light transmittance, and smoke shade is not a direct measure of particle mass. A 24-hour average level of 2.0 COH is used as a benchmark. Readings above the 2.0 COH benchmark are reported as Unhealthy for Sensitive Groups on the daily Air Quality Index. For more details see the Air Quality Index section of this report. Table 5 lists the maximum and second highest daily average and annual mean smoke shade levels recorded at the monitoring sites in 2008.

**Table 5**  
**Smoke Shade - 2008**

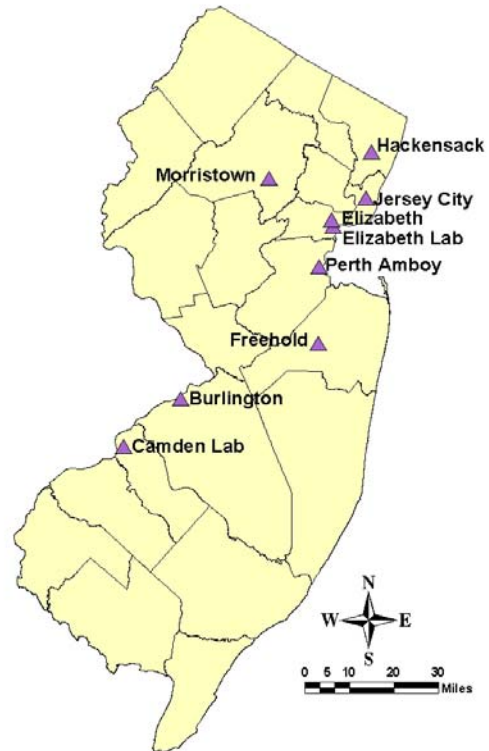
Coefficient of Haze (COHs)  
No Standard

Site	Maximum Daily Average	2nd Highest Daily Average	Annual Mean
Burlington	0.67	0.59	0.20
Camden Lab**	0.60	0.57	---
Elizabeth*	0.70	0.69	---
Elizabeth Lab	1.47	1.20	0.46
Freehold	0.49	0.38	0.15
Hackensack	0.86	0.65	0.20
Jersey City	1.19	1.17	0.43
Morristown	0.58	0.56	0.20
Perth Amboy	0.60	0.53	0.18

\*\* Site was shut down September 29, 2008 because NJDEP lost access to the site, and does not have sufficient data to calculate annual mean.

\* Site resumed operation in July 2008, but does not have sufficient data to calculate annual mean.

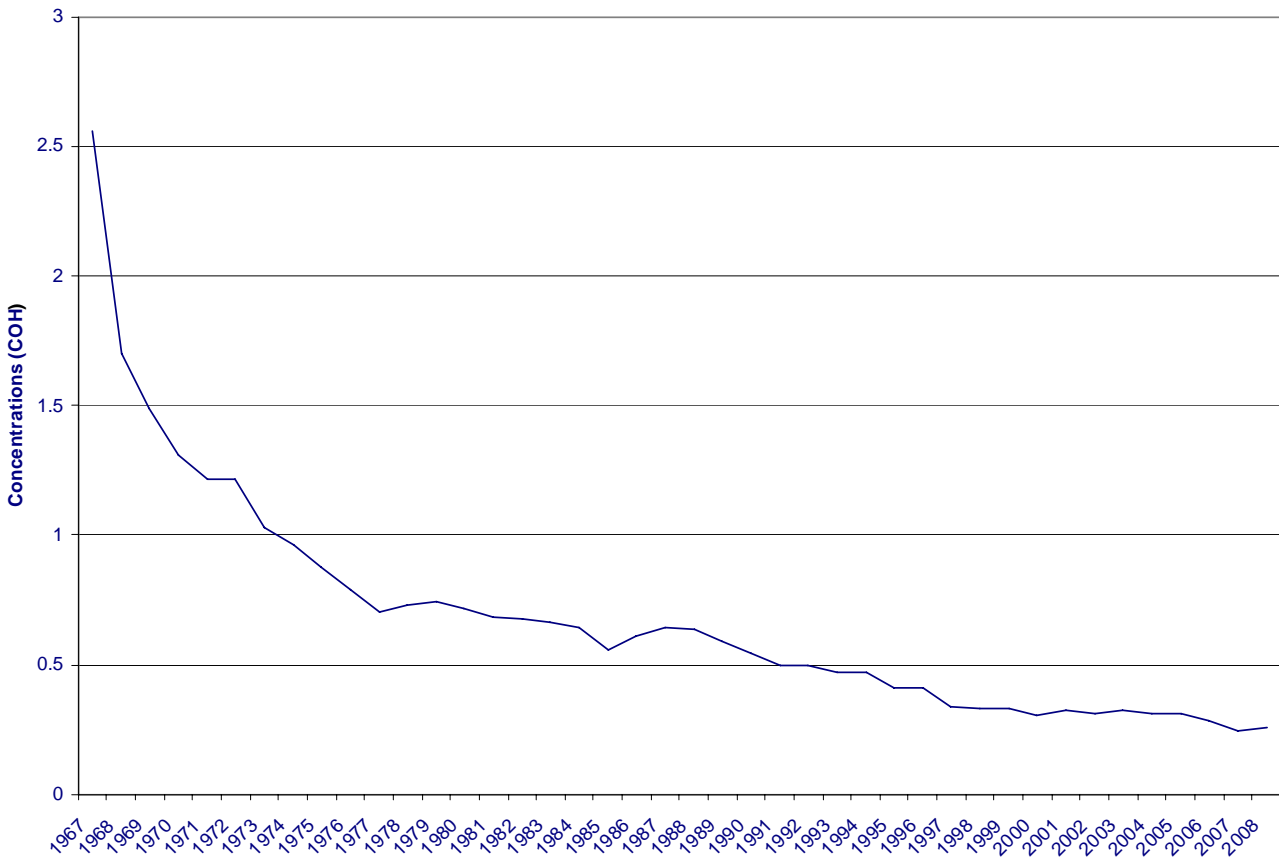
**Figure 10**  
**2008 Smoke Shade Monitoring Network**



## TRENDS IN PARTICULATE CONCENTRATIONS

The longest continuously operating particulate monitoring network in the state that is suitable for looking at trends is the smoke shade network. As noted earlier, this monitoring program has been in effect for over 40 years and still has 9 active sites. The trend graph for smoke shade, shown in Figure 11 indicates that particulate levels have steadily declined over the past 40 years. Smoke shade is not a direct measurement of particle mass, but can be related to TSP, PM<sub>10</sub> and PM<sub>2.5</sub> health standards.

**Figure 11**  
**Long Term Trend in Particulate Levels**  
**State Average**  
**1967- 2008**



## REFERENCES

*PM – How Particulate Matter Affects the Way We Live and Breathe*, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC November 2000, URL: [www.epa.gov/air/urbanair/pm/index.html](http://www.epa.gov/air/urbanair/pm/index.html)

*Air Quality Criteria for Particulate Matter*, USEPA, Office of Research and Development, EPA-600/P-99-002A and B, March 2001

*Environmental Health Threats to Children*, USEPA, Office of the Administrator, EPA-176/F-96-001, September 1996.

*National Ambient Air Quality Standards for Particulate Matter, Final Rule*, USEPA, Part 50 of Title 40 of the Code of Federal Regulations, July 1997.

*National Air Quality and Emissions Trend Report, 1999*, EPA-454/R-01-004, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 2001, URL: [www.epa.gov/airtrends/reports.html](http://www.epa.gov/airtrends/reports.html)

*Latest Findings on National Air Quality: 2000 Status and Trends*, EPA-454/K-01-002, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, September 2001, URL: [www.epa.gov/airtrends/reports.html](http://www.epa.gov/airtrends/reports.html)