



2007 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. Particles may travel hundreds of miles suspended in the atmosphere from their sources before reaching ground level.

Generally particulate pollution is categorized by size. Particles with diameters less than 2.5 microns are considered fine Particulates, often referred to as $PM_{2.5}$ (Figure 1). Particles with diameters greater than 2.5 microns are considered to be coarse Particulates. Coarse particles are further divided into Total Suspended Particulates (TSP) and PM_{10} . TSP consists of all suspended particles including the largest ones. PM_{10} consists of particles that are 10 microns in diameter or less. Particles smaller than 10 microns are considered to be inhalable and are a greater health risk. Particles 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 our WebCam site in Newark. Figure 2b is an example of a day with low particulate pollution and good visibility. The backdrop is the New York City sky-line. Airborne particles can also impact vegetation and aquatic ecosystems, and can cause damage to paints and building

materials. More information is provided in the Regional Haze section of this report.

Figure 1
Size of $PM_{2.5}$ Particle Compared to a Human Hair

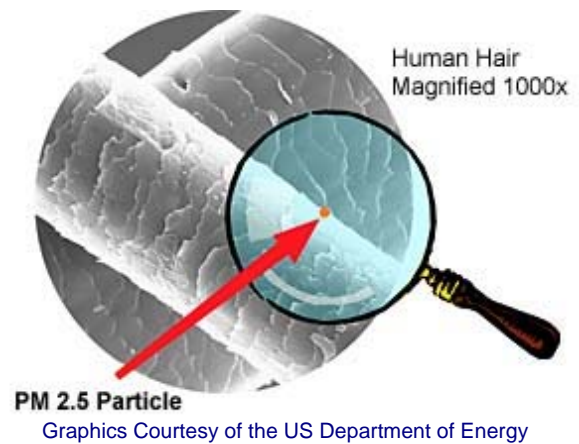


Figure 2a



Figure 2b



HEALTH EFFECTS

Inhalable particles (smaller than 10 microns) and especially fine particles (PM_{2.5}) 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 (*US EPA, 1997*). 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/m³) and the annual geometric mean health standard was set at 75 µg/m³. The 24-hour secondary standard was set at 150 µg/m³. While EPA did

not establish a secondary annual standard for TSP they did set a guideline of 60 µg/m³ 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, monitoring for TSP has largely been discontinued, with the exception of one station, where TSP samples are taken to analyze for lead (Pb). See the Lead Summary section for more details.

In 1987, EPA replaced the TSP standards with standards that focused only on inhalable particles. Inhalable particles are defined as particles less than 10 microns in diameter (PM₁₀). The 24-hour PM₁₀ primary and secondary standards were set at 150 µg/m³, and the annual primary and secondary standards were set at 50 µg/m³. The annual standard for PM₁₀ 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, which it defined as particles less than 2.5 microns in diameter (PM_{2.5}). They kept the existing standards for PM₁₀ as well. The PM_{2.5} annual primary and secondary standards were set at 15 µg/m³ and the 24-hour standard was set at 65 µg/m³. In December 2006 the EPA revised the 24-hour Standard. It currently is set at 35 µg/m³. 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 ³)				
Standard	Averaging Period	Type	New Jersey	National
Total Suspended Particulates (TSP)	12-Month [‡]	Primary	75 µg/m ³	---
	24-Hour	Primary	260 µg/m ³	---
	12-Month [‡]	Secondary	60 µg/m ³	---
	24-Hour	Secondary	150 µg/m ³	---
Inhalable Particulates (PM ₁₀)	Annual [†]	Primary & Secondary	---	50 µg/m ³
	24-Hour Average	Primary & Secondary	---	150 µg/m ³
Fine Particulates (PM _{2.5})	Annual [†]	Primary & Secondary	----	15 µg/m ³
	24-Hour Average	Primary & Secondary	----	35 µg/m ³

[‡] Annual Geometric Mean

[†] Annual Arithmetic Mean

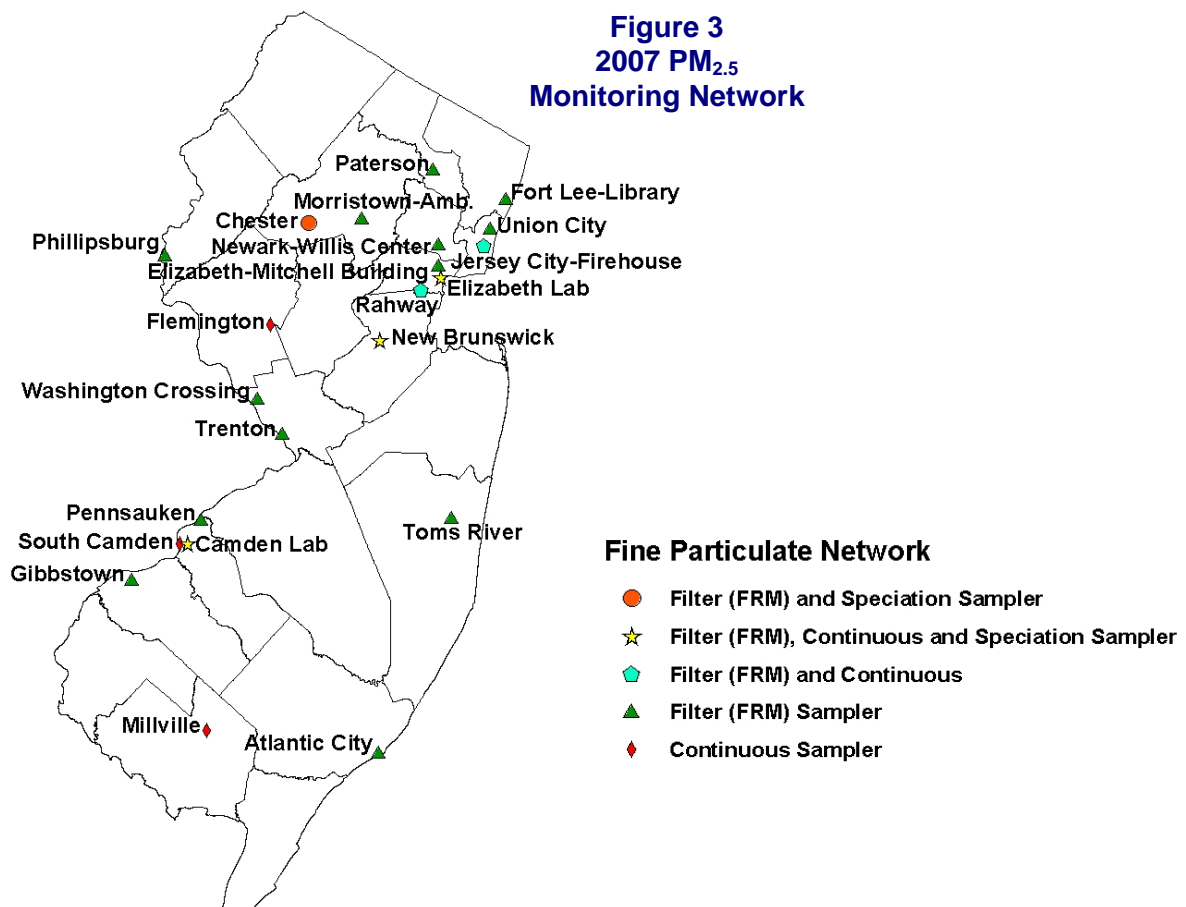
PARTICULATE MONITORING NETWORK

New Jersey's Particulate Monitoring Network consists of 24 fine particulate monitoring sites, 6 PM₁₀ monitoring sites, 1 TSP monitoring site, and 9 sites where smoke shade is monitored.

Samplers that comply with strict EPA specifications are used for collecting data that is submitted to a national database maintained by the EPA. 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 New Jersey Department of Environmental Protection (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 samplers that

continuously measure particulate concentrations. These samplers are used by the NJDEP to report current air quality to the public through the Air Quality Index (www.state.nj.us/dep/airmon). 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 particle concentrations.

Figure 3
2007 PM_{2.5}
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_{2.5} 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.state.nj.us/dep/airmon). 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.

FINE PARTICLE CONCENTRATION SUMMARY

The annual mean concentration of PM_{2.5} ranged from 10.2 µg/m³ at Atlantic City and Washington Crossing to 15.0 µg/m³ at Union City. The highest daily concentration ranged from 30.3 µg/m³ at Atlantic City to 56.9 µg/m³ at Pennsauken. Figure 4 and Table 2 depict the mean and maximum concentrations at each site. Table 2 also shows the 2007 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 2005-2007. Design values are used to determine attainment/non-attainment status.

No sites were in violation of the annual standard of 15 µg/m³. All sites, except Atlantic City measured exceedences of the new 24-hour standard of 35 micrograms.

This data has not yet been used to make attainment/non-attainment decisions. All current attainment/non-attainment designations are based on data from 2001-2003. See page 8 for more details.

Figure 4
2007 Fine Particulate (PM_{2.5})

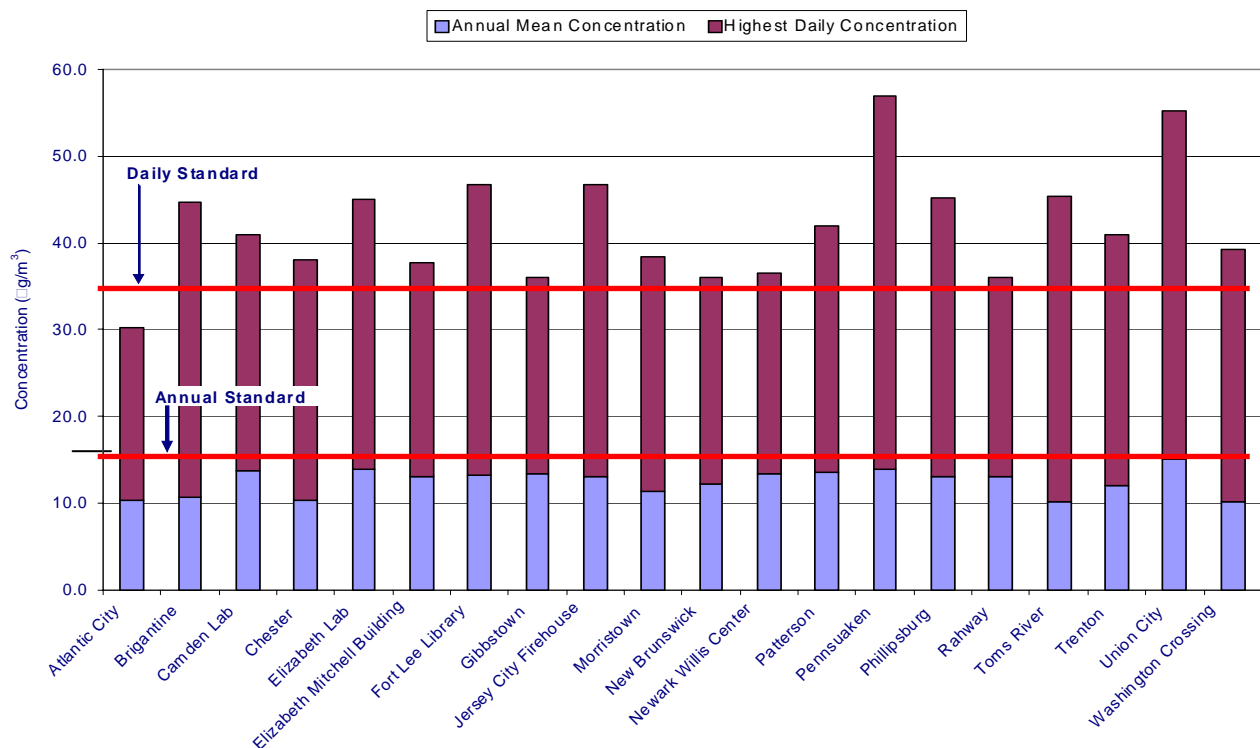


Table 2
2007 Summary of PM_{2.5} Sampler Data
Concentration in Micrograms Per Cubic Meter (µg/m³)

Monitoring Site	Number of Samples	Annual Mean Concentration	Highest Daily Concentration	Second Highest Daily Concentration	2007 Annual Average Design Values
Atlantic City	100	10.2	30.3	26.7	11.6
Brigantine*	93	10.6	44.7	31.7	-
Camden Lab	306	13.7	41.0	40.4	13.6
Chester	135	10.3	38.1	32.5	10.3
Elizabeth Lab	342	13.8	45.0	42.5	14.5
Elizabeth Mitchell Building	135	13.1	37.7	36.4	13.3
Fort Lee Library	117	13.3	46.8	36.2	13.3
Gibbstown	101	13.3	36.0	34.7	12.9
Jersey City Firehouse	318	13.1	46.7	43.8	14.0
Morristown	113	11.4	38.4	34.9	11.5
New Brunswick	112	12.2	36.0	32.2	12.4
Newark Willis Center	114	13.4	36.6	35.3	13.5
Paterson	111	13.5	41.9	36.6	13.1
Pennsauken	108	13.8	56.9	40.4	13.6
Phillipsburg	108	13.0	45.2	34.6	12.8
Rahway	107	13.1	36.0	35.7	13.1
Toms River	316	10.2	45.4	37.3	10.9
Trenton	342	12.0	41.0	40.7	12.6
Union City	112	15.0	55.2	40.8	15.2
Washington Crossing	92	10.2	39.2	27.2	11.0

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

Table 3
2007 Summary of Continuous PM_{2.5} Data

Concentration in Micrograms Per Cubic Meter (µg/m³)

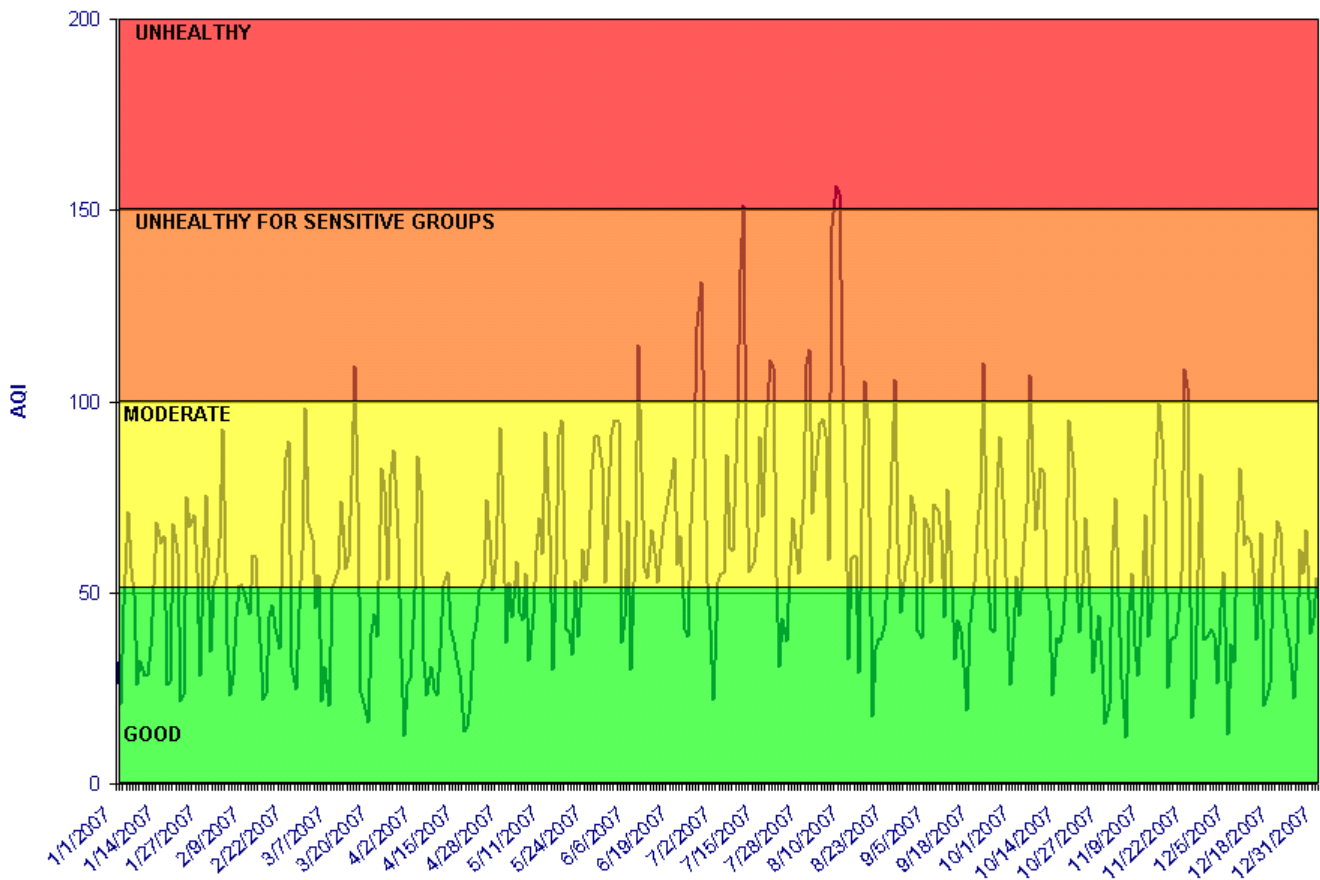
Monitoring Site	Annual Mean	Highest Daily Concentration	Second Highest Daily Concentration
Brigantine*	8.1	28.8	22.1
Camden Lab	11.5	40.2	31.9
Elizabeth Lab	12.6	48.6	40.4
Flemington	10.2	42.2	40.6
Fort Lee	16.9	54.9	53.2
Jersey City Firehouse	17.0	57.4	55.9
Millville	10.9	63.2	31.5
New Brunswick	8.8	27.8	26.9
Rahway	12.9	27.2	26.5
South Camden	14.5	51.8	48.2

* Site began collecting data on 8/11/2007

PM_{2.5} REAL-TIME MONITORING

New Jersey's continuous PM_{2.5} 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.

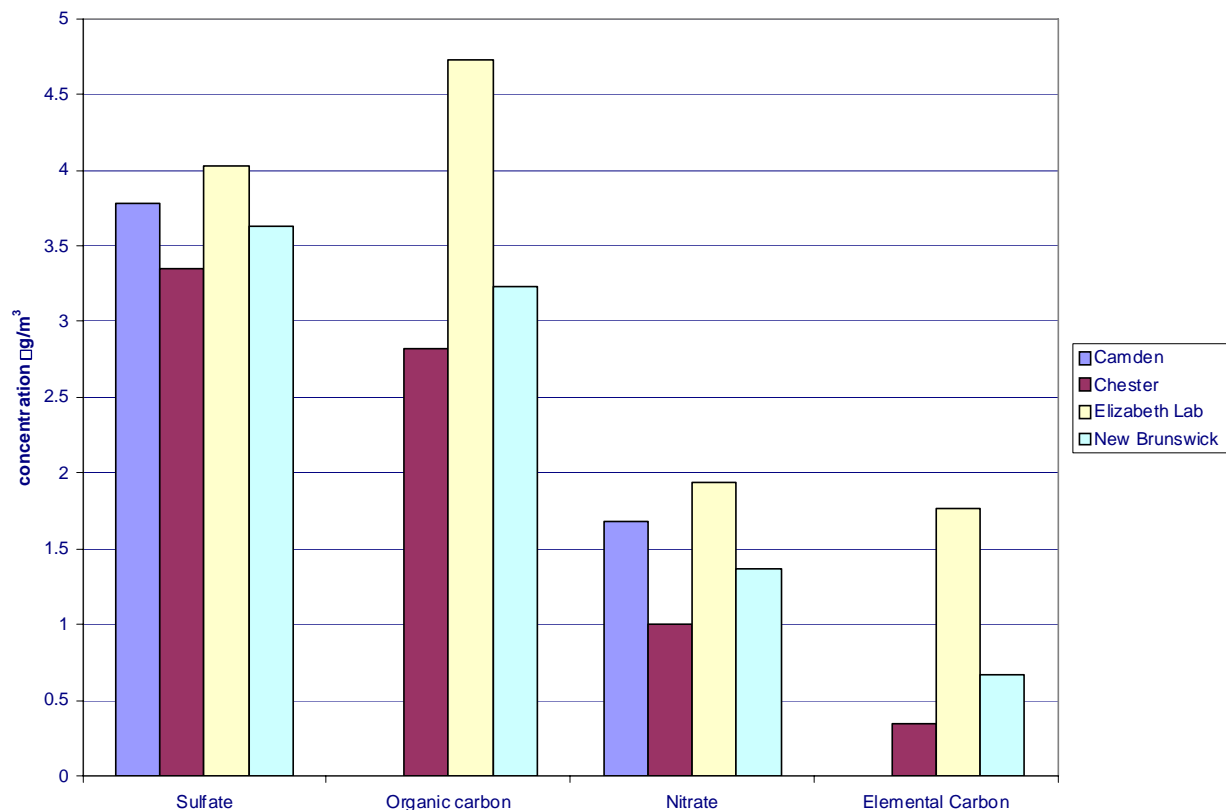
Figure 5
2007 Maximum Daily Fine Particulate Concentration
(Highest site)
Air Quality Index (AQI)



FINE PARTICLE 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 (FRM) sampling network. Of the 55 measured analytes, organic carbon, sulfate, nitrate and elemental carbon are the most prevalent species. Combined, they create the majority of the particles total mass. Figure 6 depicts the average concentration of the four most prevalent species (due to a mid-year change in sampling and analytical methods, Camden Lab does not show annual average data for Organic and Elemental Carbon. Data for each method can be viewed in appendix B). Appendix B shows the average, maximum, and 2nd highest daily average concentrations for each species for 2007.

Figure 6
2007 Fine Particulate Analyte Composition
Annual Average
(Highest 4 Analytes Depicted)



FINE PARTICULATE NON-ATTAINMENT AREAS

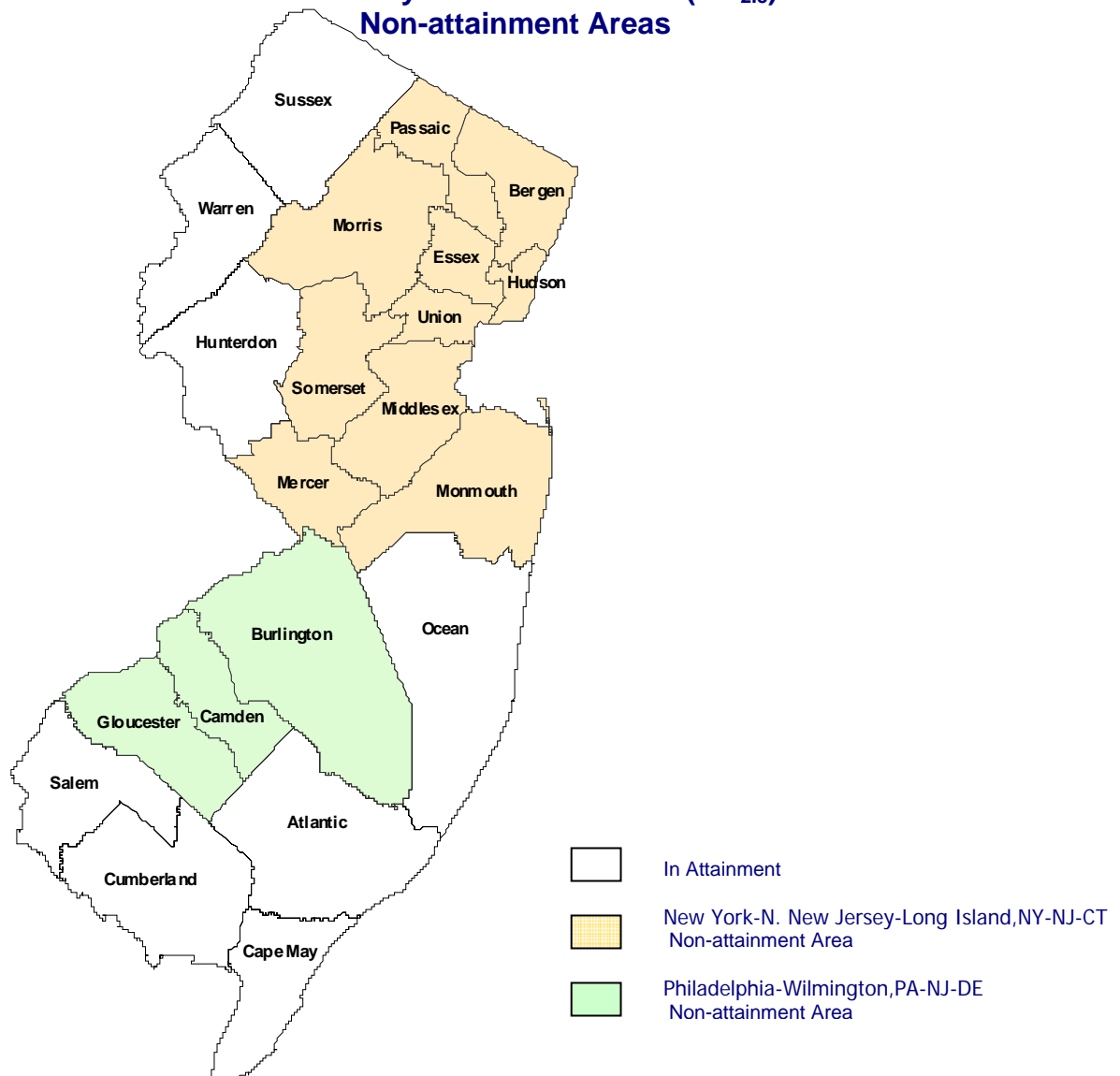
In 2006 thirteen New Jersey counties were classified as non-attainment areas. Non-attainment classification is given to an area that exceeds the air quality standard or contributes to the exceedance of that standard. In order to determine if the $PM^{2.5}$ annual standard is met, the average of 12 consecutive quarters of valid data within 3 calendar years is compared to $15 \mu g/m^3$. Data from sampling years 2001-2003 was used to make these designations.

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 $PM_{2.5}$ contribution to the Elizabeth Lab monitor and additional sites in New York City that recorded violations of the $PM_{2.5}$ Standards.

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

Figure 7
New Jersey Particulate Matter ($PM_{2.5}$)
Non-attainment Areas

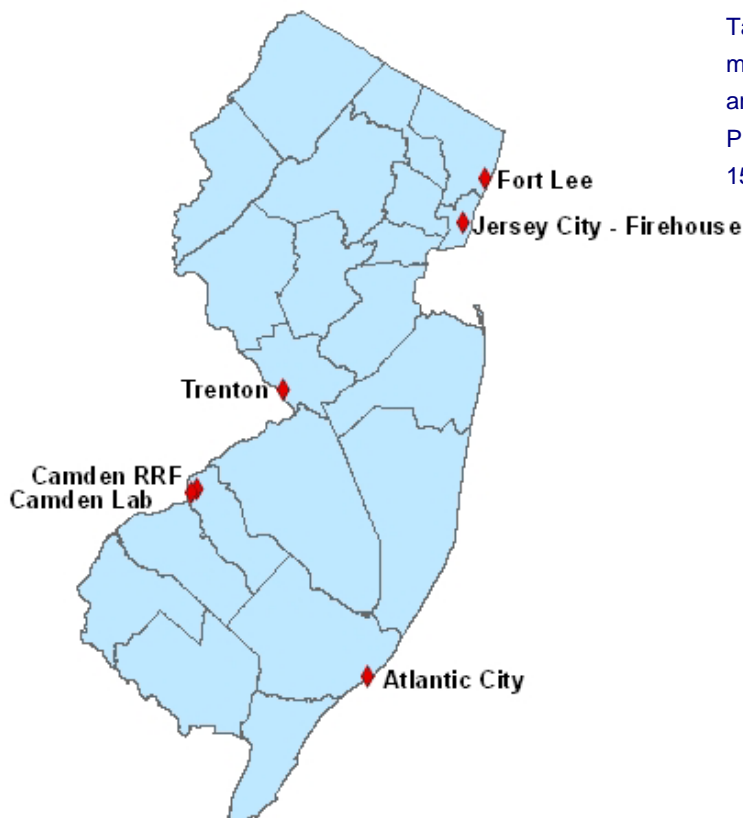


2007 COARSE PARTICLE SUMMARY

COARSE PARTICLE MONITORING SITES

The coarse particulate monitoring network is composed of 6 PM₁₀ sampling sites and 1 TSP sampling sites. Samples are collected on a filter, which is weighed before and after sampling to determine the concentration. Figure 8 depicts the PM₁₀ particulate monitoring network in New Jersey.

Figure 8
2006 PM₁₀
Monitoring Network



TSP CONCENTRATION SUMMARY

New Jersey currently operates one TSP monitoring site, located in New Brunswick. In 2007, the annual geometric mean concentration of TSP in New Brunswick was 29.0 $\mu\text{g}/\text{m}^3$, and the maximum 24-hour concentration recorded was 65.0 $\mu\text{g}/\text{m}^3$. The site was in attainment for the primary and secondary annual TSP standards of 75 $\mu\text{g}/\text{m}^3$ and 60 $\mu\text{g}/\text{m}^3$ respectively, and the site did not surpass the 24-hour primary standard of 260 $\mu\text{g}/\text{m}^3$ or the 150 $\mu\text{g}/\text{m}^3$ secondary standard.

PM₁₀ CONCENTRATION SUMMARY

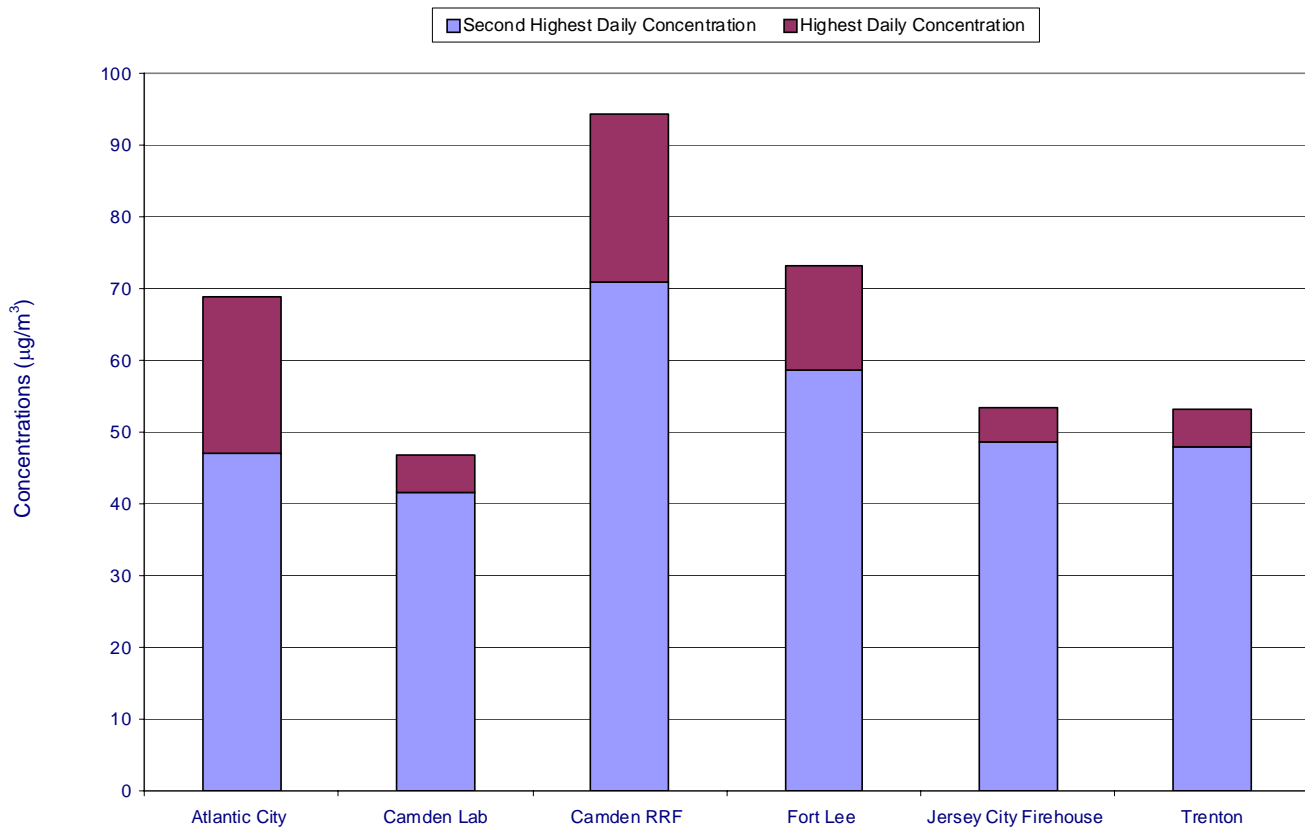
In 2007, the annual mean concentration of PM₁₀ ranged from 20.9 $\mu\text{g}/\text{m}^3$ at Trenton to 33.5 $\mu\text{g}/\text{m}^3$ at Camden RRF. Table 4 and Figure 9 show the annual mean and 24-hour maximum PM₁₀ concentrations throughout the state. All areas of the state are in attainment for both the annual PM₁₀ standards of 50 $\mu\text{g}/\text{m}^3$ and the 24-hour standard of 150 $\mu\text{g}/\text{m}^3$.

Table 4
PM₁₀ Data - 2007
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	57	68.8	47.1	21.0
Camden Lab	50	46.9	41.5	24.6
Camden RRF	54	94.3	70.9	33.5
Fort Lee	58	73.3	58.6	31.3
Jersey City-Firehouse	57	53.4	48.6	23.3
Trenton	58	53.2	47.9	20.9

Figure 9
Summary of PM₁₀ Concentrations, New Jersey 2007



SMOKE SHADE SUMMARY

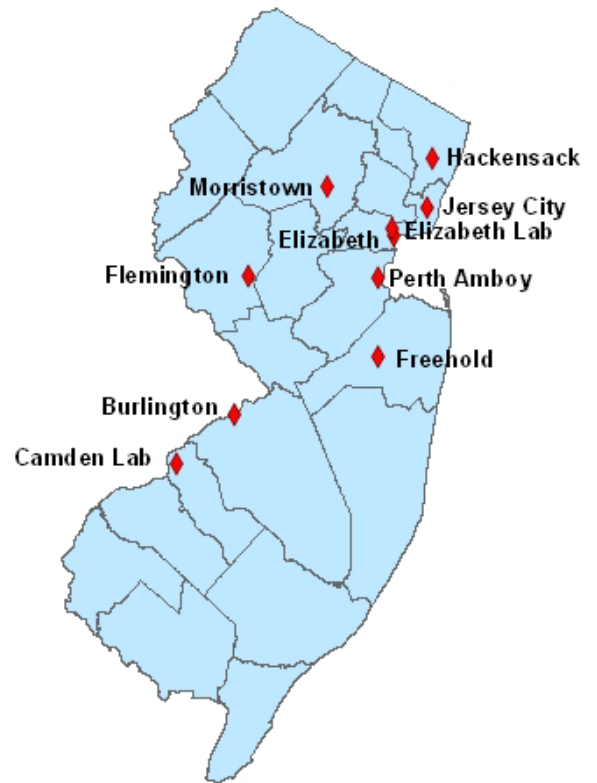
SMOKE SHADE MONITORING SITES

In addition to fine and coarse particulate monitoring, smoke shade is also monitored at 9 stations around the state. Smoke shade, which is an indirect measurement of particles in the atmosphere, has been monitored in New Jersey for over 30 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 2007, the annual mean concentration of smoke shade ranged from 0.16 Coefficient of Haze units (COH) at Camden Lab and Freehold to 0.47 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 2007.

**Figure 10
2007 Smoke Shade
Monitoring Network**



**Table 5
Smoke Shade - 2007**

Coefficient of Haze (COHs)
No Standard

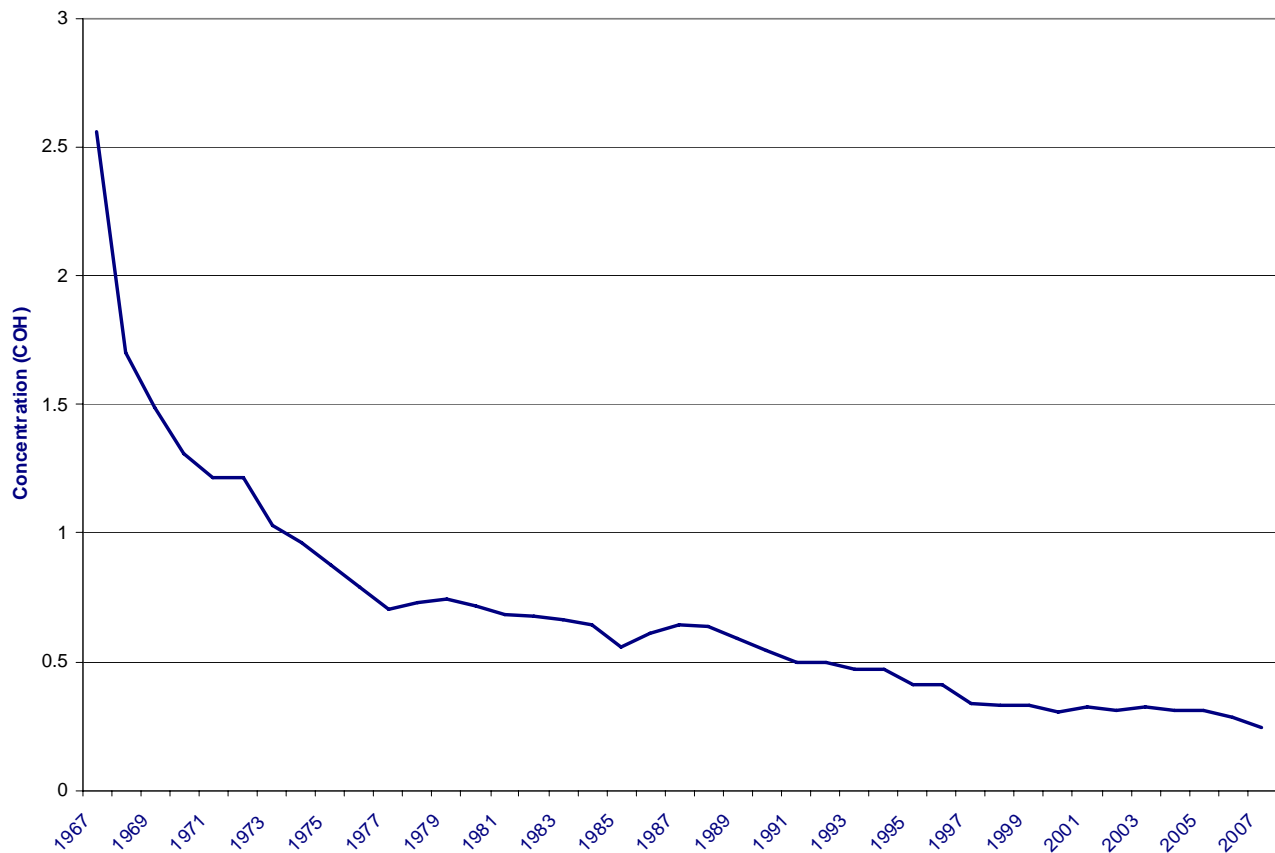
Site	Maximum Daily Average	2nd Highest Daily Average	Annual Mean
Burlington	0.56	0.53	0.18
Camden Lab	0.58	0.53	0.16
Elizabeth*	0.81	0.58	-
Elizabeth Lab	1.37	1.29	0.47
Freehold	0.48	0.42	0.16
Hackensack	0.68	0.60	0.19
Jersey City	1.02	1.01	0.42
Morristown	0.62	0.55	0.16
Perth Amboy	0.56	0.53	0.20

* Data not available after March

TRENDS IN PARTICULATE CONCENTRATIONS

The longest continuously operating particle 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 forty 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 forty years. Smoke shade is not a direct measurement of particle mass, but can be related to TSP, PM₁₀ and PM_{2.5} health standards.

Figure 11
Long Term Trend in Particulate Levels
State Average
1967- 2007



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