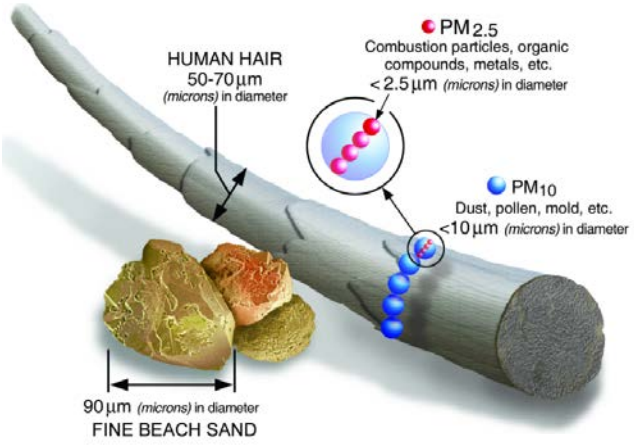
2015 Particulate Summary

New Jersey Department of Environmental Protection

SOURCES

Particulate air pollution is a complex mixture of organic and inorganic substances in the atmosphere, present 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. Particulates may travel hundreds of miles from their original sources, suspended in the atmosphere, before falling to ground level.

Figure 1
Size Comparisons for PM Particles



USEPA. www.epa.gov/pm-pollution

Particulate pollution is categorized by size. Particulates with diameters of 2.5 micrometers (or microns) or less are considered "fine particulate matter," referred to as $PM_{2.5}$ (Figure 1). Particulates with diameters of 10 microns or less are considered to be "inhalable particulate matter," and are referred to as PM_{10}. "Total suspended particulates" (TSP) refers to all suspended particulates, including the largest ones. Because particles smaller than 10 microns are inhalable, they are a health risk, but particulates of all sizes have an impact on the environment.

Particulates can occur naturally or can be man-made. Examples of naturally-occurring particles are windblown dust and sea salt. Man-made particulates, which come from sources such as fossil fuel combustion and industrial processes, can be divided into primary particulates and secondary particulates. Primary particulates are directly emitted from their sources, while secondary particulates form 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 Camnet visibility camera in Newark (www.hazecam.net) that focuses on 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 about visibility in New Jersey can be found in the Regional Haze and Visibility section of the 2015 Air Quality Summary.

Figure 2a.

Figure 2b.

HEALTH EFFECTS

PM_{10} and especially $PM_{2.5}$ are health concerns because they are easily taken into the lungs. Various health problems are associated with both long- and short-term exposures. These particles can accumulate in the respiratory system, and are responsible for heart and lung conditions such as asthma, bronchitis, cardiac arrhythmias, and heart attacks. Particle pollution can even cause premature death. Groups that appear to be at greatest risk from particulates include children, the elderly, and people with heart and lung diseases.

AMBIENT AIR QUALITY STANDARDS

The U.S. Environmental Protection Agency (USEPA) first established National Ambient Air Quality Standards (NAAQS) for particulate matter in 1971. It set primary (health-based) and secondary (welfare-based) for total suspended particulate matter (TSP), which included PM up to about 25 to 45 micrometers. Over the years, new health data have shifted the focus toward smaller and smaller particles. In 1987, USEPA replaced the TSP standards with standards for PM_{10}. The 24-hour PM_{10} primary and secondary standards were set at 150 $\mu g/m^3$. Ten years later, USEPA began regulating $PM_{2.5}$. The annual $PM_{2.5}$ primary and secondary standards were set at 15.0 $\mu g/m^3$ until 2013, when the primary standard was lowered to 12.0 $\mu g/m^3$. A 24-hour standard of 65 $\mu g/m^3$.was promulgated in 1997, then lowered in 2006 to 35 $\mu g/m^3$. Table 1 provides a summary of the current particulate matter standards. Note that the actual statistic that determines whether an area meets a NAAQS is referred to as the design value. This is generally a three-year average of a monitoring site's data specific to the particular NAAQS. This is described in more detail in the data summary discussions below.

Table 1
National Ambient Air Quality Standards for Particulate Matter
Micrograms Per Cubic Meter ($\mu g/m^3$)

Pollutant	Averaging Time	Type	Level
Fine Particulate ($PM_{2.5}$)	Annual	Primary	12.0 $\mu g/m^3$
	Annual	Secondary	15.0 $\mu g/m^3$
	24-Hour Average	Primary & Secondary	35 $\mu g/m^3$
Inhalable Particulate (PM_{10})	24-Hour Average	Primary & Secondary	150 $\mu g/m^3$

PARTICULATE MONITORING NETWORK

The New Jersey Department of Environmental Protection (NJDEP) Particulate Monitoring Network consists of twenty-four $PM_{2.5}$ monitoring sites, three PM_{10} monitoring sites, and one site where smoke shade is monitored.

NJDEP operates $PM_{2.5}$ and PM_{10} monitors that comply with strict USEPA requirements, and are designated as Federal Reference Method (FRM) samplers. These instruments use a filter, and pull a predetermined amount of air through $PM_{2.5}$ or PM_{10} size-selective inlets for a 24-hour period. The filters are weighed before and after sampling under controlled environmental conditions to determine the concentration of the particles collected. This is the data that is then used by NJDEP and USEPA to determine whether the state, or portions of the state, meet the NAAQS for particulate matter.

Since these FRM samplers do not provide data in real time, in order to report current air quality to the public through the Air Quality Index (www.njaqinow.net) NJDEP uses additional monitors that continuously measure PM concentrations. These include Beta Attenuation Monitors (BAM), Tapered Element Oscillating Microbalance (TEOM) analyzers, and smoke shade instruments. The Beta Attenuation Monitors measure the loss of intensity (attenuation) of beta particles due to absorption by $PM_{2.5}$ particles collected on a filter tape. The TEOM analyzers collect a sample of $PM_{2.5}$ 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 TSP on a paper tape for one hour, forming a spot. At the end of each hour the amount of light that passes through the spot is measured, the tape is advanced, and the cycle is started over. The measurement of light transmittance is used as an estimate of actual particulate concentrations.

Five monitoring stations are part of the national Chemical Speciation Network. They use a separate 24-hour filter-based $PM_{2.5}$ sampler to determine the concentrations of the chemical analytes that make up the particle sample. The sample is collected on three types of filter media which are subsequently analyzed using ion chromatography (IC), X-ray fluorescence (XRF), and Thermal Optical Transmittance (TOT).

Figure 3 shows the locations of all of the $PM_{2.5}$ monitors in New Jersey.

FINE PARTICLE ($PM_{2.5}$) SUMMARY

$PM_{2.5}$ SUMMARY FOR FRM MONITORS

The annual mean concentrations of $PM_{2.5}$ measured by the filter-based FRM samplers ranged from 7.0 $\mu g/m^3$ at the Brigantine monitoring site to 11.4 $\mu g/m^3$ at Union City. The highest 24-hour concentrations ranged from 24.3 $\mu g/m^3$ at Brigantine to 37.3 $\mu g/m^3$ at Toms River. Table 2 shows the 2015 annual mean, highest 24-hour and 98th percentile 24-hour concentrations as well as the 2013-2015 annual and 24-hour design values. The design value for the annual NAAQS is calculated for each monitoring site by averaging the annual mean concentrations for the three most recent consecutive calendar years, in this case 2013-2015. Similarly, the 24-hour NAAQS design value for a given site is calculated by averaging the 98th percentile 24-hour concentrations for each year for the same 3-year period. Figures 4 and 5 show the annual mean concentrations and the 98th percentile of the 24-hour average concentrations in 2015 for all the sites. In 2015, no sites were in violation of either the annual standard of 12.0 $\mu g/m^3$ or the 24-hour standard of 35 $\mu g/m^3$.

Figure 3
2015 $PM_{2.5}$ Monitoring Network

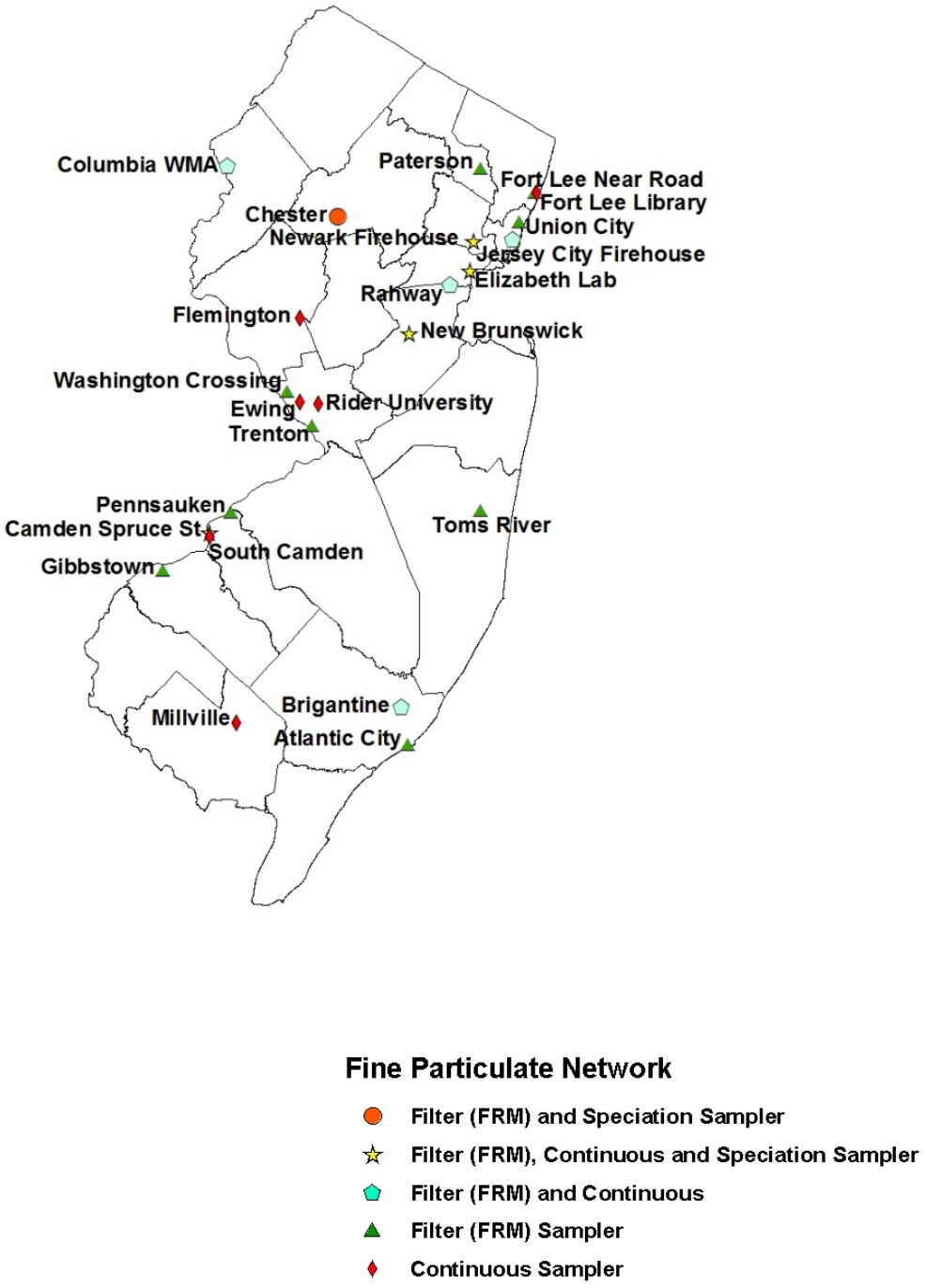


Table 2
2015 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (FRM)
Micrograms Per Cubic Meter (µg/m³)

Monitoring Site	Number of Samples	Annual Mean Concen-tration	2013-2015 Annual Design Value	Highest 24-Hour Concen-tration	98th %-ile 24-Hour Concen-tration	2013-2015 24-Hour Design Value (98th %-ile)
Atlantic City	102	7.7	8.1	24.9	16.2	19
Brigantine	120	7.0	7.2	24.3	16.8	18
Camden Spruce Street	113	10.2	10.4	30.2	26.3	26
Chester	109	7.4	7.1	26.3	21.8	18
Columbia WMA	114	9.2	8.3	30	24.8	23
Elizabeth Lab	346	10.2	10.4	33.4	26.8	28
Fort Lee Library	117	10.0	9.1	29.2	28.4	27
Gibbstown	108	8.6	8.9	25.8	22.6	24
Jersey City Firehouse	348	9.0	9.3	29.5	25.7	27
New Brunswick	116	7.9	8.0	26.8	19.8	20
Newark Firehouse	116	8.9	8.9	26.7	23.5	25
Paterson	114	9.0	8.9	27.2	24.3	25
Pennsauken	116	9.0	9.1	27.3	21.9	22
Rahway	116	8.8	9.0	31.5	24.7	25
Toms River	348	7.4	7.7	37.3	20.8	19
Trenton Library	346	8.2	8.6	28.8	24.2	24
Union City	115	11.4	10.8	33.1	29	27
Washington Crossing	118	7.8	8.0	25.5	21.3	22

Figure 4
2015 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages (FRM)
Micrograms Per Cubic Meter (µg/m³)

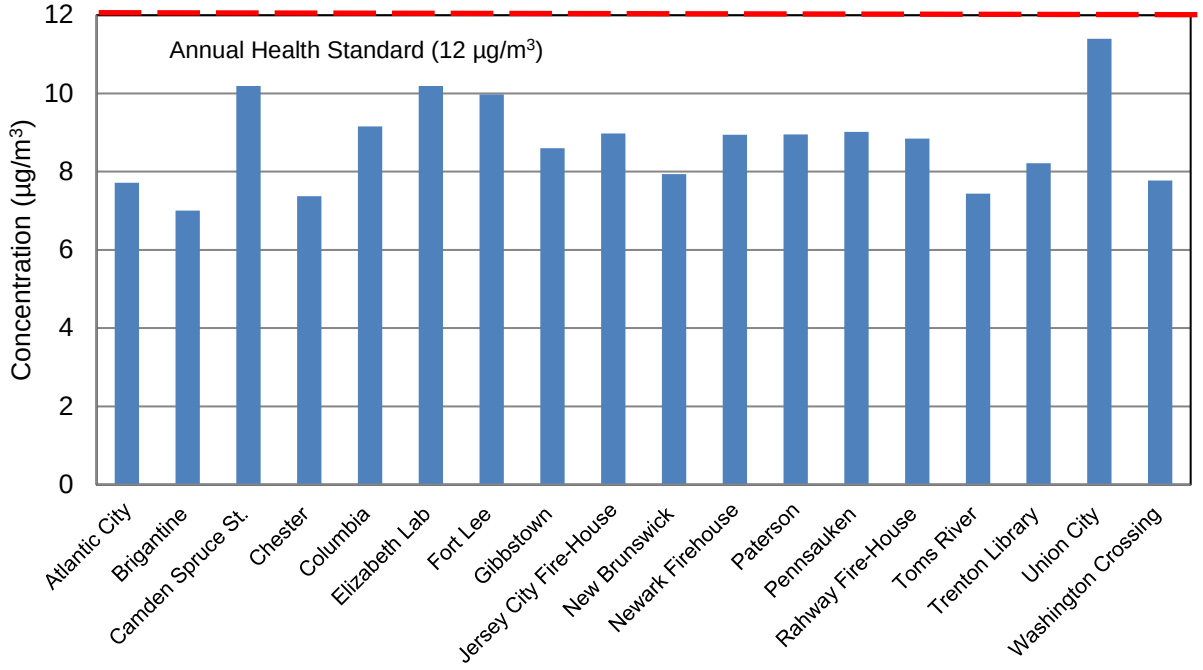
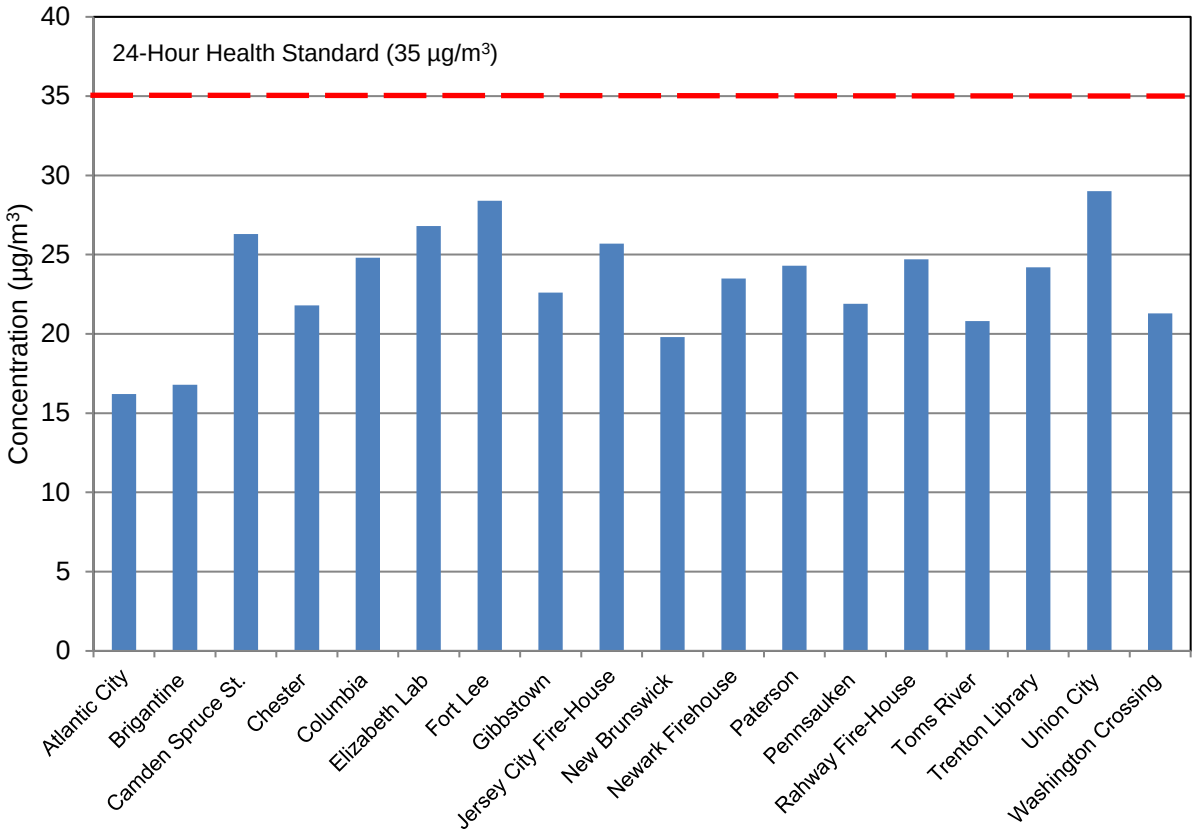


Figure 5
2015 $PM_{2.5}$ Concentrations in New Jersey
98th Percentile 24-Hour Averages (FRM)
Micrograms Per Cubic Meter (µg/m³)



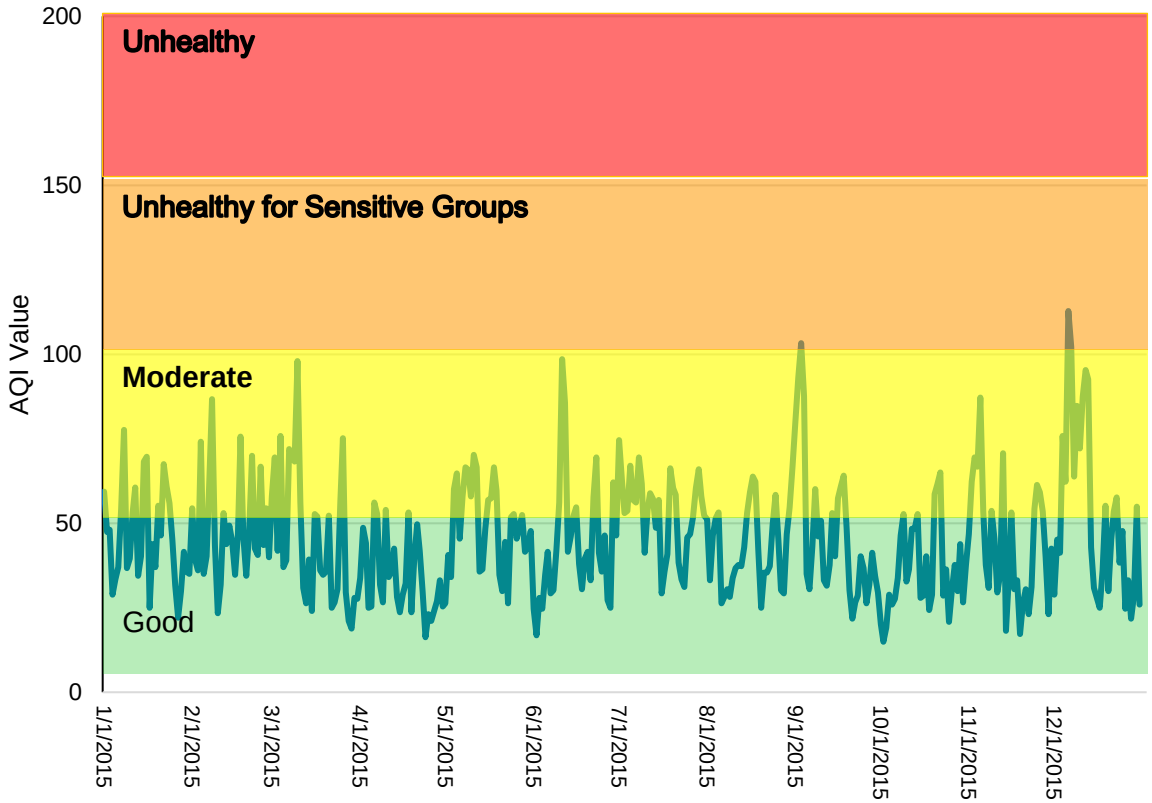
$PM_{2.5}$ Continuous Monitoring

New Jersey's continuous $PM_{2.5}$ monitoring network consists of thirteen sites: Brigantine, Columbia WMA, Elizabeth Lab, Ewing, Flemington, Jersey City Firehouse, Millville, New Brunswick, Newark Firehouse, Rahway, Rider University and South Camden. The data is transmitted at least hourly 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 for 2015. Figure 6 shows the health level associated with the highest 24-hour $PM_{2.5}$ recorded in the state each day for the entire year.

Table 3
2015 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (Continuous Monitors)
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Annual Mean Concentration	Highest 24-Hour Concentration	Number of Days Unhealthy for Sensitive Groups
Brigantine	7.8	26.6	0
Camden Spruce Street	11.4	42.7	2
Columbia WMA	9.6	32.6	0
Elizabeth Lab	11.1	33.3	0
Ewing	6.8	22.2	0
Flemington	5.6	21.4	0
Fort Lee Near Road	11.3	34.6	0
Jersey City Firehouse	10.0	33.3	0
Millville	9.4	27.1	0
New Brunswick	9.7	27.9	0
Newark Firehouse	10.4	31.3	0
Rahway	10.2	36.9	1
Rider University	8.7	28.6	0
South Camden	10.1	37.5	1

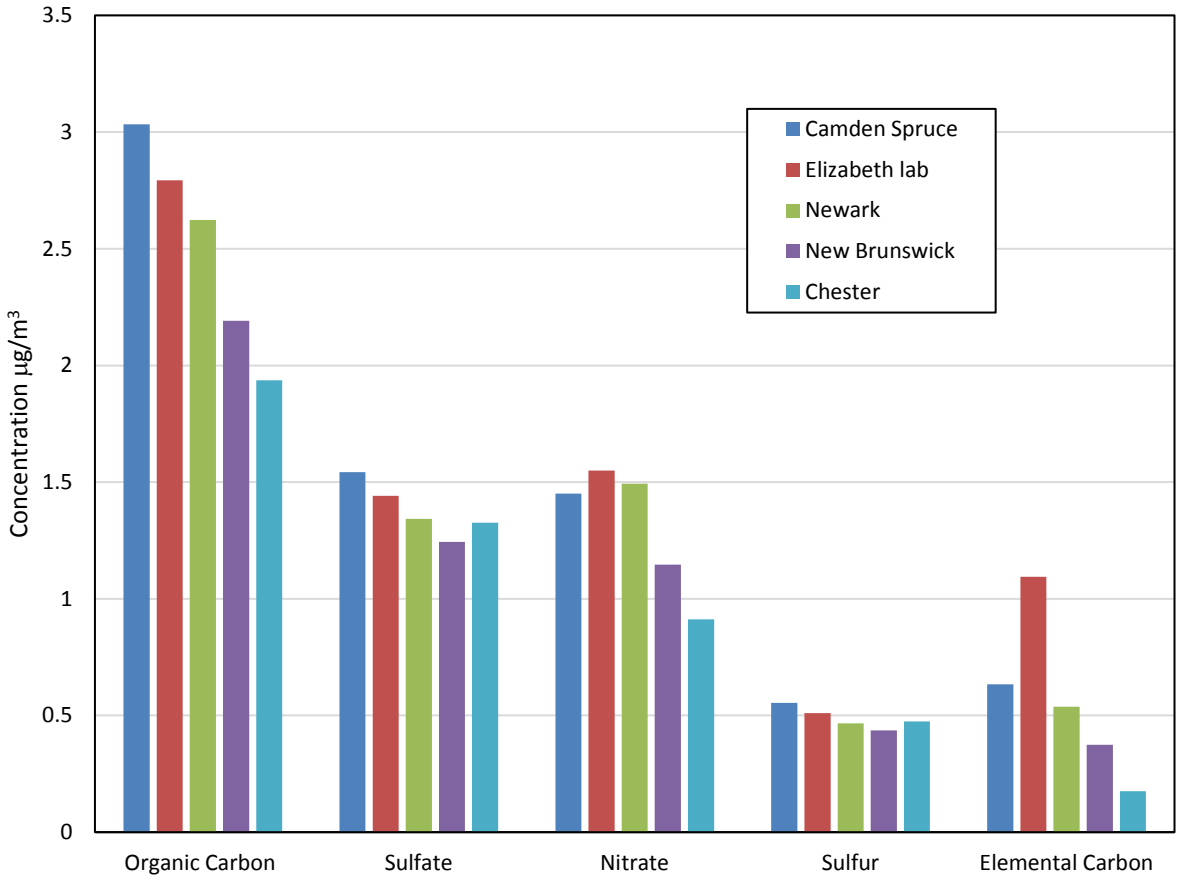
Figure 6
2015 $PM_{2.5}$ Air Quality Index (AQI) Concentrations
(Highest 24-Hour Site)



$PM_{2.5}$ Speciation Summary

New Jersey's $PM_{2.5}$ speciation network is located at five monitoring sites: Camden Spruce Street, Chester, Elizabeth Lab, Newark Firehouse, and New Brunswick. Samplers run every third or sixth day on a schedule concurrent with the Federal Reference Method sampling network. Of the 39 measured analytes, organic carbon, sulfate, nitrate, sulfur and elemental carbon are the most prevalent species. Combined, they create the majority of the $PM_{2.5}$ total mass concentration. Figure 7 presents the average concentrations of these five most prevalent species. High elemental carbon concentrations at Elizabeth Lab, located adjacent to the New Jersey Turnpike Exit 13 tollbooths, are due to the site's proximity to high traffic volume, as motor vehicles are a primary source of elemental carbon. More information about the speciated analytes, including average, highest, and 2nd highest 24-hour average concentrations, can be found in Appendix B - Fine Particulate Speciation Summary of the 2015 Air Quality Report.

Figure 7
2015 $PM_{2.5}$ Analyte Composition
Analytes with the Highest Concentrations

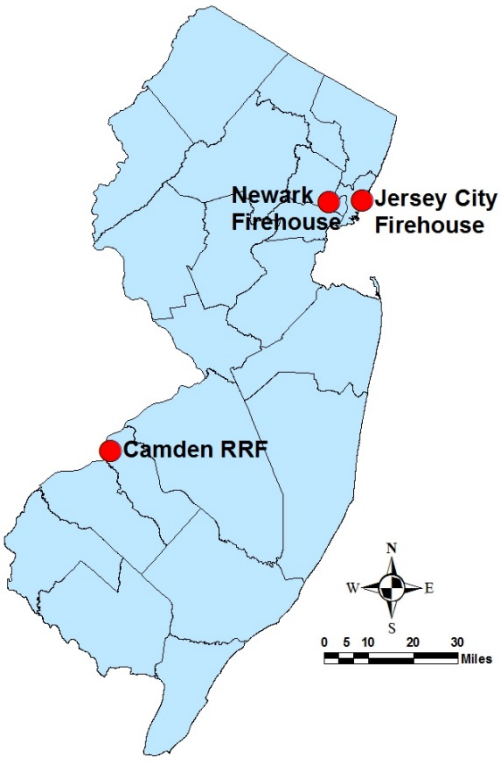


2015 Inhalable Particulate (PM_{10}) Summary

PM_{10} Monitoring Sites

At one time, NJDEP PM_{10} monitoring network consisted of more than twenty sampling sites. Due to many years of low concentrations and the shift in emphasis to $PM_{2.5}$ monitoring, the network has been reduced to only three sites, the Camden Resource Recovery Facility (RRF), Jersey City Firehouse, and Newark Firehouse. PM_{10} samples, taken once every six days, are collected on a filter that is weighed before and after sampling to determine air concentrations. Figure 8 shows the locations of New Jersey's PM_{10} monitors.

Figure 8
2015 PM_{10} Monitoring Network



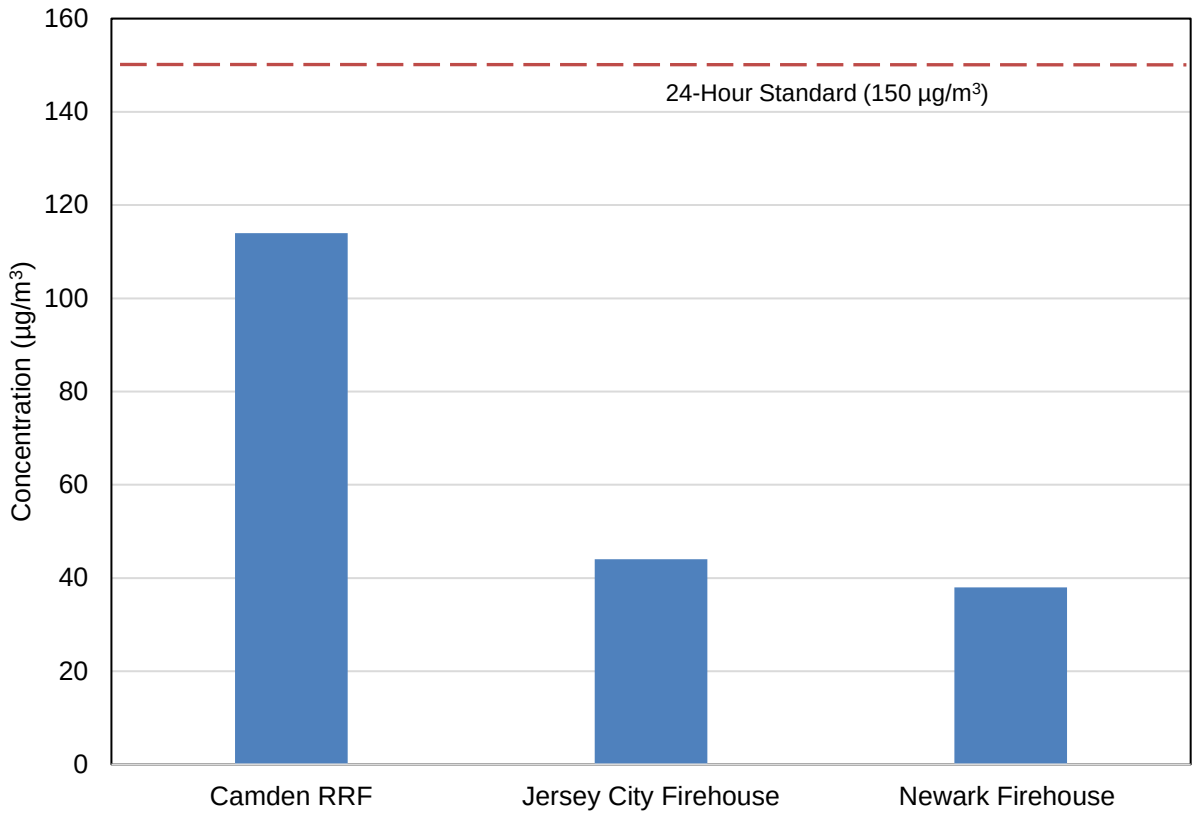
PM_{10} Concentration Summary

In 2015, the highest PM_{10} values were measured at Camden RRF. Table 4 shows each site's highest and second-highest 24-hour concentrations, as well as the annual average. All areas of the state are in attainment for the 24-hour standard of 150 $\mu g/m^3$, as can be seen in Figure 9.

Table 4
2015 PM_{10} Concentrations in New Jersey
24-Hour and Annual Averages
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Number of Samples	24-Hour Averages		Annual Mean
		Highest	Second-Highest	
Camden RRF	44	114	110	37
Jersey City Firehouse	60	44	43	19
Newark Firehouse	117	38	38	16

Figure 9
2015 PM_{10} Concentrations in New Jersey
Maximum 24-Hour Averages
Micrograms per Cubic Meter (µg/m³)



Smoke Shade Summary

Smoke Shade Monitoring Sites

Smoke shade is an indirect measurement of particles in the atmosphere. Smoke shade was once measured at about a dozen locations in New Jersey, beginning about forty years ago. Its primary use was for the daily reporting of particulate levels in the Air Quality Index, before there were newer continuous PM monitoring methods. The instruments are now obsolete and can no longer be repaired. 2015 began with three operating smoke shade monitors. The Jersey City instrument stopped functioning in January, and the Elizabeth one stopped in mid-October. The one remaining smoke shade monitor is located at the Elizabeth Lab site. Table 5 lists the highest and second-highest 24-hour and annual average smoke shade levels recorded at the monitoring site in 2015.

Table 5
2015 Smoke Shade Measurements in New Jersey
Coefficient of Haze (COH)

Site	Highest 24-Hour Average	2nd-Highest 24-Hour Average	Annual Mean
Elizabeth Lab	1.03	0.79	0.14

TRENDS IN PARTICULATE CONCENTRATIONS

The longest continuously operating particulate monitoring network in the state is the smoke shade network. As noted earlier, this monitoring program has been running for decades and still had one active site in 2015. The trend graph for smoke shade, shown in Figure 10, shows how particulate levels have steadily declined over the past 48 years. Smoke shade is not a direct measurement of particle mass, but can be viewed in relation to TSP, PM_{10} and $PM_{2.5}$ health standards.

The $PM_{2.5}$ monitoring network has been in place since 1999. Sixteen years of sampling has shown a noticeable decline in fine particulate concentrations. Figure 11 shows the trend of the annual mean $PM_{2.5}$ concentrations for all FRM sampler sites since the network began.

Figure 10
Annual Average Particulate Levels as Smoke Shade in New Jersey, 1967-2015
Coefficient of Haze (COH)

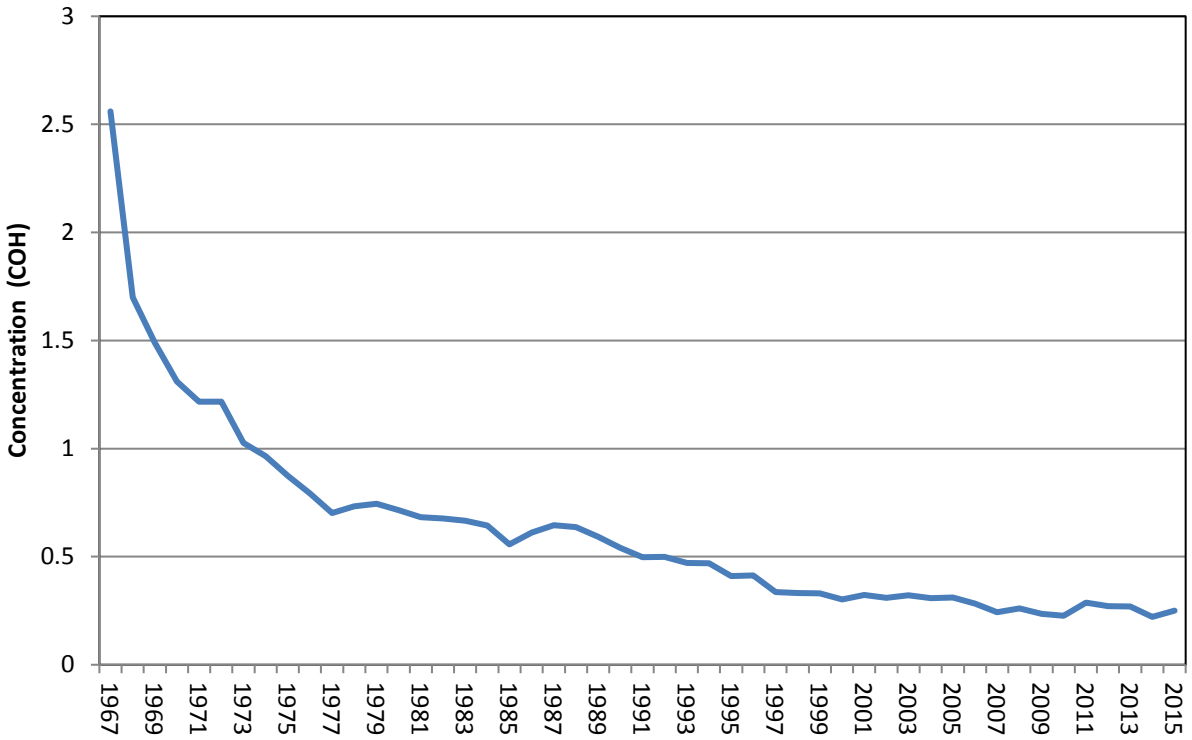
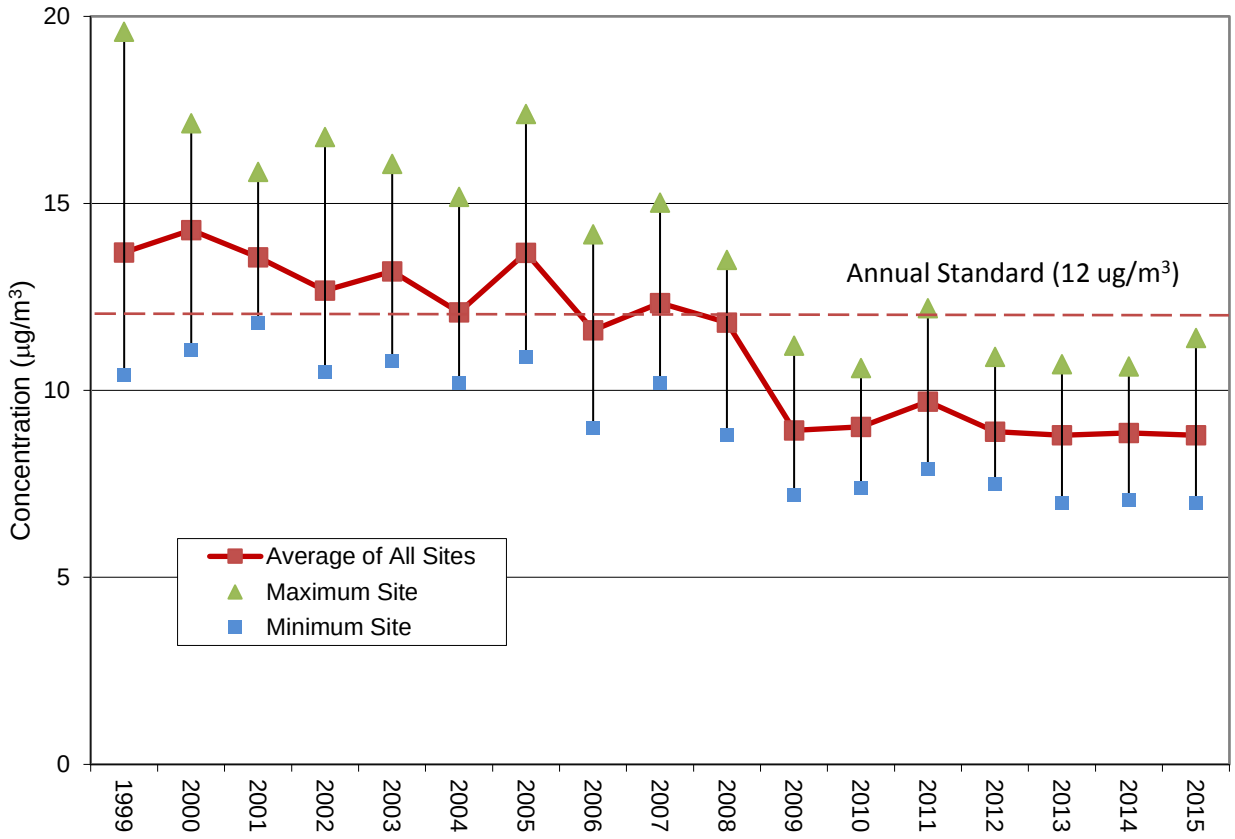


Figure 11
$PM_{2.5}$ Air Concentrations in New Jersey, 1999-2015
Annual Averages of All Sites
Micrograms per Cubic Meter (ug/m³)



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Camnet. Realtime Air Pollution & Visibility Monitoring. www.hazecam.net