2016 Particulate Matter Summary

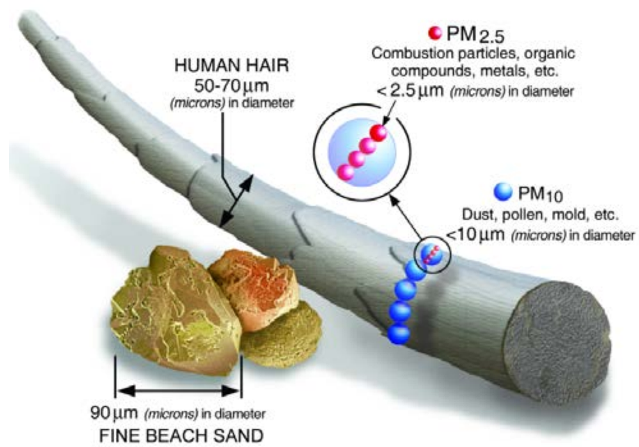
New Jersey Department of Environmental Protection

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 undetec by the human eye. Particulates may travel hundreds of miles from their original sources, suspended in the atmosphere, before falling to the ground.

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 5-1). Particulates with diameters of 10 microns or less are considered to be “inhalable particulate matter,” or “coarse particulate matter,” and are referred to as PM_{10}. “Total suspended particulates” (TSP) refers to all suspended particulates, including the largest ones.

Figure 5-1
Size Comparisons for PM Particles



USEPA. www.epa.gov/pm-pollution

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 categorized as either primary particulates or secondary particulates. Primary particulates are directly emitted from their sources, while secondary particulates form in the atmosphere through reactions of gaseous emissions.

HEALTH AND ENVIRONMENTAL EFFECTS

The size of particles is directly linked to their potential for causing health problems. Fine particles ($PM_{2.5}$) pose the greatest health risk. They can get deep into the lungs and some may even get into the bloodstream. Exposure to these particles can affect a person's lungs and heart. They can lead to premature death in people with heart or lung disease, can cause nonfatal heart attacks, decrease lung function, and aggravate asthma. Coarse particles ($PM_{10-2.5}$) are of less concern, although they are inhalable and can irritate a person's eyes, nose, and throat.

Particulates of all sizes have an impact on the environment. PM is the major cause of reduced visibility in many parts of the United States. Figure 5-2a provides an example of reduced visibility due to particulate pollution, recorded by the Camnet visibility camera in Newark (www.hazecam.net) which focuses on the New York City skyline. Figure 5-2b 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.

Figure 5-2a.

Figure 5-2b.

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) standards for total suspended particulate (TSP), which included PM up to about 25 to 45 micrometers. Over the years, new health data 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 µg/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 µg/m^3 until 2013, when the primary annual standard was lowered to 12.0 µg/m^3. A 24-hour $PM_{2.5}$ standard of 65 µg/m^3.was promulgated in 1997, then lowered in 2006 to 35 µg/m^3. Table 5-1 provides a summary of the current particulate matter standards.

Compliance with the standards is determined by calculating a statistic called the design value. For the annual $PM_{2.5}$ NAAQS, the design value is the highest statewide 3-year average of each site's annual average concentrations. For the 24-hour NAAQS, the 98th percentile of the 24-hour concentrations for each monitoring site must be averaged for the three most recent years. The highest site's value is the state's design value. For PM_{10}, the design value is the second-highest 24-hour average concentration in a given year.

Table 5-1
National Ambient Air Quality Standards for Particulate Matter
Micrograms Per Cubic Meter (µg/m^3)

Pollutant	Averaging Period	Type	Level
Fine Particulate ($PM_{2.5}$)	Annual	Primary	12.0 µg/m^3
	Annual	Secondary	15.0 µg/m^3
	24-Hours	Primary & Secondary	35 µg/m^3
Inhalable Particulate (PM_{10})	24-Hours	Primary & Secondary	150 µg/m^3

Particulate Monitoring Network

The New Jersey Department of Environmental Protection (NJDEP) Particulate Monitoring Network consists of twenty-one $PM_{2.5}$ monitoring sites and three PM_{10} monitoring sites. Criteria pollutant monitors must meet strict USEPA requirements in order to determine compliance with the NAAQS. NJDEP uses three different types of particulate monitors.

Seventeen $PM_{2.5}$ sites and the three PM_{10} sites use filter-based samplers, which 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 captured particles. This filter-based method has for years been designated as the Federal Reference Method (FRM) for particulate matter compliance determination.

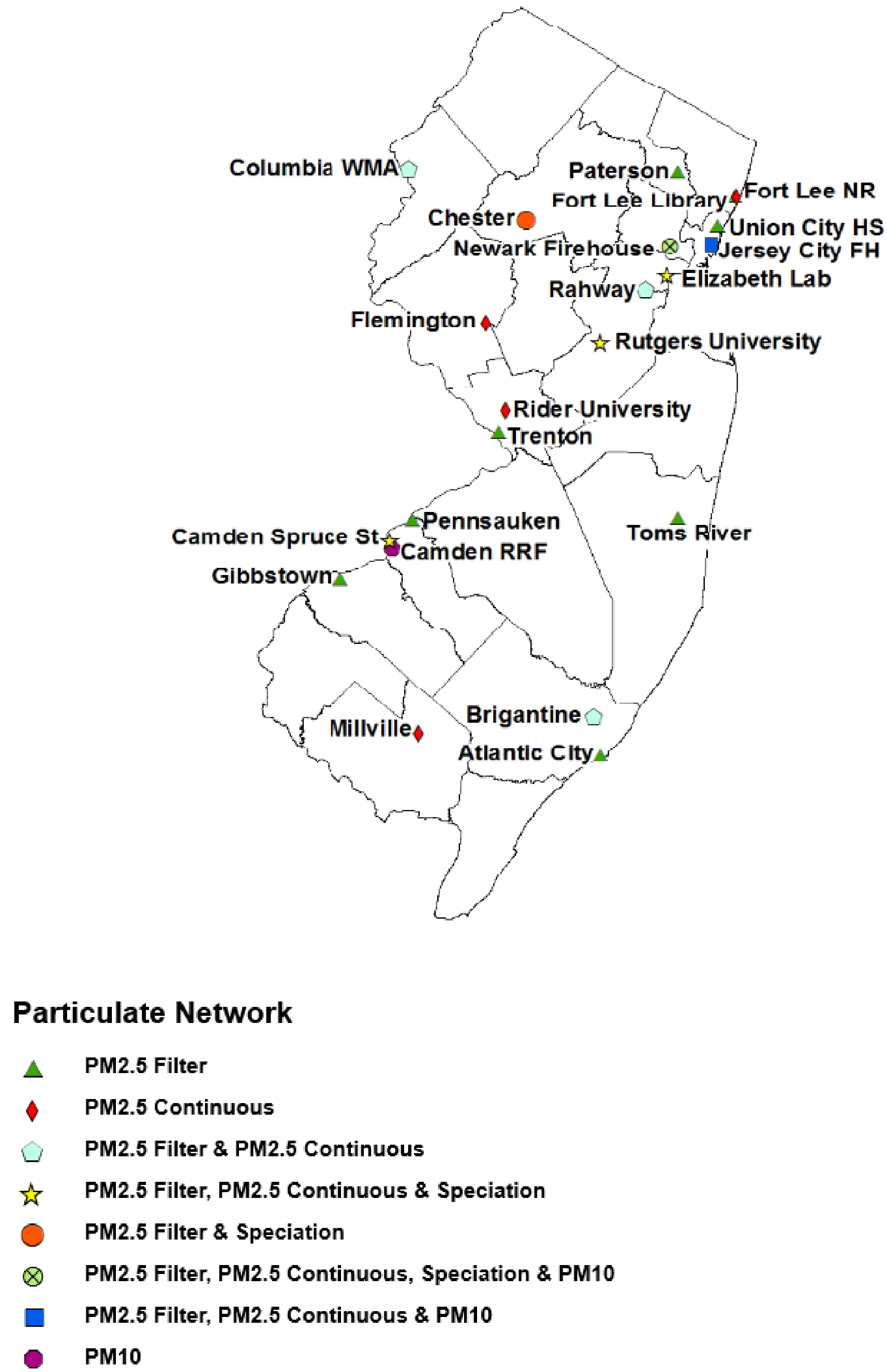
In order to provide real-time hourly data to the public (through the Air Quality Index at www.njaqinow.net), NJDEP has also been using particulate monitors that operate continuously. These monitors are classified by USEPA as Federal Equivalent Methods (FEM) for $PM_{2.5}$, and can also be used to determine compliance with the NAAQS. Eleven sites in New Jersey use Beta Attenuation Monitors (BAM), which measure the loss of intensity (attenuation) of beta particles due to absorption by $PM_{2.5}$ particles collected on a filter tape. One site, Rahway, uses a Tapered Element Oscillating Microbalance (TEOM) analyzer. 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. TEOM monitors are being phased out in New Jersey.

At one time, the 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 are taken once every six days at Camden and Jersey City, and every three days at Newark.

Five monitoring stations are part of the national Chemical Speciation Network (CSN). 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). CSN sampling was moved from the now-shuttered New Brunswick site to the Rutgers University site in July 2016. The other sites in the network are Camden Spruce Street, Chester, Elizabeth Lab and Newark Firehouse. CSN data can be found in Appendix B of the Air Quality Summaries.

Figure 5-3 shows the locations of all the particulate monitors in New Jersey.

Figure 5-3
2016 Particulate Monitoring Network



Fine Particle ($PM_{2.5}$) Levels in 2016

$PM_{2.5}$ Levels for Filter-Based FRM Monitors

The annual mean concentrations of $PM_{2.5}$ measured by the seventeen filter-based FRM samplers ranged from 5.99 $\mu g/m^3$ at the Chester monitoring site to 9.40 $\mu g/m^3$ at the Camden Spruce Street monitoring site. The highest 24-hour concentrations ranged from 15.6 $\mu g/m^3$ at Chester to 33.6 $\mu g/m^3$ at Camden Spruce Street. Table 5-2 shows the 2016 annual mean, highest 24-hour and 98th percentile 24-hour concentrations, as well as the number of valid samples collected. Four sites (Elizabeth Lab, Jersey City Firehouse, Toms river and Trenton) operate every day. The other thirteen sites (Atlantic City, Brigantine, Camden Spruce Street, Chester, Columbia, Fort Lee Library, Gibbstown, Newark Firehouse, Paterson, Pennsauken, Rahway, Rutgers University, and Union City High School) take a sample every third day. Figures 5-4 and 5-5 show the annual mean concentrations and the 98th percentile 24-hour average concentrations for all the sites in 2016. In 2016, no sites were in violation of either the annual standard of 12.0 $\mu g/m^3$ or the 24-hour standard of 35 $\mu g/m^3$.

Table 5-2
2016 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (FRM)
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Number of Samples	Annual Mean Concentration	Highest 24-Hour Concentration	98th%-ile 24-Hour Concentration
Atlantic City	115	7.18	20.7	15.1
Brigantine	118	6.54	17.3	14.2
Camden Spruce Street	113	9.40	33.6	24.0
Chester	117	5.99	15.6	12.5
Columbia	117	7.43	22.5	17.8
Elizabeth Lab	340	9.07	29.9	19.6
Fort Lee Library	120	8.10	21.8	19.0
Gibbstown	112	7.44	21.9	15.2
Jersey City Firehouse	352	7.99	29.3	17.6
Newark Firehouse	114	8.31	28.0	17.4
Paterson	111	7.39	21.0	16.1
Pennsauken	118	8.13	24.0	17.0
Rahway	110	7.87	20.5	17.3
Rutgers University	110	7.33	16.3	16.2
Toms River	348	6.64	28.8	15.5
Trenton Library	352	7.27	22.1	16.7
Union City High School	117	8.50	28.5	19.0

Figure 5-4
2016 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages (Filter-Based Monitors)
Micrograms Per Cubic Meter (µg/m³)

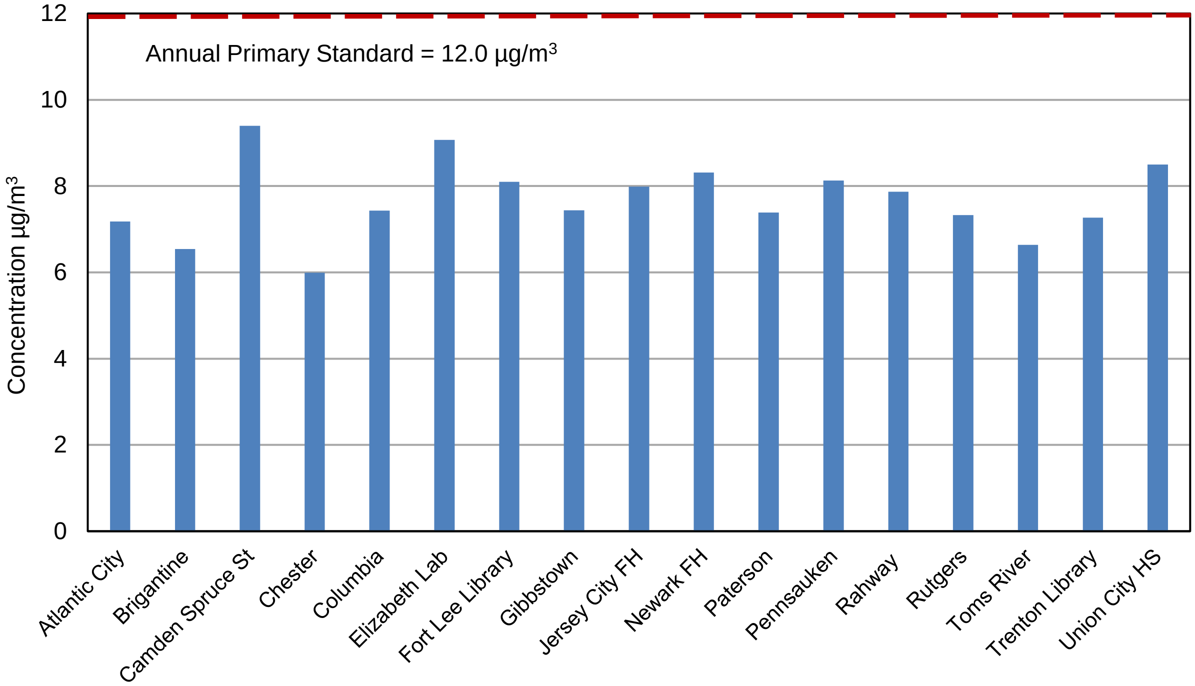
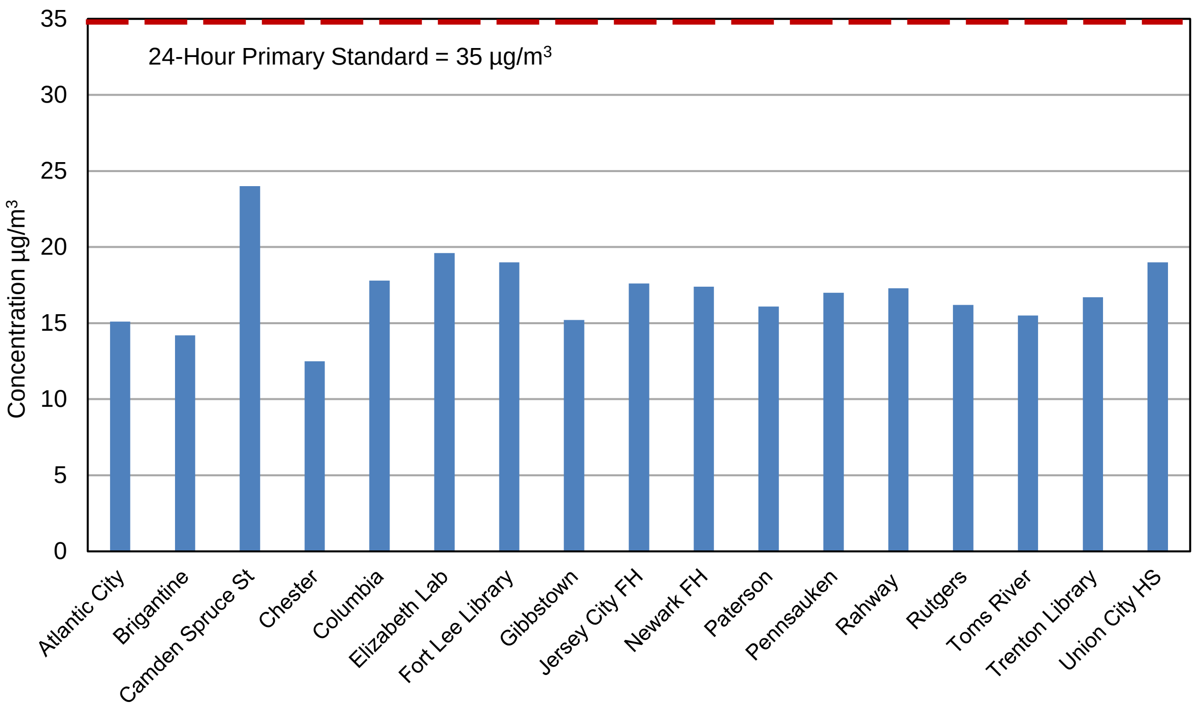


Figure 5-5
2016 $PM_{2.5}$ Concentrations in New Jersey
98th Percentile of 24-Hour Averages (Filter-Based Monitors)
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ Levels for Continuous FEM Monitors

New Jersey's continuous $PM_{2.5}$ monitoring network consists of twelve sites: Brigantine, Camden Spruce Street, Columbia, Elizabeth Lab, Flemington, Fort Lee Near Road, Jersey City Firehouse, Millville, Newark Firehouse, Rahway, Rider University, and Rutgers University. One-minute readings are transmitted to a central computer in Trenton, where they are averaged every hour and automatically updated on the NJDEP website at www.njaqinow.net. Table 5-3 presents the annual mean, highest 24-hour, and 98th percentile 24-hour values from these sites for 2016. Figures 5-6 and 5-7 show the annual means and the 98th percentile 24-hour averages. Although there was an exceedance of the 24-hour standard at the Fort Lee Near Road monitor on March 9 (39.3 µg/m^3), this did not contribute to a violation of the NAAQS because the 98th percentile value (design value) for the site was 21.7 µg/m^3.

Table 5-3
2016 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (Continuous Monitors)
Micrograms Per Cubic Meter (µg/m^3)

Monitoring Site	Annual Mean Concentration	Highest 24-Hour Concentration	98th%-ile 24-Hour Concentration
Brigantine	6.76	19.7	15.9
Camden Spruce Street	10.03	33.9	22.9
Columbia	9.37	31.0	21.4
Elizabeth Lab	10.08	28.1	21.1
Flemington	8.48	19.5	17.1
Fort Lee Near Road	10.09	39.3	21.7
Jersey City Firehouse	9.50	33.6	19.2
Millville	7.83	19.8	17.6
Newark Firehouse	8.73	26.3	18.4
Rahway	8.8	22.7	18.5
Rider University	8.62	23.9	16.7
Rutgers University	8.29	28.3	18.4

Figure 5-6
2016 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages from Continuous Monitors
Micrograms Per Cubic Meter (µg/m³)

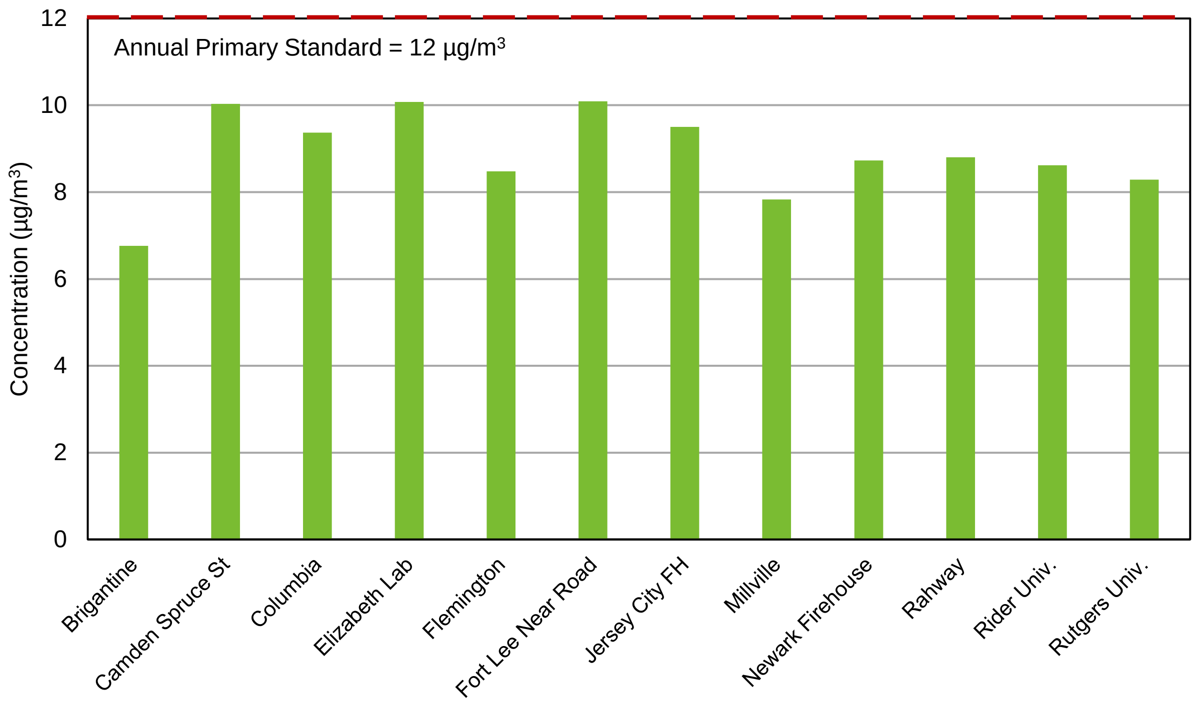
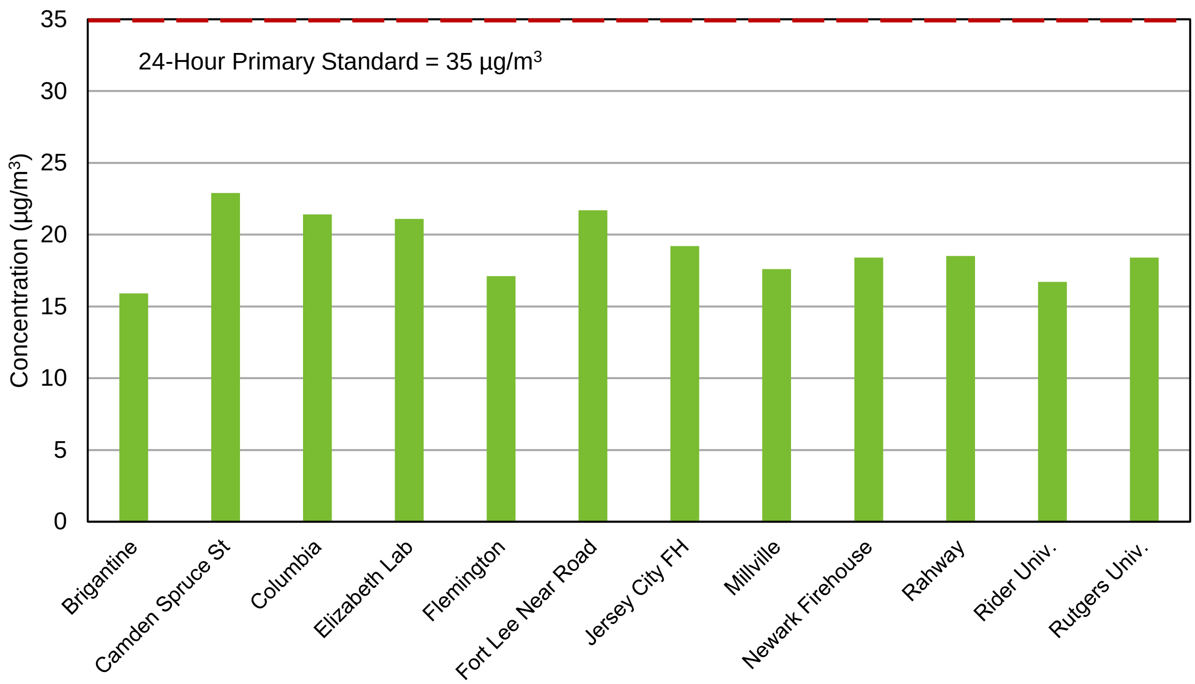


Figure 5-7
2016 $PM_{2.5}$ Concentrations in New Jersey
98th Percentile 24-Hour Averages from Continuous Monitors
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ DESIGN VALUES

Figures 5-8 and 5-9 show the design values for each of the New Jersey monitors, as determined by USEPA. Some sites have both a filter-based FRM monitor and a continuous FEM monitor. At sites with both FRM and FEM monitors, the data from the FRM monitor takes precedence, and data from the FEM monitor is included in calculating the design value when the FRM data is missing. Six sites are omitted from these graphs because USEPA does not have three years of data for them. Flemington, Rutgers University, and Union City High School began measuring $PM_{2.5}$ in 2016. Millville and Rider University data was not submitted to USEPA until 2016, and the Fort Lee Near Road $PM_{2.5}$ monitor began operating in 2015.

Figure 5-8
New Jersey $PM_{2.5}$ Design Values for 2014-2016
3-Year Average of the Annual Average Concentrations
Micrograms Per Cubic Meter (µg/m³)

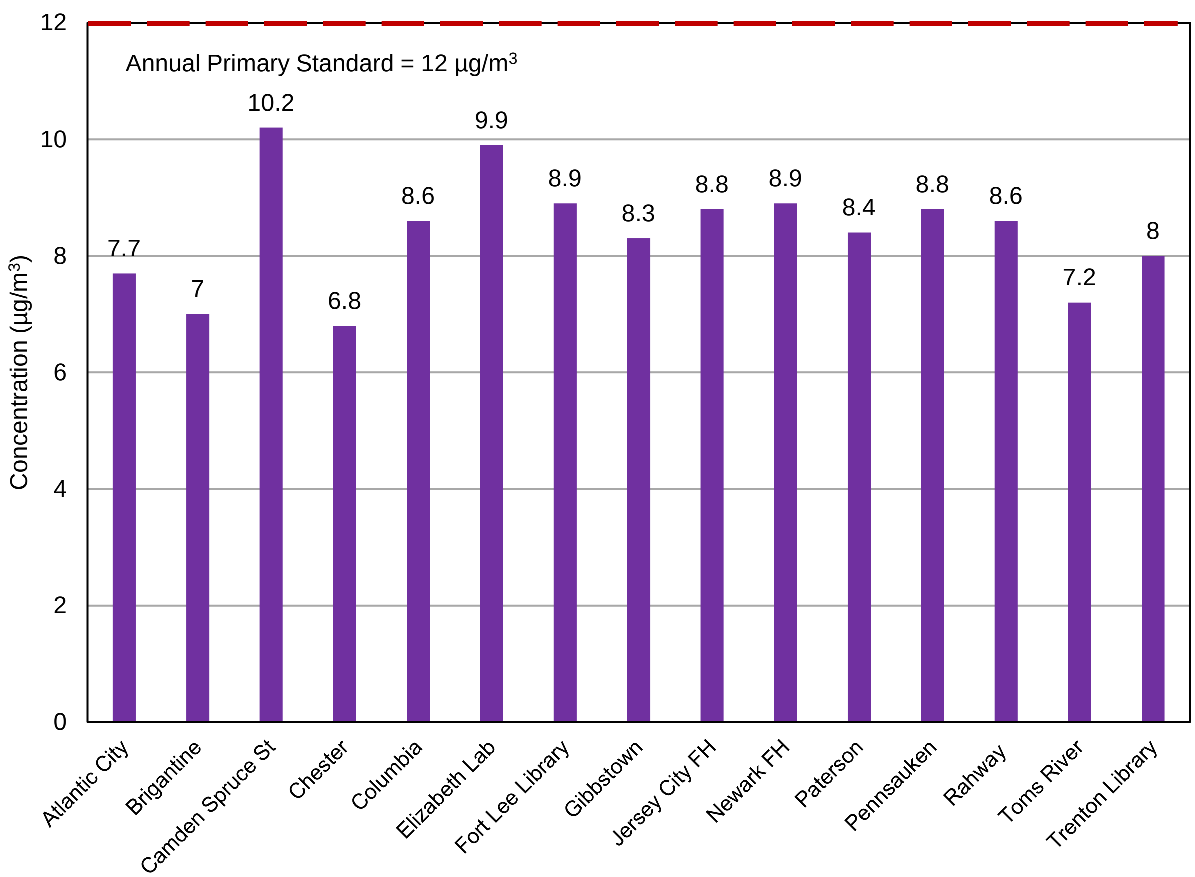
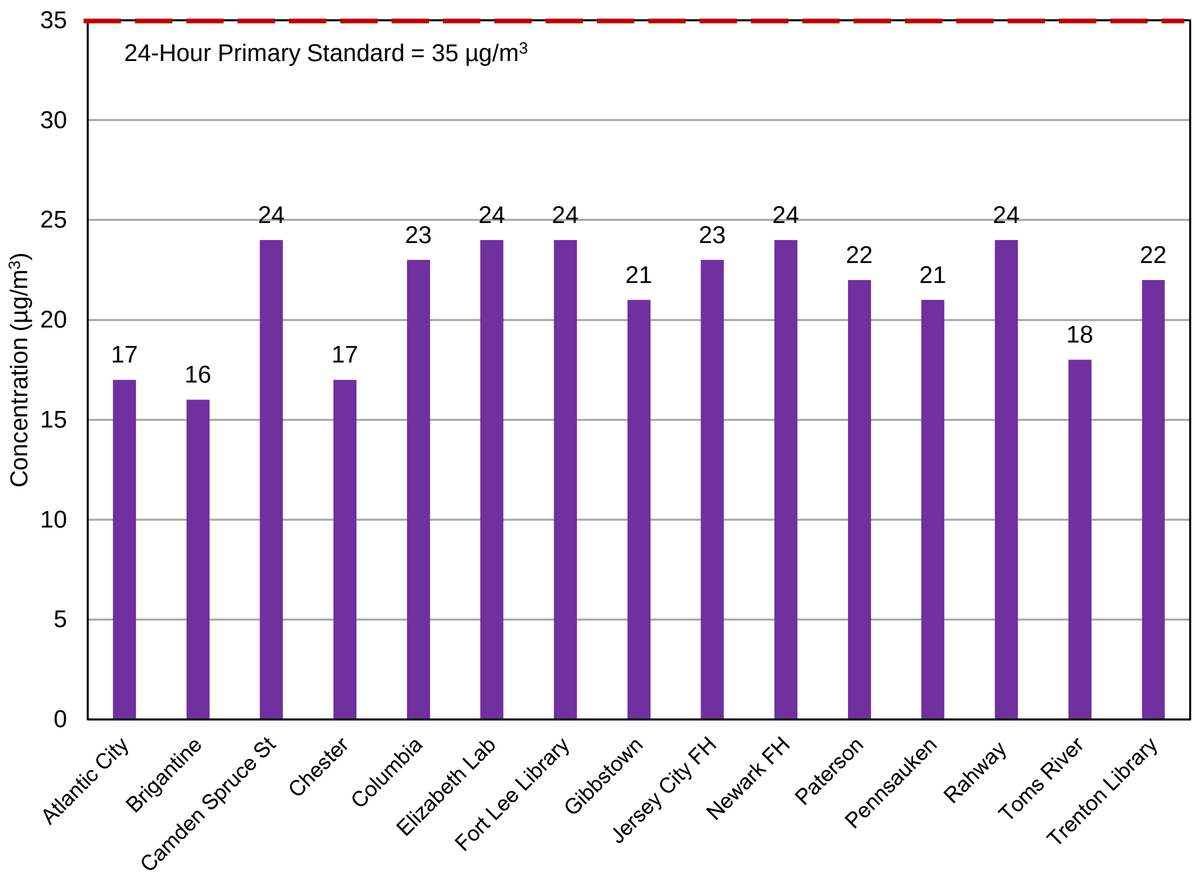


Figure 5-9
New Jersey $PM_{2.5}$ Design Values for 2014-2016
3-Year Average of the 98th Percentile of the 24-Hour Average Concentrations
Micrograms Per Cubic Meter (µg/m³)



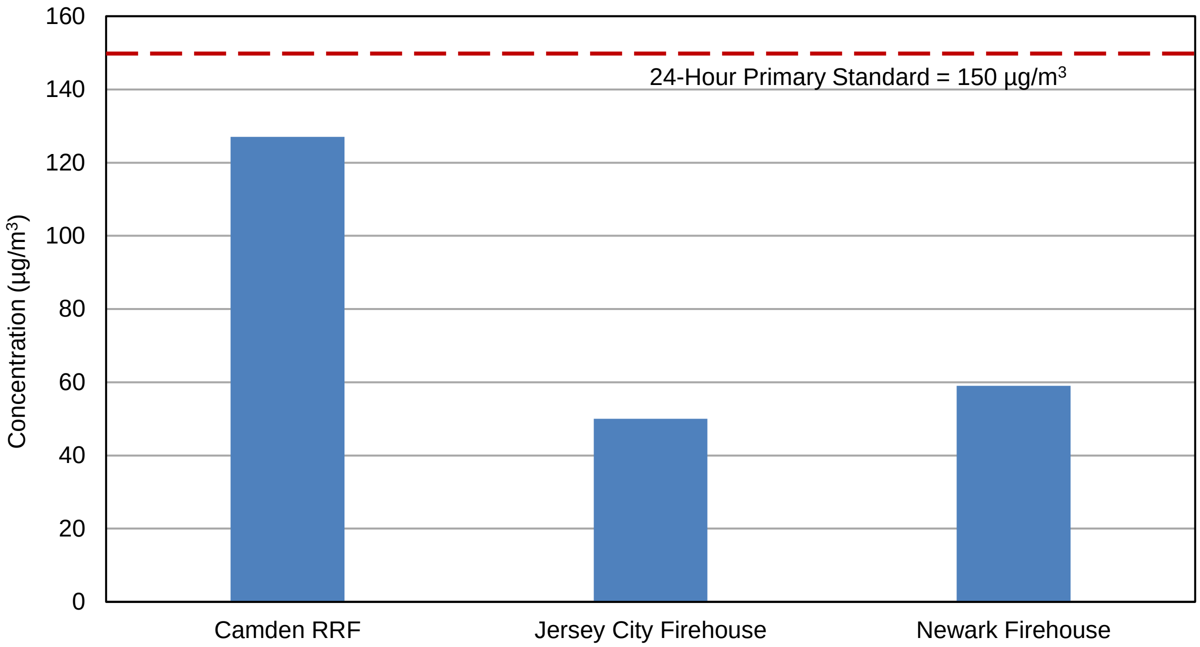
INHALABLE PARTICULATE (PM_{10}) LEVELS IN 2016

Table 5-4 shows 2016 values for each of the New Jersey PM_{10} monitors. The highest and second-highest 24-hour concentrations, as well as the annual average, are presented. All areas of the state are in attainment for the 24-hour standard of 150 µg/m³, as can be seen in Figure 5-10. In 2016, the highest PM_{10} values were measured at the Camden RRF site. Major road construction activities nearby may have contributed to the elevated PM_{10} levels.

Table 5-4
2016 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	58	127	113	39
Jersey City Firehouse	57	50	32	16
Newark Firehouse	114	59	45	14

Figure 5-10
2016 PM_{10} Concentrations in New Jersey
Maximum 24-Hour Averages
Micrograms per Cubic Meter ($\mu g/m^3$)



Particulate Trends

The $PM_{2.5}$ monitoring network has been in place since 1999. Figures 5-11 and 5-12 show the trend in the design values (3-year averages) since then. Seventeen years of data show a noticeable decline in fine particulate concentrations.

Figure 5-11
$PM_{2.5}$ Design Value Trend in New Jersey, 2001-2016
3-year Average of the Annual Average Concentrations
Micrograms per Cubic Meter (µg/m³)

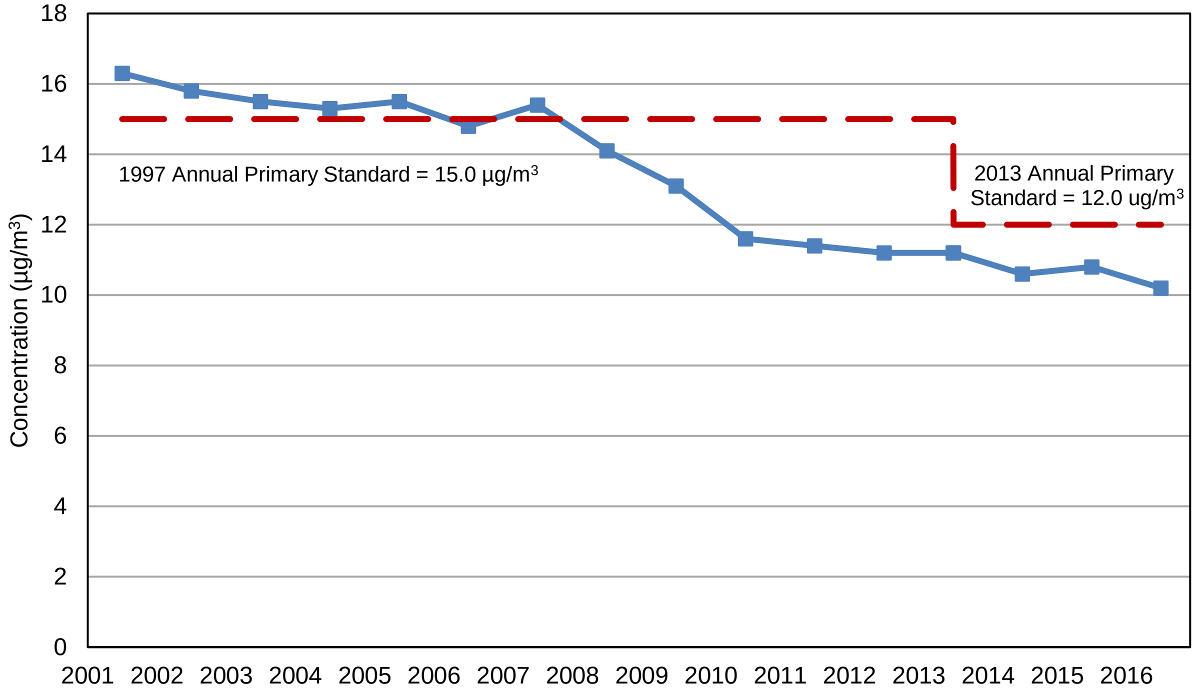
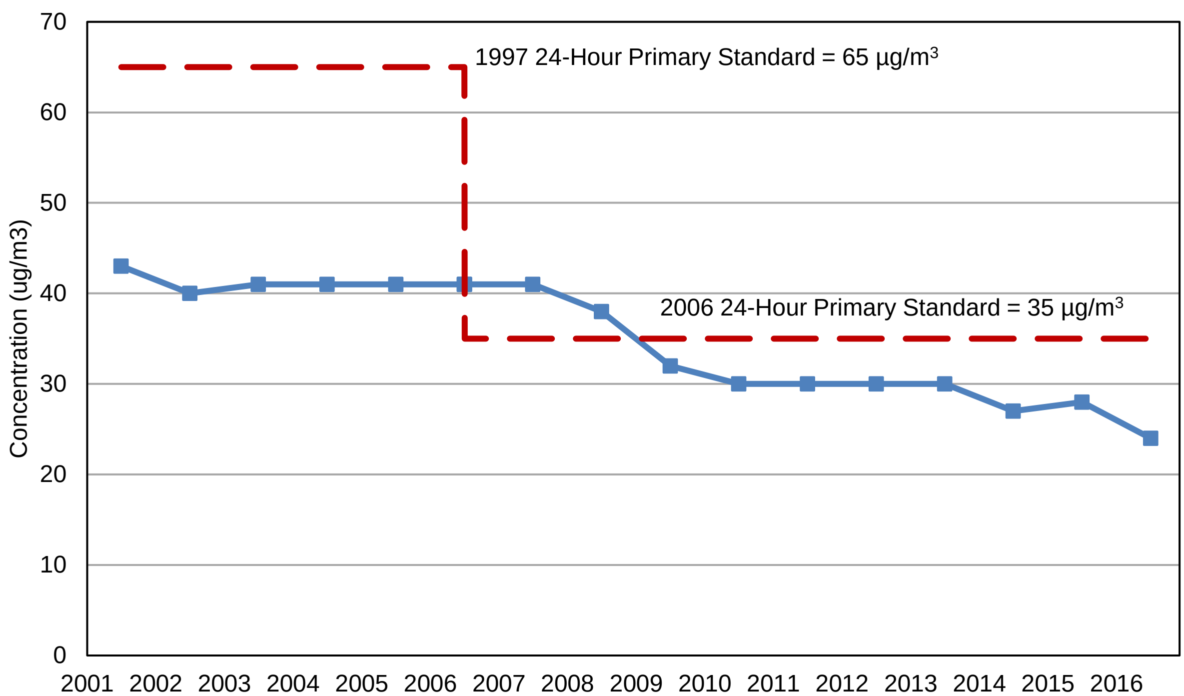


Figure 5-12
$PM_{2.5}$ Design Value Trend in New Jersey, 2001-2016
3-year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



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