2017 Particulate Matter Summary

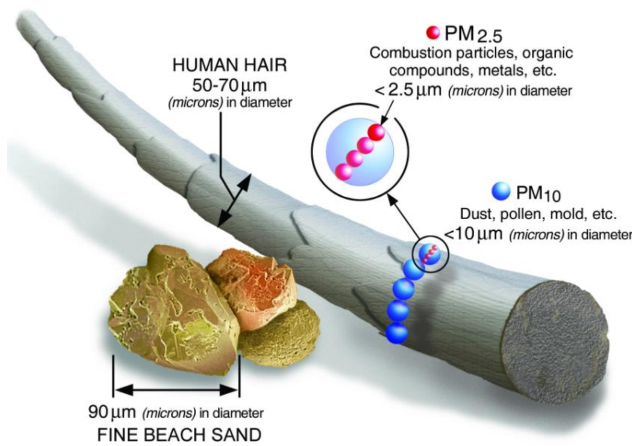
New Jersey Department of Environmental Protection

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 undetected 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, measured in microns (one millionth of a meter, also known as a micrometer). Particulates with diameters of 2.5 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 "inhalable particulate matter," and are referred to as PM_{10}. "Coarse particulate matter" is between 2.5 and 10 microns in size (PM_{coarse}). "Total suspended particulate" (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 heart attacks, decrease lung function, and aggravate asthma. PM_{10} is of less concern, although it is 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 at Brigantine (www.hazecam.net) which focuses on the Atlantic 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 in 2017 consisted of twenty-two $PM_{2.5}$ 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 methods to measure particulate.

Eighteen $PM_{2.5}$ 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.

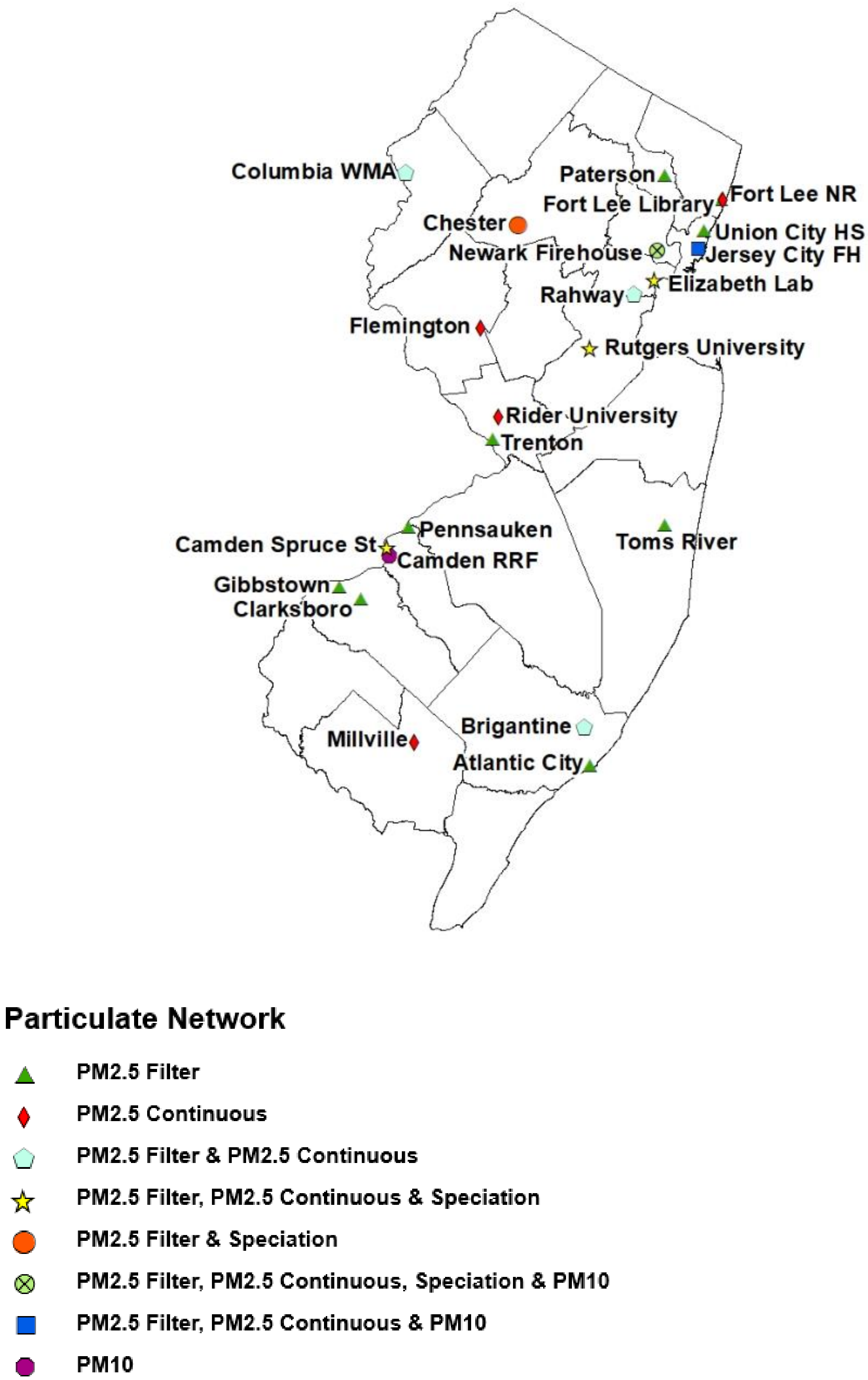
In order to provide real-time hourly data to the public (through the Air Quality Index at www.njaqinow.net), NJDEP has also been using particulate monitors that operate continuously. Eleven sites in New Jersey use Beta Attenuation Monitors (BAM), which measure the loss of intensity (attenuation) of beta particles due to absorption by $PM_{2.5}$ particles collected on a filter tape. These monitors are classified by USEPA as Federal Equivalent Methods (FEM) for $PM_{2.5}$, and can be used to determine compliance with the NAAQS. One site, Rahway, uses a Tapered Element Oscillating Microbalance (TEOM) analyzer, which is not a Federal Equivalent Method (FEM). 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. This instrument will be replaced with an FEM monitor in 2018.

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 monitoring takes place at the Camden Spruce Street, Chester, Elizabeth Lab, Newark Firehouse and Rutgers University monitoring stations. 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. Because of proposed construction at the Gibbstown monitoring station, in August of 2017 the it was shut down and the $PM_{2.5}$ monitor was moved to Clarksboro.

Figure 5-3
2017 Particulate Monitoring Network



Fine Particle ($PM_{2.5}$) Levels in 2017

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

The annual mean concentrations of $PM_{2.5}$ measured by the eighteen filter-based FRM samplers ranged from 5.85 $\mu g/m^3$ at the Brigantine monitoring site to 9.58 $\mu g/m^3$ at the Elizabeth Lab station. The highest 24-hour concentrations ranged from 18.0 $\mu g/m^3$ at Chester to 30.4 $\mu g/m^3$ at Toms River. Table 5-2 shows the 2017 annual mean, highest and 98th percentile 24-hour concentrations, as well as the number of valid samples collected. The data is also shown graphically in Figures 5-4 and 5-5. Four sites (Elizabeth Lab, Jersey City Firehouse, Toms River and Trenton) operate every day. The other fourteen sites (Atlantic City, Brigantine, Camden Spruce Street, Chester, Clarksboro, Columbia, Fort Lee Library, Gibbstown, Newark Firehouse, Paterson, Pennsauken, Rahway, Rutgers University, and Union City High School) take a sample every third day. In 2017, no FRM sites were in violation of either the annual NAAQS of 12.0 $\mu g/m^3$ or the 24-hour NAAQS of 35 $\mu g/m^3$.

Table 5-2
2017 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (FRM)
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Number of Samples	Annual Average	24-Hour Average	
			Highest	98th%-ile
Atlantic City	113	6.93	23.3	17.6
Brigantine	115	5.85	18.5	13.5
Camden Spruce Street	112	9.31	28.1	22.5
Chester	116	5.90	18.0	13.6
Clarksboro*	50	7.95	21.7	21.7
Columbia	106	8.19	23.6	18.3
Elizabeth Lab	336	9.58	29.1	20.8
Fort Lee Library	118	7.30	18.8	16.3
Gibbstown*	63	7.27	18.8	17.4
Jersey City Firehouse	349	8.14	23.3	18.5
Newark Firehouse	110	7.57	19.1	15.3
Paterson	117	7.76	20.3	17.7
Pennsauken	118	7.91	19.8	18.2
Rahway	112	7.76	21.3	17.2
Rutgers University	120	6.84	18.3	17.5
Toms River	320	6.74	30.4	16.4
Trenton Library	345	7.53	23.7	18.0
Union City High School	118	7.81	20.7	17.8

*In August 2017 the PM2.5 sampler from Gibbstown was moved to Clarksboro. Neither site collected enough data to calculate a valid annual mean concentration.

Figure 5-4
2017 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages (Filter-Based Monitors)
Micrograms Per Cubic Meter (µg/m³)

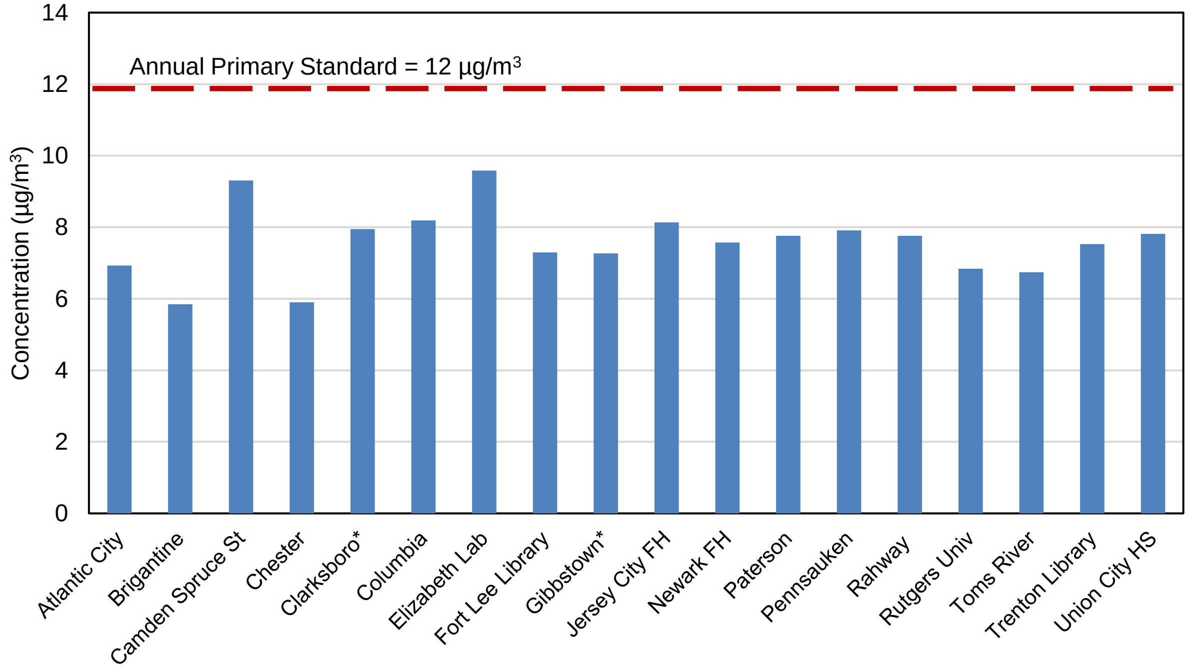
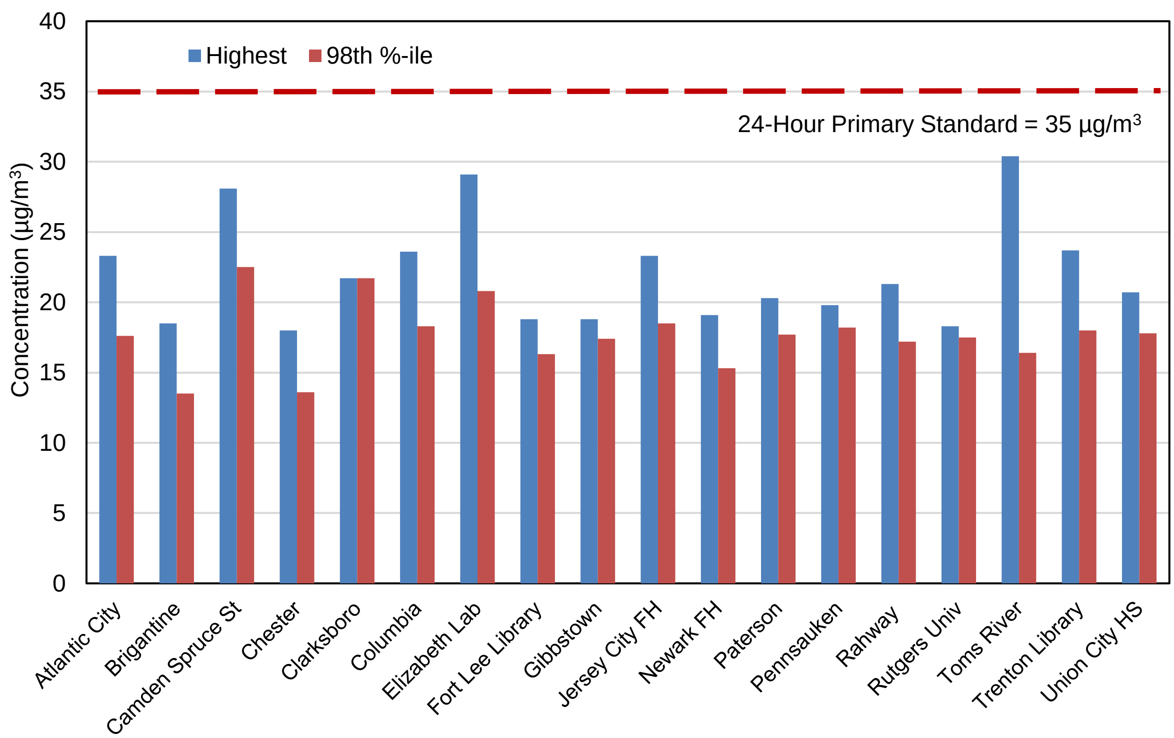


Figure 5-5
2017 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages (Filter-Based Monitors)
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ 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 2017. Figures 5-6 and 5-7 show the same data in graphs. In 2017 there were four exceedances of the 24-hour standard at Camden Spruce St. and one at the Elizabeth Lab (see the Air Quality Index Summary for details). However, the 24-hour 98th percentile values, 27.7 $\mu g/m^3$ at Camden and 22.1 $\mu g/m^3$ at Elizabeth Lab, which are used to determine compliance with the NAAQS, were below primary standard of 35 $\mu g/m^3$.

Table 5-3
2017 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (Continuous Monitors)
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Annual Average	24-Hour Average	
		Highest	98th%-ile
Brigantine	7.81	18.0	15.7
Camden Spruce Street	11.87	44.2	27.7
Columbia	8.19	31.6	19.6
Elizabeth Lab	10.29	35.6	22.1
Flemington	8.04	25.8	17.5
Fort Lee Near Road	8.88	25.9	18.2
Jersey City Firehouse	10.27	25.1	20.9
Millville	7.89	21.8	16.5
Newark Firehouse	8.59	24.7	19.2
Rahway	8.10	18.7	16.4
Rider University	8.08	26.0	17.2
Rutgers University	8.33	26.2	18.8

Figure 5-6
2017 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages from Continuous Monitors
Micrograms Per Cubic Meter (µg/m³)

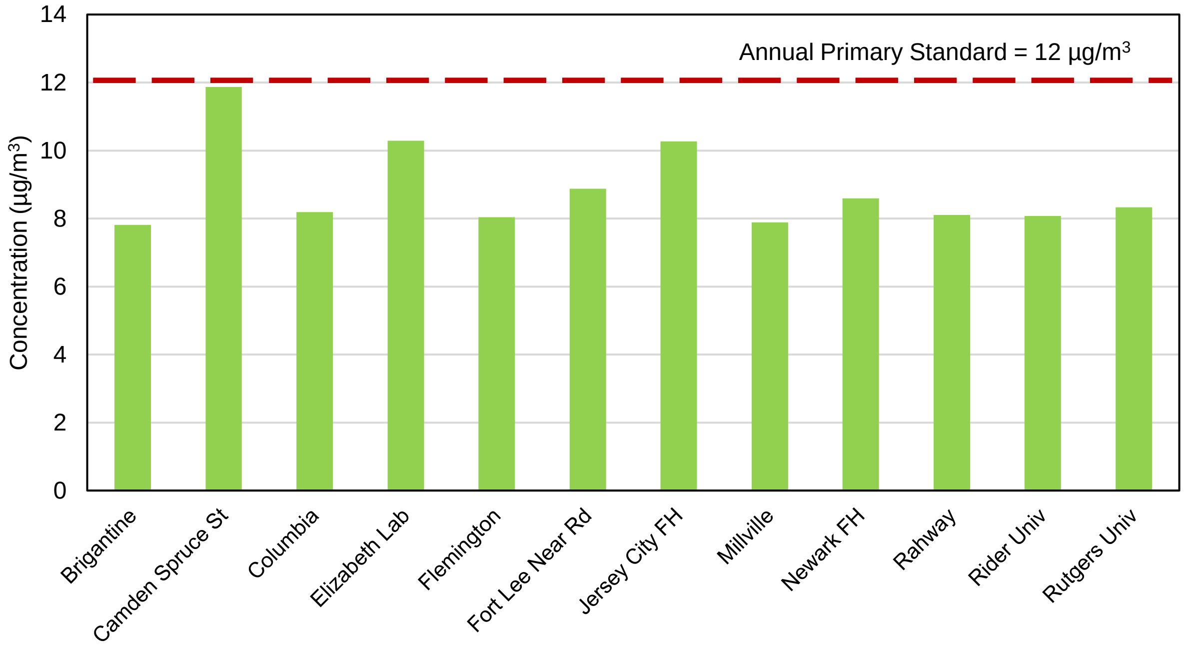
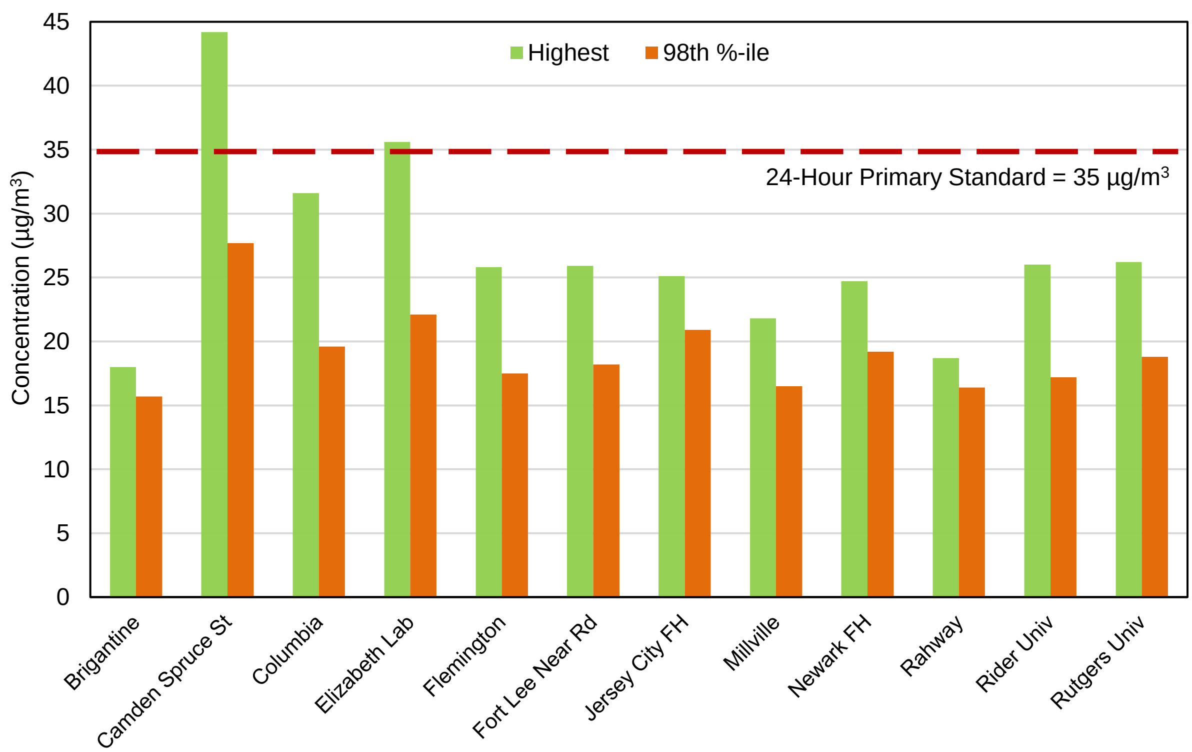


Figure 5-7
2017 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages from Continuous Monitors
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ DESIGN VALUES

Table 5-4 and Figures 5-8 and 5-9 show the $PM_{2.5}$ 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, the data from the FRM monitor usually takes precedence, and FEM data is added in for periods when there is no FRM data.

Seven sites do not have complete three-year data sets, but their USEPA design value estimates are included here anyway (marked with an asterisk). As mentioned before, Gibbstown was shut down mid-2017 and its monitor moved to Clarksboro. Flemington, Millville, Rider University, Rutgers University, and Union City High School are missing some or all 2015 $PM_{2.5}$ data.

Table 5-4
New Jersey $PM_{2.5}$ Design Values for 2015-2017
3-Year Average of the Annual Average Concentrations
& 98th Percentile 24-Hour Average Concentrations
Micrograms Per Cubic Meter (µg/m³)

Monitoring Site	3-Year (2015-2017) Average	
	Annual	98th %-ile 24-Hour
Atlantic City	7.3	16
Brigantine	6.8	15
Camden Spruce Street	10.3	25
Chester	6.4	16
Clarksboro*	7.9	22
Columbia	8.6	22
Elizabeth Lab	9.7	23
Flemington*	8.3	17
Fort Lee Library	8.5	21
Fort Lee Near Road	10.1	22
Gibbstown*	7.8	18
Jersey City Firehouse	8.4	21
Millville*	7.9	17
Newark Firehouse	8.6	20
Paterson	8.0	19
Pennsauken	8.3	19
Rahway	8.2	20
Rider University*	8.3	17
Rutgers University*	8.3	19
Toms River	6.9	18
Trenton Library	7.7	20
Union City High School*	8.2	18

*3-year data set is incomplete.

Figure 5-8
New Jersey $PM_{2.5}$ Design Values for 2015-2017
3-Year Average of the Annual Average Concentrations
Micrograms Per Cubic Meter (µg/m³)

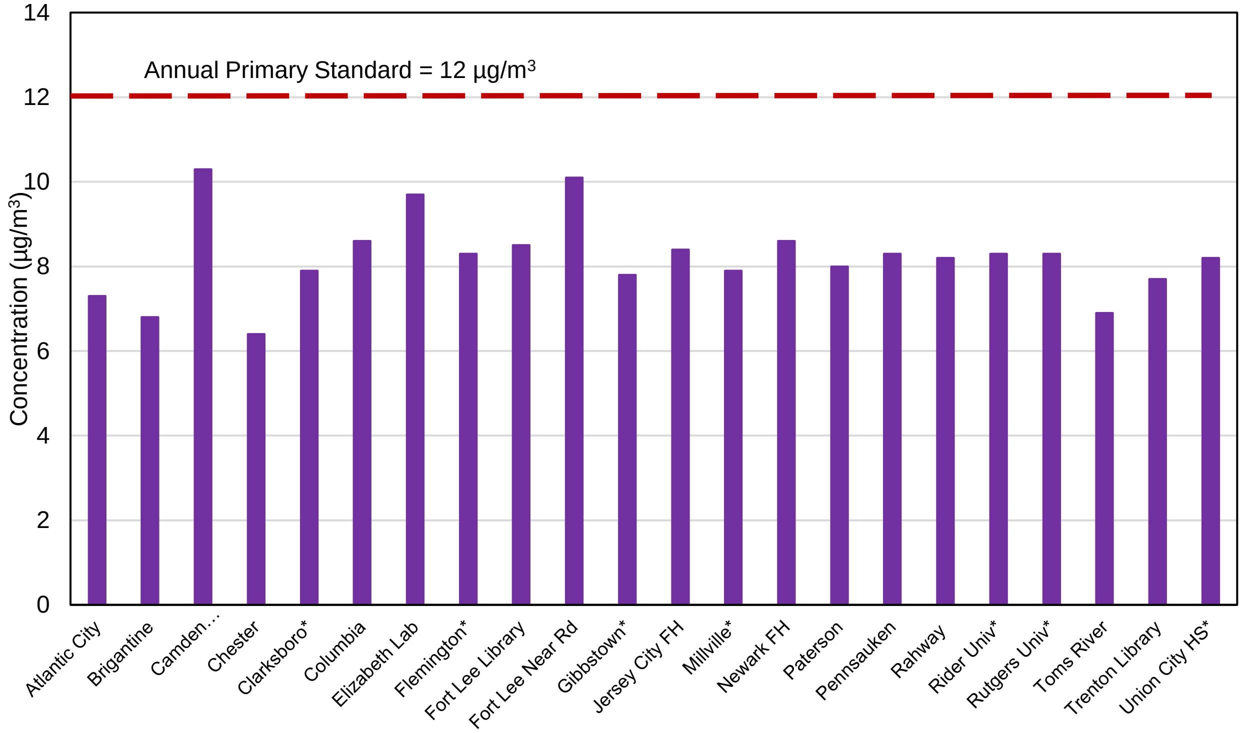
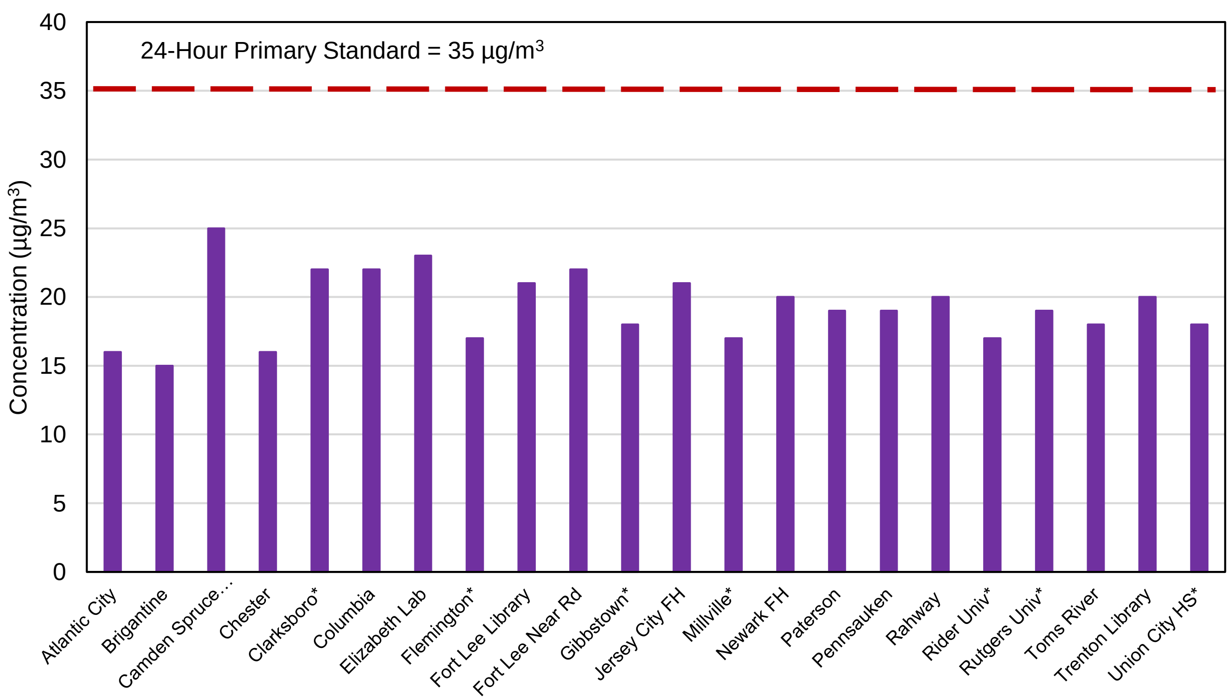


Figure 5-9
New Jersey $PM_{2.5}$ Design Values for 2015-2017
3-Year Average of the 98th Percentile of the 24-Hour Average Concentrations
Micrograms Per Cubic Meter (µg/m³)



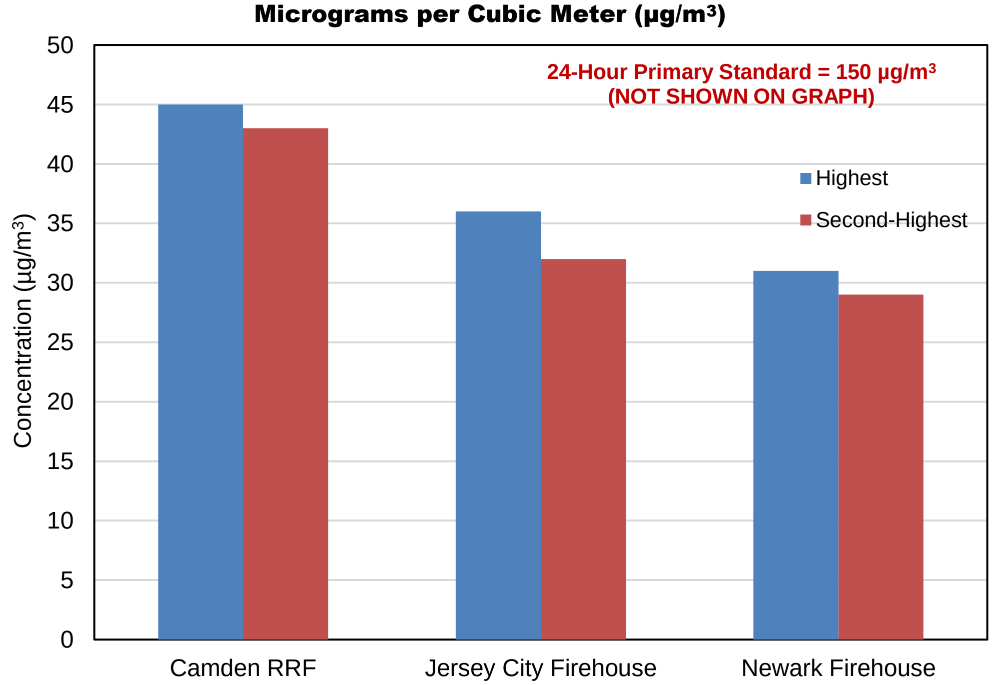
Inhalable Particulate (PM_{10}) Levels in 2017

Table 5-5 shows 2017 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/m^3, as can be seen in Figure 5-10. The standard is based on the second-highest 24-hour value. In 2017, the highest PM_{10} values were measured at the Camden RRF site.

Table 5-5
2017 PM_{10} Concentrations in New Jersey
24-Hour and Annual Averages
Micrograms Per Cubic Meter (µg/m³)

Monitoring Site	Number of Samples	Annual Average	24-Hour Average	
			Highest	Second-Highest
Camden RRF	56	20.1	45	43
Jersey City Firehouse	56	15.4	36	32
Newark Firehouse	117	13.9	31	29

Figure 5-10
2017 PM_{10} Concentrations in New Jersey
Maximum 24-Hour Averages
Micrograms per Cubic Meter (µg/m³)



PARTICULATE TRENDS

The $PM_{2.5}$ monitoring network in New Jersey has been in place since 1999. Figures 5-11 and 5-12 show the trend in the design values (3-year averages) since 2001, as well as changes to the NAAQS. Years of data show a noticeable decline in fine particulate concentrations.

Figure 5-11
$PM_{2.5}$ Design Value Trend in New Jersey, 2001-2017
3-Year Average of the Annual Average Concentrations
Micrograms per Cubic Meter (µg/m³)

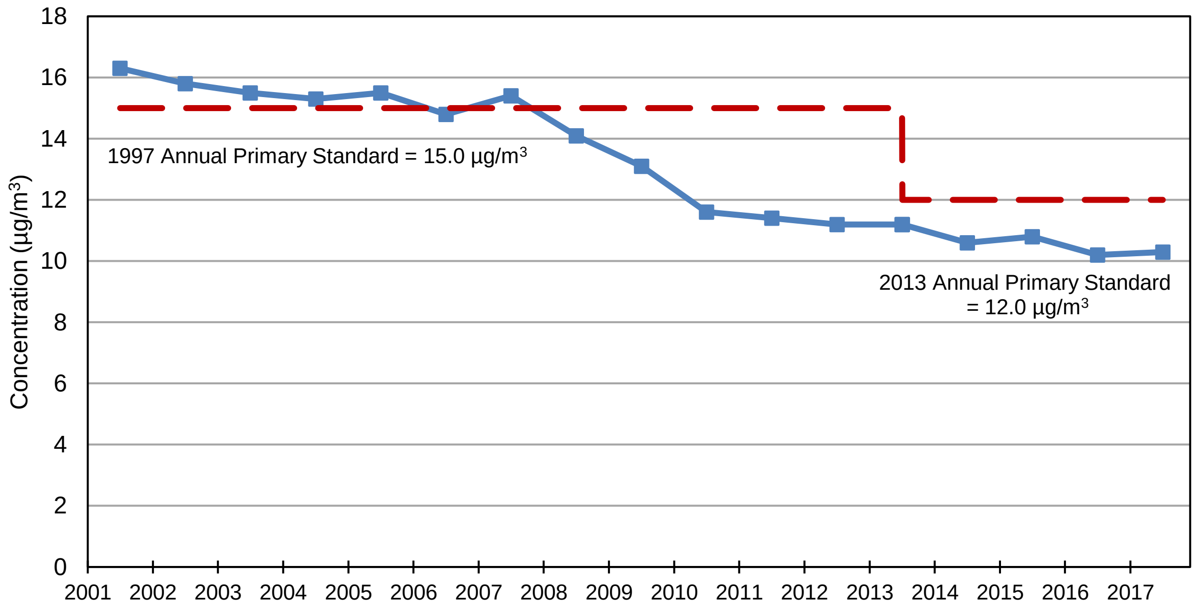
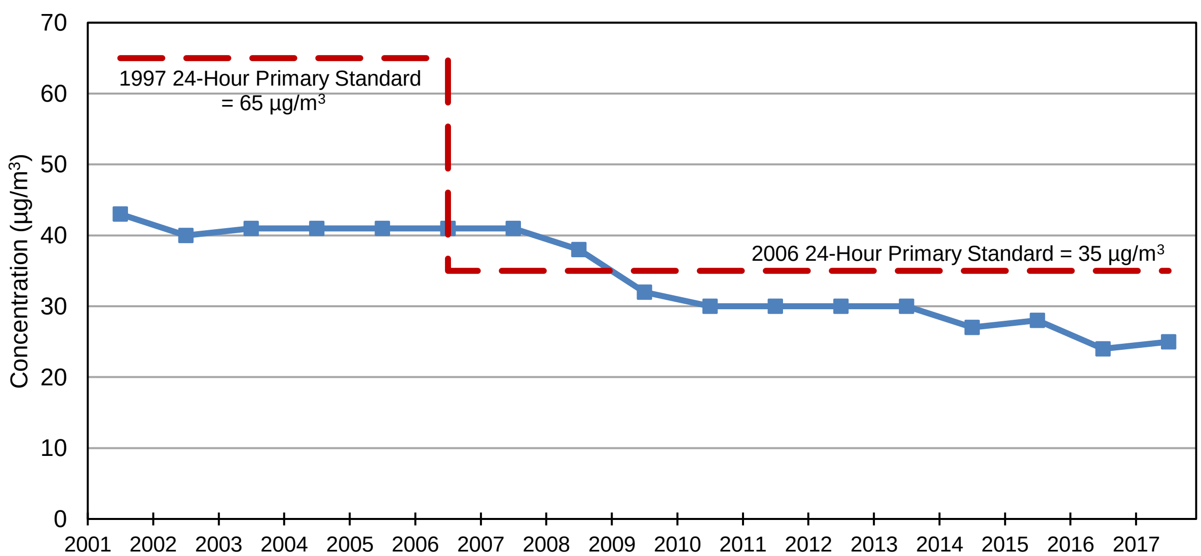
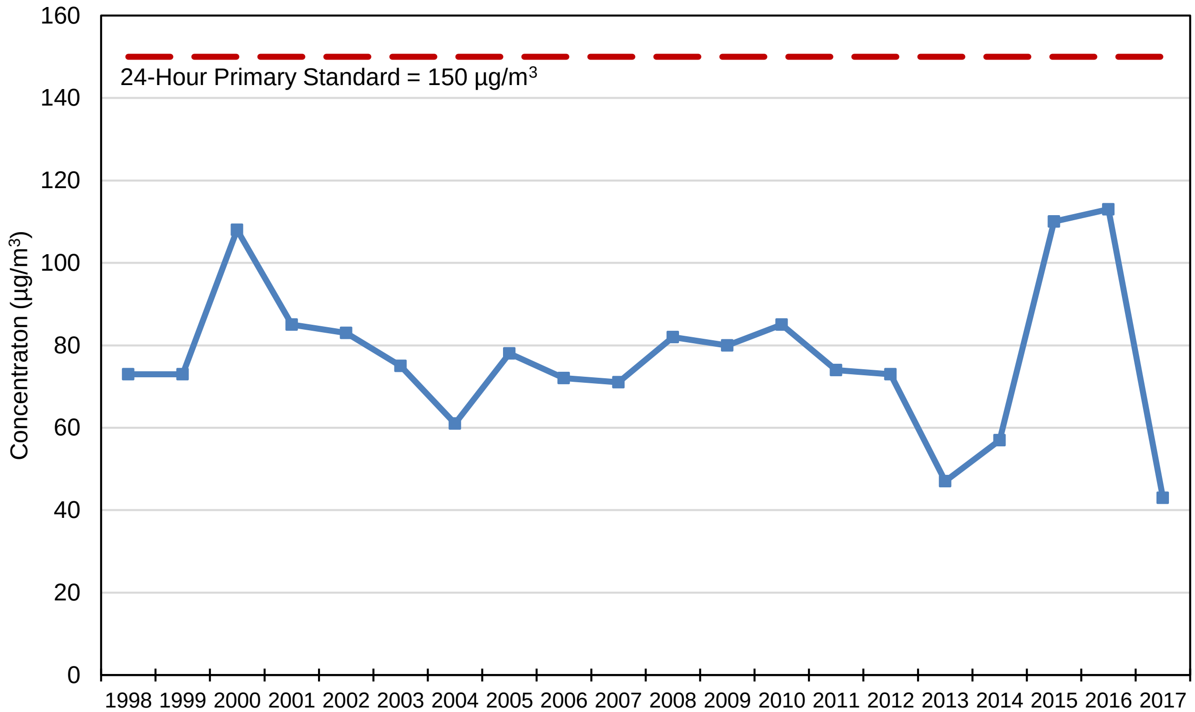


Figure 5-12
$PM_{2.5}$ Design Value Trend in New Jersey, 2001-2017
3-Year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



The PM_{10} design value trend is shown in Figure 5-13. The increase in concentration in 2015 and 2016 occurred at the Camden Spruce Street monitor, during a period of major road construction.

Figure 5-13
PM_{10} Design Value Trend in New Jersey, 1998-2017
2nd-Highest 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



REFERENCES

Camnet. Realtime Air Pollution & Visibility Monitoring. www.hazecam.net. Accessed 8/15/18.

U.S. Environmental Protection Agency (USEPA). 2012 National Ambient air Quality Standards (NAAQS) for Particulate Matter (PM). www.epa.gov/pm-pollution/2012-national-ambient-air-quality-standards-naaqs-particulate-matter-pm. Accessed 8/15/18.

USEPA. Health and Environmental Effects of Particulate Matter (PM). www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm. Accessed 8/15/18.

USEPA. Particulate Matter (PM) Pollution. www.epa.gov/pm-pollution. Accessed 8/15/18.

USEPA Region 1. How Does PM Affect Human Health? www3.epa.gov/region1/airquality/pm-human-health.html. Accessed 8/15/18.