2023 New Jersey Air Quality Report

New Jersey Department of Environmental Protection

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https://dep.nj.gov/airmon/

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Photo: Ocean City, NJ

EXECUTIVE SUMMARY

This report presents the New Jersey Department of Environmental Protection (NJDEP) air quality data for 2023, collected from NJDEP's extensive air monitoring network. The state of New Jersey has been monitoring air quality since 1965. During that time, as a result of state, regional and national air pollution reduction efforts, pollution levels have improved significantly.

In 2023, New Jersey had 20 days on which there was an exceedance of either the ozone or fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS). Ozone pollution in New Jersey tends to be a warm-season problem, since it is formed in the presence of sunlight from other pollutants such as volatile organic compounds and nitrogen oxides. During 2023, eight days had air quality ratings ranging from "Unhealthy for Sensitive Groups" to "Very Unhealthy" due to local wildfires and the record-breaking Canadian wildfires that affected the mid-Atlantic and northeast states. The worst air quality ratings were measured on June 7 when seven air monitoring stations recorded 24-hour averaged PM2.5 concentrations in the Very Unhealthy category.

The NJDEP has identified a replacement for the Newark Firehouse monitoring station which closed on September 22, 2022, and plans to resume monitoring in 2025.

What's in the Annual Air Quality Report

This report includes detailed chapters for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide and lead. These are the criteria pollutants, that is, those for which National Ambient Air Quality Standards (NAAQS), or criteria, have been set. Other measurements made at our air monitoring stations and discussed in this report include air toxics, ozone precursors, chemical components of airborne fine particles and mercury.

The chapter on the Air Quality Index (AQI) describes a national air quality rating system based on the NAAQS, and discusses the overall quality of New Jersey's air in 2023. Included is a detailed list of the 20 days on which the AQI was over 100. This means that the NAAQS were exceeded, and the days were classified as "Unhealthy for Sensitive Groups," "Unhealthy" or "Very Unhealthy."

Figures 1-1 through 1-6 below illustrate the downward trends in concentrations of criteria pollutants in New Jersey over the past few decades by graphing the statewide design values for each pollutant. A design value is the actual statistic that is compared to a NAAQS. If this value exceeds the NAAQS at any site in the state, the state is determined to be in nonattainment. Design values for each of the criteria pollutants are described in detail in each pollutant-specific chapter of this report.

New Jersey is on track for meeting the ozone NAAQS (Figure 1-1), and will continue to implement control strategies to reduce ambient concentrations. Because ozone is formed in the presence of sunlight and high temperatures, the highest levels occur in the summer months. Ozone has been found to have serious health effects at lower levels than previously thought. In response, the United States Environmental Protection Agency (USEPA) periodically revises and lowers the NAAQS. USEPA lowered the ozone standard to 0.070 ppm in 2015 (effective in 2016).

Particulate air pollution less than 2.5 micrometers in diameter is referred to as fine particulate or $PM_{2.5}$. These small particles can be inhaled deep into the lungs, and are known to have a greater impact on public health than larger particles, which were the focus of the earliest ambient air quality standards. Even though in 2023 there were nine days on which the 24-hour $PM_{2.5}$ NAAQS was exceeded, monitoring data in New Jersey shows a steady decline in overall $PM_{2.5}$ levels, which are now in compliance with the NAAQS (Figure 1-2).

Nitrogen dioxide (NO_2) is a reactive gas emitted primarily from motor vehicles. It is known to cause serious health problems, especially for sensitive individuals such as children, the elderly, and people with asthma. New Jersey has long been in compliance with the NAAQS for NO_2 (Figure 1-3).

The sharp increase and subsequent decrease in sulfur dioxide (SO_2) concentrations in New Jersey shown in Figure 1-4 are attributable to a coal-burning facility across the Delaware River in Pennsylvania. NJDEP established the Columbia monitoring station in 2010 to determine that facility's impact on New Jersey's air quality. Exceedances of the SO_2 NAAQS were recorded that same year. Since the plant ceased operations under a court agreement, SO_2 levels in New Jersey have again dropped below the standard.

Outdoor concentrations of carbon monoxide can affect people with cardiovascular problems. Levels in New Jersey have been below the NAAQS for over twenty-five years (Figure 1-5).

Air concentrations of lead have dropped dramatically since a standard was established in 1978. The phase-out of leaded gasoline and removal of lead from paint and other products have had a measurable impact. The last exceedances of the NAAQS were in the early 1980s (Figure 1-6). Since Newark Firehouse, the only air monitoring station in New Jersey that measured lead for comparison to the NAAQS, closed in September 2022, there is no 2023 data for lead. When the replacement station for Newark is established, lead monitoring will resume. The trend chart in Figure 1-6 shows data up to 2022.

The Bureau of Air Monitoring website can be found at https:/dep.nj.gov/airmon. Available information includes a table and map of current air quality readings, the daily air quality forecast, annual reports, trend graphs, and other data.

Figure 1-1
Statewide New Jersey Ozone Trend, 1997-2023
3-Year Average of the 4th-Highest Daily Maximum 8-Hour Average Concentrations
Parts per Million (ppm)

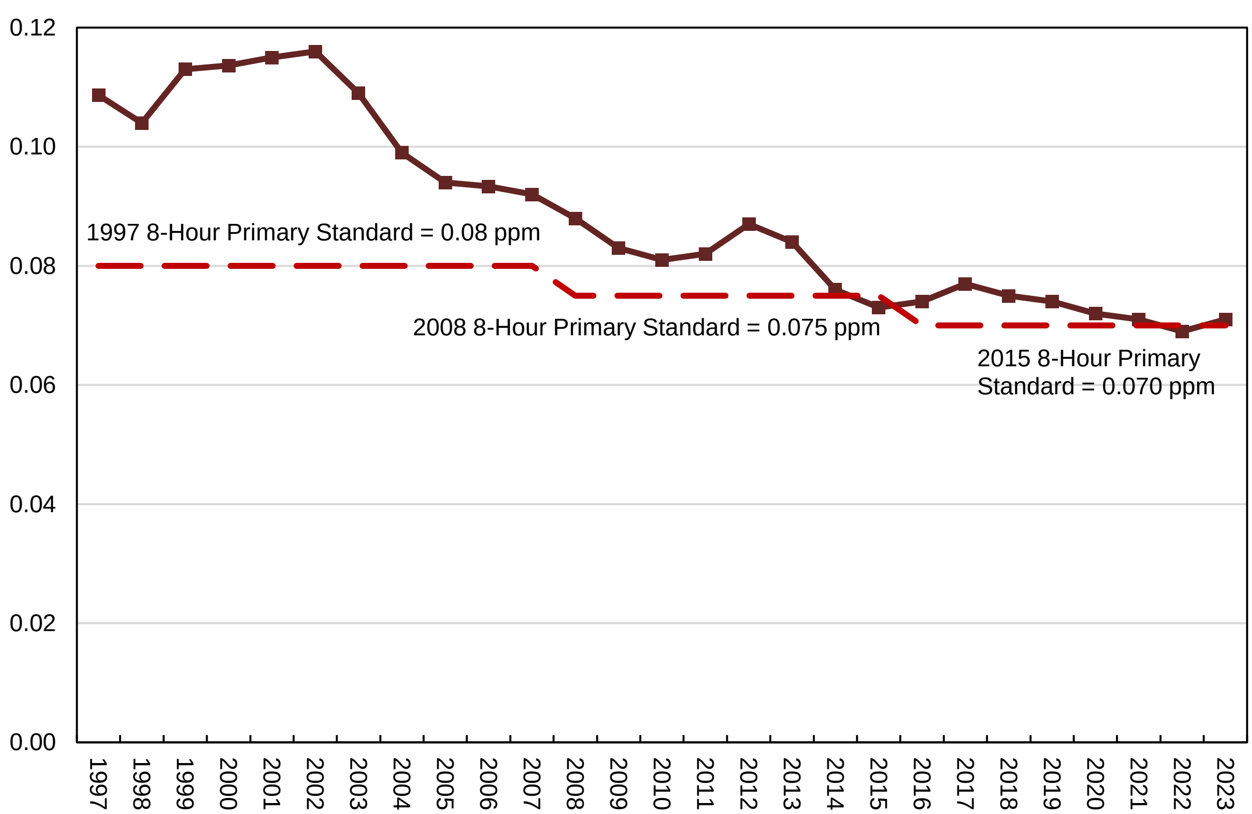


Figure 1-2
Statewide New Jersey Fine Particulate ($PM_{2.5}$) Trend, 2001-2023
3-Year Average of the Highest Annual Average Concentrations
Micrograms per Cubic Meter (µg/m³)

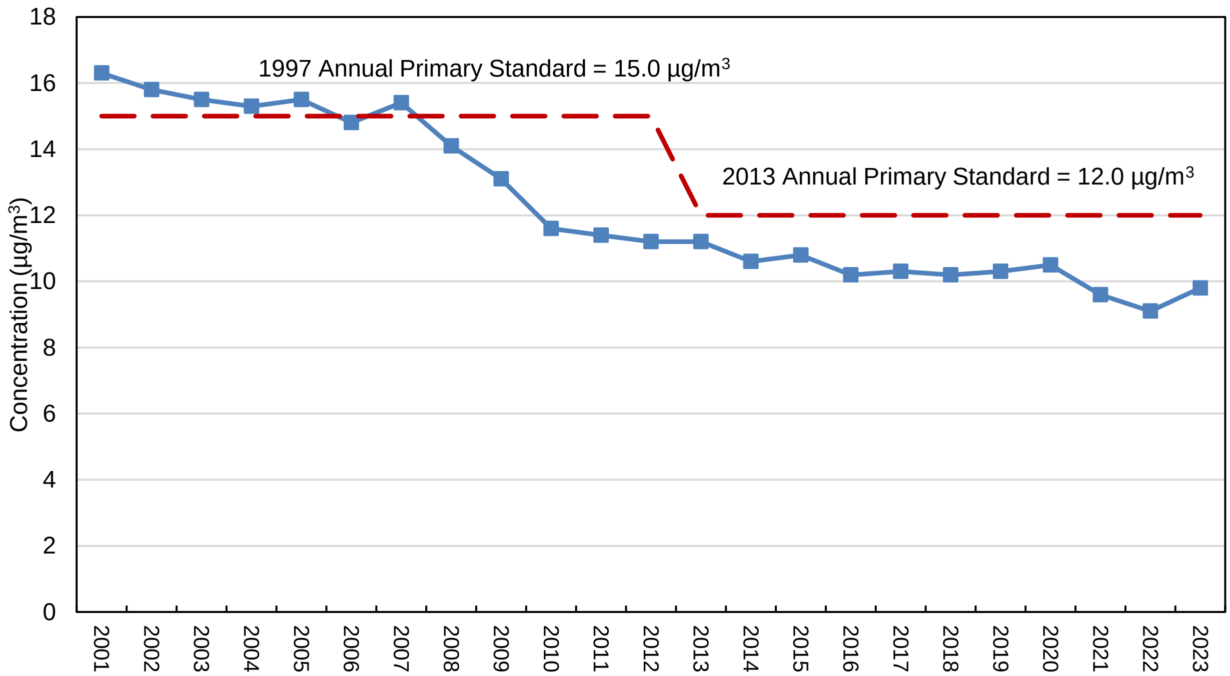


Figure 1-3
Statewide New Jersey Nitrogen Dioxide (NO_2) Trend, 2000-2023
3-Year Average of the 98th Percentile Daily Maximum 1-Hour Average Concentrations
Parts per Billion (ppb)

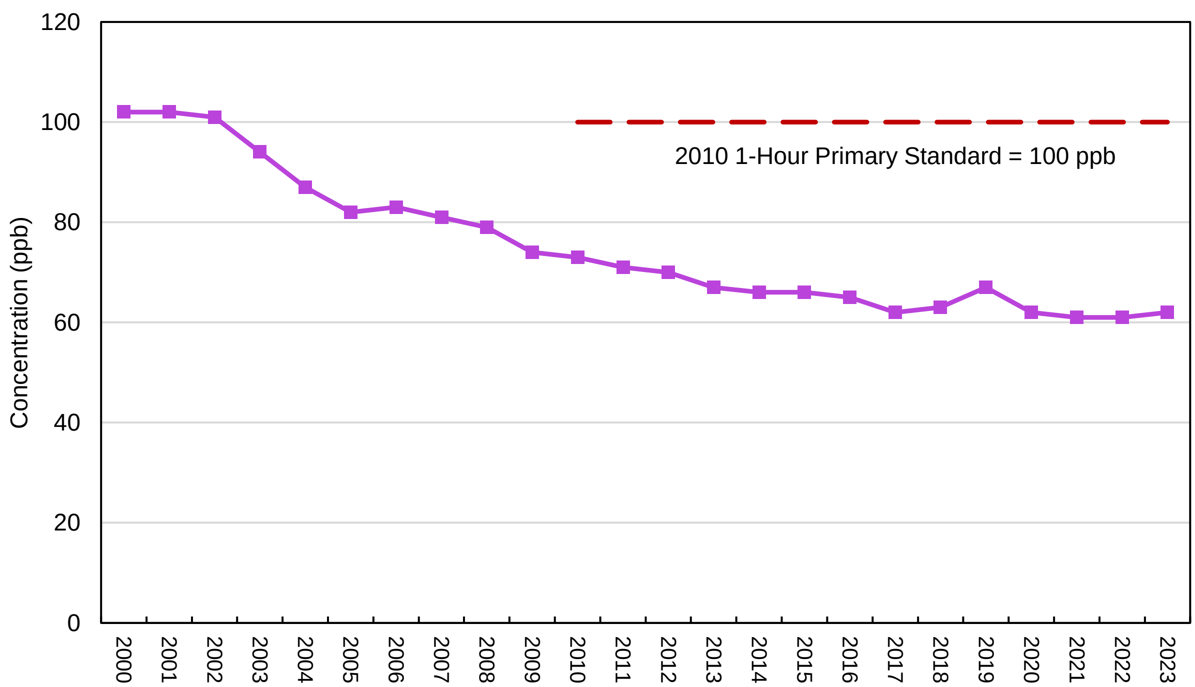


Figure 1-4
Statewide New Jersey Sulfur Dioxide (SO_2) Trend, 2000-2023
3-Year Average of the 99th-Percentile of Daily Maximum 1-Hour Average Concentrations
Parts per Billion (ppb)

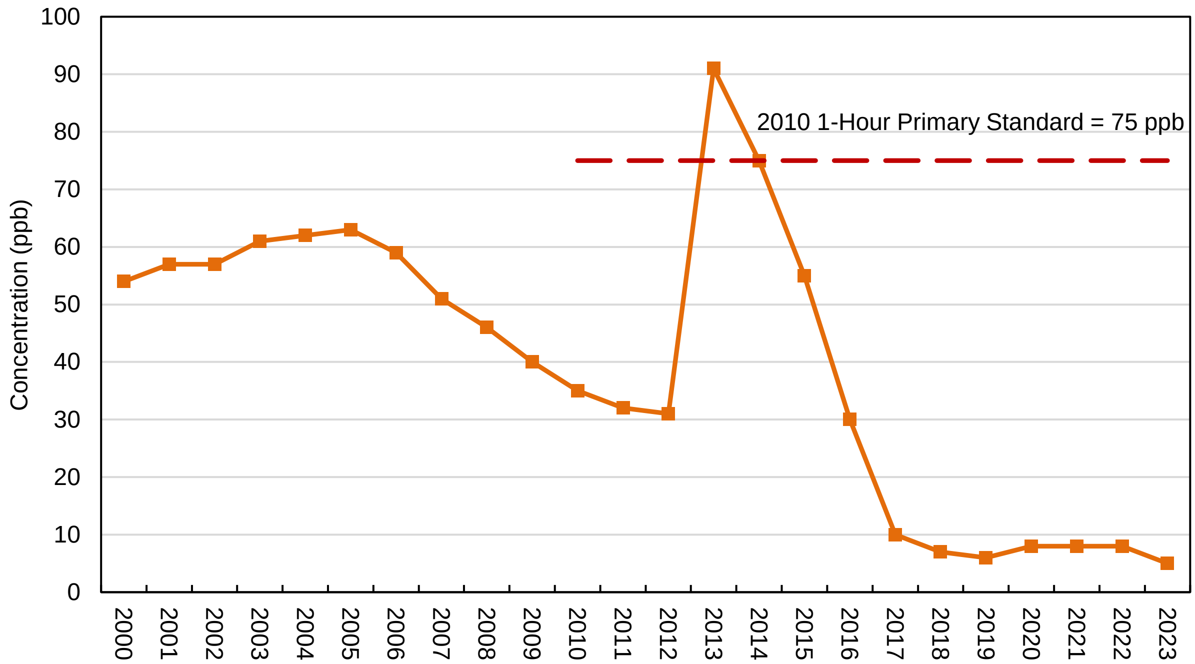


Figure 1-5
Statewide New Jersey Carbon Monoxide (CO) Trend, 1990-2023
2nd-Highest 8-Hour Average Concentrations
Parts per Million (ppm)

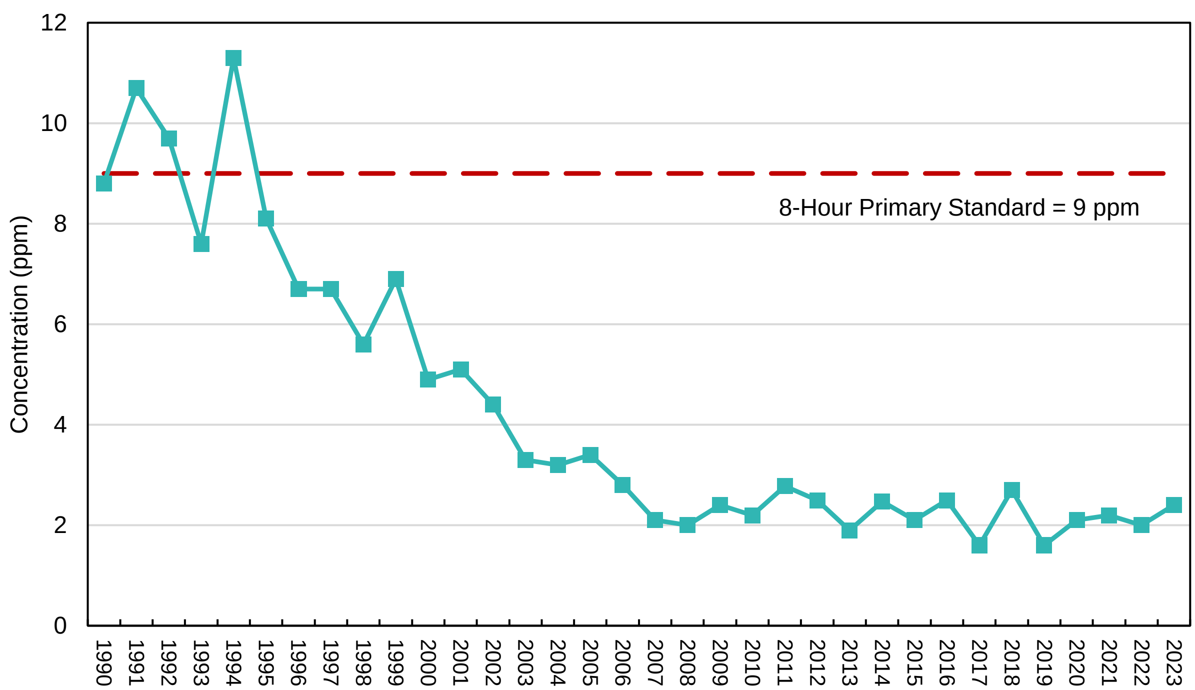
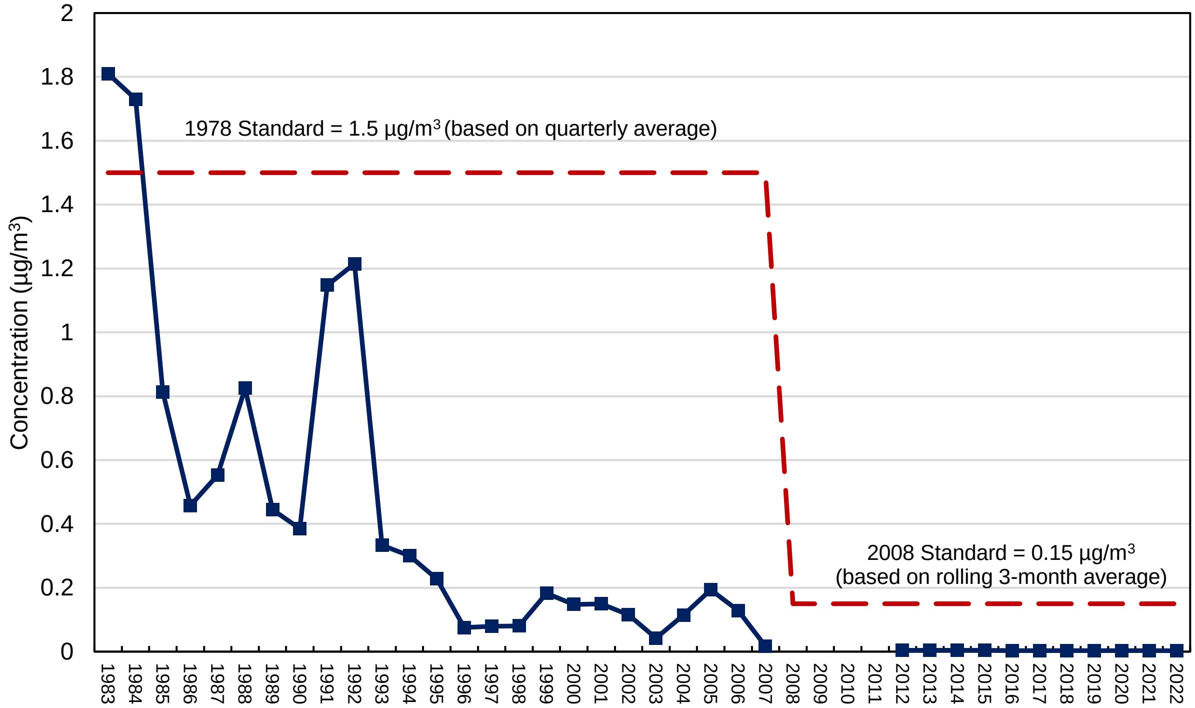


Figure 1-6
Statewide New Jersey Lead Trend, 1983-2022*
Highest 3-Month Average Concentrations
Micrograms per Cubic Meter (µg/m³)



*Lead data was not available in 2023 due to the closure of Newark Firehouse station in 2022, but NJDEP plans to resume lead monitoring in 2025 at a new Newark station.

2023 Air Monitoring Network

New Jersey Department of Environmental Protection

Network Description

In 2023, the New Jersey Department of Environmental Protection (NJDEP) Bureau of Air Monitoring (BAM) operated a network of twenty-nine ambient air monitoring stations around the state. The monitoring stations vary in the number and type of monitors at each site. New Jersey's air monitoring program is primarily focused on the measurement of pollutants for which National Ambient Air Quality Standards (NAAQS) have been established, also known as criteria pollutants. Criteria pollutant monitoring is regulated by the United States Environmental Protection Agency (USEPA), which prescribes the design and siting of the monitoring networks, the acceptable monitoring methods, and the minimum quality assurance activities. Only data which meet USEPA requirements can be used to determine compliance with the NAAQS. There are six criteria air pollutants: ozone (O_3), particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and lead (Pb). Because particulate matter includes a wide range of contaminants, there are separate NAAQS for two different size fractions of particles. There are NAAQS for fine particles, less than 2.5 microns in size, also referred to as $PM_{2.5}$ (1 micron = one millionth of a meter), and another NAAQS for inhalable particles, less than 10 microns in size, referred to as PM_{10}.

Criteria Pollutants

In New Jersey, O_3, NO_2, SO_2 and CO are measured using USEPA-approved real-time monitoring methods, and data for these pollutants are continuously transmitted to a central data acquisition system. Once an hour, the Bureau of Air Monitoring posts this air quality data to its website (https://nj.gov/dep/airmon) and to the USEPA's Air Now website (www.airnow.gov). Data is subsequently reviewed and certified, and is available from USEPA's Air Quality Database at https://www.epa.gov/outdoor-air-quality-data.

$PM_{2.5}$ is measured with both 24-hour filter-based samplers and real-time continuous monitors. Filter-based samplers are used to determine lead and PM_{10} concentrations as well. Filters must be installed and removed manually and brought to the BAM lab to be weighed and analyzed. In 2023, NJDEP established real-time $PM_{2.5}$ monitors at all $PM_{2.5}$ stations, so that the current air quality from those sites can be reported on the BAM website in real-time.

Establishment of "near road" stations were required as part of the 2010 revisions to the NO_2 NAAQS. The Fort Lee Near Road monitoring station was established to comply with these requirements, for NO_2 and other monitors in large urban areas with high vehicular traffic. These stations, located within 50 meters of a major roadway where peak hourly NO_2 concentrations are expected to occur, measure the relative worst-case population exposures that could occur in the near-road environment.

The Newark Firehouse monitoring station has been part of the USEPA's National Core Multipollutant Monitoring Network (NCore). NCore is a program that integrates several advanced measurement systems for gaseous pollutants, particles, and meteorology. This includes total reactive oxides of nitrogen, NO_y. Unfortunately, the Newark Firehouse station had to be shut down in September of 2022, but BAM has identified a replacement NCore site in Newark, and plans to resume monitoring in 2025.

Other Pollutants

Along with criteria pollutants, the NJDEP also measures "non-criteria pollutants," or pollutants that do not have health-based National Ambient Air Quality Standards. Certain non-criteria pollutants are grouped together by their purpose or collection method.

The Rutgers University monitoring site is part of USEPA's Photochemical Assessment Monitoring Station (PAMS) Program. PAMS measures non-criteria pollutants that are important in the formation of ozone. Since most ozone is not directly emitted from sources but forms in the atmosphere when volatile organic compounds and oxides of nitrogen react in the presence of sunlight, it is important to know the levels of these "precursor" pollutants. In addition, PAMS requires monitoring of NO_y, and various meteorological parameters.

Other non-criteria pollutants monitored by BAM include some commonly emitted by motor vehicles and other combustion sources: benzene, toluene, ethylbenzene, xylenes (measured with a "BTEX" analyzer), and black carbon (measured with an aethalometer).

Four air monitoring stations collect samples of $PM_{2.5}$ that are analyzed to determine the chemical makeup of the particles. These are part of USEPA's Chemical Speciation Network (CSN). This data is used in helping to identify the primary sources of particles, and in assessing potential health effects.

Volatile organic compounds (VOCs) are collected and analyzed at four monitoring sites. These non-criteria pollutants are classified as "air toxics," pollutants that have potential health effects but for which NAAQS have not been established. They can be carcinogenic or have other serious health effects and are very diverse in their chemical composition.

Cattus Island and Washington Crossing are part of the National Atmospheric Deposition Network. BAM staff collect precipitation samples and ship them to a national laboratory for analysis of acids, nutrients, and base cations. Mercury is measured at Elizabeth Lab and Rutgers University.

A few sites within the air monitoring network also take measurements of meteorological parameters, such as temperature, relative humidity, barometric pressure, wind speed, wind direction, rain, and solar radiation.

Figure 2-1 shows the Atlantic City air monitoring station.

CHANGES TO THE NETWORK IN 2023

The most significant change to New Jersey's air monitoring network, in the past few years, was in August 2022. The Newark Firehouse station shut down abruptly. BAM received notice that construction of a new building was about to start next to the Newark Firehouse air monitoring station, and that our equipment would have to be removed as soon as possible. Data collection ended there on September 26, 2022, and the station was subsequently shut down and dismantled. BAM plans to have a new site operational in Newark in 2025.

Figure 2-1
Atlantic City Air Monitoring Station

BAM completed in 2023 the process of establishing continuous $PM_{2.5}$ monitors at all $PM_{2.5}$ monitoring sites. These instruments provide 1-hour data in real-time, which can then be displayed on BAM's air quality website. BAM plans to reduce the of filter-based $PM_{2.5}$ samplers during the next few years to the number required for quality assurance purposes. In 2023, real-time $PM_{2.5}$ monitoring started at Atlantic City, Clarksboro, and Pennsauken. At the end of 2023, filter-based fine particulate monitors were shutdown at Atlantic City, Clarksboro and Pennsauken.

The locations of all the monitoring stations that operated in 2023 are displayed on the map in Figure 2-2. Table 2-1 lists the parameters that were measured at each site. More information about the monitoring stations can be found in Appendix A.

Figure 2-2
New Jersey Air Monitoring Sites in 2023

Table 2-1
2023 New Jersey Air Monitoring Network Parameters

	Monitoring Parameter / Monitoring Station	O_3	$PM_{2.5}$ (Filter-based)	Real-Time $PM_{2.5}$	PM_{10}	NO_2[a]	NO_y	SO_2	CO	Toxics	$PM_{2.5}$-Speciation	O_3 Precursors (PAMS)	BTEX & Black Carbon	Visibility	Acid Deposition	Mercury	Meteorological[b]	Solar Radiation
1	Ancora State Hospital	X																
2	Atlantic City		X[1]	X[2]														
3	Bayonne	X				X		X					X				X	
4	Brigantine	X	X	X				X						X	X[3]			
5	Camden Spruce Street	X	X	X	X	X		X	X	X	X		X				X	
6	Cattus Island														X			
7	Chester	X	X			X		X		X	X							
8	Clarksboro	X	X[1]	X[2]														
9	Colliers Mills	X																
10	Columbia	X		X		X		X									X	
11	Elizabeth							X	X									
12	Elizabeth Lab		X	X		X		X	X	X	X		X			X	X	
13	Flemington	X		X													X	
14	Fort Lee Near Road			X		X			X				X				X	
15	Jersey City					X		X	X									
16	Jersey City Firehouse		X	X	X													
17	Leonia	X																
18	Millville	X		X		X												
19	Monmouth University	X																
20	Paterson			X														
21	Pennsauken		X[1]	X[2]														
22	Rahway			X														
23	Ramapo	X																
24	Rider University	X		X													X	
25	Rutgers University	X	X	X		X	X			X	X	X				X	X	X
26	Toms River			X														
27	Trenton			X														
28	Union City High School			X														
29	Washington Crossing*	X													X			
	TOTAL	16	9	18	2	9	1	8	5	4	4	1	4	1	3	2	8	1

X - Parameter measured in 2023.
[a] - NO_2 usually includes NO and NO_x.
[b] - Meteorological parameters include temperature, relative humidity, barometric pressure, wind direction & wind speed, and rain.
* - This site is part of the Clean Air Status and Trends Network (CASNET) managed by EPA.
[1] - Filter-based $PM_{2.5}$ samplers that were shutdown at the end of 2023.
[2] - Real-Time $PM_{2.5}$ monitors started operating during the year.
[3] - United States Fish and Wildlife Service-Air Quality Branch (USFWS-AQB) is responsible for ACID sample collection.

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2023 Air Quality Index

New Jersey Department of Environmental Protection

What is the Air Quality Index (AQI)?

The Air Quality Index (AQI) is a national air quality rating system based on the National Ambient Air Quality Standards (NAAQS). An index value of 100 is equal to the primary, or health-based, NAAQS for each pollutant. This allows for a comparison of each of the pollutants used in the AQI. These pollutants are ozone (O_3), fine particulate matter ($PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). Although air concentrations of pollutants have been dropping over the past few years, the U.S. Environmental Protection Agency (USEPA) periodically reviews the NAAQS to make sure that they are protective of public health, and adjusts them accordingly in response to new research. The latest NAAQS revision, for ozone, occurred in October 2015.

Every morning an air pollution forecast for the current and following day is prepared by the New Jersey Department of Environmental Protection (NJDEP) using the AQI format. The forecast is provided to USEPA and is disseminated through the Enviroflash system to subscribers who sign up to receive air quality forecast and alert emails or texts (www.enviroflash.info). Anyone can view the forecast and current air quality conditions at USEPA's AirNow website (www.airnow.gov) or at NJDEP's air monitoring webpage (https://dep.nj.gov/airmon).

In an effort to make the AQI easier to understand, a color code and descriptive interpretation are assigned to the numerical ratings (see Table 3-1). Table 3-2 contains suggested actions to take to protect public health for different AQI levels. For more information on the AQI, visit EPA's web site at www.airnow.gov.

Table 3-1
Air Quality Index Levels and Associated Health Impacts

AQI Level of Health Concern	*Numerical Value*	*Meaning*	*Color Code*
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.	**Green**
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	**Yellow**
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	**Orange**
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	**Red**
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.	**Purple**
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.	**Maroon**

Table 3-2
AQI Suggested Actions to Protect Health

Air Quality Index Level	AQI Value Actions to Protect Your Health
Good (1-50)	None
Moderate (51-100)	Unusually sensitive individuals should consider limiting prolonged outdoor exertion.
Unhealthy for Sensitive Groups (101-150)	Children, active adults, and people with respiratory disease such as asthma should limit prolonged outdoor exertion.
Unhealthy (151-200)	Children, active adults, and people with respiratory disease such as asthma should avoid prolonged outdoor exertion: Everyone else should limit prolonged outdoor exertion.
Very Unhealthy (201-300)	Children, active adults, and people with respiratory disease such as asthma should avoid outdoor exertion. Everyone else should limit outdoor exertion.
Hazardous (301-500)	Everyone should avoid all physical activity outdoors.

Table 3-3 shows the pollutant-specific ranges for the AQI categories. These are set according to the corresponding NAAQS.

Table 3-3
AQI Pollutant-Specific Ranges

Category	AQI Level	O_3 (ppm) 8-hour	$PM_{2.5}$ (µg/m^3) 24-hour	NO_2 (ppb) 1-hour	SO_2 (ppb) 1-hour	CO (ppm) 8-hour
Good	0-50	0.000-0.054	0.0-12.0	0-53	0-35	0.0-4.4
Moderate	51-100	0.055-0.070	12.1-35.4	54-100	36-75	4.5-9.4
Unhealthy for Sensitive Groups	101-150	0.071-0.085	35.5-55.4	101-.360	76-185	9.5-12.4
Unhealthy	151- 200	0.086-0.105	55.5-150.4	361-649	186-304	12.5-15.4
Very Unhealthy	201-300	0.106-0.200	150.5-250.4	605-1249	305-604	15.5-30.4
Hazardous	301-500	>0.200	250.5-500.4	1250-2049	605-1004	30.5-1004

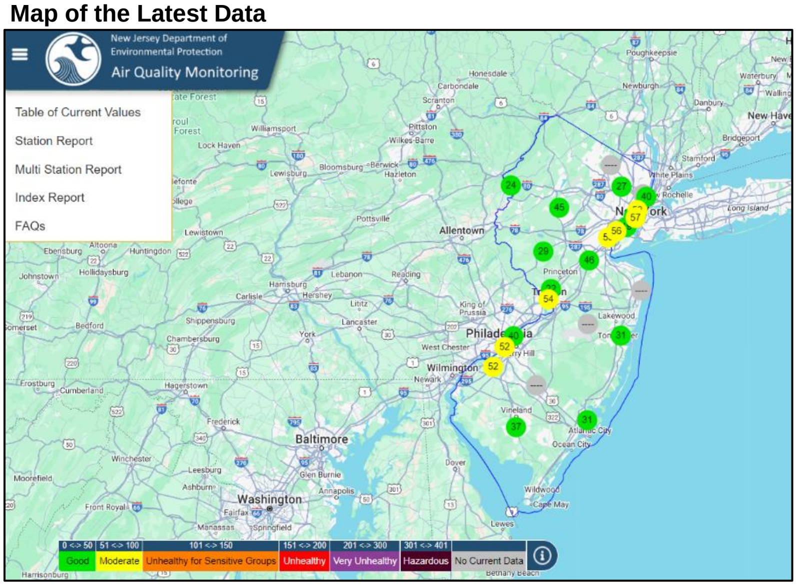
Pollutants:
O_3 – Ozone
$PM_{2.5}$ – Fine particulate matter
NO_2 – Nitrogen dioxide
SO_2 – Sulfur dioxide
CO – Carbon monoxide

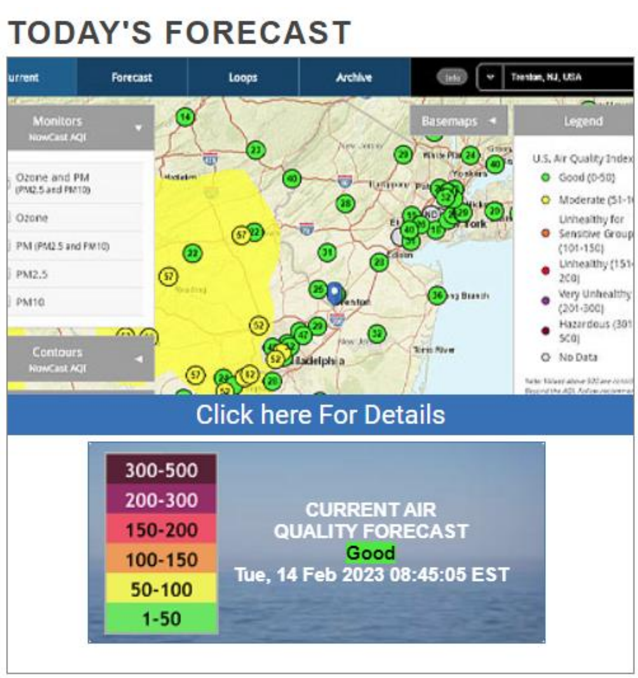
Units:
ppm – parts per million
µg/m^3 – micrograms per cubic meter
ppb – parts per billion

On days when the air quality is expected to reach the "Unhealthy for Sensitive Groups" range or above, cautionary statements similar to those in Tables 3-1 and 3-2 are provided as part of the forecast. These air quality alerts are issued through Enviroflash emails, are displayed on the AirNow and NJDEP air monitoring websites, and can also be viewed on the National Weather Service page for the Philadelphia/Mount Holly area (http://airquality.weather.gov/). Maps, tables, annual trends and other air quality information are also available on the NJDEP air monitoring web site, as shown in Figure 3-1 below.

Figure 3-1
Examples of Information Available on NJDEP's Air Monitoring Website
https://dep.nj.gov/airmon

Map of the Latest Data





2023 New Jersey AQI Summary

Not all of New Jersey's monitoring sites have 365 (or 366) days of reported air quality index values. Certain ozone monitors only operate during "ozone season," from March through October. Also, not all monitoring sites measure all pollutants. Table 3-4 shows which pollutants are used to determine the daily AQI at different monitoring stations.

There is also an ozone monitor at Washington Crossing State Park that is managed by USEPA. Although it is not officially part of the NJDEP network and does not report to the BAM website, its data is included in determining exceedances in New Jersey.

Table 3-4
Pollutants Monitored at Each Air Quality Index Monitoring Site in New Jersey in 2023

	Monitoring Site	Ozone	Fine Particulate Matter	Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide
1	Atlantic City*		√			
2	Ancora State Hospital	√ (s)				
3	Bayonne	√			√	√
4	Brigantine	√	√		√	
5	Camden Spruce St.	√	√	√	√	√
6	Chester	√			√	√
7	Clarksboro**	√ (s)	√			
8	Colliers Mills	√ (s)				
9	Columbia	√	√		√	√
10	Elizabeth			√	√	
11	Elizabeth Lab		√	√	√	√
12	Flemington	√	√			
13	Fort Lee Near Road		√	√		√
14	Jersey City			√	√	√
15	Jersey City Firehouse		√			
16	Leonia	√ (s)				
17	Millville	√	√			√
18	Monmouth University	√ (s)				
19	Paterson		√			
20	Pennsauken***		√			
21	Rahway		√			
22	Ramapo	√ (s)				
23	Rider University	√	√			
24	Rutgers University	√	√			√
25	Toms River		√			
26	Trenton		√			
27	Union City High School		√			

(s) – Seasonal operation only (March 1 through October 31).
*Atlantic City began collecting continuous $PM_{2.5}$ on 7/1/23
**Clarksboro began collecting continuous $PM_{2.5}$ on 9/1/23
***Pennsauken began collecting continuous $PM_{2.5}$ on 7/8/23

A summary of the 2023 AQI ratings for New Jersey is displayed in the pie chart in Figure 3-2 below. In 2023, there were 178 “Good” days (48.8%), 167 “Moderate” days (45.6%), 14 “Unhealthy for Sensitive Groups” days (3.8%), five “Unhealthy” days (1.4%), and one “Very Unhealthy” day (0.3%).

Figure 3-2
2023 Air Quality Summary by Days

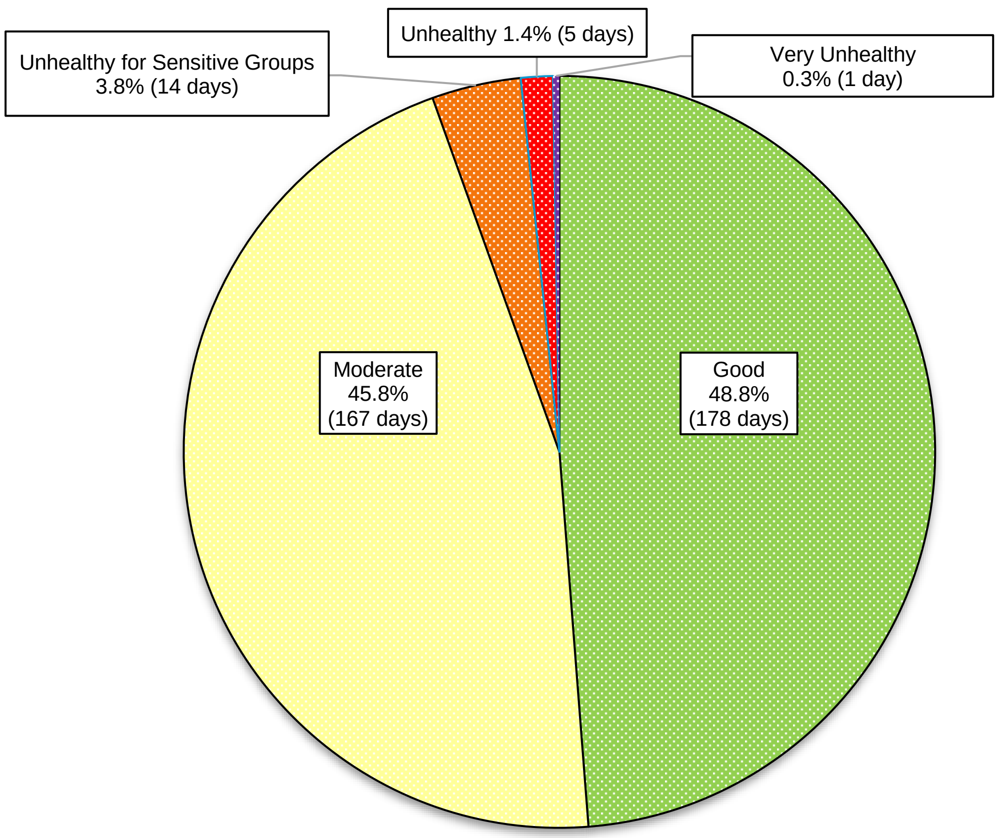


Figure 3-3 shows the distribution of AQI days since 2000. It should be noted that AQI ranges change whenever a NAAQS for a specific pollutant is revised. So even though improvement in AQI days appears to be somewhat erratic, to see how things really have improved, refer to the concentration trend graphs in the individual criteria pollutant reports or in the executive summary.

Figure 3-3
Number of Days in Each AQI Category Since 2000

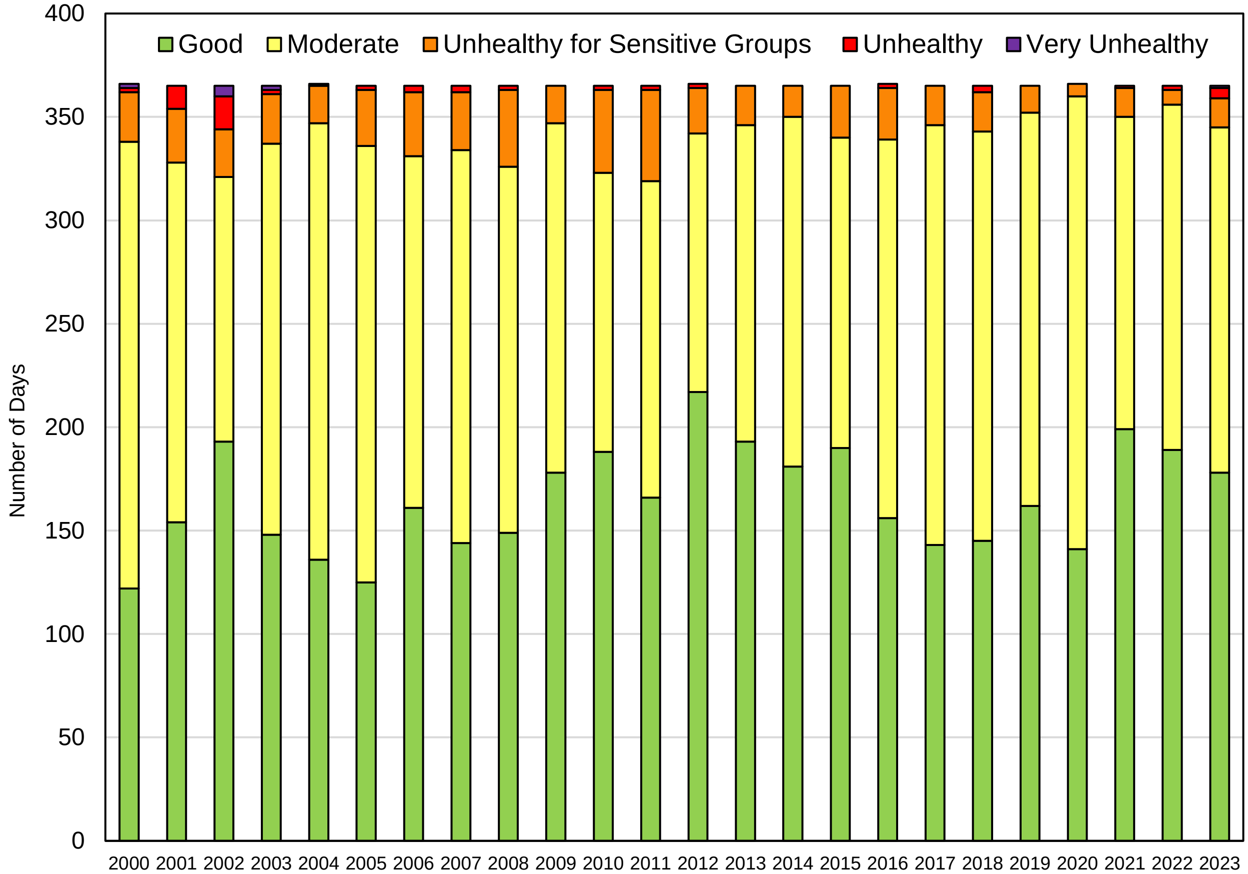


Table 3-5 shows the number of days when the AQI reached or exceeded the “Unhealthy for Sensitive Groups”, “Unhealthy”, OR “Very Unhealthy” threshold at any monitoring location in New Jersey in 2023. Table 3-6 lists the individual exceedance dates and shows the specific pollutants and their locations and concentrations.

Of all the criteria pollutants, ozone is predominantly responsible for AQI days above the moderate range in New Jersey. Exceedances are the result of weather conditions that favor the formation and transport of ozone. Ozone forms when emissions of nitrogen oxides and volatile organic compounds undergo chemical reactions in the presence of sunlight. Additionally, the ozone exceedance on April 13 is attributed to prescribed fires turned wildfire in Flint Hills, Kansas.

Of the six particulate matter exceedance days that are within the AQI threshold of “Unhealthy” and “Very Unhealthy”, five of those days were attributed to wildfires that occurred in Canada. The following dates were directly impacted by wildfires: June 6-8 and June 29-30. In 2023, Canada experienced a record-breaking fire season that resulted in a total-to-date burned area of 7,974,865 hectares by June 28. The severity of this fire season was impacted by an abnormally warm winter, early snowmelt, high summer temperatures, dry conditions, and drought.

Table 3-5
2023 Total Number of NAAQS Exceedance Days in New Jersey

Pollutant	Exceedance Days	USG Days	Unhealthy Days	Very Unhealthy Days
Ozone	17	15	2	---
$PM_{2.5}$	9	4	4	1
Total Individual Days	20	14	5	1

Table 3-6
AQI Days & Sites Over 100 in New Jersey in 2023

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
1	4/13/23*	Chester	O_3	0.071	ppm	USG	101
		Clarksboro	O_3	0.073	ppm	USG	108
		Colliers Mills	O_3	0.075	ppm	USG	115
		Flemington	O_3	0.072	ppm	USG	105
		Monmouth University	O_3	0.071	ppm	USG	101
		Ramapo	O_3	0.071	ppm	USG	101
		Rutgers University	O_3	0.072	ppm	USG	105
		Washington Crossing	O_3	0.071	ppm	USG	101
2	4/14/23	Chester	O_3	0.078	ppm	USG	126
		Flemington	O_3	0.076	ppm	USG	119
		Leonia	O_3	0.071	ppm	USG	101
		Ramapo	O_3	0.078	ppm	USG	126
		Rutgers University	O_3	0.074	ppm	USG	112
		Washington Crossing	O_3	0.072	ppm	USG	105
3	5/12/23	Colliers Mills	O_3	0.072	ppm	USG	105
4	6/1/23	Chester	O_3	0.080	ppm	USG	133
		Flemington	O_3	0.079	ppm	USG	129
		Rutgers University	O_3	0.072	ppm	USG	105
		Millville	$PM_{2.5}$	49.8	µg/m³	USG	136
5	6/2/23**	Camden Spruce Street	O_3	0.081	ppm	USG	136
		Clarksboro	O_3	0.089	ppm	U	159
		Colliers Mills	O_3	0.074	ppm	USG	112
		Leonia	O_3	0.078	ppm	USG	126
		Rider University	O_3	0.098	ppm	U	182
		Rutgers University	O_3	0.092	ppm	U	166
		Brigantine	$PM_{2.5}$	53.1	µg/m³	USG	144

Continued

AQI Days & Sites Over 100 in New Jersey in 2023 (continued)

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
6	6/6/23***	Camden Spruce Street	$PM_{2.5}$	44.3	µg/m3	USG	123
		Elizabeth Lab	$PM_{2.5}$	64.1	µg/m3	U	155
		Flemington	$PM_{2.5}$	58.1	µg/m3	U	152
		Fort Lee Near Road	$PM_{2.5}$	66.5	µg/m3	U	157
		Jersey City Firehouse	$PM_{2.5}$	61.1	µg/m3	U	154
		Paterson	$PM_{2.5}$	66.3	µg/m3	U	157
		Rahway	$PM_{2.5}$	63.5	µg/m3	U	155
		Rider University	$PM_{2.5}$	47.2	µg/m3	USG	130
		Rutgers University	$PM_{2.5}$	55.7	µg/m3	U	151
		Toms River	$PM_{2.5}$	49.4	µg/m3	USG	135
		Union City High School	$PM_{2.5}$	55.4	µg/m3	USG	150
7	6/7/23***	Brigantine	$PM_{2.5}$	124.3	µg/m^3	U	187
		Camden Spruce Street	$PM_{2.5}$	135.9	µg/m^3	U	193
		Columbia	$PM_{2.5}$	120.7	µg/m^3	U	185
		Elizabeth Lab	$PM_{2.5}$	151.5	µg/m^3	VU	202
		Flemington	$PM_{2.5}$	187.1	µg/m^3	VU	237
		Fort Lee Near Road	$PM_{2.5}$	120.6	µg/m^3	U	185
		Jersey City Firehouse	$PM_{2.5}$	127.6	µg/m^3	U	188
		Millville	$PM_{2.5}$	106.4	µg/m^3	U	177
		Paterson	$PM_{2.5}$	123.4	µg/m^3	U	186
		Rahway	$PM_{2.5}$	150.5	µg/m^3	VU	201
		Rider University	$PM_{2.5}$	152.8	µg/m^3	VU	203
		Rutgers University	$PM_{2.5}$	172.1	µg/m^3	VU	222
		Toms River	$PM_{2.5}$	172.7	µg/m^3	VU	223
		Trenton	$PM_{2.5}$	169.3	µg/m^3	VU	220
		Union City High School	$PM_{2.5}$	114.0	µg/m^3	U	181

Continued

AQI Days & Sites Over 100 in New Jersey in 2023 (continued)

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
8	6/8/23***	Brigantine	$PM_{2.5}$	139.8	µg/m^3	U	195
		Camden Spruce Street	$PM_{2.5}$	107.8	µg/m^3	U	178
		Chester	$PM_{2.5}$	54.6	µg/m^3	USG	148
		Clarksboro	$PM_{2.5}$	104.6	µg/m^3	U	176
		Columbia	$PM_{2.5}$	60.1	µg/m^3	U	153
		Elizabeth Lab	$PM_{2.5}$	95.6	µg/m^3	U	172
		Flemington	$PM_{2.5}$	108.8	µg/m^3	U	179
		Fort Lee Near Road	$PM_{2.5}$	73.7	µg/m^3	U	160
		Jersey City Firehouse	$PM_{2.5}$	67.0	µg/m^3	U	157
		Millville	$PM_{2.5}$	128.0	µg/m^3	U	188
		Paterson	$PM_{2.5}$	65.9	µg/m^3	U	156
		Pennsauken	$PM_{2.5}$	88.0	µg/m^3	U	168
		Rahway	$PM_{2.5}$	77.5	µg/m^3	U	162
		Rider University	$PM_{2.5}$	101.5	µg/m^3	U	175
		Rutgers University	$PM_{2.5}$	107.8	µg/m^3	U	178
		Toms River	$PM_{2.5}$	112.6	µg/m^3	U	180
		Trenton	$PM_{2.5}$	89.6	µg/m^3	U	169
		Union City High School	$PM_{2.5}$	63.4	µg/m^3	U	155
9	6/11/23	Flemington	O_3	0.073	ppm	USG	108
		Ramapo	O_3	0.074	ppm	USG	112
10	6/29/23***	Ancora	O_3	0.073	ppm	USG	108
		Camden Spruce Street	O_3	0.071	ppm	USG	101
		Clarksboro	O_3	0.078	ppm	USG	126
		Millville	O_3	0.075	ppm	USG	115
		Brigantine	$PM_{2.5}$	40.5	µg/m^3	USG	113
		Camden Spruce Street	$PM_{2.5}$	60.8	µg/m^3	U	154
		Chester	$PM_{2.5}$	55.6	µg/m^3	U	151
		Clarksboro	$PM_{2.5}$	55.8	µg/m^3	U	151
		Columbia	$PM_{2.5}$	58.6	µg/m^3	U	153
		Elizabeth Lab	$PM_{2.5}$	41.5	µg/m^3	USG	116
		Flemington	$PM_{2.5}$	44.4	µg/m^3	USG	123
		Millville	$PM_{2.5}$	51.8	µg/m^3	USG	141
		Paterson	$PM_{2.5}$	36.2	µg/m^3	USG	103
		Rahway	$PM_{2.5}$	41.8	µg/m^3	USG	117
		Pennsauken	$PM_{2.5}$	56.7	µg/m^3	U	152
		Rider University	$PM_{2.5}$	47.0	µg/m^3	USG	129
		Rutgers University	$PM_{2.5}$	48.2	µg/m^3	USG	132
		Toms River	$PM_{2.5}$	38.0	µg/m^3	USG	107
		Trenton	$PM_{2.5}$	51.9	µg/m^3	USG	141

Continued

AQI Days & Sites Over 100 in New Jersey in 2023 (continued)

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
11	6/30/23***	Bayonne	O_3	0.083	ppm	USG	143
		Camden Spruce Street	O_3	0.078	ppm	USG	126
		Chester	O_3	0.087	ppm	U	154
		Clarksboro	O_3	0.077	ppm	USG	122
		Colliers Mills	O_3	0.073	ppm	USG	108
		Flemington	O_3	0.094	ppm	U	172
		Leonia	O_3	0.087	ppm	U	154
		Millville	O_3	0.072	ppm	USG	105
		Ramapo	O_3	0.078	ppm	USG	126
		Rider University	O_3	0.086	ppm	U	151
		Rutgers University	O_3	0.087	ppm	U	154
		Washington Crossing	O_3	0.089	ppm	U	159
		Brigantine	$PM_{2.5}$	38.0	$\mu g/m^3$	USG	107
		Camden Spruce Street	$PM_{2.5}$	44.3	$\mu g/m^3$	USG	123
		Columbia	$PM_{2.5}$	60.2	$\mu g/m^3$	U	153
		Elizabeth Lab	$PM_{2.5}$	66.1	$\mu g/m^3$	U	156
		Flemington	$PM_{2.5}$	56.4	$\mu g/m^3$	U	151
		Fort Lee Near Road	$PM_{2.5}$	54.0	$\mu g/m^3$	USG	147
		Jersey City Firehouse	$PM_{2.5}$	54.3	$\mu g/m^3$	USG	147
		Millville	$PM_{2.5}$	40.7	$\mu g/m^3$	USG	114
		Rahway	$PM_{2.5}$	62.1	$\mu g/m^3$	U	154
		Rider University	$PM_{2.5}$	63.0	$\mu g/m^3$	U	155
		Rutgers University	$PM_{2.5}$	66.3	$\mu g/m^3$	U	157
		Toms River	$PM_{2.5}$	42.2	$\mu g/m^3$	USG	117
		Trenton	$PM_{2.5}$	60.3	$\mu g/m^3$	U	153
		Union City High School	$PM_{2.5}$	54.3	$\mu g/m^3$	USG	147
12	7/1/23	Leonia	O_3	0.071	ppm	USG	101
		Columbia	$PM_{2.5}$	39.0	$\mu g/m^3$	USG	110
13	7/5/23	Bayonne	O_3	0.081	ppm	USG	136
		Leonia	O_3	0.071	ppm	USG	101
		Rutgers University	O_3	0.075	ppm	USG	115
		Jersey City Firehouse	$PM_{2.5}$	41.5	$\mu g/m^3$	USG	116
		Union City High School	$PM_{2.5}$	39.6	$\mu g/m^3$	USG	111
14	7/11/23	Clarksboro	O_3	0.071	ppm	USG	101
15	7/12/23	Clarksboro	O_3	0.074	ppm	USG	112
		Colliers Mills	O_3	0.075	ppm	USG	115

Continued

AQI Days & Sites Over 100 in New Jersey in 2023 (continued)

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
16	7/20/23	Flemington	O_3	0.071	ppm	USG	101
		Washington Crossing	O_3	0.074	ppm	USG	112
17	7/26/23	Leonia	O_3	0.071	ppm	USG	101
		Rider University	O_3	0.078	ppm	USG	126
		Rutgers University	O_3	0.077	ppm	USG	122
18	8/21/23	Clarksboro	O_3	0.073	ppm	USG	108
19	9/5/23	Camden Spruce Street	O_3	0.071	ppm	USG	101
		Monmouth University	O_3	0.082	ppm	USG	140
20	9/6/23	Monmouth University	O_3	0.078	ppm	USG	126

Continued

*This ozone exceedance day is attributable to wildfires in Flint Hills, Kansas.
**This ozone exceedance day is attributable to multiple wildfires in northwestern Canada.
***These particulate matter exceedance days are attributed to wildfires in Quebec, Canada.

For more information and details about these exceedances caused by wildfires, please refer to NJDEP's exceptional event (EE) demonstration analyses for ozone and particulate matter.

Rating
USG = Unhealthy for Sensitive Groups
U = Unhealthy

Pollutants
O_3 – Ozone
$PM_{2.5}$ – Fine particulate matter

Units
ppm – parts per million
µg/m^3 - micrograms per cubic meter

References

American Lung Association. *Air Quality Index: Using Air Quality information to Protect Yourself from Outdoor Air Pollution*. http://www.lung.org/our-initiatives/healthy-air/outdoor/air-pollution/air-quality-index.html. Accessed 5/31/2023.

U.S. Environmental Protection Agency (USEPA) Air Now. *Air Quality Index.* https://www.airnow.gov/aqi/ Accessed 5/31/2023.

USEPA Office of Air Quality Planning and Standards. Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI). September 2018. EPA-454/B-18-007. https://www.airnow.gov/publications/air-quality-index/technical-assistance-document-for-reporting-the-daily-aqi/.

"Appendix G to Part 58 - Uniform Air Quality Index (AQI) and Daily Reporting." Title 40 *Code of Federal Regulations*. https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=3b421c7ca640647158c90279e577c578&mc=true&n=pt40.6.58&r=PART&ty=HTML#ap40.6.58_161.g. Accessed 5/20/23.

New Jersey Department of Environmental Protection, Bureau of Evaluation and Planning. *Exceptional Events (EE) Dashboard.* https://dep.nj.gov/airplanning/exceptional-events/. Accessed 11/22/24.

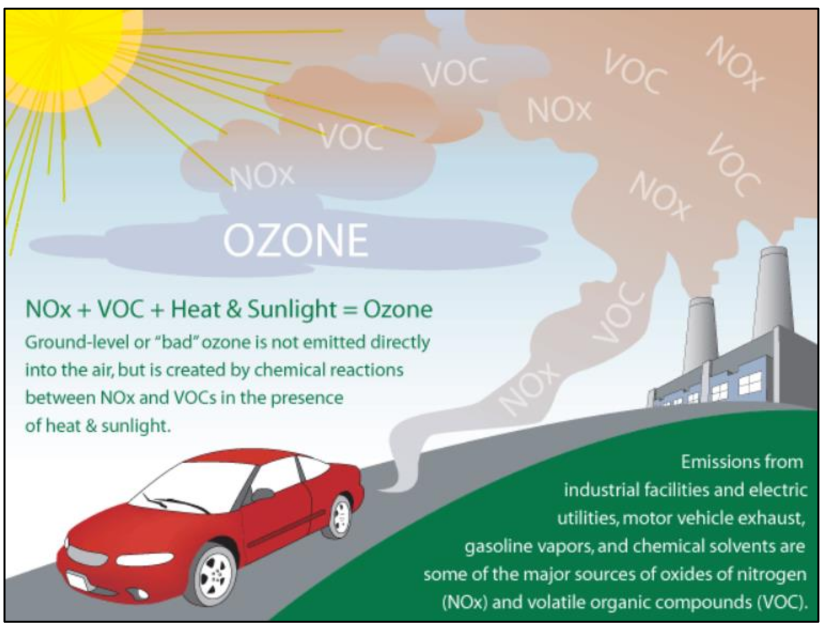
2023 Ozone Summary

New Jersey Department of Environmental Protection

SOURCES

Ozone (O_3) is a gas consisting of three oxygen atoms. It occurs naturally in the upper atmosphere (stratospheric ozone) where it protects us from harmful ultraviolet rays. However, at ground-level (tropospheric ozone), it is considered an air pollutant and can have serious adverse health effects. Ground-level ozone is created when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight (see Figure 4-1). NO_x is primarily emitted by motor vehicles, power plants, and other sources of combustion. VOCs are emitted from sources such as motor vehicles, chemical plants, factories, consumer and commercial products, and even natural sources such as trees. The pollutants that form ozone, referred to as "precursor" pollutants, and ozone itself can also be transported into an area from sources hundreds of miles upwind.

Figure 4-1
Ozone Formation



https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#wwh

Since ground-level ozone needs sunlight to form, it is mainly a problem in the daytime during the summer months. The U.S. Environmental Protection Agency (USEPA) requires New Jersey to monitor ozone from March 1st to October 31st, the so-called "ozone season." However, weather patterns have a significant effect on ozone formation, and hot dry summers will result in higher levels than cool wet ones. Figures 4-2 and 4-3 show the effect of sunlight on ambient ozone concentrations. In 2023, the highest monthly average and maximum hourly values occurred in June. The highest daily and maximum 1-hour averages occurred after 3 p.m.

Figure 4-2
2023 Ozone Concentrations in New Jersey
Monthly Variation of Statewide Hourly Averages
Parts per Million (ppm)

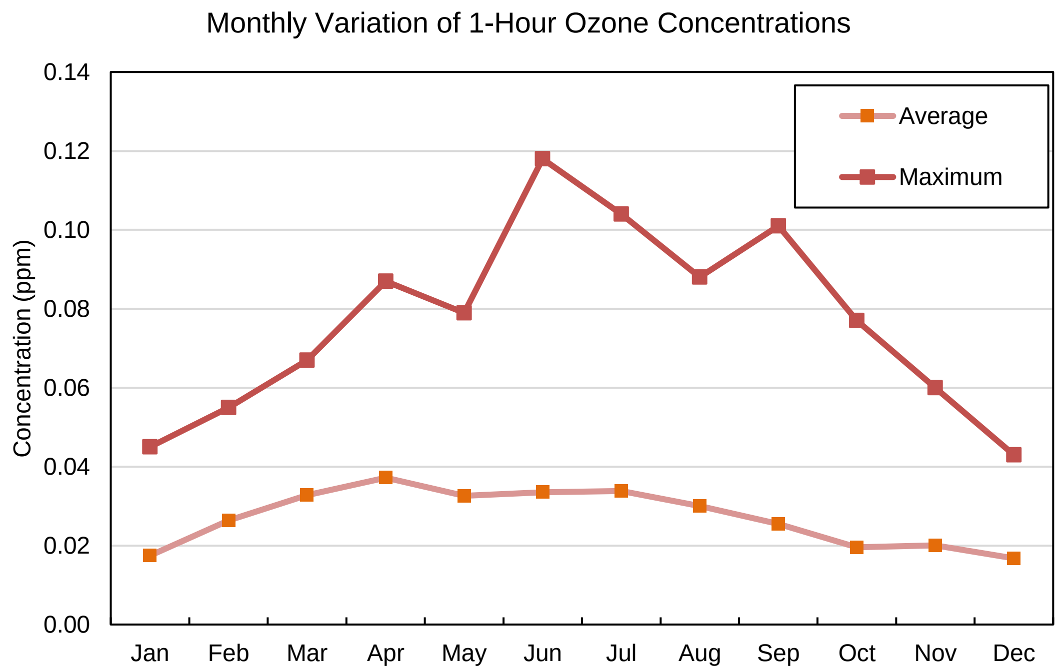


Figure 4-3
2023 Ozone Concentrations in New Jersey
Daily Variation of Statewide Hourly Averages, March through October
Parts per Million (ppm)

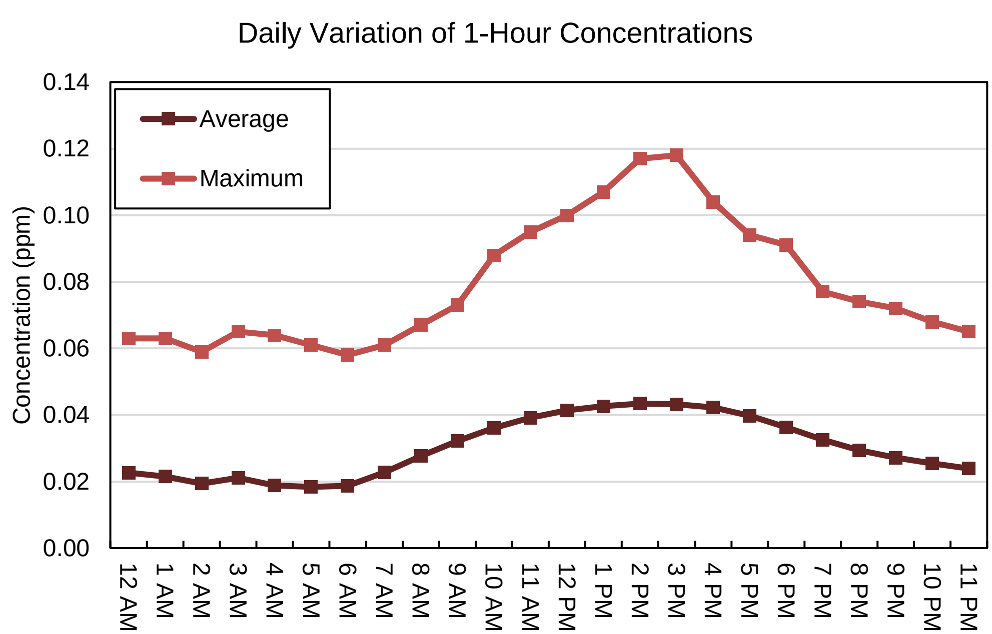
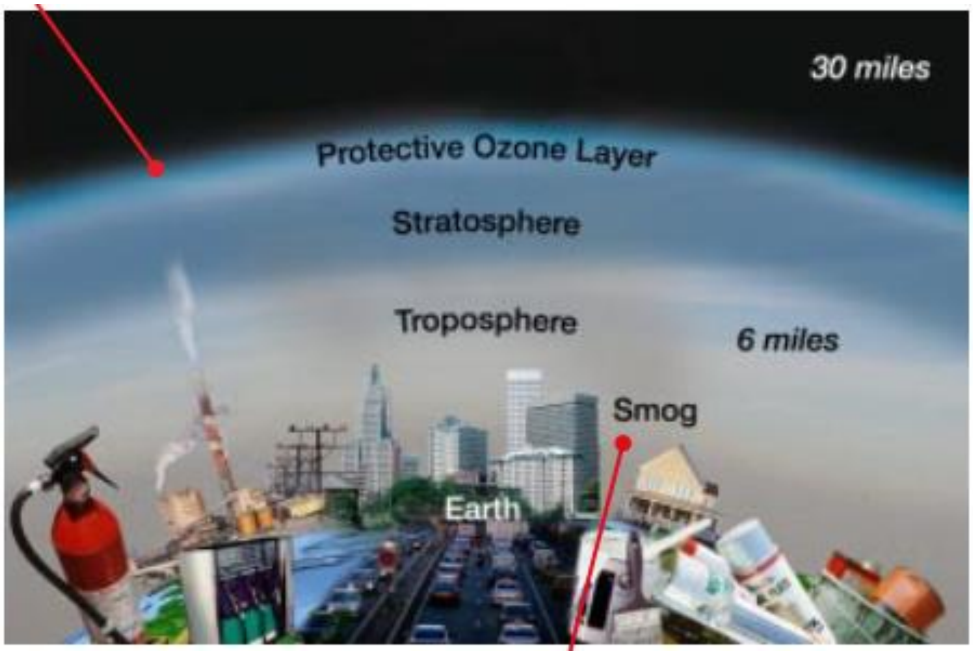


Figure 4-4 explains the difference between ozone in the upper and lower atmosphere. For more information, refer to the USEPA publication, "Good Up High, Bad Nearby – What is Ozone?"

Figure 4-4. Good and Bad Ozone

Ozone is good up here…Many popular consumer products like air conditioners and refrigerators involve CFCs or halons during either manufacturing or use. Over time, these chemicals damage the earth's protective ozone layer.



Ozone is bad down here…Cars, trucks, power plants and factories all emit air pollution that forms ground-level ozone.

https://www.epa.gov/sites/production/files/documents/gooduphigh.pdf

HEALTH AND ENVIRONMENTAL EFFECTS

Ozone can irritate the entire respiratory tract. Repeated exposure to ozone pollution may cause permanent damage to the lungs. Even when ozone is present at low levels, inhaling it can trigger a variety of health problems including chest pains, coughing, nausea, throat irritation, and congestion. Ozone also can aggravate other medical conditions such as bronchitis, heart disease, emphysema, and asthma, and can reduce lung capacity. People with pre-existing respiratory ailments are especially prone to the effects of ozone. For example, asthmatics affected by ozone may have more frequent or severe attacks during periods when ozone levels are high. Children are at special risk for ozone-related problems. They breathe more air per pound of body weight than adults, and ozone can impact the development of their immature respiratory systems. They tend to be active outdoors during the summer when ozone levels are at their highest. Anyone who spends time outdoors in the summer can be affected, and studies have shown that even healthy adults can experience difficulty in breathing when exposed to ozone. Anyone engaged in strenuous outdoor activities, such as jogging, should limit activity to the early morning or late evening hours on days when ozone levels are expected to be high.

Ground-level ozone damages plant life, and a recent study (see below) estimated that it is responsible for about $1 billion in reduced crop yield in the U.S. each year. It interferes with the ability of plants to produce and store food, making them more susceptible to harsh weather, disease, insects, and other pollutants. It damages the foliage of trees and other plants, sometimes marring the landscape of cities, national parks and forests, and recreation areas. For more information see: https://coe.northeastern.edu/news/research-reveals-air-pollution-costs-us-estimated-1b-a-year-in-perennial-crop-yield/.

Ambient Air Quality Standards

National and state air quality standards for ground-level ozone were first promulgated in 1971. There are both primary standards, which are set to provide public health protection (including protecting the health of sensitive populations such as asthmatics, children, and the elderly), and secondary standards, which are based on welfare effects (such as damage to trees, crops and materials). For ground-level ozone, the primary and secondary National Ambient Air Quality Standards (NAAQS) are the same (see Table 4-1). The USEPA must periodically review the NAAQS to determine if they are sufficiently protective of public health based on the latest studies. Initially, the ozone NAAQS was an hourly average of 0.12 ppm, established in 1979. It has since been revoked by USEPA, although New Jersey retains it as a primary state standard. In 1997, the 0.08 parts per million (ppm) ozone NAAQS was promulgated, based on the daily maximum 8-hour average concentration. It was changed to 0.075 ppm in 2008. In October 2015 the 8-hour ozone NAAQS was lowered once again, to 0.070 ppm, effective in 2016.

Compliance with a NAAQS is based on meeting the design value, the actual statistic that determines whether the standard is being met. For ozone, calculating the design value is a two-step process using data from the most recent three years. The first step involves determining the annual fourth-highest daily maximum 8-hour average concentration for each monitoring site in the state for each of the three years. The design value for 2023 is the 3-year average of the annual 4th highest daily maximum 8-hour averages from 2021, 2022 and 2023. The ozone NAAQS is met when the design value is less than or equal to 0.070 ppm.

Table 4-1
National and New Jersey Ambient Air Quality Standards for Ozone
Parts per Million (ppm)

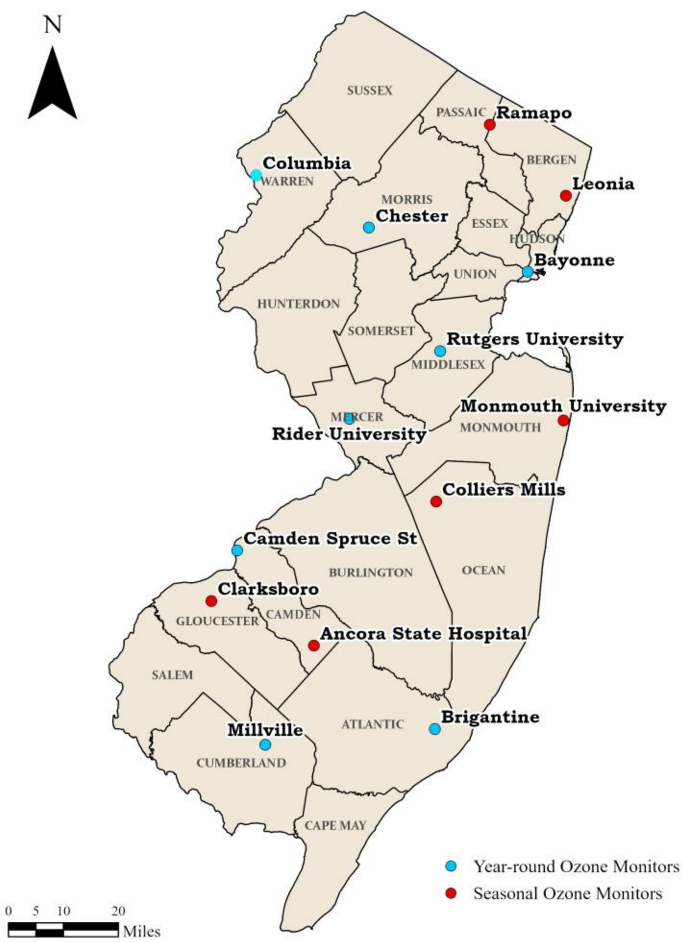
Averaging Period	Type	National Level	New Jersey Level	Design Value
1-Hour	Primary	---	0.12 ppm	Annual 2nd-highest daily maximum
8-Hours	Primary & secondary	0.070 ppm	---	3-year average of the annual 4th-highest daily maximum 8-hour average concentrations

Ozone Monitoring Network

The New Jersey Department of Environmental Protection operated 15 monitoring stations in New Jersey during 2023 (see Figure 4-5). Of those 15 sites, nine operate year-round and six operate only during the ozone season, which is March 1st through October 31st. Bayonne, Brigantine, Camden Spruce Street, Chester, Columbia, Flemington, Millville, Rider University and Rutgers University operate year-round. The Ancora, Clarksboro, Colliers Mills, Leonia, Monmouth University, and Ramapo sites operate only during the ozone season. The Newark Firehouse monitoring station was shut down in September of 2022 and therefore did not have data for the 2023 ozone season. The NJDEP has identified a replacement for the Newark Firehouse station and plans to resume ozone monitoring in 2025.

There is an ozone monitor at Washington Crossing State Park in Mercer County which is maintained and operated by USEPA. The site is included when determining New Jersey's NAAQS compliance status, although the data is not presented here. It can be obtained from USEPA at https://www.epa.gov/outdoor-air-quality-data.

Figure 4-5
2023 Ozone Monitoring Network



Ozone Levels in 2023

The 2023 ozone season had seventeen days on which the NAAQS (daily maximum 8-hour average concentration of 0.070 ppm) was exceeded, as shown in Table 4-2. Thirteen monitoring sites recorded levels above the standard at least once. Clarksboro and Rutgers University had the most exceedances (seven), followed by Flemington and Leonia (six) and Colliers Mills (five). Camden, Chester, and Ramapo all had four exceedances while Millville, Monmouth University, and Rider University had three, Bayonne had two and Ancora had one. Brigantine and Columbia had no exceedances in 2023. The "Unhealthy" Air Quality Index (AQI) level was exceeded in 2023 on both June 2nd at Clarksboro, Rider University, and Rutgers University and June 30th at Chester, Flemington, Leonia, Rider University, and Rutgers University. For details, see the Air Quality Index section of this air quality report.

Table 4-2
2023 Exceedances of the O_3 NAAQS

Day	Date	Site	Daily Maximum 8-Hour Average Concentration (ppm)	AQI Rating
1	4/13/2023	Chester	0.071	USG
		Clarksboro	0.073	USG
		Colliers Mills	0.075	USG
		Flemington	0.072	USG
		Monmouth University	0.071	USG
		Ramapo	0.071	USG
		Rutgers University	0.071	USG
2	4/14/2023	Chester	0.078	USG
		Flemington	0.076	USG
		Leonia	0.071	USG
		Ramapo	0.078	USG
		Rutgers University	0.074	USG
3	5/12/2023	Colliers Mills	0.072	USG
4	6/1/2023	Chester	0.080	USG
		Flemington	0.079	USG
		Rutgers University	0.072	USG
5	6/2/2023	Camden Spruce Street	0.081	USG
		Clarksboro	0.089	U
		Colliers Mills	0.074	USG
		Leonia	0.078	USG
		Rider University	0.098	U
		Rutgers University	0.092	U
6	6/11/2023	Flemington	0.073	USG
		Ramapo	0.074	USG
7	6/29/2023	Ancora	0.073	USG
		Camden Spruce Street	0.071	USG
		Clarksboro	0.078	USG
		Millville	0.075	USG

AQI = Air Quality Index
USG = Unhealthy for Sensitive Groups
U = Unhealthy

Table 4-2
2023 Exceedances of the O_3 NAAQS (cont.)

Day	Date	Site	Daily Maximum 8-Hour Average Concentration (ppm)	AQI Rating
8	6/30/2023	Bayonne	0.083	USG
		Camden Spruce Street	0.078	USG
		Chester	0.087	U
		Clarksboro	0.077	USG
		Colliers Mills	0.073	USG
		Flemington	0.094	U
		Leonia	0.087	U
		Millville	0.072	USG
		Ramapo	0.078	USG
		Rider University	0.086	U
		Rutgers University	0.087	U
9	7/1/2023	Leonia	0.071	USG
10	7/5/2023	Bayonne	0.081	USG
		Leonia	0.071	USG
		Rutgers University	0.085	USG
11	7/11/2023	Clarksboro	0.071	USG
12	7/12/2023	Clarksboro	0.074	USG
		Colliers Mills	0.075	USG
13	7/20/2023	Flemington	0.071	USG
14	7/26/2023	Leonia	0.071	USG
		Rider University	0.078	USG
		Rutgers University	0.077	USG
15	8/21/2023	Clarksboro	0.073	USG
16	9/5/2023	Camden Spruce Street	0.071	USG
		Monmouth University	0.082	USG
17	9/6/2023	Monmouth University	0.078	USG

AQI = Air Quality Index
USG = Unhealthy for Sensitive Groups
U = Unhealthy

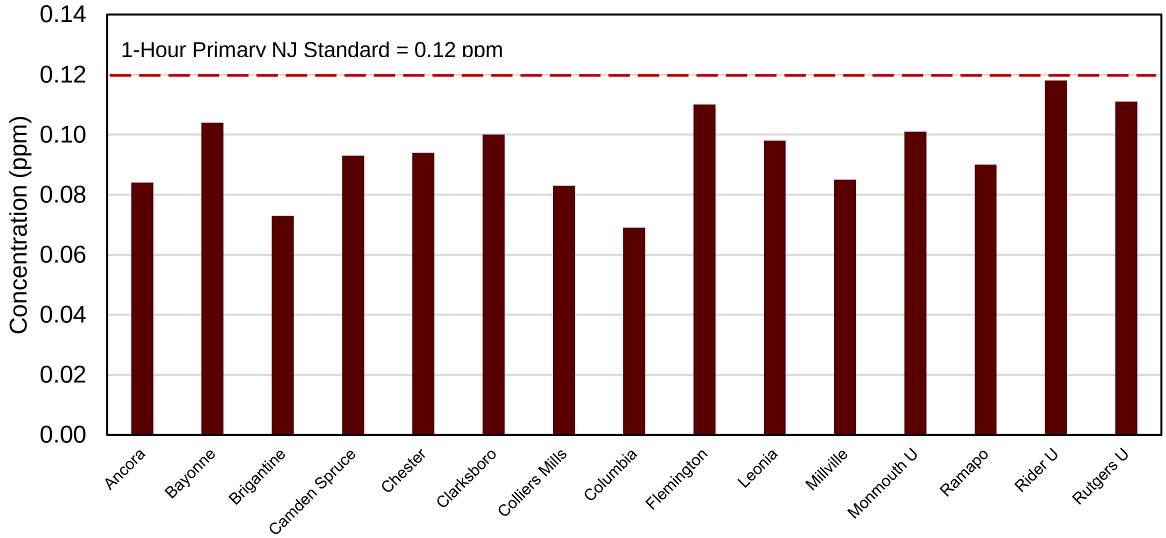
Table 4-3 presents a summary of the 2023 ozone data for the fifteen monitoring sites operated by NJDEP as they pertain to the 1-hour NJAAQS the and 8-hour ozone NAAQS. The table includes the highest and 2nd highest daily maximum 1-hour ozone concentrations for each monitor, and the highest and the 4th highest daily maximum 8-hour concentrations, and the 3-year average of the annual 4th highest daily maximum 8-hour averages in 2021, 2022 and 2023 (the 2023 design value) for each ozone monitor.

Table 4-3
2023 Ozone Concentrations in New Jersey
Parts per Million (ppm)

Monitoring Site	1-Hour Averages		8-Hour Averages		
	Highest Daily Maximum	2nd Highest Daily Maximum	Highest Daily Maximum	4th-Highest Daily Maximum	3-Year (2021-2023) Average of 4th-Highest Daily Max.
Ancora	0.084	0.079	0.073	0.067	0.063
Bayonne	0.104	0.096	0.083	0.068	0.067
Brigantine	0.073	0.069	0.067	0.058	0.059
Camden Spruce St.	0.093	0.086	0.081	0.071	0.067
Chester	0.094	0.088	0.087	0.071	0.065
Clarksboro	0.100	0.088	0.089	0.074	0.070
Colliers Mills	0.083	0.081	0.075	0.073	0.070
Columbia	0.069	0.066	0.063	0.054	0.058
Flemington	0.110	0.087	0.094	0.073	0.067
Leonia	0.098	0.093	0.087	0.071	0.070
Millville	0.085	0.078	0.075	0.068	0.065
Monmouth University	0.101	0.095	0.082	0.070	0.070
Ramapo	0.090	0.086	0.078	0.071	0.063
Rider University	0.118	0.100	0.098	0.070	0.069
Rutgers University	0.111	0.100	0.092	0.075	0.071

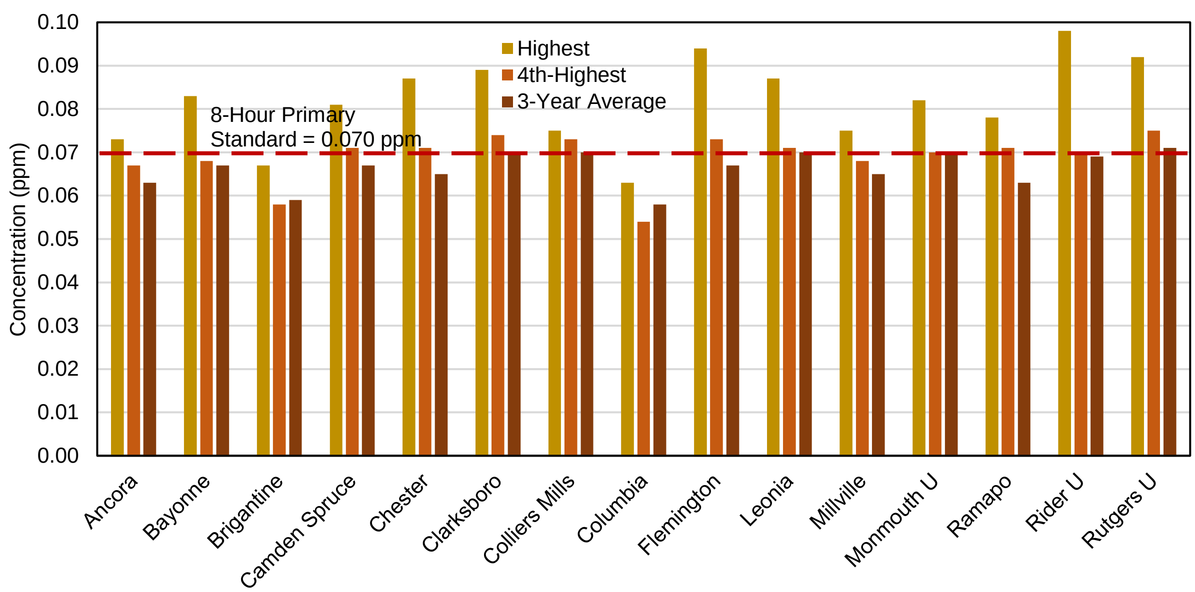
No site recorded levels above the New Jersey 1-hour standard of 0.12 ppm. The highest daily maximum 1-hour concentration was 0.118 ppm, recorded at Rider University on June 2nd, and the highest 2nd highest was 0.100 measured at both Rider University and Rutgers University. The 1-hour standard was most recently exceeded in 2018. Figure 4-6 shows the highest daily maximum one-hour averages for each site.

Figure 4-6
2023 Ozone Concentrations in New Jersey
Highest Daily Maximum 1-Hour Averages



The highest daily maximum 8-hour average concentration was 0.098 ppm, recorded at Rider University on July 26. The 4th-highest daily maximum 8-hour value (0.075 ppm) was measured at Rutgers University. The design value (3-year average of the annual 4th highest daily maximum 8-hour averages) at Rutgers University in 2023 was 0.071 ppm which is above the level of the NAAQS. Figure 4-7 shows the highest, and 4th highest daily maximum 8-hour values for each site, and their design values.

Figure 4-7
2023 Ozone Concentrations in New Jersey
Highest, 4th-Highest, and 3-Year Average of 4th Highest Daily Maximum 8-Hour Averages
Parts per Million (ppm)



Ozone Trends

Studies have shown that to decrease ground-level ozone concentrations, emissions of VOCs and NOx must be reduced. Over the past couple of decades, emissions reductions have resulted in a relatively steady lowering of ozone levels in New Jersey. The chart in Figure 4-8 shows the maximum value from all NJDEP air monitoring stations of the annual 4th highest daily maximum 8-hour average concentration and the maximum ozone design value from all NJDEP stations for each year since 1997. The data for Figure 4-8 can be found in Table 4-4.

Figure 4-9 shows the total number days the 8-hour average ozone NAAQS was exceeded in New Jersey since 2000.

Figure 4-8
Statewide New Jersey Ozone Trends, 1997-2023
Maximum 4th-Highest Daily Maximum 8-Hour Averages and
Maximum 3-Year Average of 4th Highest Daily Maximum 8-Hour Averages (Design Value)
Parts per Million (ppm)

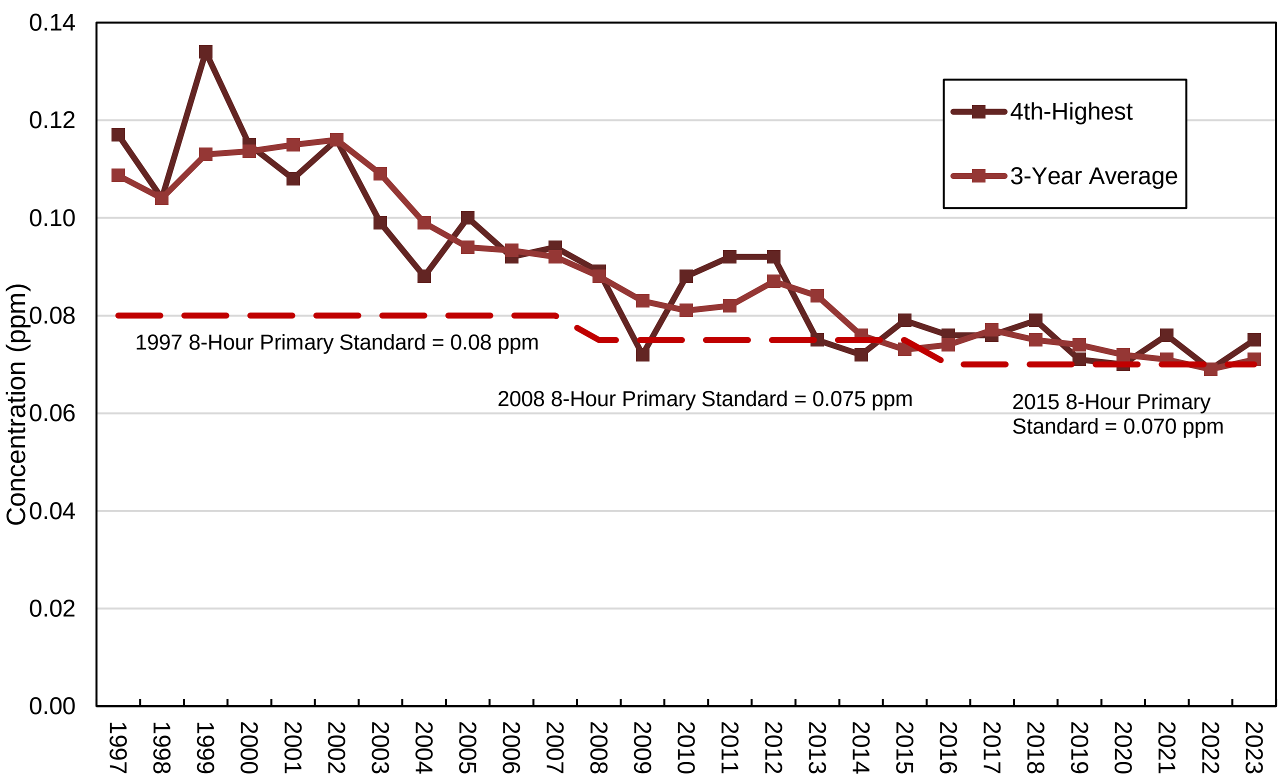
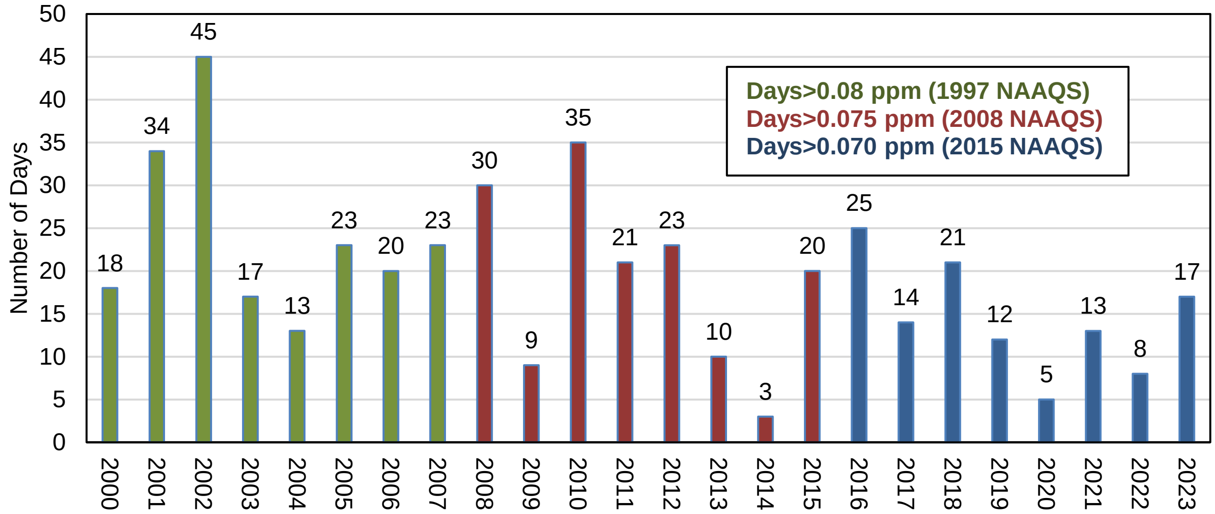


Table 4-4
Statewide New Jersey Ozone Trends, 1997-2023
Maximum 4th Highest Daily Maximum 8-Hour Averages and
Maximum 3-Year Average of 4th Highest Daily Maximum 8-Hour Averages (Design Value)
Parts per Million (ppm)

Year	Maximum 4th-Highest Daily Maximum 8-Hour Average	Maximum 3-Year Average of 4th-Highest Daily Maximum 8-Hour Average
1997	0.117	0.109
1998	0.104	0.104
1999	0.134	0.113
2000	0.115	0.114
2001	0.108	0.115
2002	0.116	0.116
2003	0.099	0.109
2004	0.088	0.099
2005	0.100	0.094
2006	0.092	0.093
2007	0.094	0.092
2008	0.089	0.088
2009	0.072	0.083
2010	0.088	0.081
2011	0.092	0.082
2012	0.092	0.087
2013	0.075	0.084
2014	0.072	0.076
2015	0.079	0.073
2016	0.076	0.074
2017	0.076	0.077
2018	0.079	0.075
2019	0.071	0.074
2020	0.070	0.072
2021	0.076	0.071
2022	0.069	0.070
2023	0.075	0.071

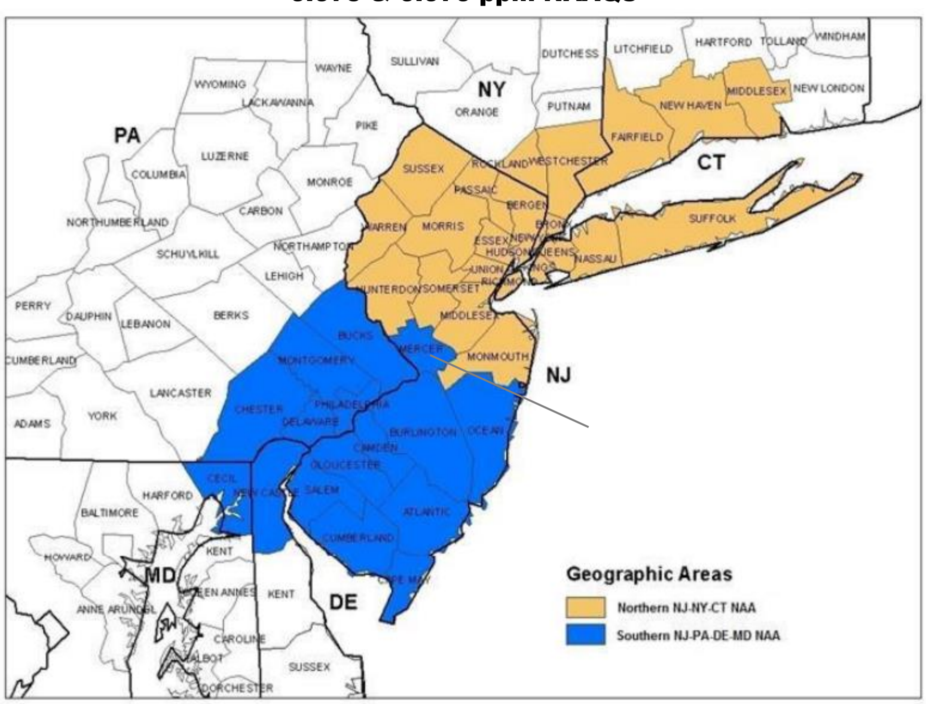
Figure 4-9
Number of Days 8-Hour Ozone NAAQS was Exceeded in New Jersey, 2000-2023



Ozone Nonattainment Areas in New Jersey

The Clean Air Act requires that all areas of the country be evaluated for attainment or nonattainment of each of the NAAQS. The entire state of New Jersey is designated as nonattainment for the ozone NAAQS, but in two separate sections that extend into neighboring states. New Jersey's nonattainment areas for the 2008 (0.075 ppm) and 2015 (0.070 ppm) 8-hour standards are shown in Figure 4-10.

Figure 4-10
New Jersey 8-Hour Ozone Nonattainment Areas (NAA)
0.075 & 0.070 ppm NAAQS



Source: NJDEP. State Implementation Plan (SIP) Revision for the Attainment and Maintenance of the Ozone NAAQS

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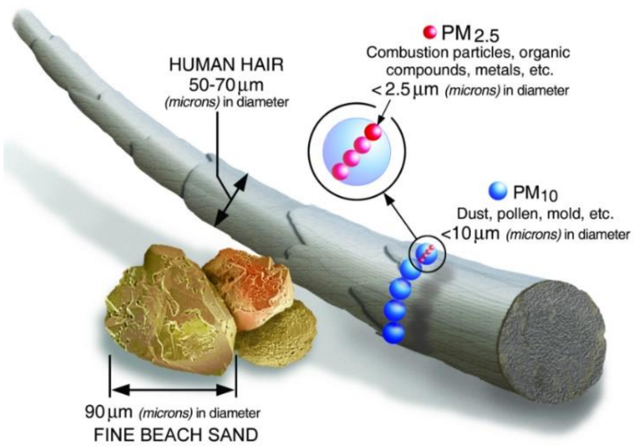
2023 Particulate Matter Summary

New Jersey Department of Environmental Protection

Figure 5-1
Size Comparisons for PM



USEPA. www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM

Sources

Particulate air pollution is a complex mixture of organic and inorganic substances in the atmosphere, occurring 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}. "Total suspended particulate" (TSP) refers to all suspended particulates, including the largest ones.

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. New Jersey has one Class I area listed under the Regional Haze Program. The program seeks to improve and protect visibility and air quality in specially designated areas such as national parks and wilderness areas. New Jersey's Class I site is the Brigantine wilderness area, located within the Edwin B. Forsythe National Wildlife Refuge. A visibility camera (www.hazecam.net) is located there. Airborne particles can also impact vegetation and aquatic ecosystems, and can cause damage to paints and building materials.

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, and an annual standard was set at 50 µg/m^3 (it was revoked in 2010).

In 1997, 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 3-year average of each site's annual average concentrations. For the 24-hour NAAQS, the annual 98th percentile of the 24-hour concentrations for each monitoring site must be averaged for the three most recent years. The maximum design value from all the sites is the state's design value. For PM_{10}, the design value is the second-highest 24-hour average concentration for 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	Design Value
Fine Particulate ($PM_{2.5}$)	Annual	Primary	12.0 µg/m^3	3-year average of the annual average $PM_{2.5}$ concentrations
	Annual	Secondary	15.0 µg/m^3	3-year average of the annual average $PM_{2.5}$ concentrations
	24-Hours	Primary & Secondary	35 µg/m^3	3-year average of the annual 98th percentile 24-hour average $PM_{2.5}$ concentrations
Inhalable Particulate (PM_{10})	24-Hours	Primary & Secondary	150 µg/m^3	Annual 2nd-highest 24-hour average PM_{10} concentration

Particulate Monitoring Network

Criteria pollutant monitors must meet strict USEPA requirements to determine compliance with the NAAQS. To measure ambient particulate matter, the New Jersey Department of Environmental Protection (NJDEP) uses two different approaches: a filter-based method, and continuous beta attenuation.

Filter-based samplers 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. It requires daily to weekly visits to pick up and replace filters.

New Jersey also uses 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 also be used to determine compliance with the NAAQS. These monitors provide real-time hourly PM data, which is available to the public on the NJDEP air monitoring website, https://dep.nj.gov/airmon/.

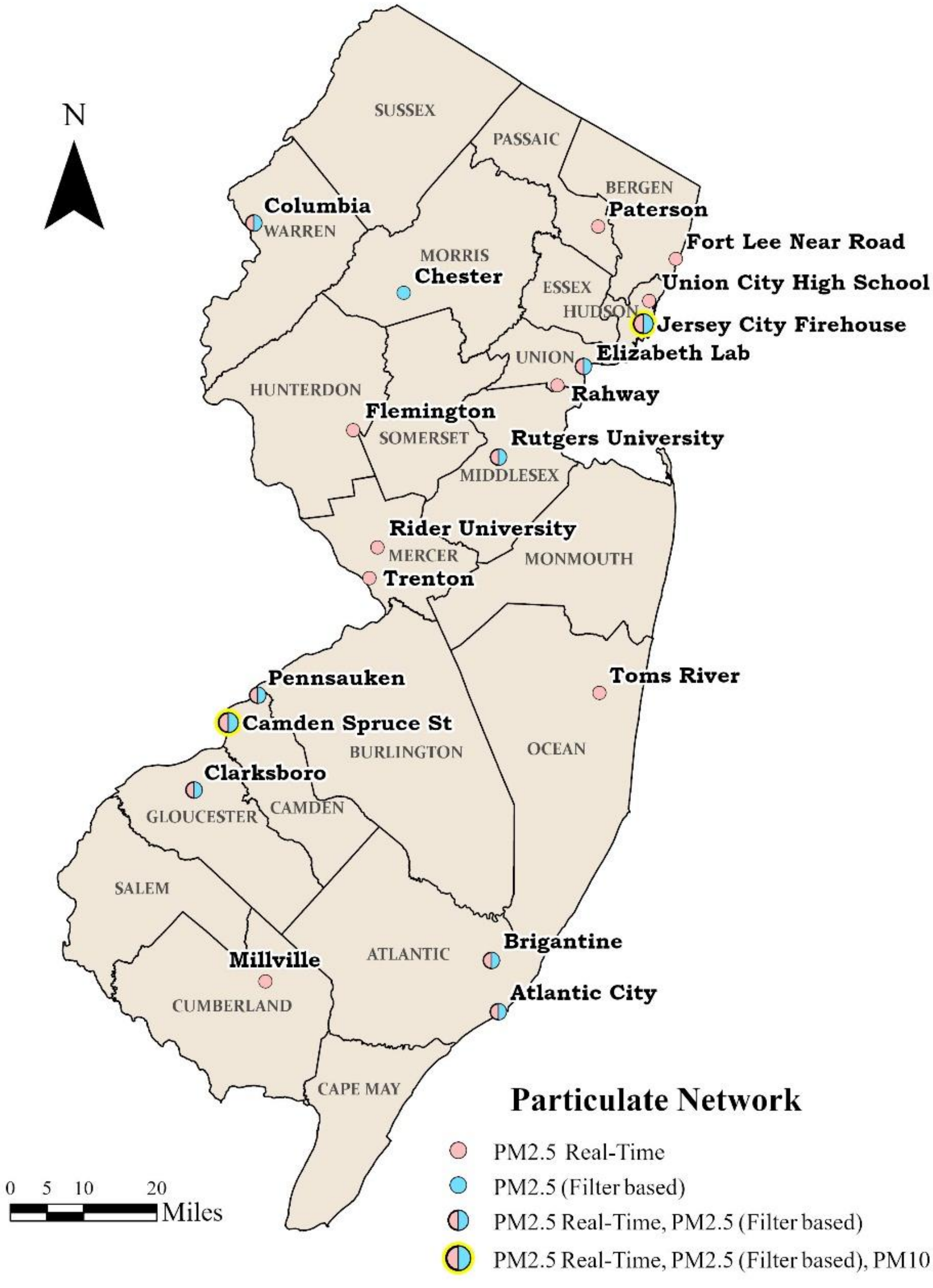
For 2023, NJDEP had nineteen $PM_{2.5}$ monitoring sites around the state. There are nine filter-based monitors and 18 continuous monitors. Eight sites have both. In 2023, continuous $PM_{2.5}$ monitors started at Atlantic City and Pennsauken in July, and at Clarksboro in September. The NJDEP shut down the $PM_{2.5}$ and PM_{10} monitors at the Newark Firehouse monitoring station in September 2022 after being required to vacate the property for construction. The NJDEP has identified a replacement for the Newark Firehouse station and plans to resume $PM_{2.5}$ and PM_{10} monitoring in 2025.

At one time, NJDEP had more than twenty PM_{10} sampling sites. After many years of low concentrations and the shift in emphasis to $PM_{2.5}$ monitoring, two sites remain. Currently, PM_{10} samples are taken once every six days at Camden and Jersey City.

There are four monitoring stations that are part of the national Chemical Speciation Network (CSN). They use separate 24-hour filter-based $PM_{2.5}$ samplers to determine the concentrations of the chemical analytes that make up the particles. Teflon filters are analyzed for 33 elements, nylon filters are analyzed for ions, and quartz filters are analyzed for carbon. CSN monitoring takes place at the Camden Spruce Street, Chester, Elizabeth Lab, Newark Firehouse and Rutgers University monitoring stations. New Jersey's 2023 CSN data can be found in Appendix B of the Air Quality Report.

Figure 5-2 shows the locations of all the particulate monitors in New Jersey.

Figure 5-2
2023 Particulate Monitoring Network



FINE PARTICLE ($PM_{2.5}$) LEVELS IN 2023

$PM_{2.5}$ LEVELS FOR FILTER-BASED MONITORS

In 2023, there were no exceedances of the 12.0 μg/m³ annual average $PM_{2.5}$ NAAQS. However, there were 7 days (a total of 22 collected filters) during which the $PM_{2.5}$ concentrations exceeded the 35 μg/m³ 24-hour average $PM_{2.5}$ NAAQS. This was mainly due to smoke from record-breaking Canadian wildfires that occurred during the months of June and July. Despite these exceedances, none of the monitoring stations measured an annual 98th percentile 24-hour average $PM_{2.5}$ concentration that exceeded 35 μg/m³.

The annual mean concentrations of $PM_{2.5}$ measured at the nine filter-based samplers ranged from 6.9 μg/m³ at the Chester monitoring station, to 10.4 μg/m³ at the Camden Spruce St. monitoring station. The highest 24-hour concentrations ranged from 45.0 μg/m³ at the Brigantine monitoring station to 138.8 μg/m³ at the Elizabeth Lab monitoring station. Table 5-2 shows the annual average, highest and 98th-percentile 24-hour concentrations, as well as the number of valid samples collected. The data is also shown graphically in Figures 5-3 and 5-4. Two sites (Elizabeth Lab, Jersey City Firehouse) sample $PM_{2.5}$ every day. The other seven sites (Atlantic City, Brigantine, Camden Spruce Street, Chester, Clarksboro, Pennsauken and Rutgers University) take a sample every third day, resulting in about 122 samples per year.

Table 5-2
2023 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages for Filter-Based Monitors
Micrograms Per Cubic Meter (μg/m³)

Monitoring Site	Number of Samples	Annual Average	24-Hour Average	
			Highest	98th%-ile
Atlantic City	110	7.0	28.1	17.5
Brigantine	111	7.0	45.0	25.0
Camden Spruce St.	117	10.4	95.3	27.0
Chester	112	6.9	55.6	29.1
Clarksboro	111	8.6	104.6	19.2
Elizabeth Lab	346	9.6	138.8	26.9
Jersey City Firehouse	328	9.2	127.6	31.2
Pennsauken	119	8.6	88.0	21.2
Rutgers University	120	7.7	67.8	23.2

Figure 5-3
2023 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages for Filter-Based Monitors
Micrograms Per Cubic Meter (µg/m³)

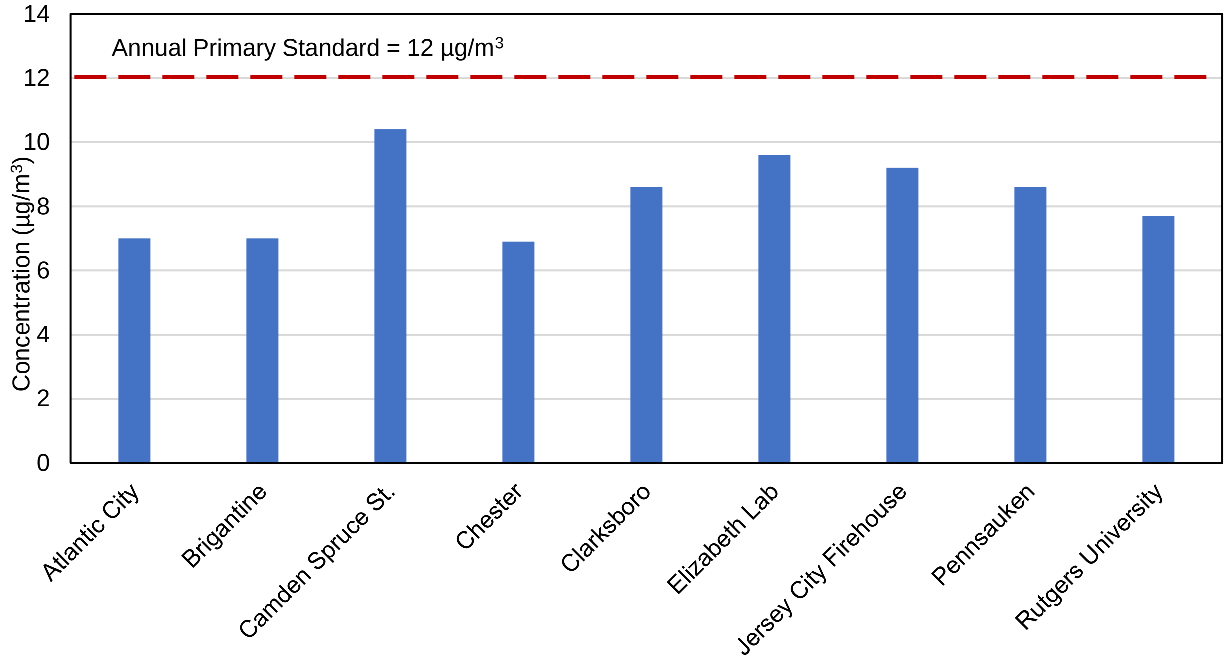
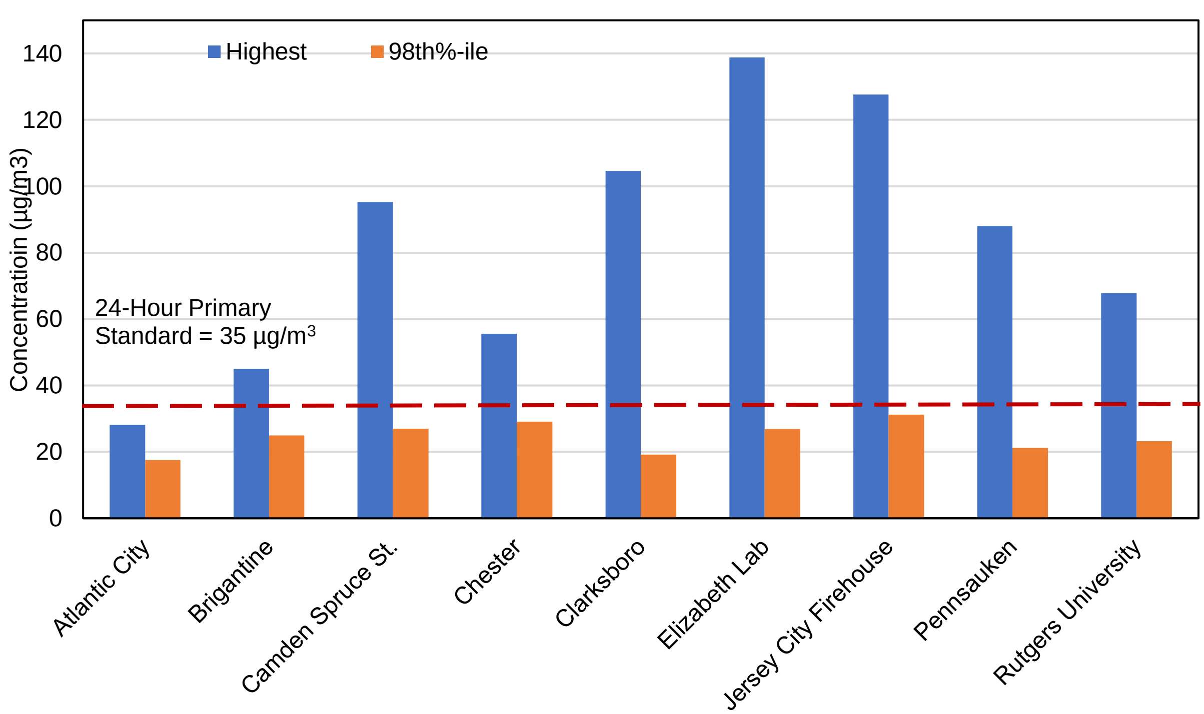


Figure 5-4
2023 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages for Filter-Based Monitors
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ LEVELS FOR CONTINUOUS MONITORS

In 2023, New Jersey had continuous $PM_{2.5}$ monitors at eighteen sites: Atlantic City, Brigantine, Camden Spruce Street, Columbia, Clarksboro, Elizabeth Lab, Flemington, Fort Lee Near Road, Jersey City Firehouse, Millville, Paterson, Pennsauken, Rahway, Rider University, Rutgers University, Toms River, Trenton and Union City. Real-time $PM_{2.5}$ readings are transmitted to a central computer in Trenton, where they are averaged every hour and reported on the NJDEP website at https://dep.nj.gov/airmon/.

Table 5-3 presents the annual average, highest 24-hour average, and annual 98th percentile 24-hour average $PM_{2.5}$ concentrations from these sites for 2023. Figures 5-5 and 5-6 show the same data displayed as figures. In 2023, there were no exceedances of the 12.0 $\mu g/m^3$ annual average NAAQS. There were however 9 days during which the $PM_{2.5}$ concentrations exceeded the 24-hour average standard of 35 $\mu g/m^3$. The highest concentrations were measured on June 7 when seven air monitoring stations recorded 24-hour averaged $PM_{2.5}$ concentrations greater than 150 $\mu g/m^3$, or a rating of Very Unhealthy in the Air Quality Index (AQI). This is attributed to smoke from record-breaking Canadian forest fires during the months of June and July. Despite these high concentrations, none of the monitors measured an annual 98th percentile 24-hour average concentration that exceeded of 35 $\mu g/m^3$.

Table 5-3
2023 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Average Concentrations for Continuous Monitors
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Annual Average	24-Hour Average	
		Highest	98th-%ile
Atlantic City*	7.2	24.4	17.5
Brigantine	8.2	139.8	27.9
Camden Spruce Street	10.8	135.9	26.2
Columbia	8.8	120.7	20.0
Clarksboro*	6.5	19.2	16.6
Elizabeth Lab	11.7	151.5	31.4
Flemington	9.2	187.1	23.7
Fort Lee Near Road	10.2	120.6	31.7
Jersey City Firehouse	8.6	110.4	27.7
Millville	8.3	128.0	24.0
Paterson	8.5	123.4	27.0
Pennsauken*	7.2	23.4	20.1
Rahway*	9.2	150.5	28.7
Rider University	9.8	152.8	26.3
Rutgers University	9.4	172.1	28.2
Toms River	8.5	172.7	28.2
Trenton	10.0	169.3	26.3
Union City	7.8	114.0	28.6

*Monitor did not operate for a complete year.

Figure 5-5
2023 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages for Continuous Monitors
Micrograms Per Cubic Meter (µg/m^3)

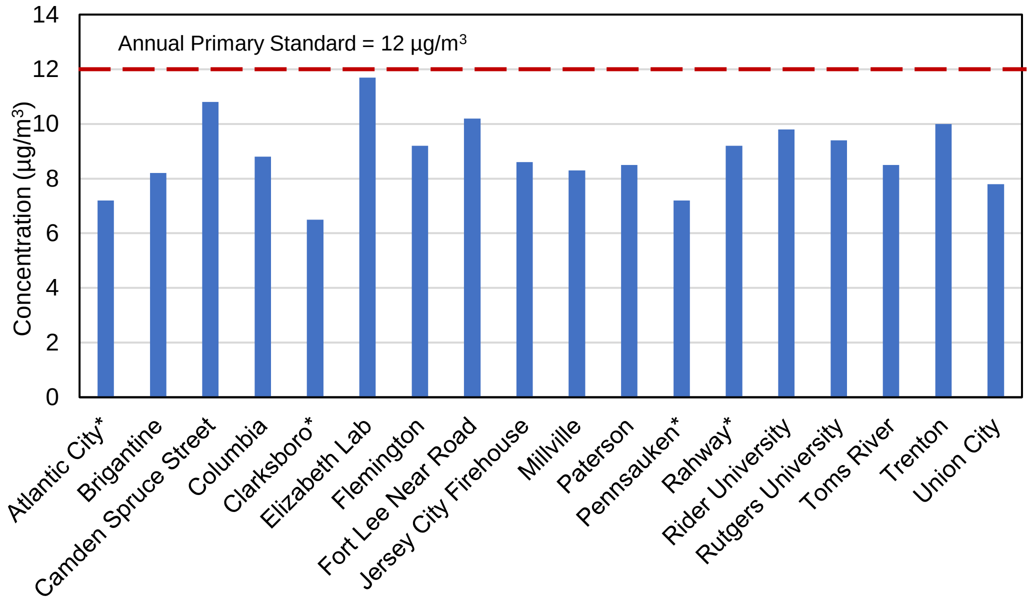
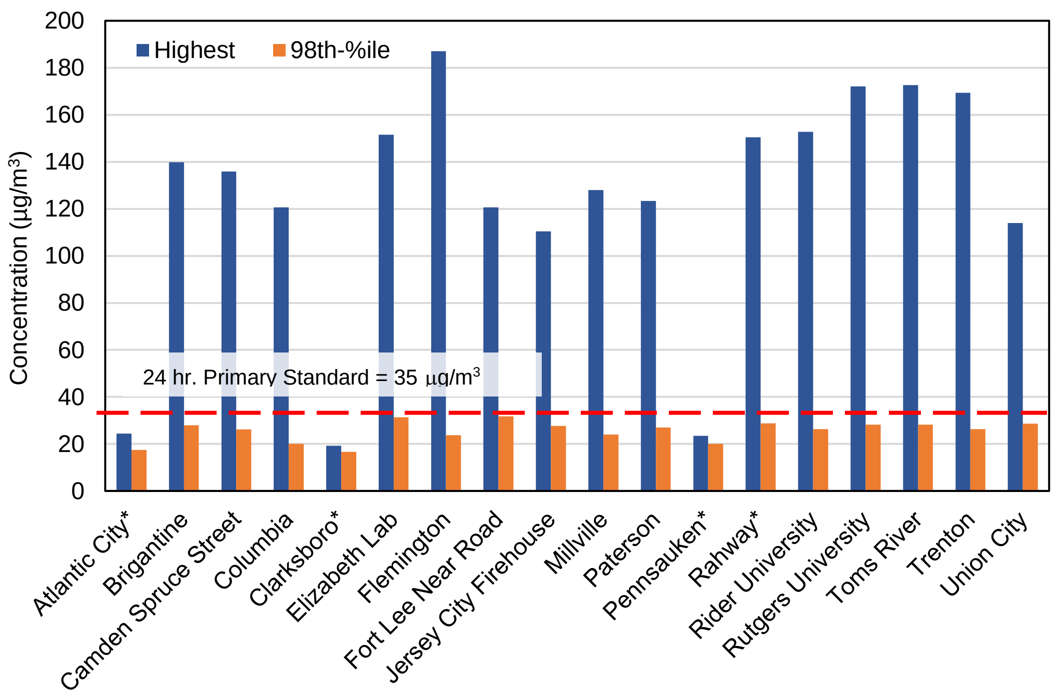


Figure 5-6
2023 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages for Continuous Monitors
Micrograms Per Cubic Meter (µg/m^3)



*Monitor did not operate for a complete year

2023 $PM_{2.5}$ DESIGN VALUES

For $PM_{2.5}$ monitoring sites that have both a filter-based monitor and a continuous monitor, the data from both monitors are used by EPA to calculate all monitoring sites' annual average $PM_{2.5}$ concentrations, the annual 98th percentile 24-hour average $PM_{2.5}$ concentrations and their respective 3-year average design values. The EPA also applies completeness and quality assurance criteria on both data sets to determine the validity of each monitoring site's design values. Monitoring sites with incomplete data are determined to have invalid design values, and these are marked with an asterisk in the table and figures below.

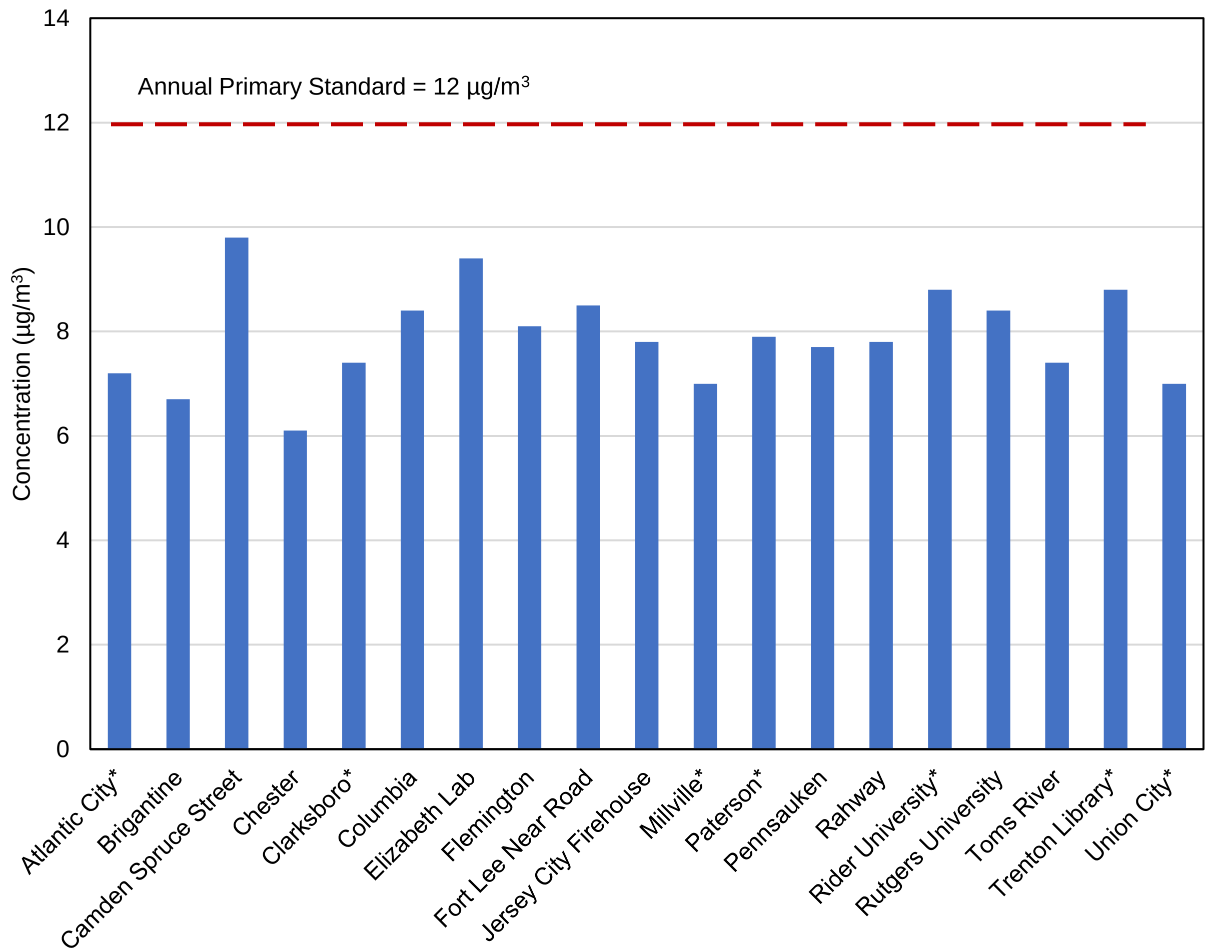
Table 5-4 and Figures 5-7 and 5-8 show USEPA's calculated $PM_{2.5}$ 2023 design values for each of the New Jersey monitors. All of New Jersey's $PM_{2.5}$ monitoring sites in 2023 have design values that are below the levels of the annual average and 24-hour average NAAQS.

Table 5-4
New Jersey $PM_{2.5}$ Design Values for 2021-2023
3-Year Average of the Annual Average $PM_{2.5}$ Concentrations &
3-Year Average of 98th Percentile 24-Hour Average $PM_{2.5}$ Concentrations
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	3-Year (2021-2023) Average	
	Annual	98th Percentile 24-Hour
Atlantic City*	7.2	18
Brigantine	6.7	18
Camden Spruce Street	9.8	23
Chester	6.1	20
Clarksboro*	7.4	17
Columbia	8.4	22
Elizabeth Lab	9.4	23
Flemington	8.1	20
Fort Lee Near Road	8.5	24
Jersey City Firehouse	7.8	21
Millville*	7.0	19
Paterson*	7.9	22
Pennsauken	7.7	19
Rahway	7.8	21
Rider University*	8.8	21
Rutgers University	8.4	21
Toms River	7.4	19
Trenton Library*	8.8	21
Union City*	7.0	22

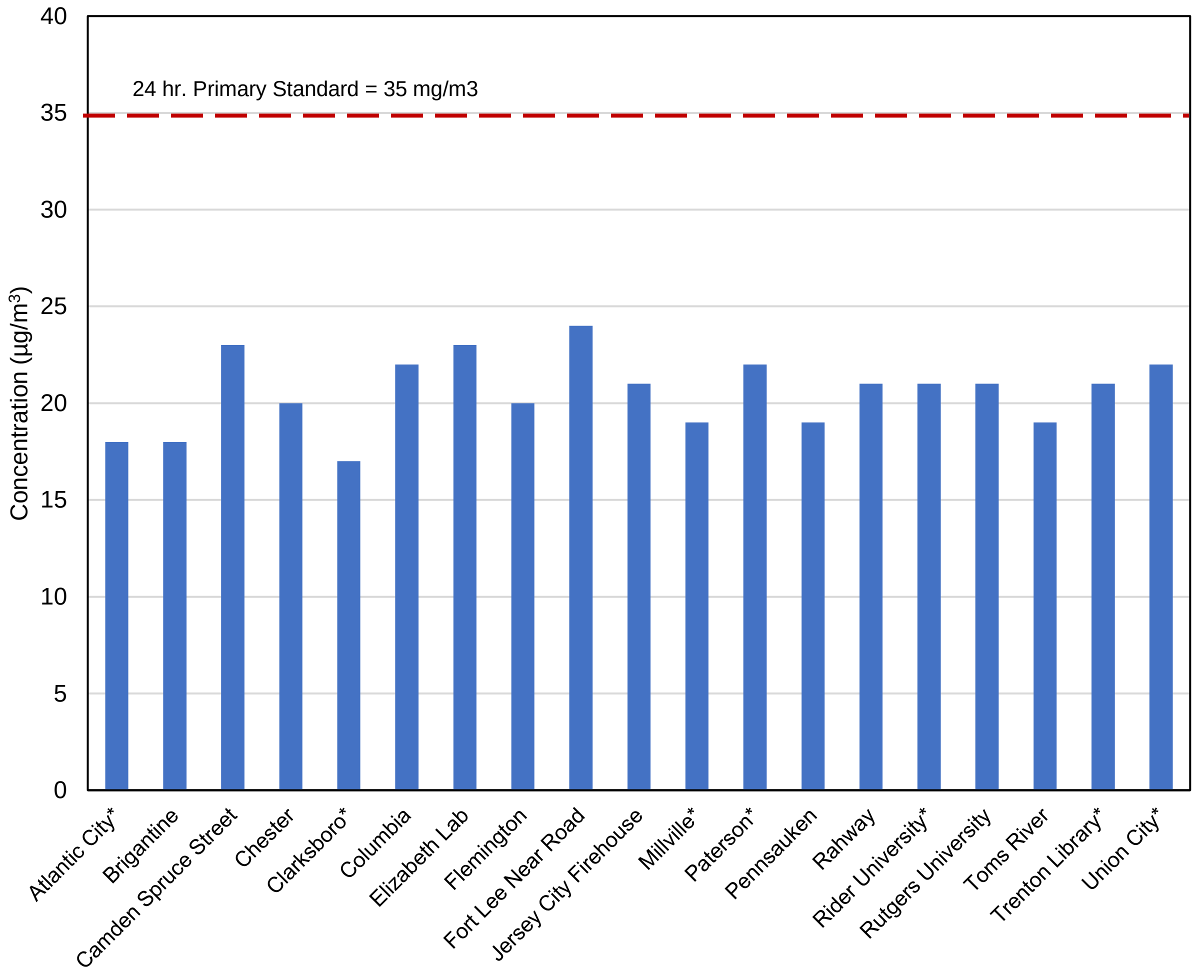
*Monitor did not operate for a complete 3-year period, and design value does not meet EPA requirements for a valid $PM_{2.5}$ design value

Figure 5-7
New Jersey $PM_{2.5}$ Design Values for 2021-2023
3-Year Average of the Annual Average Concentrations
Micrograms Per Cubic Meter (µg/m³)



*Monitor did not operate for a complete 3-year period, and design value does not meet EPA requirements for comparison to the PM2.5 NAAQS.

Figure 5-8
New Jersey $PM_{2.5}$ Design Values for 2021-2023
3-Year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms Per Cubic Meter ($\mu g/m^3$)



*Monitor did not operate for a complete 3-year period, and design value does not meet EPA requirements for comparison to the PM2.5 NAAQS.

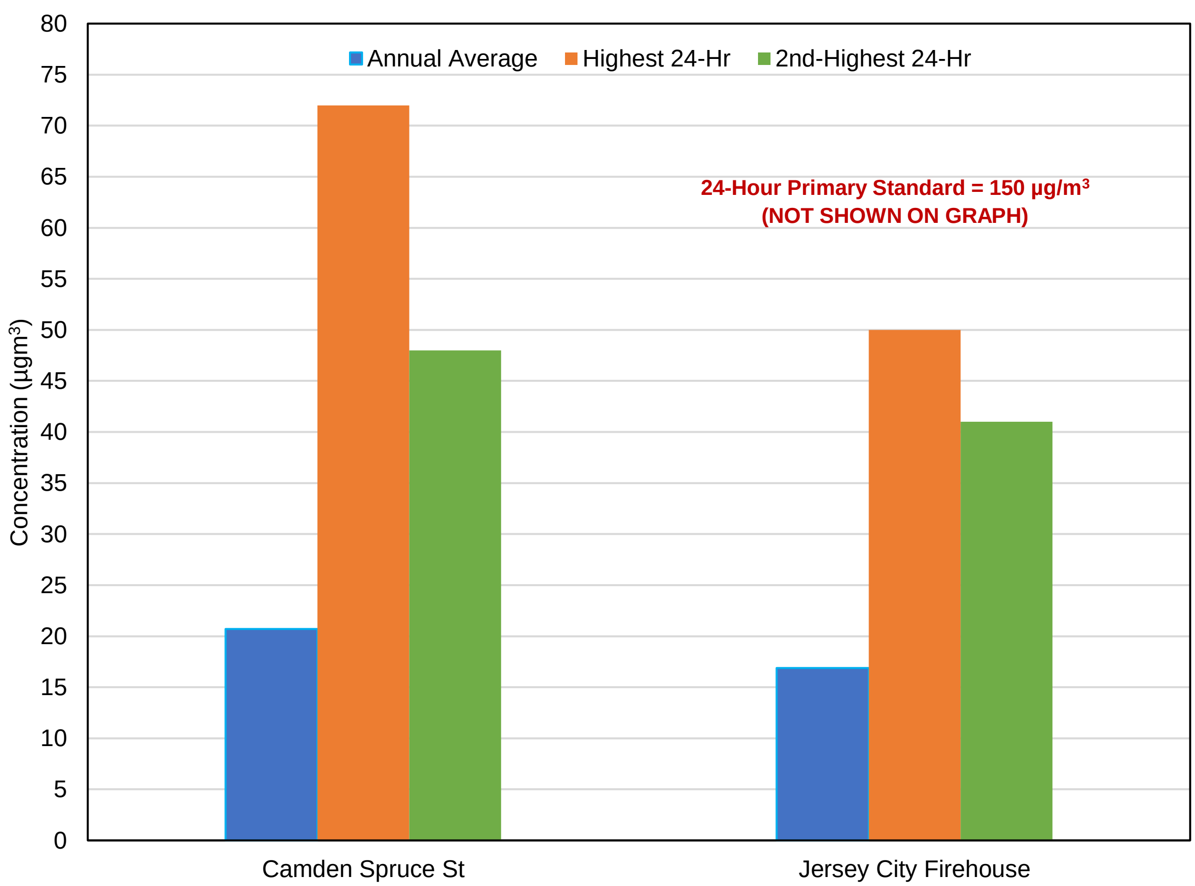
INHALABLE PARTICULATE (PM_{10}) LEVELS IN 2023

Table 5-5 presents 2023 data for each of the New Jersey PM_{10} monitors. The highest and second-highest 24-hour average concentrations are shown, as well as the annual averages. All areas of the state are in attainment for the 24-hour average standard of 150 μg/m³, as can be seen in Figure 5-9. The standard is based on the second-highest 24-hour average concentration.

Table 5-5
2023 PM_{10} Concentrations in New Jersey
Annual and 24-Hour Averages
Micrograms Per Cubic Meter (μg/m³)

Monitoring Site	Number of Samples	Annual Average*	24-Hour Average	
			Highest	Second-Highest
Camden Spruce Street	58	20.7	72	48
Jersey City Firehouse	58	16.9	50	41

Figure 5-9
2023 PM_{10} Concentrations in New Jersey
Annual and 24-Hour Averages
Micrograms per Cubic Meter (μg/m³)



PARTICULATE TRENDS

The $PM_{2.5}$ monitoring network was established in New Jersey in 1999. Figure 5-10 shows the maximum value from all NJDEP air monitoring stations of the annual average PM2.5 concentrations and the maximum design value (the 3-year average of the annual averages) for each year since 2001, as well as changes to the NAAQS. Figure 5-11 shows the maximum value from all NJDEP air monitoring stations of the annual 98th Percentile PM2.5 24-hour average concentrations and the maximum design value (the 3-year average of the annual 98th percentile PM2.5 24-hour averages) for each year since 2001, as well as changes to the NAAQS.

The data from 2001 to 2022 show a noticeable decline in fine particulate concentrations, but the 2023 data was contrary to this trend due to the transport of smoke from the record-breaking Canadian forest fires into New Jersey skies during June and July 2023. The NJDEP is preparing an analysis to demonstrate that transport of smoke from the Canadian forest fires should be classified as an exceptional event, and the $PM_{2.5}$ concentrations measured during the Canadian forest fires should be excluded from the calculation of design values.

Figure 5-10
Statewide New Jersey $PM_{2.5}$ Trends, 2001-2023
Maximum Annual Average Concentrations
Maximum 3-Year Average of the Annual Average Concentrations
Micrograms per Cubic Meter (µg/m³)

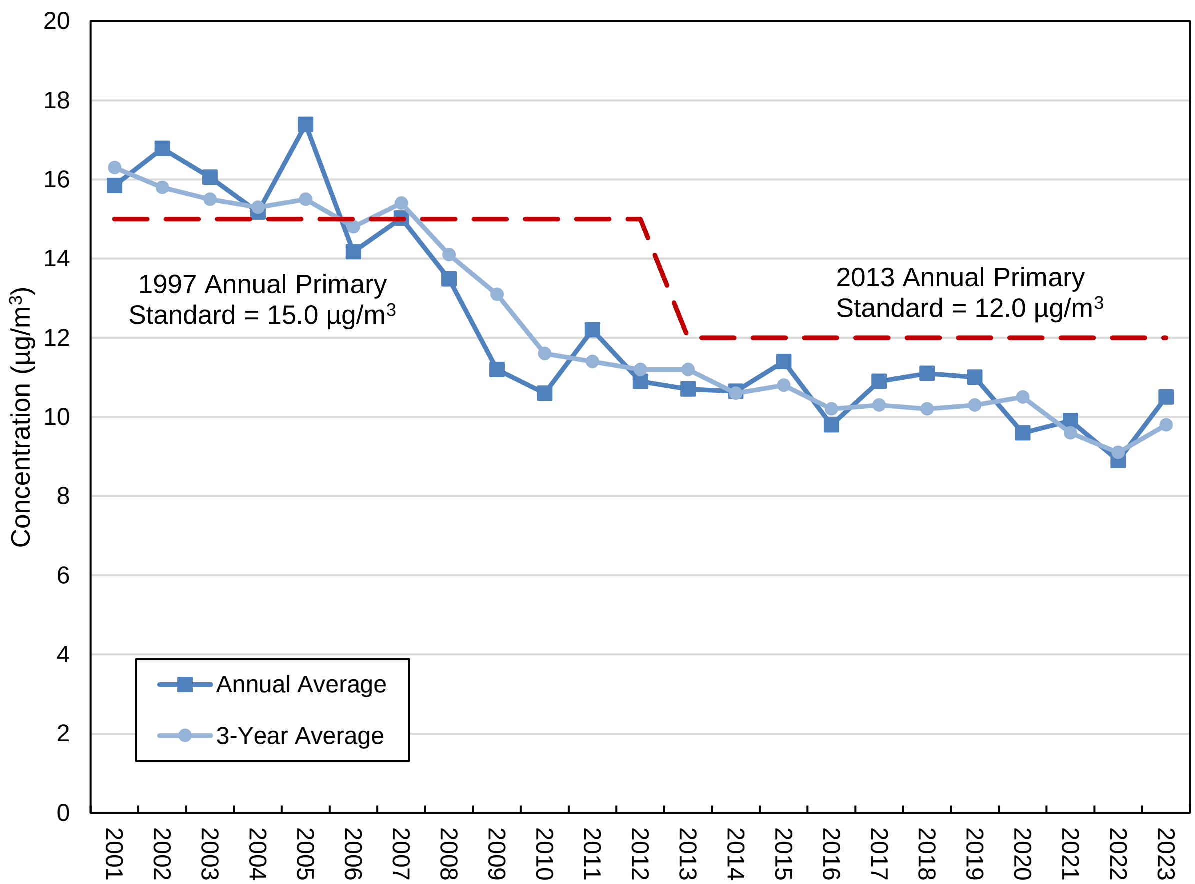
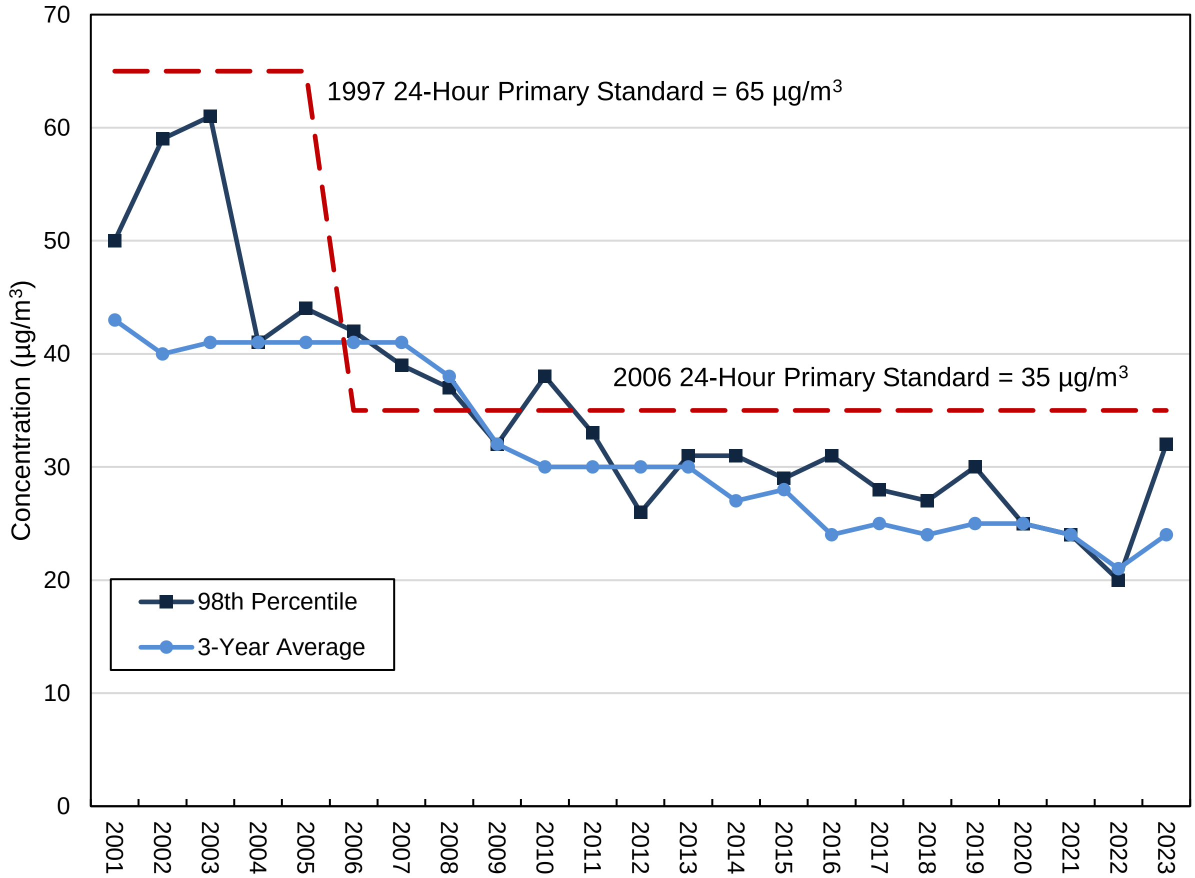


Figure 5-11
Statewide New Jersey $PM_{2.5}$ Trends, 2001-2023
Maximum Annual 98th Percentile 24-Hour Average Concentrations
Maximum 3-Year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



The PM_{10} statewide design value trend is shown in Figure 5-12. The increase in concentration in 2015 and 2016 occurred at the Camden RRF monitor at 600 Morgan Street, during a period of major road reconstruction nearby. The Camden RRF site was shut down in early 2020, when a PM_{10} monitor was placed at the Camden Spruce Street station. Table 5-6 below presents the trend data displayed in Figures 5-10, 5-11 and 5-12.

Figure 5-12
Statewide New Jersey PM_{10} Trend, 2001-2023
Maximum 2nd-Highest 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)

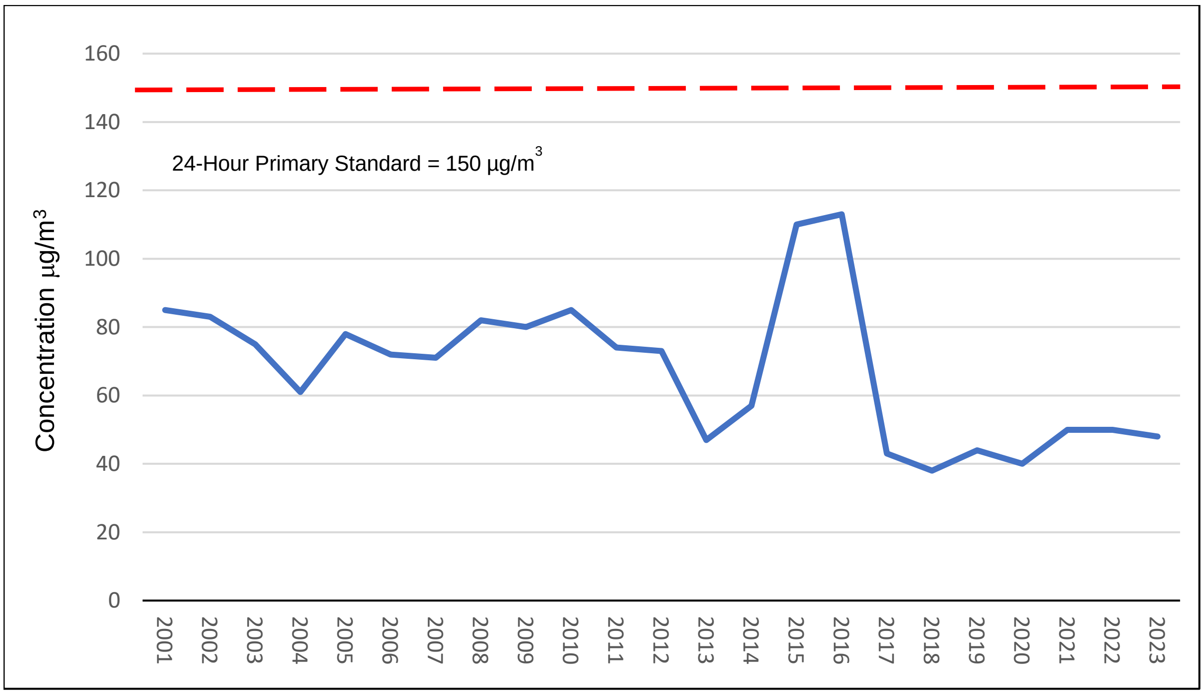


Table 5-6
Statewide New Jersey Particulate Matter Trends, 2001-2023
Maximum $PM_{2.5}$ & PM_{10} Concentrations
Micrograms per Cubic Meter (µg/m^3)

Year	$PM_{2.5}$				PM_{10}
	Annual		24-Hour		24-Hour
	Average	3-Year Average*	98th Percentile	3-Year Average*	2nd-Highest*
2001	15.8	16.3	50	43	85
2002	16.8	15.8	59	40	83
2003	16.1	15.5	61	41	75
2004	15.2	15.3	41	41	61
2005	17.4	15.5	44	41	78
2006	14.2	14.8	42	41	72
2007	15.0	15.4	39	41	71
2008	13.5	14.1	37	38	82
2009	11.2	13.1	32	32	80
2010	10.6	11.6	38	30	85
2011	12.2	11.4	33	30	74
2012	10.9	11.2	26	30	73
2013	10.7	11.2	31	30	47
2014	10.6	10.6	31	27	57
2015	11.4	10.8	29	28	110
2016	9.8	10.2	31	24	113
2017	10.9	10.3	28	25	43
2018	11.1	10.2	27	24	38
2019	11.0	10.3	30	25	44
2020	9.6	10.5	25	25	40
2021	9.9	9.6	24	24	50
2022	8.9	9.1	20	21	50
2023	10.5	9.8	32	24	48

*Design value

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2023 Nitrogen Dioxide Summary

New Jersey Department of Environmental Protection

SOURCES

Nitrogen dioxide (NO_2) is a reddish-brown highly reactive gas that is formed in the air through the oxidation of nitric oxide (NO). NO_2 is used by regulatory agencies as the indicator for the group of gases known as nitrogen oxides (NO_x). These gases are emitted from motor vehicle exhaust, combustion of coal, oil or natural gas, and industrial processes such as welding, electroplating, and dynamite blasting. Although most NO_x is emitted as NO, it is readily converted to NO_2 in the atmosphere. In the home, gas stoves and heaters produce substantial amounts of nitrogen dioxide. When NO_2 reacts with other chemicals it can form ozone, particulate matter, and other pollutant compounds. A pie chart summarizing the major sources of NO_x in New Jersey in 2017 is shown in Figure 6-1.

Figure 6-2 shows that NO_x concentrations tend to be higher in the winter than in the summer. This is due in part to heating of buildings, and to weather conditions that are more prevalent in the colder months of the year, such as lighter winds that result in poorer local dispersion conditions.

Figure 6-1
2017 New Jersey
NO_x Annual Emissions

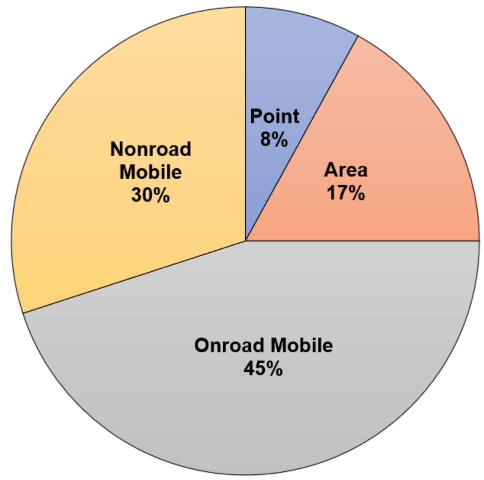
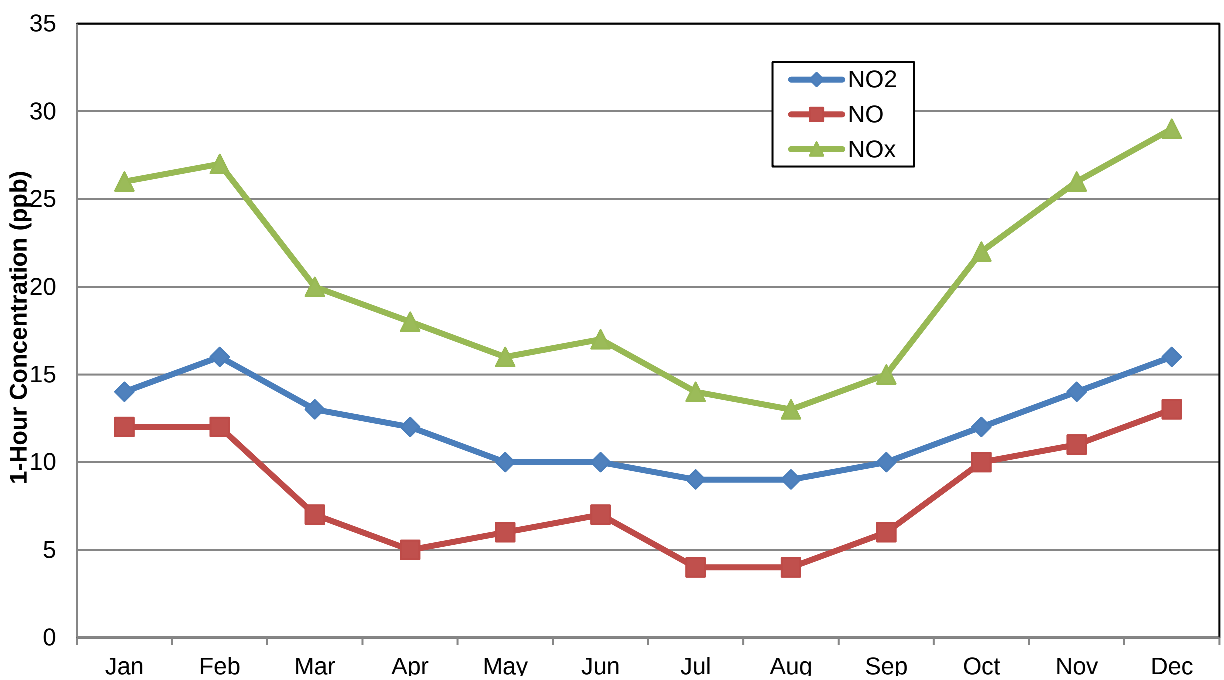
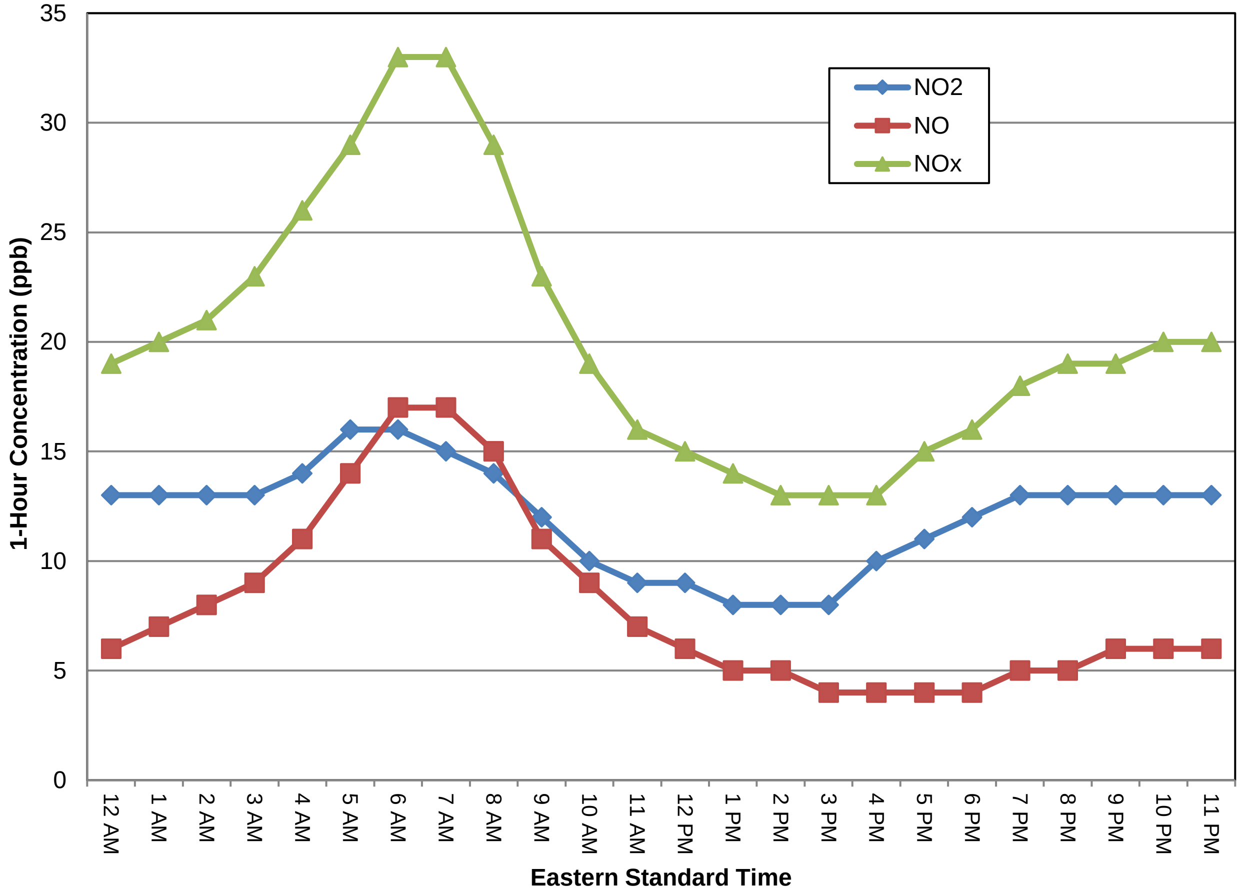


Figure 6-2
2023 Nitrogen Oxides Concentrations in New Jersey
Monthly Variation of Statewide Hourly Averages
Parts per Billion (ppb)



Because much of the NO_x in the air is emitted by motor vehicles, concentrations tend to peak during the morning and afternoon rush hours. This is shown in Figure 6-3.

Figure 6-3
2023 Nitrogen Oxides Concentrations in New Jersey
Daily Variation of Statewide Hourly Averages
Parts per Billion (ppb)



Health and Environmental Effects

Short-term exposures to low levels of nitrogen dioxide may aggravate pre-existing respiratory illnesses and cause respiratory illnesses in children, people with asthma, and the elderly. Symptoms of low-level exposure to NO and NO_2 include irritation to eyes, nose, throat and lungs, coughing, shortness of breath, tiredness and nausea. Long-term exposures to NO_2 may increase susceptibility to respiratory infection and may cause permanent damage to the lung. Studies show a connection between breathing elevated short-term NO_2 concentrations and increases in hospital emergency room visits and hospital admissions for respiratory issues, especially asthma. Individuals who spend time on or near major roadways can experience elevated short-term NO_2 exposures.

Nitrogen oxides contribute to a wide range of environmental problems. Chemical reactions in the air form both ozone and particulate matter. Nitrate particles make the air hazy and impair visibility, and contribute to nutrient pollution in coastal waters, resulting in eutrophication. NO_2 also reacts with water and oxygen to form nitric acid, a component of acid rain, which causes acidification of freshwater bodies and harms sensitive ecosystems such as lakes and forests.

AMBIENT AIR QUALITY STANDARDS

There are two types of National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (USEPA), primary and secondary. Primary standards protect public health, including sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. A 1-hour primary standard for NO_2 of 100 parts per billion (ppb) was promulgated in 2010. The primary and secondary annual NAAQS for NO_2 is the same, a calendar year average concentration of 53 ppb. The annual New Jersey Ambient Air Quality Standards (NJAAQS) are identical to the NAAQS, except that micrograms per cubic meter ($\mu g/m^3$) are the standard units (converted to ppm below) and the averaging time is any 12-month period (a running average) instead of a calendar year. Table 6-1 presents a summary of the NO_2 standards.

Table 6-1
National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO_2)
Parts per Billion (ppb)
Parts per Million (ppm)

Averaging Period	Type	National Level	New Jersey Level	Design Value
1-Hour	Primary	100 ppb	---	3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations
Annual	Primary & secondary	53 ppb	---	Annual mean
12-Month	Primary & secondary	---	0.05 ppm	Highest 12-month running average

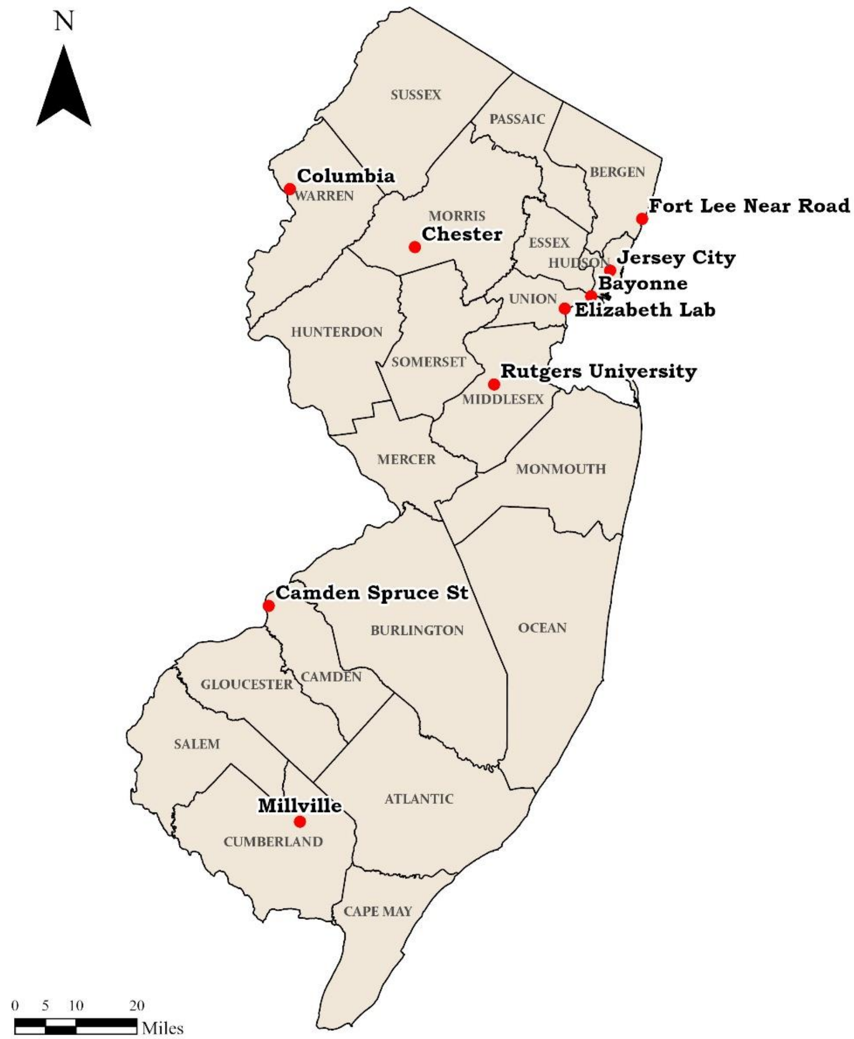
A state or other designated area is in compliance with a NAAQS when it meets the design value. The annual average NO_2 NAAQS is met when the annual average is less than or equal to 53 ppb. For the 1-hour NO_2 standard, the NAAQS is met when the 3-year average of the annual 98^{th}-percentile of the daily maximum 1-hour average concentration is less than or equal to 100 ppb. This statistic is calculated by first obtaining the maximum 1-hour average NO_2 concentrations for each day at each monitor. Then the 98^{th}-percentile value of the daily maximum NO_2 concentrations must be determined for the current year, and for each of the previous two years. Finally, the average of these three annual 98^{th}-percentile values is the design value.

NO_2 MONITORING NETWORK

NJDEP measured NO_2 levels at nine locations in 2023. The monitoring stations are Bayonne, Camden Spruce Street, Chester, Columbia, Elizabeth Lab, Fort Lee Near Road, Jersey City, Millville, and Rutgers University. These sites are shown in Figure 6-4. These sites also measure NO and NOx, except for Rutgers, which measures NO and total reactive nitrogen (NO_y) as required for the Photochemical Assessment Monitoring Station (PAMS) Program.

The NJDEP shut down the Newark Firehouse monitoring station on September 26^{th}, 2022 after being required to vacate the property for construction. The NJDEP has identified a replacement for the Newark Firehouse station, and plans to resume NO_2 monitoring in 2025.

Figure 6-4
2023 Nitrogen Dioxide Monitoring Network



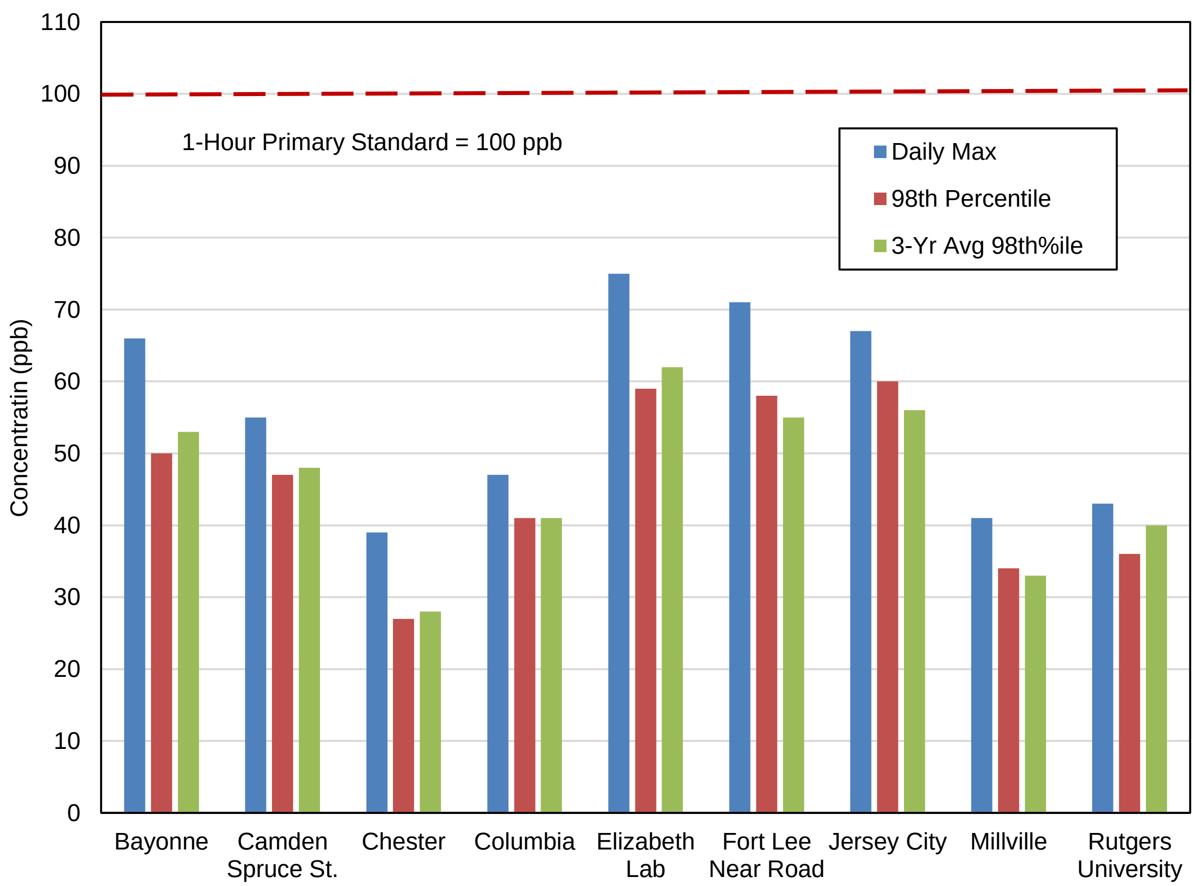
NO_2 LEVELS IN 2023

There were no exceedances of any NO_2 NAAQS in 2023. See Table 6-2 and Figure 6-5 for the highest daily maximum 1-hour averages, 98th percentile daily maximum 1-hour averages and design values (3-year average of the annual 98th percentile daily maximum 1-hour averages) for all the monitoring sites. The highest daily maximum 1-hour average concentration was 75 ppb, recorded at Elizabeth Lab. Jersey City had the highest 98th percentile of the daily maximum of 60 ppb. Elizabeth Lab had the highest design value with 62 ppb. As noted, the Newark Firehouse site had no data after September 26th, 2022 because the site had to be vacated.

Table 6-2
2023 Nitrogen Dioxide Concentrations in New Jersey
Highest, 98th-Percentile, & 3-Year Average of 98th-Percentile Daily Maximum 1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)		
	Highest Daily Maximum	98th-Percentile Daily Maximum	3-Year Avg 2021-2023 98th-%ile Daily Maximum
Bayonne	66	50	53
Camden Spruce St.	55	47	48
Chester	39	27	28
Columbia	47	41	41
Elizabeth Lab	75	59	62
Fort Lee Near Road	71	58	55
Jersey City	67	60	56
Millville	41	34	33
Rutgers University	43	36	40

Figure 6-5
2023 Nitrogen Dioxide Concentrations in New Jersey
Highest, 98th-Percentile, & 3-Year Average of 98th-Percentile Daily Maximum 1-Hour Averages
Parts per Billion (ppb)



In order to meet the annual NAAQS for NO_2, the calendar-year average (January 1 to December 31) must be less than or equal to 53 ppb, rounded to no more than one decimal place. The NJAAQS is also 53 ppb, but it is compared to the maximum running 12-month average (of any twelve consecutive months in the year). As shown in Table 6-3 and Figure 6-6, the highest calendar-year average of 19 ppb occurred at both Elizabeth Lab (located off Exit 13 of the New Jersey Turnpike) and Jersey City (located on JFK Blvd. in Journal Square) monitoring stations and the highest 12-month running average of 20 ppb occurred at the Elizabeth Lab monitoring station. Both these values are well below the standards.

Table 6-3
2023 Nitrogen Dioxide Concentrations in New Jersey
Annual (12-Month) Averages
Parts per Billion (ppb)

Monitoring Site	12-Month Average (ppb)	
	Calendar Year	Maximum Running
Bayonne	14	15
Camden Spruce Street	11	12
Chester	3	3
Columbia	11	11
Elizabeth Lab	19	20
Fort Lee Near Road	18	18
Jersey City	19	19
Millville	5	6
Rutgers University	8	8

Figure 6-6
2023 Nitrogen Dioxide Concentrations in New Jersey
Annual (12-Month) Averages
Parts per Billion (ppb)

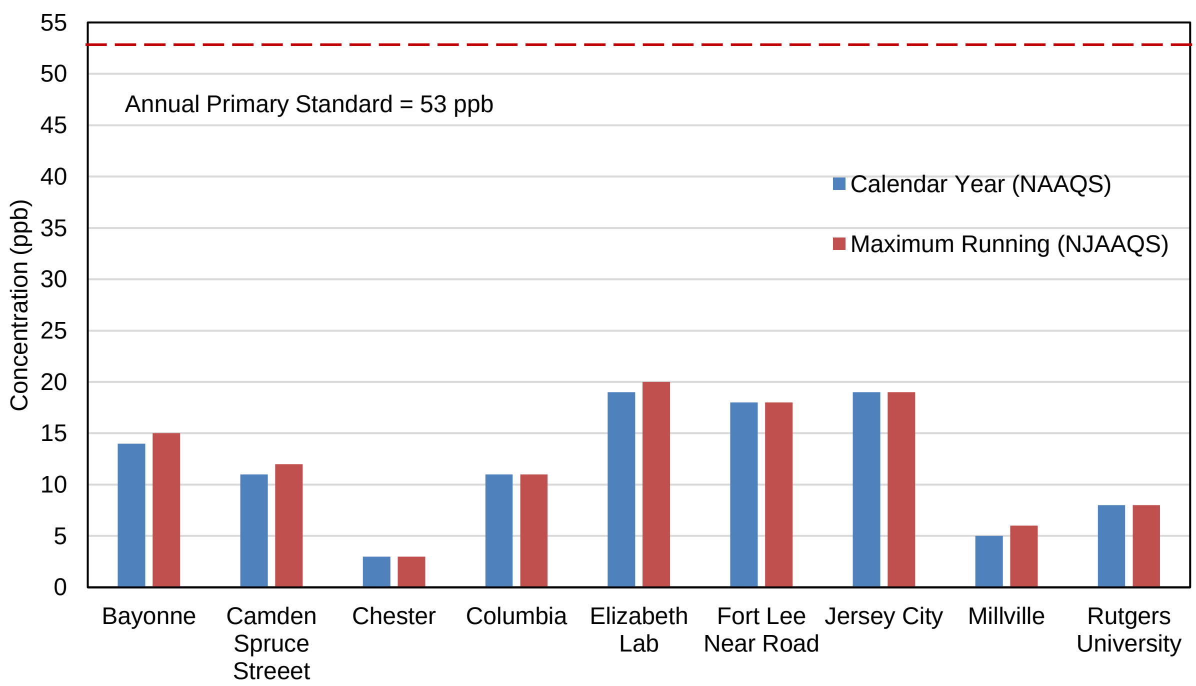


Figure 6-7 and Table 6-4 show the calendar-year annual average concentrations of NO_2, NO and NO_x at each New Jersey monitoring site. Even though there are no ambient air standards for NO and NO_x, the stations that measure NO_2 concentrations also measure them (except for Rutgers, which measures NO_y instead of NO_x). NO_x levels are approximately (not exactly) the sum of the NO_2 and NO concentrations. The concentration of NO tends to be lower than NO_2, because it quickly reacts with other air pollutants (particularly ozone) after it is emitted from a source and converts to NO_2. The Columbia monitoring site is an exception to this, with annual average levels of NO higher than NO_2. The monitor is about 100 feet from Interstate Highway 80. The road is a significant source of NO emissions from vehicles, but the expected conversion of NO to NO_2 is probably hindered by the area's relatively low levels of other pollutants.

Figure 6-7
2023 Nitrogen Oxides Concentrations in New Jersey
Annual Averages
Parts per Billion (ppb)

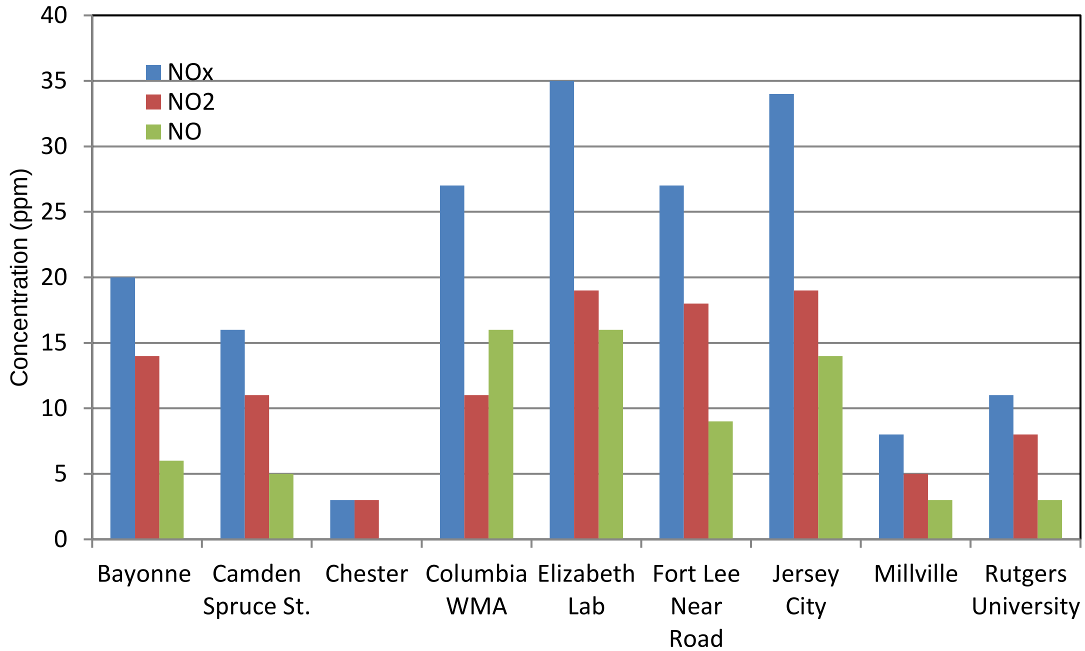


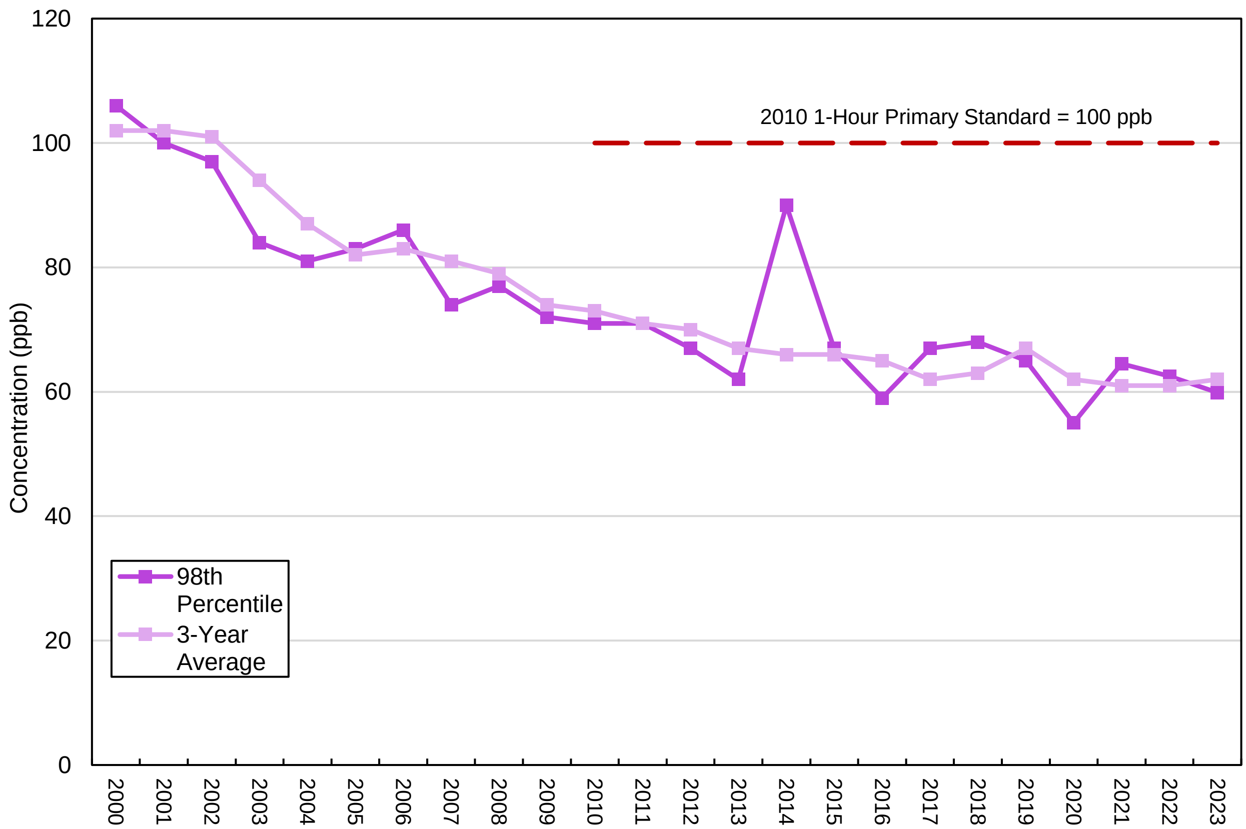
Table 6-4
2023 Nitrogen Oxides Concentrations in New Jersey
Annual Averages
Parts per Billion (ppb)

Site	NO_2	NO	NO_x
Bayonne	14	6	20
Camden Spruce Street	11	5	16
Chester	3	0	3
Columbia	11	16	27
Elizabeth Lab	19	16	35
Fort Lee Near Road	18	9	27
Jersey City	19	14	34
Millville	5	3	8
Rutgers University	8	3	11

NO_2 TRENDS

New Jersey has not violated the 1-hour NAAQS since it was implemented in 2010. Figure 6-8 shows the maximum value from all NJDEP air monitoring stations of the annual 98th percentile daily maximum 1-hour average and the maximum design value from all NJDEP stations for each year since 2000.

Figure 6-8
Statewide New Jersey Nitrogen Dioxide Trends, 2000-2023
Maximum 98th Percentile Daily Maximum 1-Hour Averages
Maximum 3-Year Average of 98th Percentile Daily Maximum 1-Hour Averages (Design Value)
Parts per Billion (ppb)



Routine monitoring for NO_2 in New Jersey began in 1966. The last year in which the annual average NO_2 concentration exceeded the NAAQS was 1974. The graph of NO_2 levels in Figure 6-9 shows the maximum value from all NJDEP air monitoring stations of the annual average concentrations for each year since 1990. Although NO_2 concentrations are well within the NAAQS, there is still a great deal of concern about the role of nitrogen oxides in the formation of other pollutants, most notably ozone and fine particles. Both of those pollutants still occasionally reach problematic levels in the northeastern United States. Efforts to reduce levels of ozone and fine particles are likely to require continued reductions in NO_x emissions.

The data for Figures 6-8 and 6-9 are presented in Table 6-5.

Figure 6-9
Statewide New Jersey Nitrogen Dioxide Trend, 1990-2023
Maximum Annual (Calendar Year) Average Concentrations
Parts per Billion (ppb)

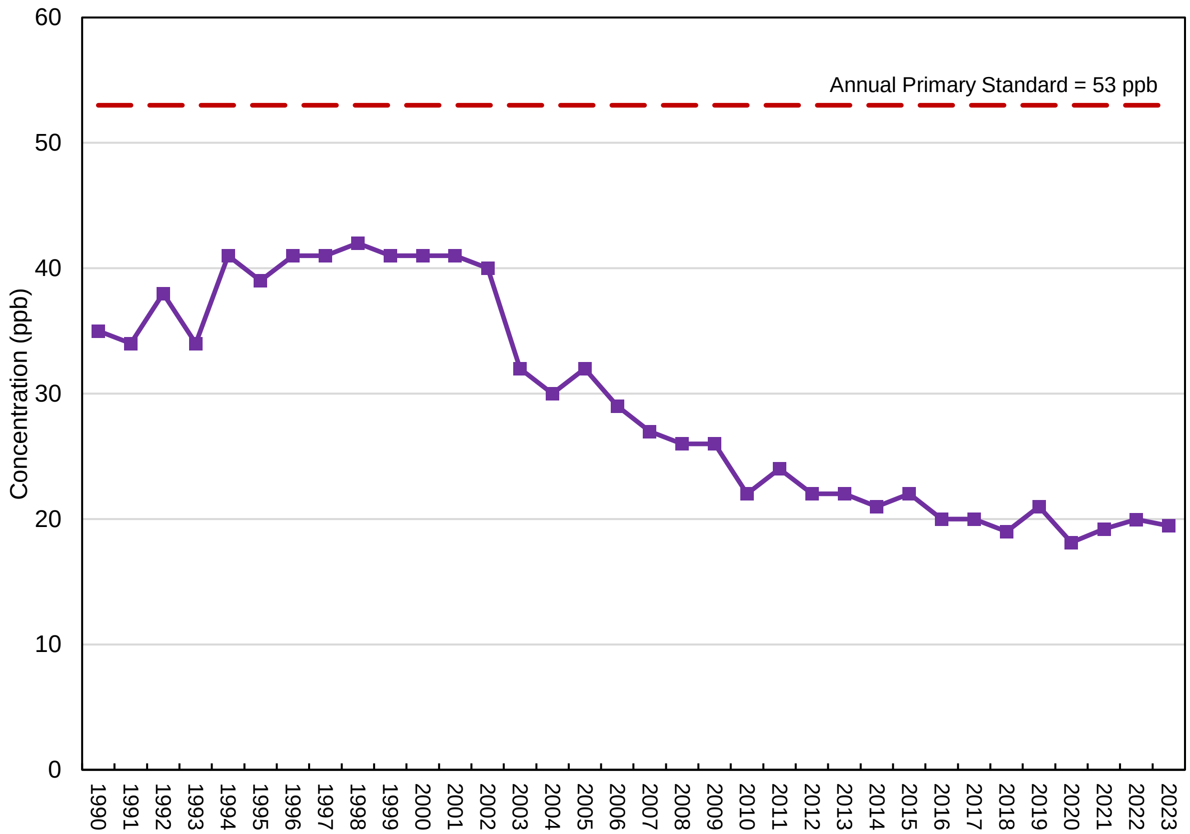


Table 6-5
Statewide New Jersey Nitrogen Dioxide Trends, 1990-2023
Maximum 98th Percentile Daily Maximum 1-Hour Averages,
Maximum 3-Year Average of 98th Percentile Daily Maximum 1-Hour Averages (Design Value)
And Maximum Annual Average Concentrations
Parts per Billion (ppb)

Year	1-Hour Average		Maximum Annual Average*
	Maximum 98th Percentile Daily Maximum	Maximum 3-Year Average of 98th Percentile Daily Maximum*	
1990	112	---	35
1991	103	---	34
1992	120	112	38
1993	96	106	34
1994	116	111	41
1995	92	101	39
1996	104	104	41
1997	106	101	41
1998	101	104	42
1999	100	102	41
2000	106	102	41
2001	100	102	41
2002	97	101	40
2003	84	94	32
2004	81	87	30
2005	83	82	32
2006	86	83	29
2007	74	81	27
2008	77	79	26
2009	72	74	26
2010	71	73	22
2011	71	71	24
2012	67	70	22
2013	62	67	22
2014	90	66	21
2015	67	66	22
2016	59	65	20
2017	67	62	20
2018	68	63	19
2019	65	67	21
2020	55	62	18
2021	65	61	19
2022	63	61	20
2023	60	62	19

*Design value

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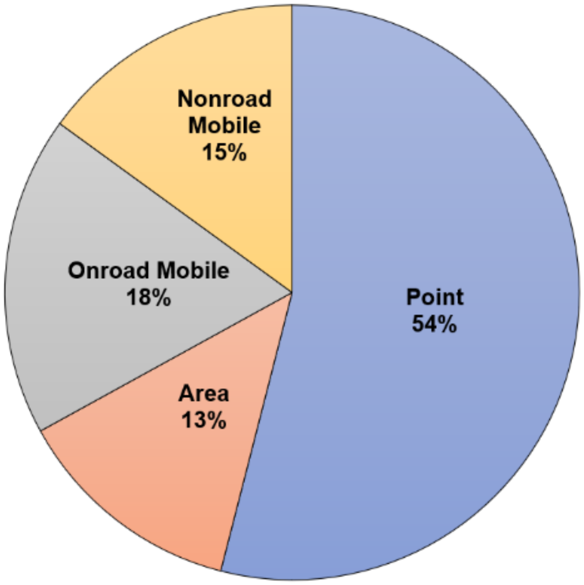
2023 Sulfur Dioxide Summary

New Jersey Department of Environmental Protection

Figure 7-1
2017 New Jersey
SO_2 Annual Emissions



Sources

Sulfur dioxide (SO_2) is a heavy, colorless gas with a suffocating odor, that easily dissolves in water to form sulfuric acid. SO_2 gases are formed when fuels containing sulfur (coal, oil, and gasoline) are burned, or when gasoline is extracted from oil. Most of the sulfur dioxide released into the air comes from fuel combustion in electric utilities, especially those that burn coal with a high sulfur content. Sulfur is found in raw materials such as crude oil, coal, and ores that contain metals. Industrial facilities that derive their products from these materials may also release SO_2. The pie chart in Figure 7-1 summarizes the primary sources of SO_2 in New Jersey in 2017, the most recent data available.

Health and Environmental Effects

Sulfur dioxide causes irritation of the mucous membranes. This is probably the result of sulfurous acid forming when the highly soluble SO_2 gas dissolves at the surface of the membranes. Groups that are especially susceptible to the harmful health effects of SO_2 include children, the elderly, and people with heart or lung disorders such as asthma. When SO_2 concentrations in the air become elevated, people in these sensitive groups and those who are active outdoors may have trouble breathing.

Sulfur dioxide reacts with other gases and particles in the air to form sulfates, which also can be harmful to people and the environment. Sulfate particles are the major cause of reduced visibility in the eastern United States. SO_2 forms acids that fall to the earth in rain and snow. Better known as acid rain, this acidic precipitation can damage forests and crops, can make lakes and streams too acidic for fish, and can speed up the decay of building materials and paints.

AMBIENT AIR QUALITY STANDARDS

The current National Ambient Air Quality Standards (NAAQS) for SO_2 are shown in Table 7-1. Primary standards are set to provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. In June 2010 the United States Environmental Protection Agency (USEPA) established a new primary 1-hour NAAQS for SO_2 at a level of 75 parts per billion (ppb). At the same time, the old 24-hour and annual average NAAQS were revoked, and the 3-hour secondary NAAQS was retained. Compliance with the 1-hour standard is determined by calculating the 99th percentile of 1-hour daily maximum concentrations for each monitoring site in the state each year, and then averaging each site's values for the three most recent years. This statistic is called the design value. The 1-hour average SO2 NAAQS is met when the design value is less than or equal to 75 ppb. Compliance with the secondary standard is based on the second-highest 3-hour average concentration for a given year.

Table 7-1 also shows New Jersey's ambient air quality standards (NJAAQS) for SO_2, which are based on the older NAAQS. NJAAQS for SO_2 are calculated using running averages (consecutive 3-hour, 24-hour and 12-month averages) rather than calendar year or non-overlapping block averages. The secondary 3-hour New Jersey standard is the same as the NAAQS, except that New Jersey uses a running average. Also, the NJAAQS use ppm units instead of ppb.

Table 7-1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide (SO_2)
Parts per Billion (ppb)
Parts per Million (ppm)

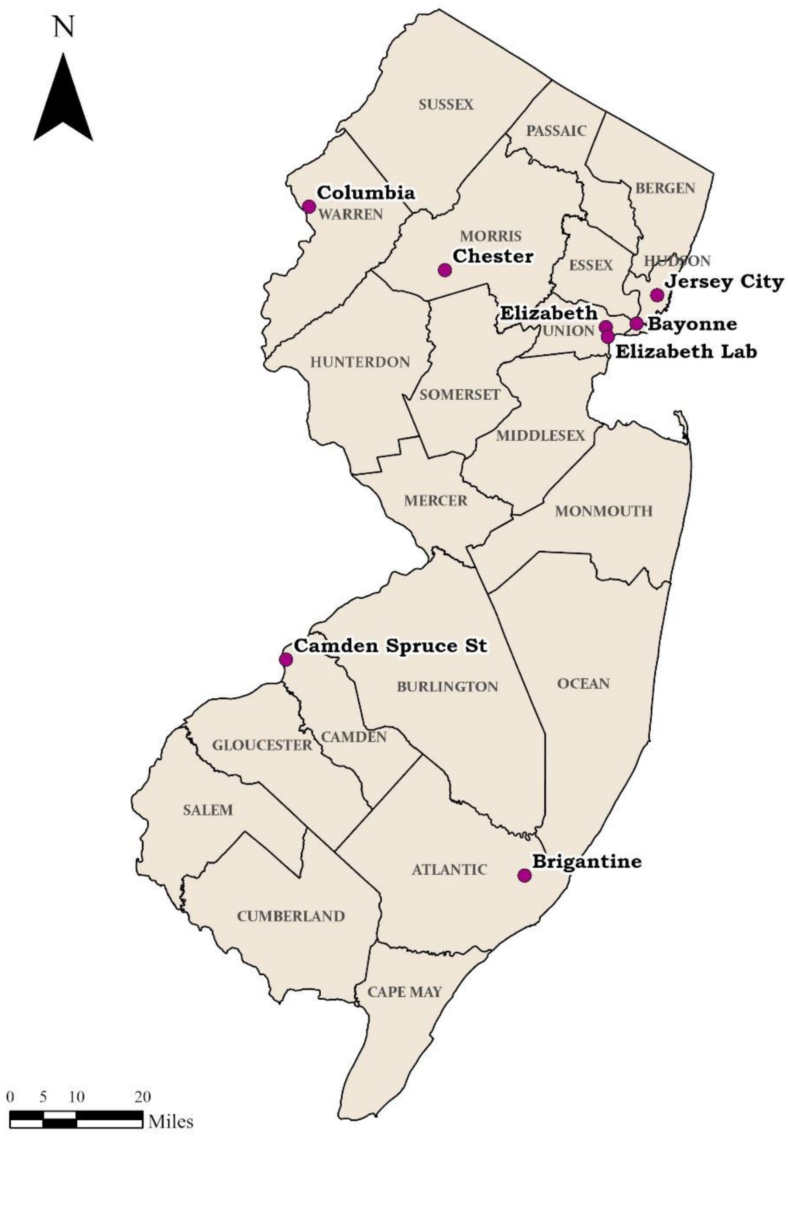
Averaging Period	Type	National Level	New Jersey Level[a]	Design Value
1–hour	Primary	75 ppb	---	3-year average of the annual 99th percentile daily maximum 1-hour average concentrations
3–hours	Secondary	0.5 ppm[b]	0.5 ppm	Annual 2nd-highest
24–hours	Primary	---	0.14 ppm	Annual 2nd-highest
24–hours	Secondary	---	0.1 ppm	Annual 2nd-highest
12–months	Primary	---	0.03 ppm	Not to be exceeded
12–months	Secondary	---	0.02 ppm	Not to be exceeded

[a] Based on running averages, over any 12 consecutive months.
[b] Based on successive non-overlapping blocks, beginning at midnight each day.

SO_2 MONITORING NETWORK

The New Jersey Department of Environmental Protection (NJDEP) monitored SO_2 levels at eight sites in 2023. The monitoring stations are Bayonne, Brigantine, Camden Spruce Street, Chester, Columbia, Elizabeth, Elizabeth Lab, and Jersey City. The locations are shown in Figure 7-2. The NJDEP identified a replacement for the Newark Firehouse station which closed in 2022 and plans to resume SO_2 monitoring in 2025.

Figure 7-2
2023 Sulfur Dioxide Monitoring Network



SO_2 LEVELS IN 2023

For 2023, there were no exceedances of any AAQS. The highest daily maximum 1-hour averages, 99th percentile daily maximum and design values (3-year average of the annual 99th percentile daily maximum 1-hour averages) are presented in Table 7-2 and Figure 7-3. Elizabeth had the highest daily maximum 1-hour value at 7.3 ppb, and Elizabeth Lab had the second highest at 6.8 ppb. Elizabeth Lab had the highest 99th percentile daily maximum value at 5.3 ppb. The highest design value was measured at Elizabeth Lab and Camden Spruce Street, both with a value of 5 ppb.

Three-hour averages for all sites were well below the national and New Jersey 3-hour secondary standards of 0.5 ppm for the second-highest value. The NAAQS is based on successive non-overlapping 3-hour blocks, while the NJAAQS uses running 3-hour averages (although the second-highest value can't overlap the highest value). The maximum and second-highest values were all measured at Elizabeth Lab. The block averages were 0.0054 and 0.0053 ppm respectively, and the running averages were 0.0057 and 0.0052 ppm. Results are shown in Table 7-3 and Figure 7-4.

The New Jersey 24-hour AAQS is 0.14 ppm, and the 12-month standard is 0.03 ppm. In 2023, the highest and second-highest 24-hour average concentrations were 0.0046 ppm and 0.0030 ppm, both at the Elizabeth Lab site. The highest 12-month running average concentration of SO_2 was 0.0008 ppm at Elizabeth Lab. See Tables 7-4 and 7-5, and Figures 7-5 and 7-6, for data for the other monitoring sites.

Table 7-2
2023 Sulfur Dioxide Concentrations in New Jersey
Highest, 99th Percentile, and 3-Year Average of the 99th Percentile Daily Maximum 1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Daily Average (ppb)		
	Highest Daily Maximum	99th Percentile Daily Maximum	3-Yr Avg 2021-2023 99th -%ile Daily Maximum
Bayonne	3.0	2.2	3
Brigantine	0.8	0.2	1
Camden Spruce Street	5.6	4.7	5
Chester	6.0	3.8	4
Columbia	6.1	3.9	4
Elizabeth	7.3	4.2	4
Elizabeth Lab	6.8	5.3	5
Jersey City	5.2	3.3	4

Figure 7-3
2023 Sulfur Dioxide Concentrations in New Jersey
Highest, 99th Percentile, and 3-Year Average of the 99th Percentile Daily Maximum 1-Hour Averages
Parts per Billion (ppb)

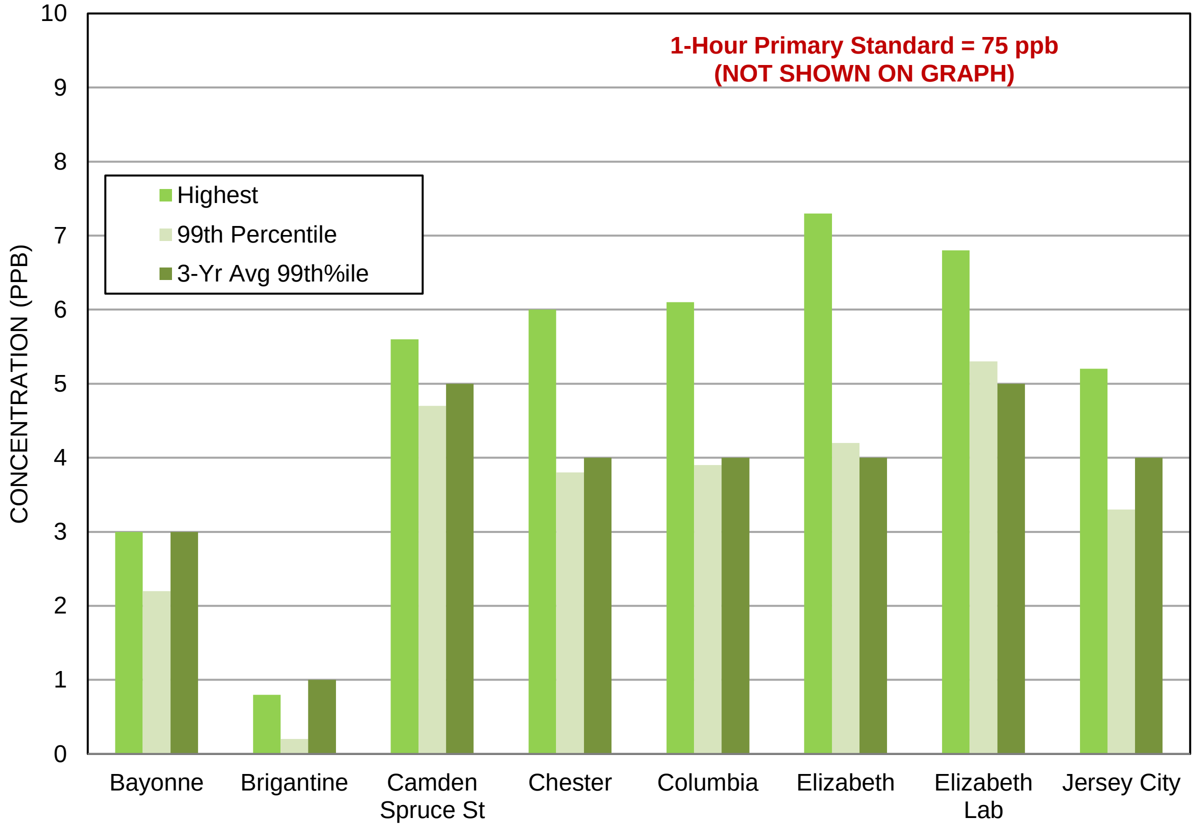


Table 7-3
2023 Sulfur Dioxide Concentrations in New Jersey
Maximum and 2nd Highest 3-Hour Averages
Parts per Million (ppm)

Monitoring Site	3-Hour Average Concentrations			
	Block[a]		Running[b]	
	Maximum	2nd-Highest	Maximum	2nd-Highest*
Bayonne	0.0025	0.0019	0.0025	0.0019
Brigantine	0.0003	0.0002	0.0004	0.0002
Camden Spruce Street	0.0032	0.0032	0.0032	0.0032
Chester	0.0042	0.0042	0.0042	0.0042
Columbia	0.0045	0.0032	0.0045	0.0035
Elizabeth	0.0036	0.0035	0.0046	0.0036
Elizabeth Lab	0.0054	0.0053	0.0057	0.0052
Jersey City	0.0042	0.0036	0.0042	0.0037

[a] NAAQS
[b] NJAAQS
*Non-overlapping

Figure 7-4
2023 Sulfur Dioxide Concentrations in New Jersey
2nd Highest 3-Hour Averages
Parts per Million (ppm)

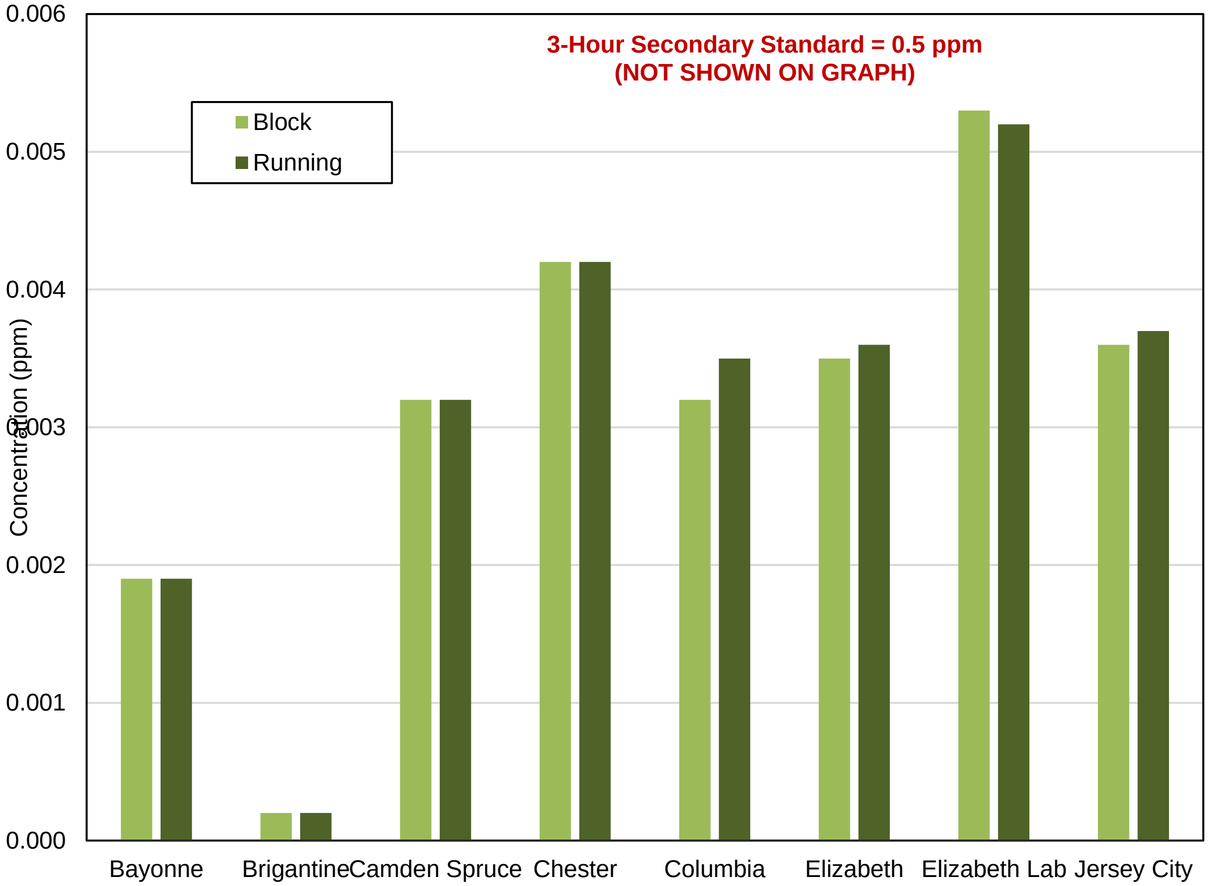


Table 7-4
2023 Sulfur Dioxide Concentrations in New Jersey
Maximum and 2nd Highest 24-Hour Running Averages
Parts per Million (ppm)

Monitoring Site	24-Hour Running Average	
	Maximum	2nd Highest (Non-overlapping)
Bayonne	0.0010	0.0015
Brigantine	0.0000	0.0000
Camden Spruce Street	0.0017	0.0015
Chester	0.0017	0.0015
Columbia	0.0013	0.0011
Elizabeth	0.0019	0.0017
Elizabeth Lab	0.0046	0.0030
Jersey City	0.0020	0.0018

Figure 7-5
2023 Sulfur Dioxide Concentrations in New Jersey
Maximum and 2nd Highest 24-Hour Running Averages
Parts per Million (ppm)

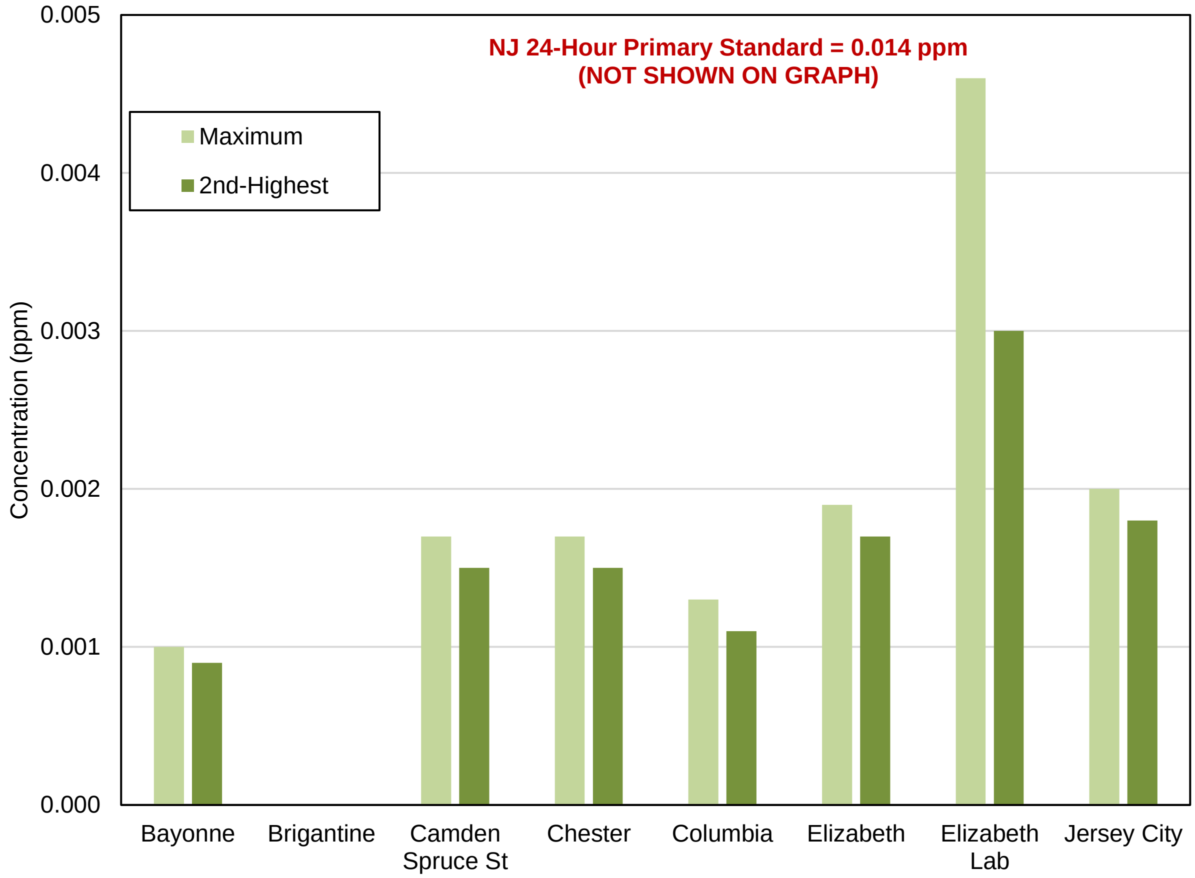
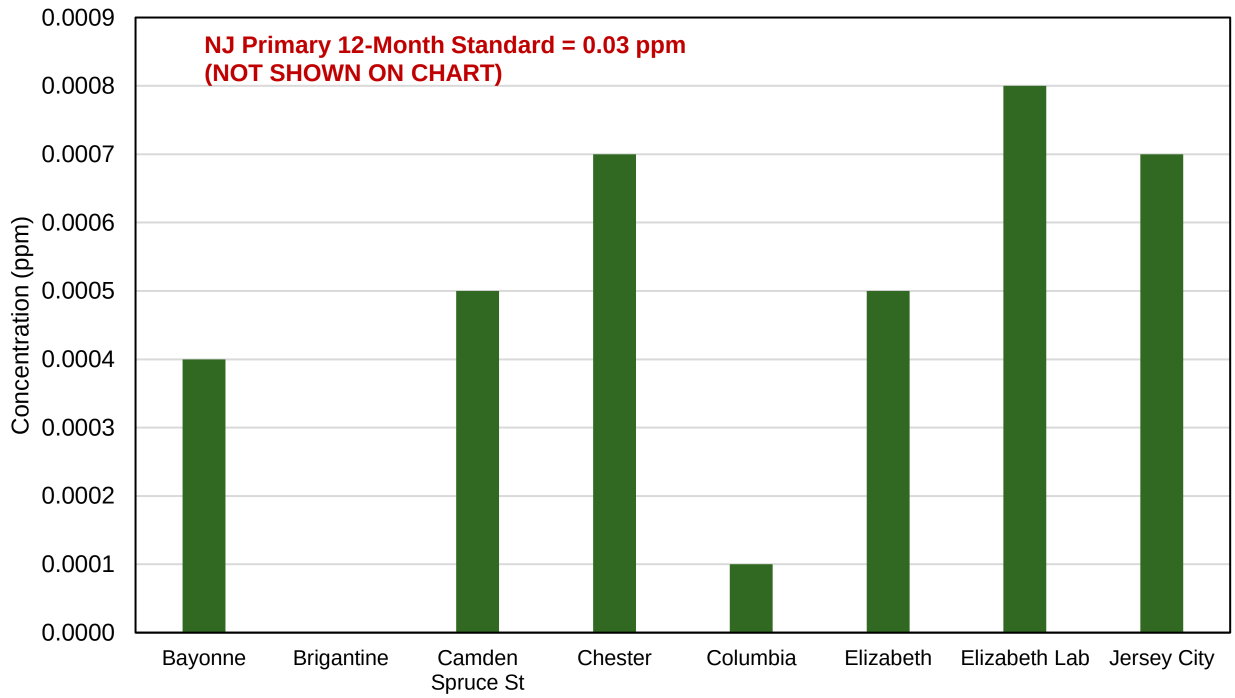


Table 7-5
2023 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)

Monitoring Site	Maximum 12-Month Running Average
Bayonne	0.0004
Brigantine	0.0000
Camden Spruce Street	0.0005
Chester	0.0007
Columbia	0.0001
Elizabeth	0.0005
Elizabeth Lab	0.0008
Jersey City	0.0007

Figure 7-6
2023 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)



SO_2 TRENDS

Sulfur dioxide concentrations across the country have decreased significantly since the first NAAQS were set in 1971. Figure 7-7 shows the maximum value from all NJDEP air monitoring stations of the second-highest daily average concentrations of SO_2 for each year since 1980 (also see Table 7-6). Nationwide efforts to reduce ambient sulfur levels have focused on sulfur in fuels. Regulations passed in 2000 reduced the sulfur content of gasoline by up to 90 percent, and enabled the use of new emission control technologies in cars, sport utility vehicles (SUVs), minivans, vans and pick-up trucks (beginning with model year 2004). Even more stringent gasoline and emissions controls for sulfur went into effect in 2017. And in New Jersey, limits on sulfur in commercial fuel oil were implemented beginning in 2014.

A coal-burning power plant across the Delaware River in Pennsylvania had for many years been suspected of causing high SO_2 levels in New Jersey. Air dispersion modeling carried out by NJDEP showed that the facility was causing likely violations of the SO_2 NAAQS. New Jersey petitioned the USEPA under Section 126 of the Clean Air Act to take action against the Portland Power Plant. In support of the petition, NJDEP established an SO_2 monitoring station at the Columbia Wildlife Management Area in Knowlton Township, Warren County, in September 2010. The dramatic increase in the monitored maximum value from all NJDEP stations of the 99th percentile daily maximum 1-hour SO_2 concentration in 2010 (shown in Figure 7-8) is attributable to measurements taken at the Columbia site. In October 2011, USEPA finalized a rule to grant New Jersey's petition. This final rule required the Portland Power Plant to reduce its SO_2 emissions such that the plant's contribution to predicted air quality standard violations would be lowered within one year, and completely eliminated within three years. The power plant stopped operating in mid-2014. Recent monitoring data has shown that Warren County and its vicinity are now able to meet the 1-hour SO_2 NAAQS.

Figure 7-8 also shows the trend in the maximum SO_2 design value (3-year average of the annual 99th percentile of the daily maximum 1-hour concentrations) from all NJDEP stations for each year since 1980.

Figure 7-7
Statewide New Jersey Sulfur Dioxide Trend, 1980-2023
Maximum 2nd-Highest 24-Hour Average Concentrations
Parts per Billion (ppb)

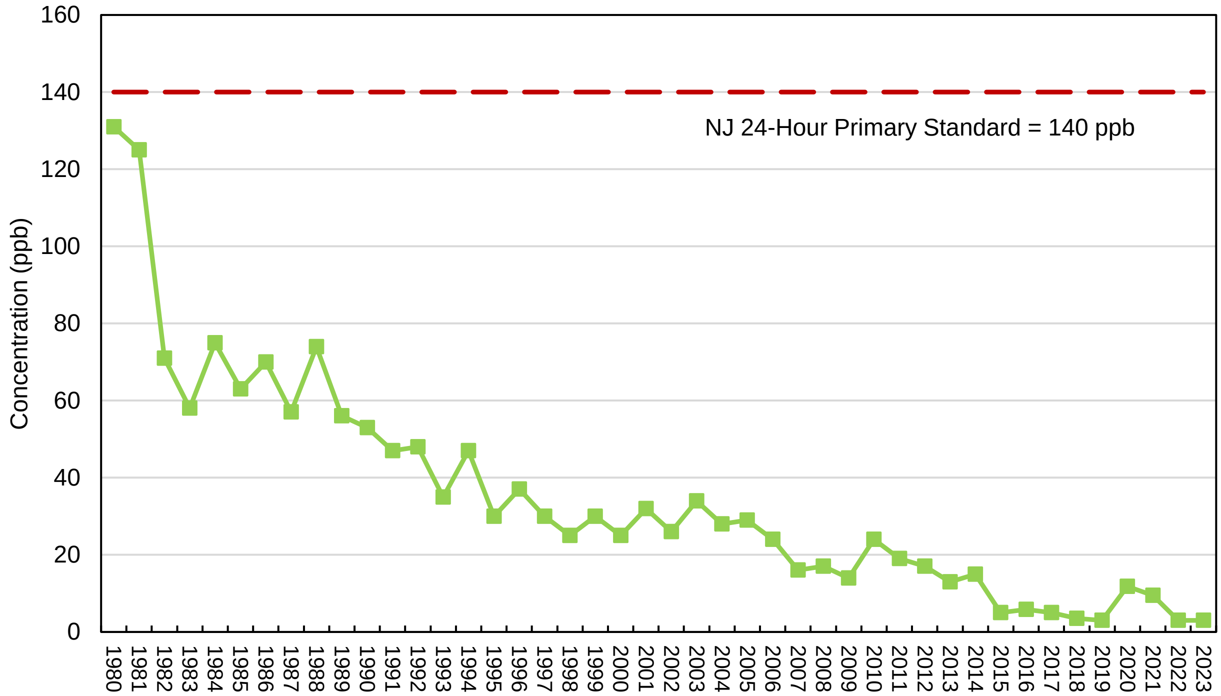


Figure 7-8
Statewide New Jersey Sulfur Dioxide Trends, 1980-2023
Maximum 99th Percentile Daily Maximum 1-Hour Average and
Maximum 3-Year Average of 99th Percentile Daily Maximum 1-Hour Averages (Design Value)
Parts per Billion (ppb)

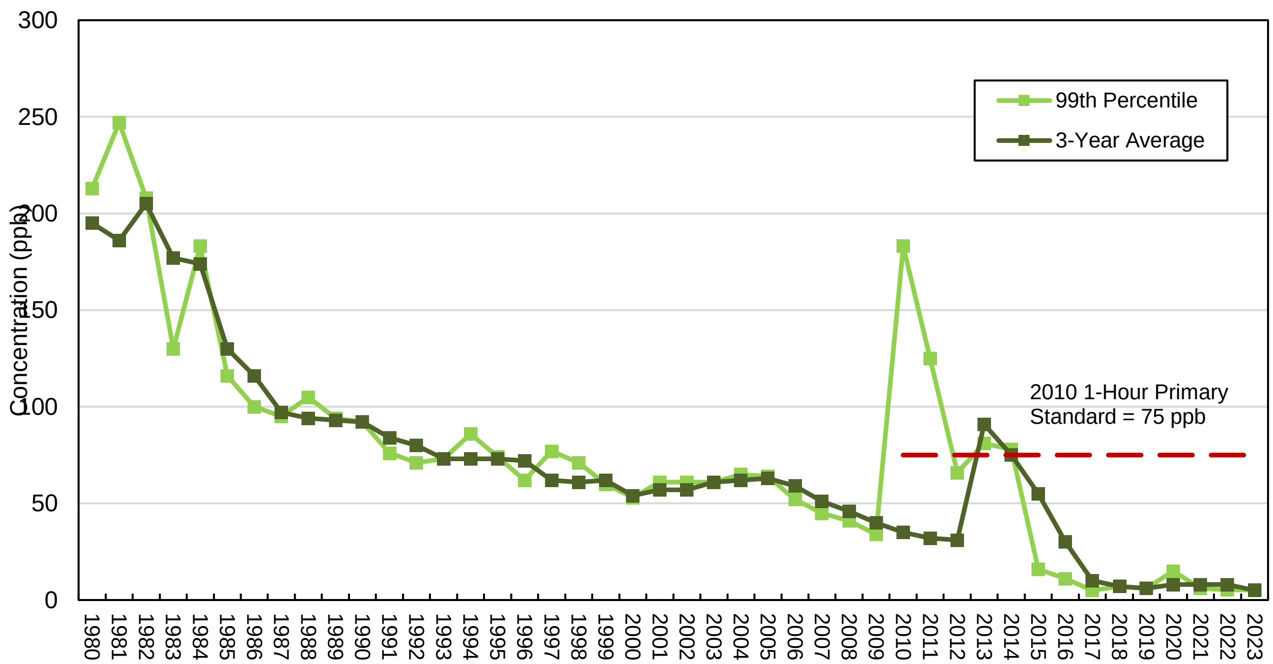


Table 7-6
Statewide New Jersey Sulfur Dioxide Trends
Maximum 2nd Highest 24-Hour Average
Maximum 99th Percentile Daily Maximum 1-Hour Averages
Maximum 3-Year Average of 99th Percentile Daily Maximum 1-Hour Averages (Design Value)
Parts per Billion (ppb)

Year	24-Hour Average	1-Hour Average	
	Maximum 2nd-Highest	Maximum 99th Percentile Daily Maximum	Maximum 3-Year Average of 99th Percentile Daily Maximum*
1980	131	213	195
1981	125	247	186
1982	71	208	205
1983	58	130	177
1984	75	183	174
1985	63	116	130
1986	70	100	116
1987	57	95	97
1988	74	105	94
1989	56	94	93
1990	53	92	92
1991	47	76	84
1992	48	71	80
1993	35	73	73
1994	47	86	73
1995	30	74	73
1996	37	62	72
1997	30	77	62
1998	25	71	61
1999	30	60	62
2000	25	53	54
2001	32	61	57
2002	26	61	57
2003	34	61	61
2004	28	65	62
2005	29	64	63
2006	24	52	59
2007	16	45	51
2008	17	41	46
2009	14	34	40
2010	24	183	35
2011	19	125	32
2012	17	66	31
2013	13	81	91
2014	15	78	75
2015	5	16	55
2016	5.8	11	30
2017	5	5	10
2018	3.5	7	7
2019	3	6	6
2020	11.8	15	8
2021	9.5	6	8
2022	3	5.2	8
2023	3	5.3	5

*Design value

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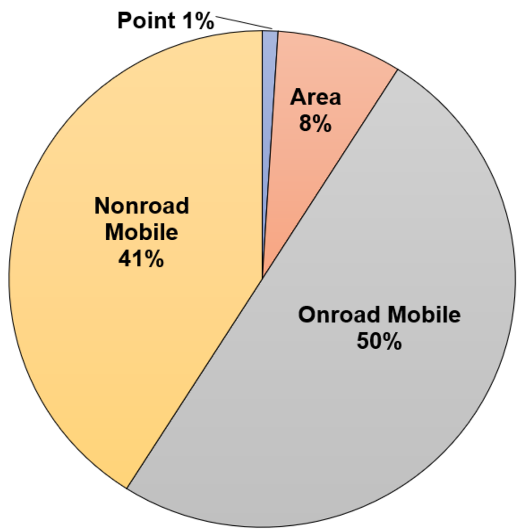
2023 Carbon Monoxide Summary

New Jersey Department of Environmental Protection

Sources

Carbon monoxide (CO) is a colorless, odorless gas formed when carbon in fuels is not burned completely. The main source of outdoor CO is exhaust from internal combustion engines, primarily on-road vehicles, as well as non-road vehicles, generators, construction equipment, boats, and other types of mobile sources. Fifty percent of all CO emissions nationwide are attributable to mobile sources, and over 90% in New Jersey. Significant amounts of CO are also emitted from fuel combustion in boilers and incinerators, natural sources such as forest fires, and various industrial processes. A pie chart estimating the contribution of different source categories of CO in New Jersey in 2017 (latest estimate available) is shown in Figure 8-1.

Figure 8-1
2017 New Jersey
CO Annual Emissions



Health Effects

Carbon monoxide reduces the oxygen-carrying capacity of blood, therefore reducing the distribution of oxygen to organs like the heart and brain. The most common symptoms of exposure to high concentrations of carbon monoxide are headaches and nausea. Exposure to extremely high concentrations, usually resulting from combustion exhaust accumulating in enclosed indoor spaces, can be life-threatening. Such high levels of CO are not likely to occur outdoors. The health threat from exposure to outdoor CO is most serious for those who suffer from cardiovascular disease. For a person with heart disease, a single exposure to CO at low levels may reduce that individual's ability to exercise and may cause chest pain (also known as angina).

Ambient Air Quality Standards

National Ambient Air Quality Standards (NAAQS) for CO are summarized in Table 8-1. Primary standards are set to protect the health of the public, including sensitive populations such as asthmatics, children, and the elderly. For carbon monoxide, there are currently two primary health-based, NAAQS: a 1-hour standard of 35 parts per million (ppm), and an 8-hour standard of 9 ppm. These levels are not to be exceeded more than once in any calendar year, so the design values, or the actual statistical values that determine compliance with the NAAQS, are the second-highest 1-hour and 8-hour values in a given year. Even though New Jersey's primary standards are the same as the NAAQS, the 8-hour state standard is based on a running average, not to be exceeded more than once in a 12-month period, rather than a calendar year.

Secondary standards provide public welfare protection from decreased visibility and damage to animals, crops, vegetation, and buildings. Although there are no national secondary standards for CO at this time, New Jersey has set secondary standards for CO equal to the primary standards.

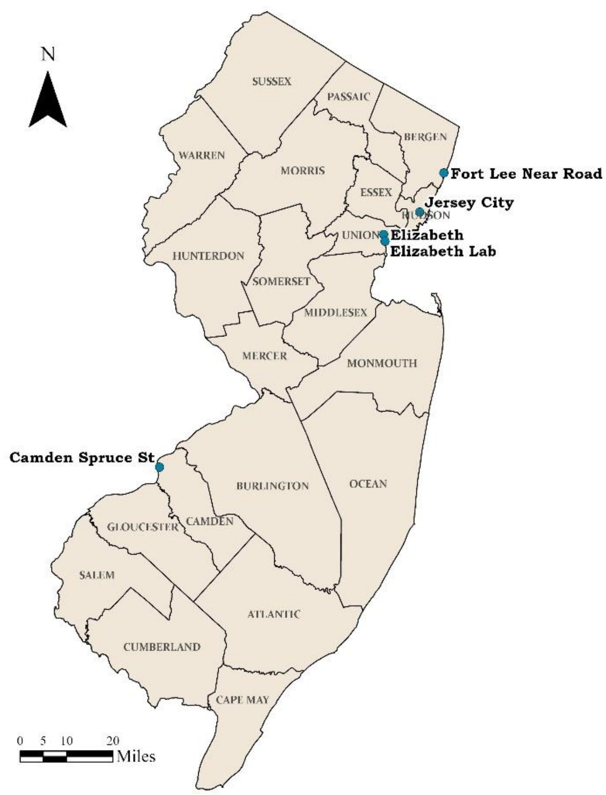
Table 8-1
National and New Jersey Ambient Air Quality Standards
for Carbon Monoxide
Parts per Million (ppm)

Averaging Period	Type	National Level	New Jersey Level	Design Value
1-Hour	Primary	35 ppm	35 ppm	Annual 2nd-highest
1-Hour	Secondary	----	35 ppm	2nd-highest 12-month value
8-Hours	Primary	9 ppm	9 ppm	Annual 2nd-highest
8-Hours	Secondary	----	9 ppm	2nd-highest 12-month value

CO Monitoring Network

The New Jersey Department of Environmental Protection (NJDEP) had five CO monitors around the state in 2023, as shown on the map in Figure 8-2. They are located at the Camden Spruce Street, Elizabeth, Elizabeth Lab, Fort Lee Near Road, and Jersey City. Unfortunately, the Newark Firehouse station had to be shut down in September of 2022. The Newark Firehouse station was part of the U.S. Environmental Protection Agency's (USEPA) National Core Multipollutant Monitoring Network (NCore). The NJDEP identified a replacement for the Newark Firehouse station and plans to resume CO monitoring in 2025.

Figure 8-2
2023 Carbon Monoxide Monitoring Network



CO LEVELS IN 2023

There were no exceedances of any CO standards at any of the New Jersey monitoring sites during 2023. The maximum 1-hour average CO concentration was recorded at Fort Lee Near Road with 3.1 ppm, and 2nd-highest 1-hour average CO concentrations was recorded at the Jersey City site with 2.7 ppm. The highest and second-highest 8-hour average CO concentrations were 2.6 and 2.4 ppm, both recorded at the Fort Lee Near Road station. The 2023 data is summarized in Table 8-2, and Figures 8-3 and 8-4.

Table 8-2
2023 Carbon Monoxide Concentrations in New Jersey
Highest and 2nd Highest 1-Hour and 8-Hour Average Concentrations
Parts per Million (ppm)

Monitoring Site	1-Hour Average Concentrations		8-Hour Average Concentrations	
	Highest	2nd-Highest	Highest	2nd-Highest*
Camden Spruce Street	1.9	1.8	1.5	1.4
Elizabeth	2.3	2.1	1.6	1.5
Elizabeth Lab	2.4	2.2	1.5	1.4
Fort Lee Near Road	3.1	1.5	1.1	1.1
Jersey City	2.7	2.7	2.6	2.4

*Non-overlapping 8-hour periods

Figure 8-3
2023 Carbon Monoxide Concentrations in New Jersey
Highest and 2nd Highest 1-Hour Average Concentrations
Parts per Million (ppm)

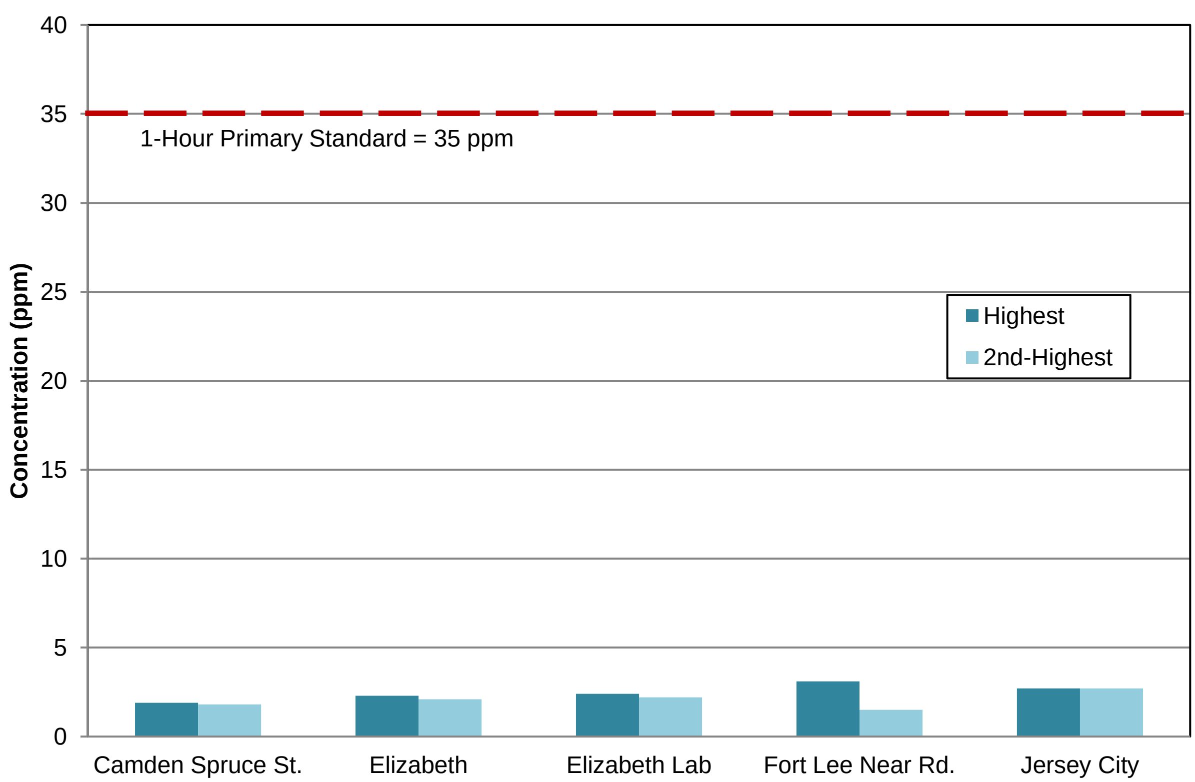
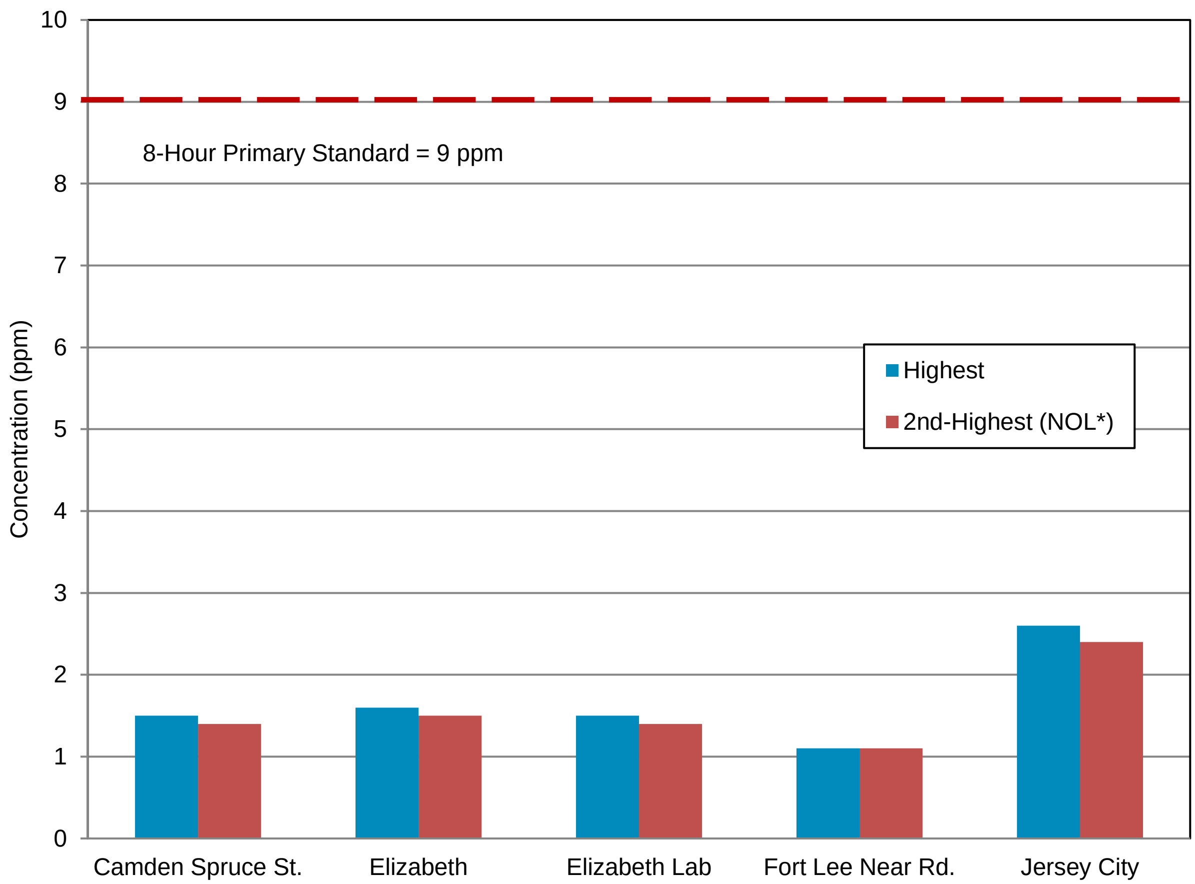


Figure 8-4
2023 Carbon Monoxide Concentrations in New Jersey
Highest and 2nd Highest 8-Hour Average Concentrations
Parts per Million (ppm)



*Non-overlapping 8-hour periods

CO Trends

Carbon monoxide levels in outdoor air have improved dramatically over the past two-and-a-half decades. Figures 8-5 and 8-6 and Table 8-3 present the trends in CO levels since 1990. The graphs and table actually show the second-highest 1-hour and 8-hour values recorded, because those are the design values that determine if the NAAQS are being met (one exceedance per site is allowed each year). The entire state was officially declared to have attained the CO standards as of August 23, 2002. Years ago, unhealthy levels of CO were recorded on a regular basis. The reduction in CO levels is due primarily to cleaner-running cars and other vehicles, which are by far the largest source of this pollutant outdoors. The last violation of the 8-hour NAAQS was in 1994.

Figure 8-5
Statewide Carbon Monoxide Trend in New Jersey, 1990-2023
Maximum 2nd-Highest 1-Hour Average Concentration
Parts per Million (ppm)

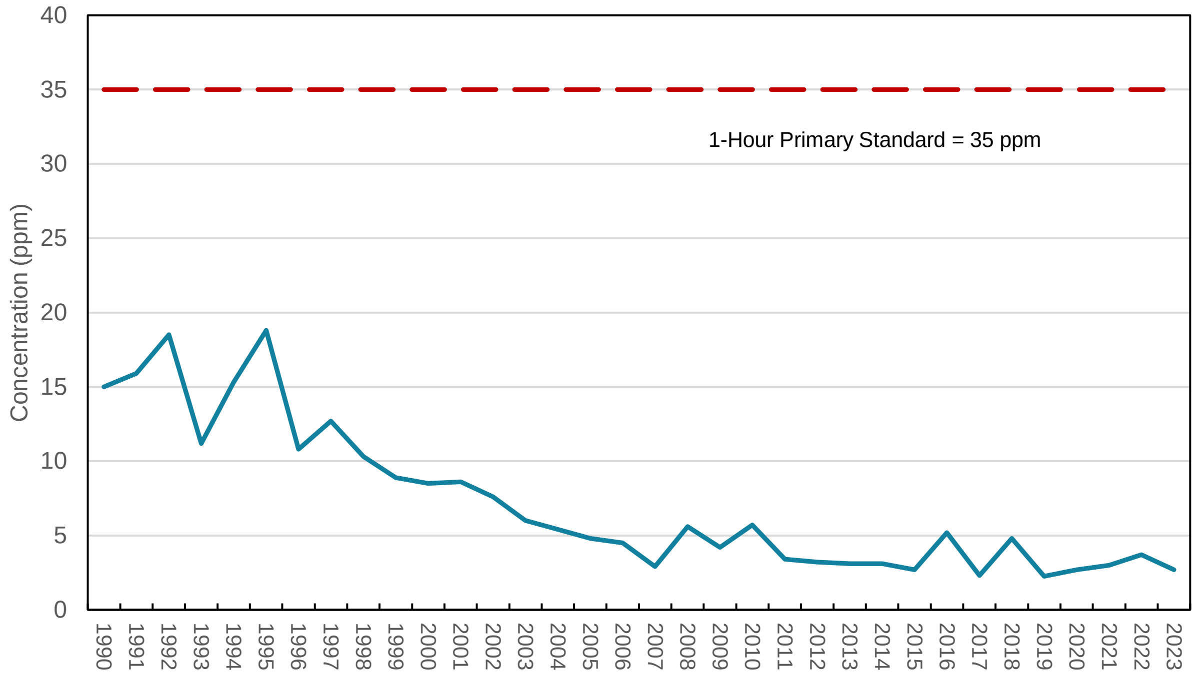


Figure 8-6
Statewide Carbon Monoxide Trend in New Jersey, 1990-2023
Maximum 2nd-Highest 8-Hour Average Concentration
Parts per Million (ppm)

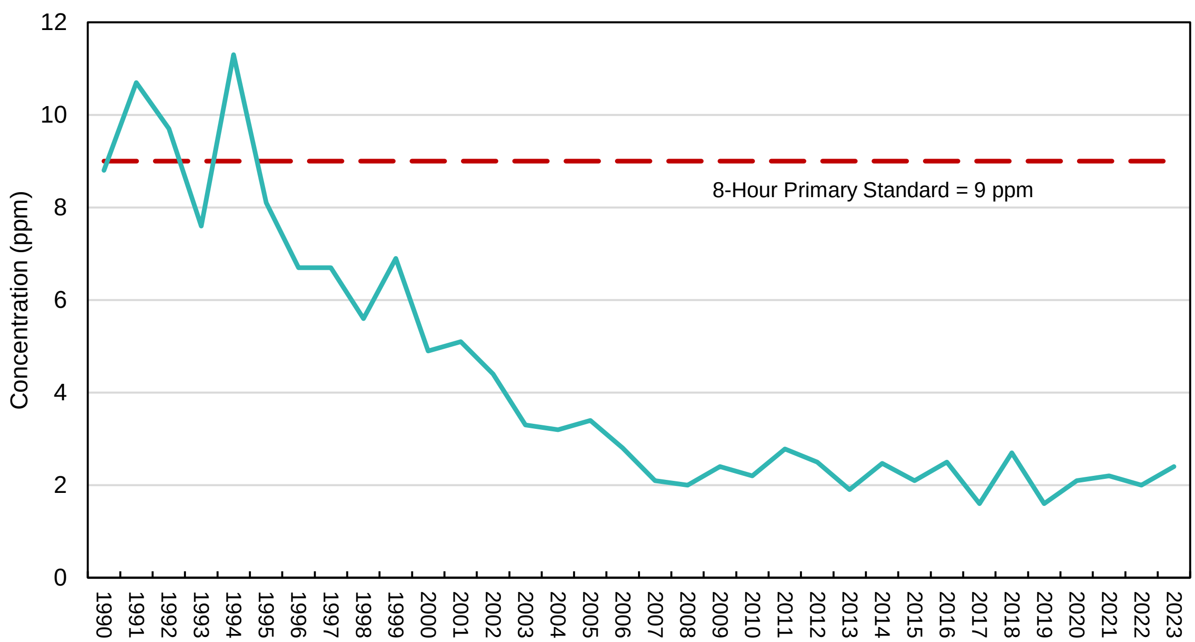


Table 8-3
Statewide New Jersey Carbon Monoxide Trends, 1990-2023
Maximum 2nd Highest 1-Hour and 8-Hour Average Concentrations
Parts per Million (ppm)

Year	Maximum 2nd-Highest Average Concentrations*	
	1-Hour	8-Hour
1990	15	8.8
1991	15.9	10.7
1992	18.5	9.7
1993	11.2	7.6
1994	15.3	11.3
1995	18.8	8.1
1996	10.8	6.7
1997	12.7	6.7
1998	10.3	5.6
1999	8.9	6.9
2000	8.5	4.9
2001	8.6	5.1
2002	7.6	4.4
2003	6	3.3
2004	5.4	3.2
2005	4.8	3.4
2006	4.5	2.8
2007	2.9	2.1
2008	5.6	2
2009	4.2	2.4
2010	5.7	2.2
2011	3.4	2.8
2012	3.2	2.5
2013	3.1	1.9
2014	3.1	2.5
2015	2.7	2.1
2016	5.2	2.5
2017	2.3	1.6
2018	4.8	2.7
2019	2.3	1.6
2020	2.7	2.1
2021	3.0	2.2
2022	3.7	2.0
2023	2.7	2.4

*Design values

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2023 Lead Summary

New Jersey Department of Environmental Protection

Sources

Lead is a criteria pollutant as well as a Hazardous Air Pollutant listed under the 1990 Clean Air Act. It is one of the first known and most widely studied environmental and occupational toxins.

Lead was once commonly used in paint and gasoline, and is still used in batteries, solder, pipes, pottery, roofing materials and some cosmetics. Since 1980, there has been a 99% decrease in the average lead air concentration nationwide. A phase-out of lead additive in gasoline began in the mid-1970s, although it is still used in aviation fuel in some smaller aircraft. The U.S. Environmental Protection Agency (USEPA) National Emissions Inventory estimates that 4.36 tons of lead were emitted in New Jersey in 2017, mostly from aircraft. New Jersey no longer has any significant industrial sources of lead.

Health Effects

Lead that is emitted into the air can be inhaled, or ingested after it settles (ingestion is actually the main route of human exposure to airborne lead). There is no level of lead exposure that is considered safe. The main target for lead toxicity is the nervous system, both in adults and children. However, children's developing brains are the most vulnerable to the effects of lead, leading to lifelong effects, even after exposure ceases. The brain damage caused by lead exposure can result in learning disabilities and delinquent behavior, impacting IQ and academic achievement. Lead can also damage red blood cells and weaken the immune system. Other effects in adults include increased blood pressure, cardiovascular disease, and decreased kidney function. In addition, lead is classified as a "probable human carcinogen."

Ambient Air quality Standards

A NAAQS for lead was first promulgated in 1978. A value of 1.5 µg/m^3 was established as both the primary and secondary standard. It was based on an average for each calendar quarter and was not to be exceeded. The New Jersey AAQS was based on a rolling three-month average. Thirty years later, in 2008, the NAAQS was lowered tenfold to 0.15 µg/m^3, also averaged over a rolling three-month period, and not to be exceeded.

A rolling three-month average considers each of the 12 three-month periods associated with a given year, not just the four calendar quarters within that year. The old NAAQS required lead to be sampled as total suspended particulate (TSP). In New Jersey, lead is now measured as inhalable particulates, PM_{10}.

Table 9-1
National Ambient Air Quality Standards for Lead
Micrograms Per Cubic Meter (µg/m^3)

Averaging Period	Type	Level	Design Value
3 Months (Rolling)	Primary & Secondary	0.15 µg/m^3	Not to be exceeded

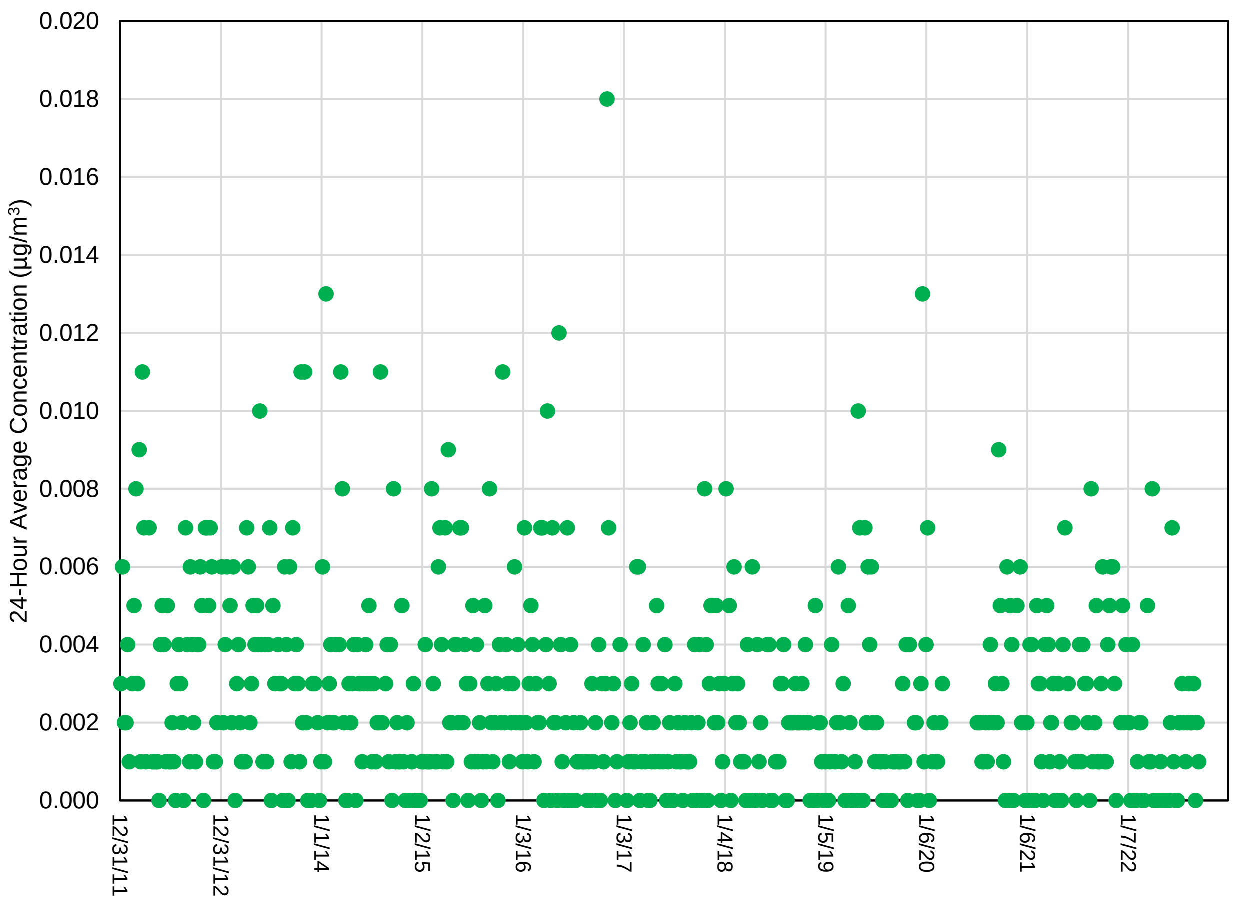
LEAD AIR LEVELS, 2012-2022

In the 1980s NJDEP had more than 20 lead monitors around the state, including a few specifically located near lead-emitting facilities, such as a battery manufacturer in New Brunswick and a paint factory in Newark. By 2008, after years of decreasing concentrations, all of New Jersey's lead monitors were shut down. In March 2012, a lead monitor was installed at the Newark Firehouse monitoring station in accordance with new NAAQS requirements. Almost all 24-hour lead concentrations measured at Newark Firehouse since 2012 were less than 10% of the 3-month average lead NAAQS. Figure 9-1 presents all the data from the Newark from 2012 to 2022.

Unfortunately, the Newark Firehouse monitoring station had to be shut down in late September 2022 and there was no lead data collected in 2023 for comparison to the lead NAAQS. NJDEP identified a replacement for the Newark Firehouse station and plans to resume lead monitoring in 2025.

Lead is also one of the elements analyzed from 24-hour filter-based $PM_{2.5}$ samples collected as part of the U.S Environmental Protection Agency Chemical Speciation Network (CSN). Since the CSN collects $PM_{2.5}$ samples rather than TSP or PM_{10} samples, the concentrations of lead from the analysis of $PM_{2.5}$ samples are not suitable for comparison to the lead NAAQS. More information about the lead data collected by the NJDEP stations in the CSN network is available from Appendix B: Fine Particulate Speciation Summary of the 2023 Annual Air Quality Report.

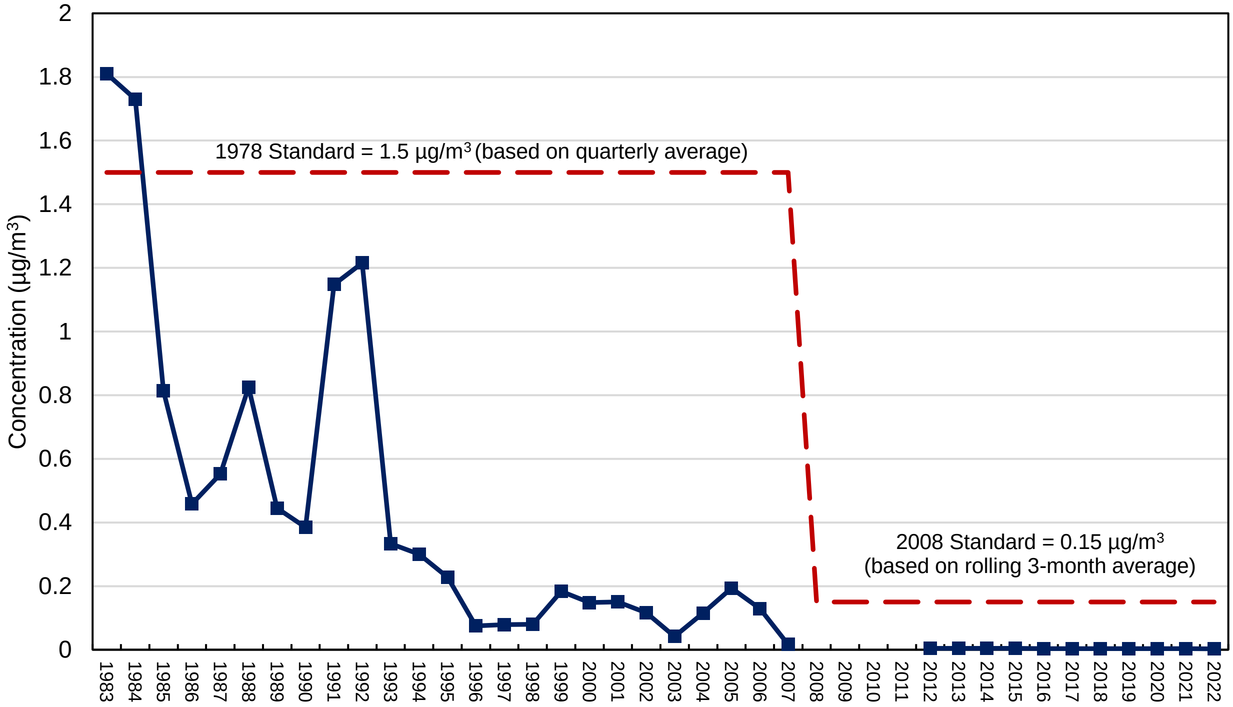
Figure 9-1
Lead Concentrations at Newark Firehouse in New Jersey, 2012-2022
24-Hour Averages
Micrograms per Cubic Meter (µg/m³)



LEAD AIR TREND

The last exceedances of the NAAQS were in 1983 and 1984 (as shown in Figure 9-2), and the last exceedance of the NJAAQS was in 1992 (based on a rolling 3-month average; not shown in the graph). Since then, air concentrations of lead in New Jersey have dropped considerably. The highest annual 3-month rolling average concentrations at Newark Firehouse from 2012 to 2022 have ranged from 0.003 to 0.004 µg/m³.

Figure 9-2
Statewide New Jersey Lead Trend, 1983-2022
Highest 3-Month Averages
Micrograms per Cubic Meter (µg/m³)



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2023 Air Toxics Summary

New Jersey Department of Environmental Protection

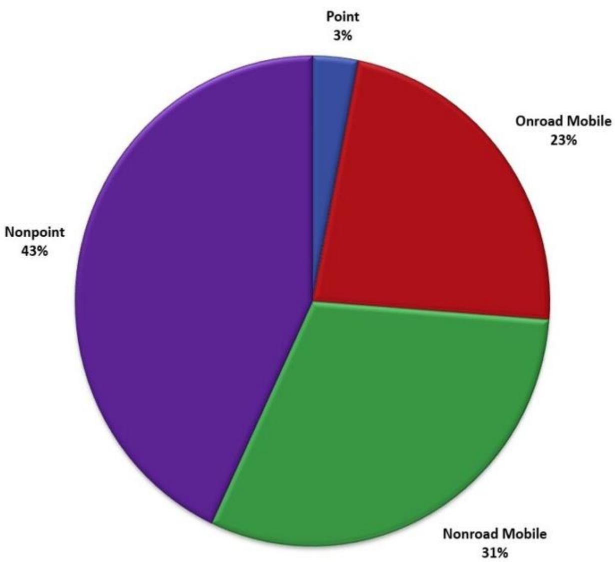
Introduction

Air pollutants can be generally divided into two categories: criteria pollutants (ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter, and lead); and air toxics. The criteria pollutants have been regulated at the national level since the 1970s. The United States Environmental Protection Agency (USEPA) has set National Ambient Air Quality Standards (NAAQS) for them, and states and local or tribal jurisdictions are required to plan and implement a process to bring and keep levels below the NAAQS, using monitoring, reporting, and control measures. Each of these pollutants is discussed in its own section (Sections 4 through 9) of this New Jersey Department of Environmental Protection (NJDEP) 2019 Air Quality Report.

Air toxics are all the other chemicals released into the air that have the potential to cause adverse health effects in humans. These effects cover a wide range of conditions, from lung irritation to birth defects to cancer. There are no NAAQS for these pollutants, but in 1990 the U.S. Congress directed the USEPA to begin addressing a list of 187 air toxics by developing control technology standards for specific types of sources that emit them. These air toxics are known as the Clean Air Act Hazardous Air Pollutants (HAPs). You can get more information about HAPs at the USEPA Air Toxics web site at https://www.epa.gov/haps. NJDEP also has several web pages dedicated to air toxics. They can be accessed at www.nj.gov/dep/airtoxics.

Sources of Air Toxics

Figure 10-1
2019 Air Toxics Emissions Source Estimates for New Jersey



Source:
https://dep.nj.gov/airplanning/airtoxics/sources-of-air-toxics-2019-airtoxscreen/

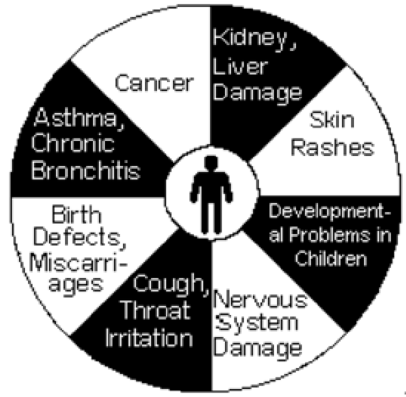
USEPA compiles a National Emissions Inventory (NEI) every three years. In addition to criteria pollutants and criteria precursors, it also collects information on emissions of hazardous air pollutants. The pie chart in Figure 10-1, taken from the most recent available NEI (for 2019), shows that mobile sources are the largest contributors of air toxics emissions in New Jersey.

In New Jersey, on-road mobile sources (cars and trucks) account for 23% of the air toxics emissions, and non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, dirt bikes, etc.) contribute an additional 31%. Nonpoint sources (residential, commercial, and small industrial sources) represent 43% of the inventory and point sources (such as factories and power plants) account for the remaining 3%.

HEALTH EFFECTS

People exposed to air toxics in significant amounts or for significant periods may have an increased chance of developing cancer or experiencing other serious health effects. The noncancer health effects can range from respiratory, neurological, reproductive, developmental, or immune system damage, to irritation and effects on specific organs (see Figure 10-2). In addition to inhalation exposure, there can be risks from the deposition of toxic pollutants onto soil or surface water. There, they can be taken up by humans directly, or by consuming exposed plants and animals.

Figure 10-2
Potential Effects of Air Toxics

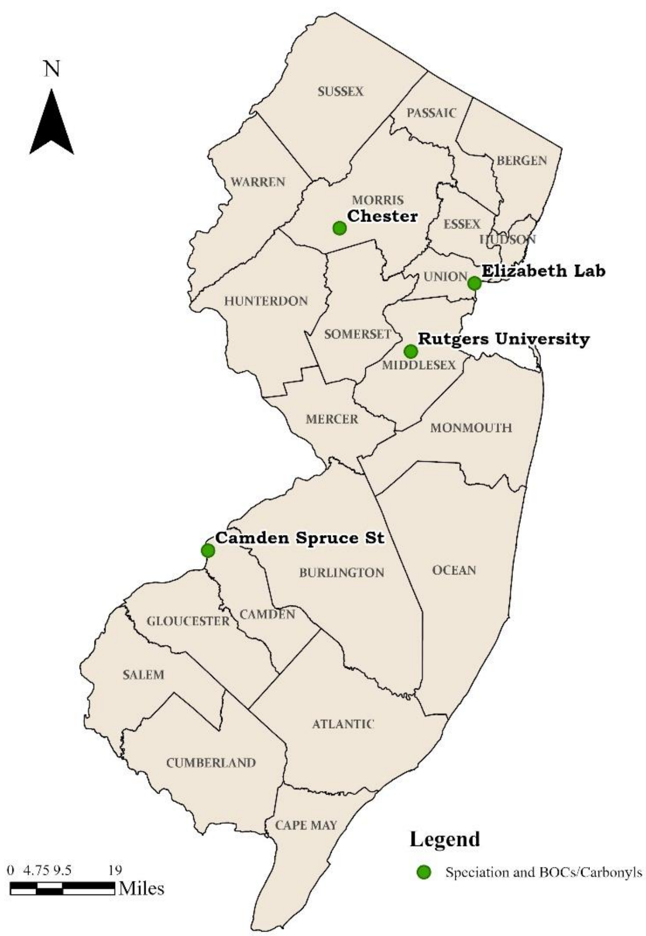


www3.epa.gov/ttn/atw/3_90_024.html

AIR TOXICS MONITORING NETWORK

NJDEP has four air toxics monitoring sites that measure volatile organic compounds (VOCs) and carbonyls (a subset of VOCs that includes formaldehyde, acetaldehyde and other related compounds).

Figure 10-3
2023 Air Toxics Monitoring Network



As shown in Figure 10-3, the monitors are located at Camden Spruce Street, Chester, Elizabeth Lab, and Rutgers University in East Brunswick. Toxic metals data are collected at the same four monitoring stations, plus Newark Firehouse which unfortunately closed in September of 2022. The NJDEP plans to resume toxic metals monitoring at a new site in Newark in 2025.

The Chester monitoring site is in rural Morris County, away from known sources, and serves as kind of a "background" monitor. The Rutgers University monitoring station is situated on Rutgers University agricultural lands in East Brunswick. The Elizabeth Lab monitoring station sits next to the Exit 13 tollbooths on the New Jersey Turnpike. The Camden Spruce Street monitoring station is located in an industrial urban setting. More information about the air monitoring sites can be found in the Air Monitoring Network section and Appendix A of this annual Air Quality Report.

New Jersey's VOC monitors are part of the Urban Air Toxics Monitoring Program (UATMP), sponsored by the USEPA. A 24-hour integrated air sample is collected in a canister every six days, and then sent to the USEPA contract laboratory (ERG, located in North Carolina) to be analyzed for VOCs and carbonyls. A previous monitoring site in Camden (officially called the Camden Lab site) had been measuring toxic VOCs for the UATMP since 1989, but was shut down in 2008 when NJDEP lost access to the location. A new monitoring station, the Camden Spruce Street monitoring site, became operational in 2013. The Elizabeth Lab site began measuring VOCs in 2000, and in July 2001 toxics monitoring began at the Chester and New Brunswick monitoring stations. In 2016 the New Brunswick VOC monitor was moved to the Rutgers University monitoring site, less than a mile away.

The map in Figure 10-3 also shows the monitoring sites that are part of USEPA's Chemical Speciation Network (CSN). The CSN was established to analyze fine particulate matter ($PM_{2.5}$) for toxic metals, elements, ions and carbon constituents. Filters are collected every three or six days and sent to a national lab for analysis. Sampling began in 2001 at Camden, Chester, Elizabeth Lab and New Brunswick. The Newark Firehouse site was added in 2010 (and shut down in 2022), and the New Brunswick CSN monitor was moved to Rutgers University in 2016. See Appendix B for more information.

AIR TOXICS LEVELS IN 2023

Annual average concentrations of VOCs and carbonyls for the four New Jersey monitoring sites are shown in Table 10-1. All values are in micrograms per cubic meter ($\mu g/m^3$). Values in parts per billion by volume (ppbv), as well as other statistics and risk estimates, can be found in Tables 10-4 through 10-7. The ppbv units are more common in air monitoring, while $\mu g/m^3$ units are generally used in air dispersion modeling and health studies.

Detection limit information and the health benchmarks used in the analysis can be found in Table 10-9. Some compounds are not always detected in the samples analyzed by the lab; however, this does not mean they are not present in the air below the detection limit level. For chemicals detected in less than 50% of the samples, there is significant uncertainty in the calculated averages. Median values (the value of the middle sample when the results are ranked) are reported in Tables 10-4 through 10-7 along with the mean (average) concentrations, because for some compounds only a single value or a few very high values were recorded. These high values could skew the mean concentrations, but would have less effect on the median value. In such cases, the median value may be a better indicator of long-term exposure concentrations.

Table 10-1
2023 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey
Annual Average Concentrations

Micrograms per Cubic Meter (μg/m^3)

	Pollutant	Synonym	HAP	CAS No.	Camden	Chester	Elizabeth	Rutgers
1	Acetaldehyde		*	75-07-0	2.074	1.495	1.733	1.916
2	Acetone			67-64-1	2.091	1.860	2.408	2.921
3	Acetonitrile		*	75-05-8	0.686	4.019	0.665	0.627
4	Acetylene			74-86-2	0.843	0.482	0.991	0.616
5	Acrolein		*	107-02-8	0.627	0.585	0.728	0.012
6	Acrylonitrile		*	107-13-1	*0.007*	*0.006*	*0.014*	*0.0002*
7	tert-Amyl Methyl Ether			994-05-8	*0.002*	*0.0003*	*0.0003*	0.072
8	Benzaldehyde			100-52-7	0.138	0.168	0.110	0.532
9	Benzene		*	71-43-2	0.715	0.420	0.804	0.009
10	Bromochloromethane			74-97-5	0.009	0.009	0.009	*0.005*
11	Bromodichloromethane			75-27-4	*0.005*	*0.002*	*0.004*	0.017
12	Bromoform		*	75-25-2	0.016	0.014	0.020	0.037
13	Bromomethane	Methyl bromide	*	74-83-9	0.162	0.052	0.044	0.024
14	1,3-Butadiene		*	106-99-0	0.043	0.012	0.057	0.080
15	Butyraldehyde			123-72-8	0.203	0.110	0.116	0.063
16	Carbon Disulfide		*	75-15-0	0.063	0.061	0.058	0.488
17	Carbon Tetrachloride		*	56-23-5	0.497	0.497	0.493	*0*
18	Chlorobenzene		*	108-90-7	*0.001*	*0*	*0.001*	0.073
19	Chloroethane	Ethyl chloride	*	75-00-3	0.071	0.045	0.059	0.132
20	Chloroform		*	67-66-3	0.120	0.099	0.147	1.015
21	Chloromethane	Methyl chloride	*	74-87-3	1.009	0.993	1.008	*0.0002*
22	Chloroprene	2-Chloro-1,3-butadiene	*	126-99-8	*0.0003*	*0.0002*	*0*	*0.009*
23	Crotonaldehyde			123-73-9	*0.012*	*0.008*	*0.010*	0.004
24	Dibromochloromethane	Chlorodibromomethane		124-48-1	0.004	0.003	0.005	*0.001*
25	1,2-Dibromoethane	Ethylene dibromide	*	106-93-4	*0.001*	*0.001*	*0.001*	0.003
26	m-Dichlorobenzene	1,3-Dichlorobenzene		541-73-1	*0.002*	0.002	0.004	0.003
27	o-Dichlorobenzene	1,2-Dichlorobenzene		95-50-1	0.002	0.002	0.005	0.029
28	p-Dichlorobenzene	1,4-Dichlorobenzene	*	106-46-7	0.053	0.014	0.053	2.550
29	Dichlorodifluoromethane			75-71-8	2.590	2.549	2.521	*0.0003*
30	1,1-Dichloroethane	Ethylidene dichloride	*	75-34-3	*0.0005*	*0.0004*	*0.0005*	0.071
31	1,2-Dichloroethane	Ethylene dichloride	*	107-06-2	0.090	0.067	0.069	0.005
32	1,1-Dichloroethylene	Vinylidene chloride	*	75-35-4	0.005	0.004	0.003	*0*
33	cis-1,2-Dichloroethylene	cis-1,2-Dichloroethene		156-59-2	*0.0001*	*0*	*0.001*	0.008
34	trans-1,2-Dichloroethylene	trans-1,2-Dichloroethene		156-60-5	0.017	0.042	0.019	1.633
35	Dichloromethane	Methylene chloride	*	75-09-2	0.526	0.464	0.623	*0*
36	1,2-Dichloropropane	Propylene dichloride	*	78-87-5	*0*	*0*	*0*	*0*

Continued

- Values in ppbv can be found in Tables 10-4 through 10-7.
- *Values in **italics** indicate that fewer than 50% of samples had detectable levels.*
- **Zero** indicates that there were no samples with reportable levels.
- HAP = Hazardous air pollutant as listed in the Clean Air Act.

Table 10-1 (continued)
2023 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey
Annual Average Concentrations
Micrograms per Cubic Meter (μg/m³)

	Pollutant	Synonym	HAP	CAS No.	Camden	Chester	Elizabeth	Rutgers
37	cis-1,3-Dichloropropylene	cis-1,3-Dichloropropene	*	10061-01-5	*0*	*0.0001*	*0*	*0*
38	trans-1,3-Dichloropropylene	trans-1,3-Dichloropropene	*	10061-02-6	*0*	*0*	*0*	0.124
39	Dichlorotetrafluoroethane	Freon 114		76-14-2	0.120	0.123	0.111	*0*
40	Ethyl Acrylate		*	140-88-5	*0*	*0*	*0*	0.146
41	Ethylbenzene		*	100-41-4	0.251	0.072	0.282	*0.0001*
42	Ethyl tert-Butyl Ether	tert-Butyl ethyl ether		637-92-3	0.009	*0.001*	*0.002*	1.567
43	Formaldehyde		*	50-00-0	2.799	3.478	2.705	0.005
44	Hexachlorobutadiene	Hexachloro-1,3-butadiene	*	87-68-3	0.004	0.004	0.005	0.259
45	Hexaldehyde	Hexanaldehyde		66-25-1	0.175	0.307	0.552	0.272
46	Methyl Ethyl Ketone	MEK, 2-Butanone		78-93-3	0.278	0.204	0.286	0.057
47	Methyl Isobutyl Ketone	MIBK	*	108-10-1	0.091	0.046	0.080	*0*
48	Methyl Methacrylate		*	80-62-6	*0*	*0*	*0*	*0*
49	Methyl tert-Butyl Ether	MTBE	*	1634-04-4	*0*	*0*	*0*	0.120
50	n-Octane			111-65-9	0.280	0.077	0.332	0.218
51	Propionaldehyde		*	123-38-6	0.356	0.271	0.271	1.118
52	Propylene			115-07-1	2.660	0.865	2.406	0.085
53	Styrene		*	100-42-5	0.259	0.032	0.097	*0.001*
54	1,1,2,2-Tetrachloroethane		*	79-34-5	*0.001*	*0.002*	*0.002*	0.070
55	Tetrachloroethylene	Perchloroethylene	*	127-18-4	0.141	0.054	0.114	1.552
56	Toluene		*	108-88-3	1.498	0.465	1.565	0.014
57	1,2,4-Trichlorobenzene		*	120-82-1	0.010	0.009	0.022	0.011
58	1,1,1-Trichloroethane	Methyl chloroform	*	71-55-6	0.013	0.009	0.011	*0*
59	1,1,2-Trichloroethane		*	79-00-5	*0*	*0.001*	*0.001*	0.020
60	Trichloroethylene		*	79-01-6	0.021	*0.009*	0.024	1.410
61	Trichlorofluoromethane			75-69-4	1.952	1.445	1.436	0.587
62	Trichlorotrifluoroethane	1,1,2-Trichloro-1,2,2-trifluoroethane		76-13-1	0.586	0.573	0.587	0.120
63	1,2,4-Trimethylbenzene			95-63-6	0.344	0.068	0.267	0.028
64	1,3,5-Trimethylbenzene			108-67-8	0.073	0.012	0.060	0.071
65	Valeraldehyde			110-62-3	0.156	0.091	0.117	0.003
66	Vinyl chloride		*	75-01-4	0.010	*0.001*	0.002	
67	m,p-Xylene		*	108-38-3 106-42-3	0.733	0.160	0.779	0.340
68	o-Xylene		*	95-47-6	0.293	0.069	0.310	0.139

- Values in ppbv can be found in Tables 10-4 through 10-7.
- *Values in **italics** indicate that fewer than 50% of samples had detectable levels.*
- **Zero** indicates that there were no samples with reportable levels.
- HAP = Hazardous air pollutant as listed in the Clean Air Act.

ESTIMATING HEALTH RISK

The effects on human health resulting from exposure to specific air toxics can be estimated by using chemical-specific **health benchmarks**. These are based on toxicity values developed by the USEPA and other agencies, using animal or human health studies. For carcinogens, which are chemicals suspected of causing cancer, the health benchmark is the concentration of the pollutant that corresponds to a one-in-one-million increase in the risk of getting cancer if a person was to breathe that concentration over his or her entire lifetime. The health benchmark for a noncarcinogen is the air concentration at which no adverse health effect is expected to occur, even if a person is exposed to that concentration on a daily basis for a lifetime (this is also known as a reference concentration). Because of a lack of toxicity studies, not all air toxics have health benchmarks. The health benchmarks used to evaluate the VOCs and carbonyls monitored in New Jersey are listed in Table 10-9. Health benchmarks for specific toxic metals and elements are shown in Table 10-3. These are all based on long-term exposure.

A **risk ratio** can be used to quantify risk from exposure to a specific chemical. This is calculated by dividing the annual average air concentration of a chemical by its long-term health benchmark. If the risk ratio is less than one, the air concentration should not pose a health risk. If it is greater than one, it may be of concern. The risk ratio also indicates how much higher or lower the estimated air concentration is compared to the health benchmark. Identifying problematic chemicals helps regulatory agencies focus their efforts to reduce emissions and exposure.

Air toxics with risk ratios greater than one for at least one monitoring site are summarized in Table 10-2. Acrolein and Formaldehyde showed the highest risk statewide. Other pollutants above health benchmarks at all four sites were Acetaldehyde, Benzene, Carbon Tetrachloride, Chloroform, Chloromethane (Methyl Chloride), and 1,2-Dichloroethane (Ethylene Dichloride).
1,3-Butadiene had a risk ratio slightly greater than one at all sites except Chester and Rutgers.

Table 10-2
Monitored Air Toxics with Risk Ratios Greater Than One in 2023

Pollutant		CAS No.	Annual Average Risk Ratio			
			Camden	Chester	Elizabeth	Rutgers
1	Acetaldehyde	75-07-0	4.6	3.3	3.9	2.2
2	Acrolein	107-02-8	*31.4*	*29.3*	*36.4*	*30.8*
3	Benzene	71-43-2	5.5	3.2	6.2	4.1
4	1,3-Butadiene	106-99-0	1.3	0.4	1.7	0.7
5	Carbon Tetrachloride	56-23-5	2.9	2.9	2.9	2.9
6	Chloroform	67-66-3	2.8	2.3	3.4	3.1
7	Chloromethane	74-87-3	1.8	1.8	1.8	1.8
8	1,2-Dichloroethane	107-06-2	2.4	1.8	1.8	1.9
9	Formaldehyde	50-00-0	36.4	45.2	35.1	20.4

- Risk ratio = annual average air concentration/health benchmark
- Health benchmarks in italics have a noncancer endpoint. See section on “Estimating Health Risk” for more information.
- Health benchmarks in bold are based on less than 50% of samples detected and are highly uncertain.

Table 10-3 presents annual average concentrations and health benchmarks for certain toxic metals and elements that can be found in fine particles. This fine particulate matter is analyzed through USEPA’s Chemical Speciation Network (CSN). No risk ratios were calculated, because most of the chemicals were below the detection limit and so the resulting average concentrations are highly uncertain. Additional data from the CSN monitors can be found in Appendix B (Fine Particulate Speciation Summary) of the annual Air Quality Report.

Table 10-3
2023 Summary of Toxic Metals and Elements Monitored in New Jersey
Annual Average Concentrations & Health Benchmarks
Micrograms per Cubic Meter ($\mu g/m^3$)

Pollutant	HAP	Camden	Chester	Elizabeth	Rutgers	Health Benchmark
Antimony	*	0.005	*0.003*	0.004	0.005	0.2
Arsenic	*	*0.00001*	*0*	*0.000*	*0.00001*	0.00023
Cadmium	*	0.005	*0.003*	0.004	0.004	0.00024
Chlorine	*	0.090	0.002	0.015	0.013	0.2
Chromium[a]	*	0.003	0.001	0.003	0.002	0.000083
Cobalt	*	*0.000*	*0.0004*	*0.0002*	*0.0002*	0.00013
Lead	*	0.005	0.003	0.003	0.004	0.083
Manganese	*	0.004	0.001	0.003	0.003	0.05
Nickel[b]	*	0.001	0.001	0.002	0.001	0.0021
Phosphorus	*	0.000	0.0002	0.0007	0.0005	0.07
Selenium	*	*0.001*	*0.001*	*0.0007*	0.001	20
Silicon		0.063	0.035	0.061	0.045	3
Vanadium		*0.000*	*0.0001*	*0.0004*	*0.0001*	0.1

- Annual average values in italics had fewer than 50% of samples detectable, so the averages are highly uncertain.
- HAP = Hazardous air pollutant listed in the Clean Air Act.
- Health benchmarks in italics have a noncancer endpoint. See section on “Estimating Health Risk” for more information.

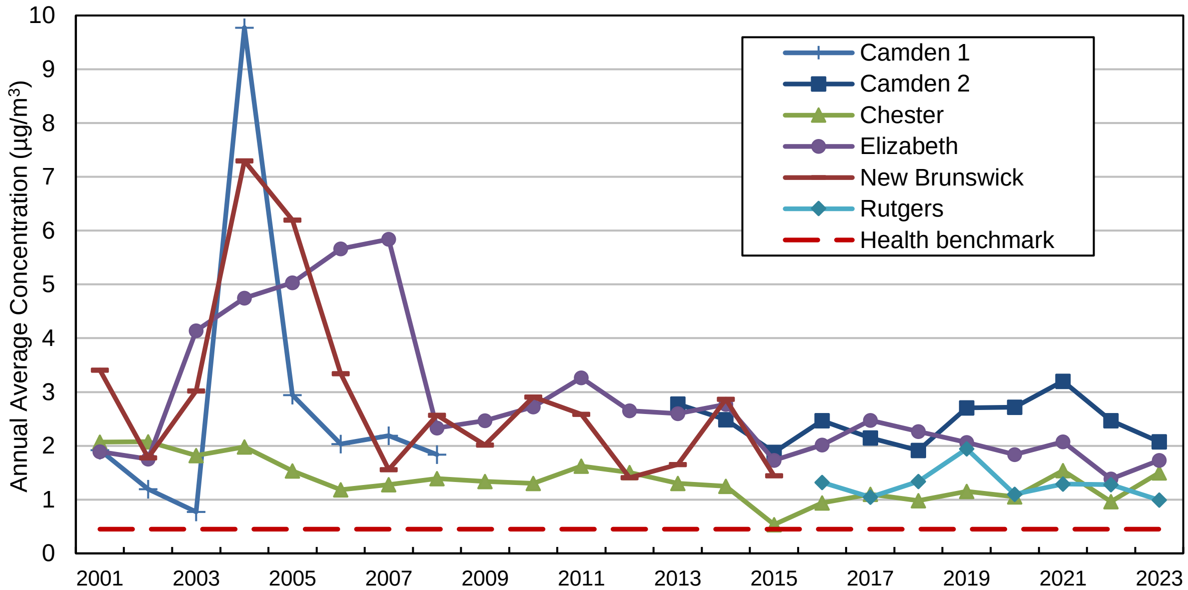
a) Chromium’s health benchmark is based on carcinogenicity of hexavalent chromium (Cr+6). It is not known how much of the chromium measured by the monitor is hexavalent.
b) Nickel’s health benchmark is based on specific nickel compounds. It is not known how much of the nickel measured by the monitor is in that form.

TRENDS AND COMPARISONS

Monitoring of air toxics in New Jersey has been going on since a UATMP site was established in Camden in 1989. Sampling and analysis methods continue to evolve, most notably with improvements in the ability to detect chemicals at lower concentrations. Figures 10-4 through 10-11 present data for some of the VOCs that have been measured for a number of years and are at levels of concern (above their health benchmarks). As mentioned previously, the first toxics monitoring site in Camden (Camden Lab) was shut down in 2008. It is identified in Figures 10-4 through 10-11 as “Camden 1.” The new Camden site (Camden Spruce Street), located about two miles from the old site, is designated “Camden 2” in the trend graphs. The New Brunswick monitoring station was shut down in 2016, and the monitors were moved less than a mile to the Rutgers University site.

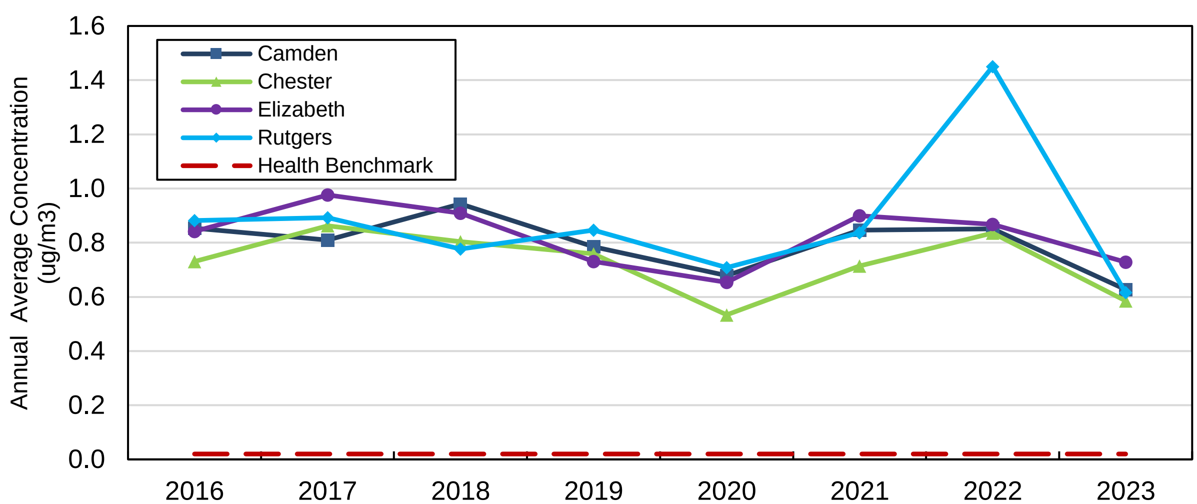
According to USEPA's 2014 National Air Toxics Assessment (NATA), **Acetaldehyde** concentrations in New Jersey (Figure 10-4) are primarily influenced by secondary formation, a process in which chemicals in the air react with each other and are transformed into other chemicals. Mobile sources also contribute to ambient levels. In 2003, no data was collected in Camden after September, which probably had an influence on the low annual average for that year. In 2004, high levels of acetaldehyde were measured over a number of weeks at both Camden and New Brunswick.

Figure 10-4
ACETALDEHYDE – New Jersey Monitored Concentrations



Acrolein is sometimes used as a pesticide and to make other chemicals, but by far most of it is formed in the air from burning fossil fuels (gasoline, oil) and organic matter (including cigarettes). It is not known if it causes cancer, but it can have detrimental effects on the respiratory system. Prior to 2016, there were concerns that the laboratory methods used to measure acrolein were inadequate. The analysis methods have since been improved, and the recent data is presented in Figure 10-5. The increase in the Rutgers average is the result of an exceptionally high value on 8/27/2022.

Figure 10-5
ACROLEIN – New Jersey Monitored Concentrations



Figures 10-6 and 10-7 show a general decrease in **Benzene** and **1,3-Butadiene** concentrations over the past decade. Over 50% of New Jersey's ambient Benzene and 1,3-Butadiene comes from on-road mobile sources, and about 20% comes from non-road mobile sources.

Figure 10-6
BENZENE – New Jersey Monitored Concentrations

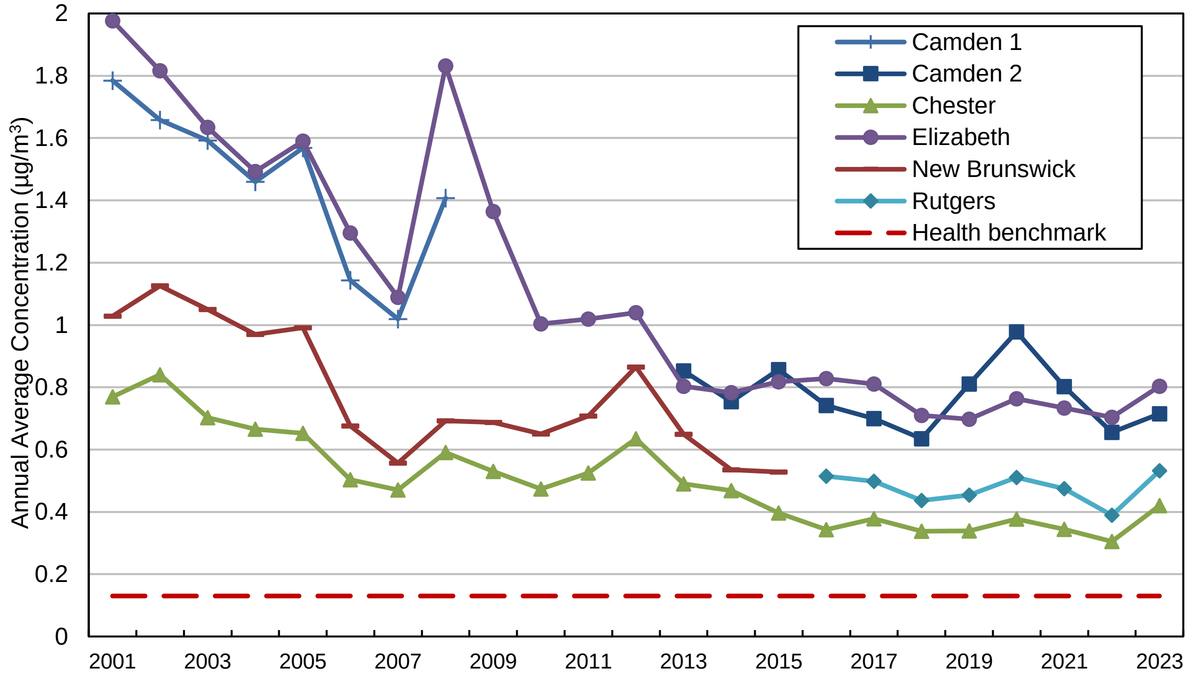
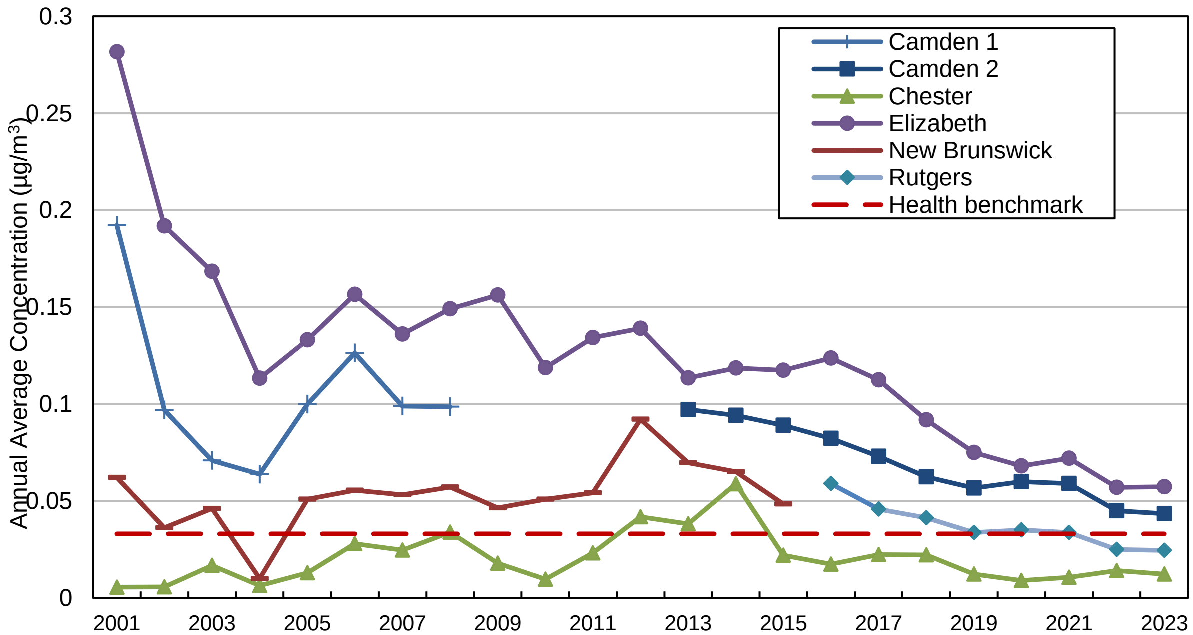
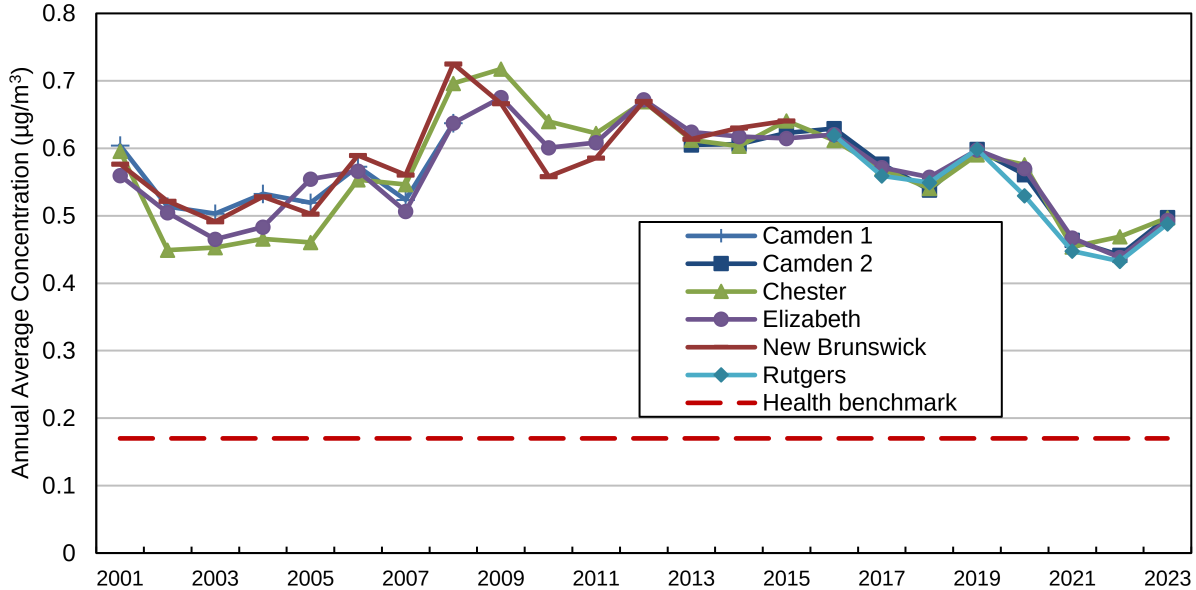


Figure 10-7
1,3-BUTADIENE – New Jersey Monitored Concentrations



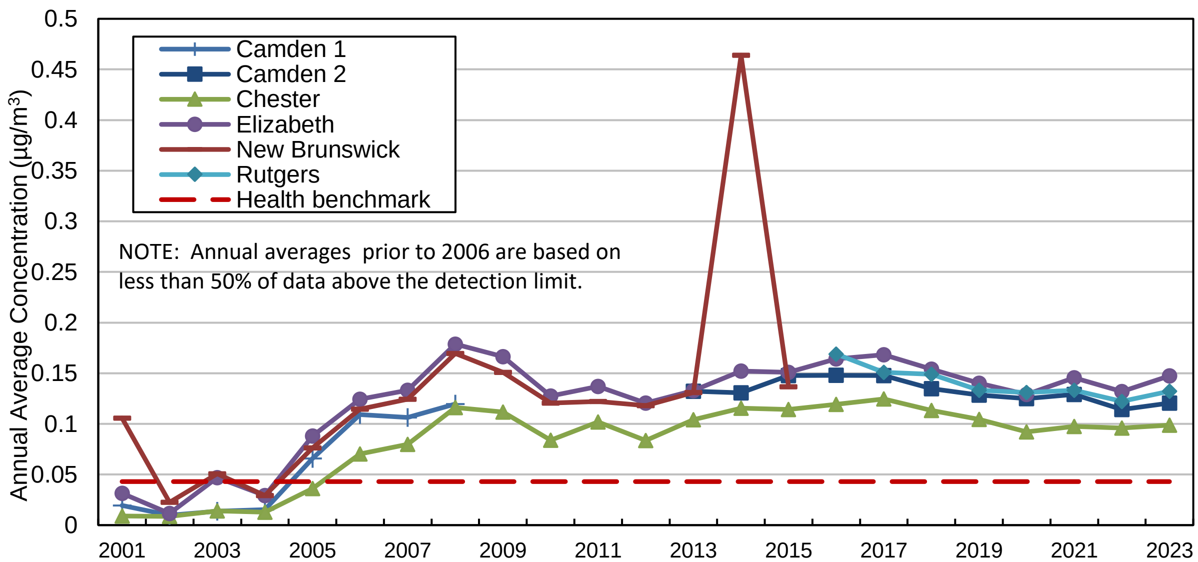
Carbon Tetrachloride (Figure 10-8) was once used widely as a degreaser, household cleaner, propellant, refrigerant, and fumigant. It has been phased out of most production and use because of its toxicity and because it depletes stratospheric ozone. However, about 100 tons are still emitted annually by industry in the U.S., although no emissions have been reported in New Jersey for years. It degrades slowly in the environment, so it can be transported from other areas, and levels in the air can remain relatively steady for a long time.

Figure 10-8
CARBON TETRACHLORIDE – New Jersey Monitored Concentrations



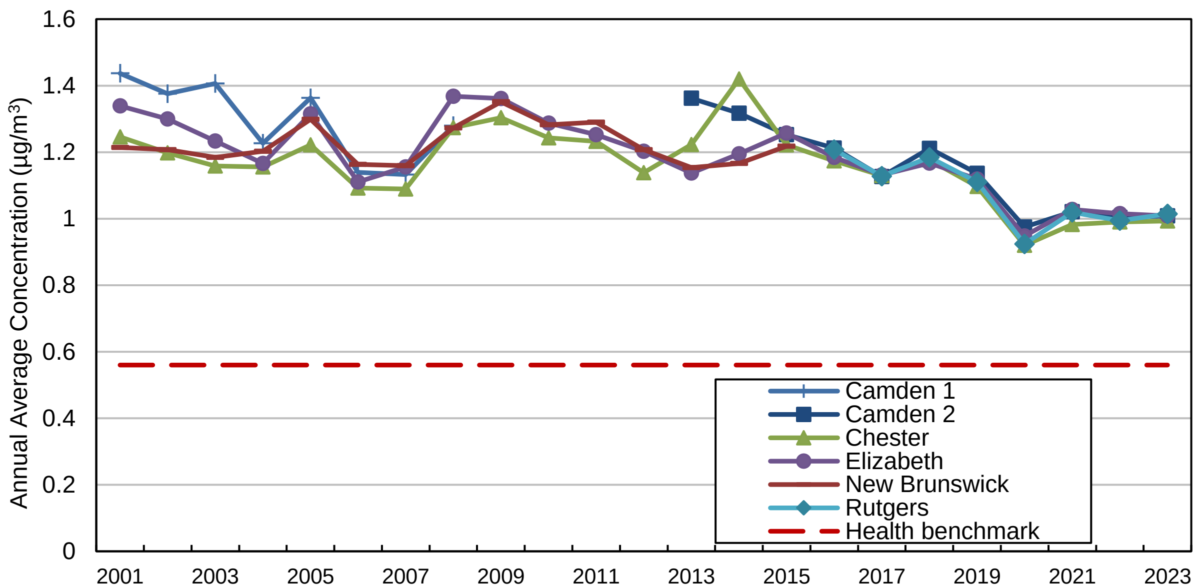
Some of the increase in the **Chloroform** concentration shown in Figure 10-9 is believed to be from improvements in the laboratory detection limit. The high annual average concentration for New Brunswick in 2014 is attributable to a period of high values in May and June. Point and nonpoint sources (related to waste disposal) are the major contributors to ambient chloroform levels in New Jersey. Chloroform can be formed in small amounts by chlorination of water. It breaks down slowly in ambient air.

Figure 10-9
CHLOROFORM – New Jersey Monitored Concentrations



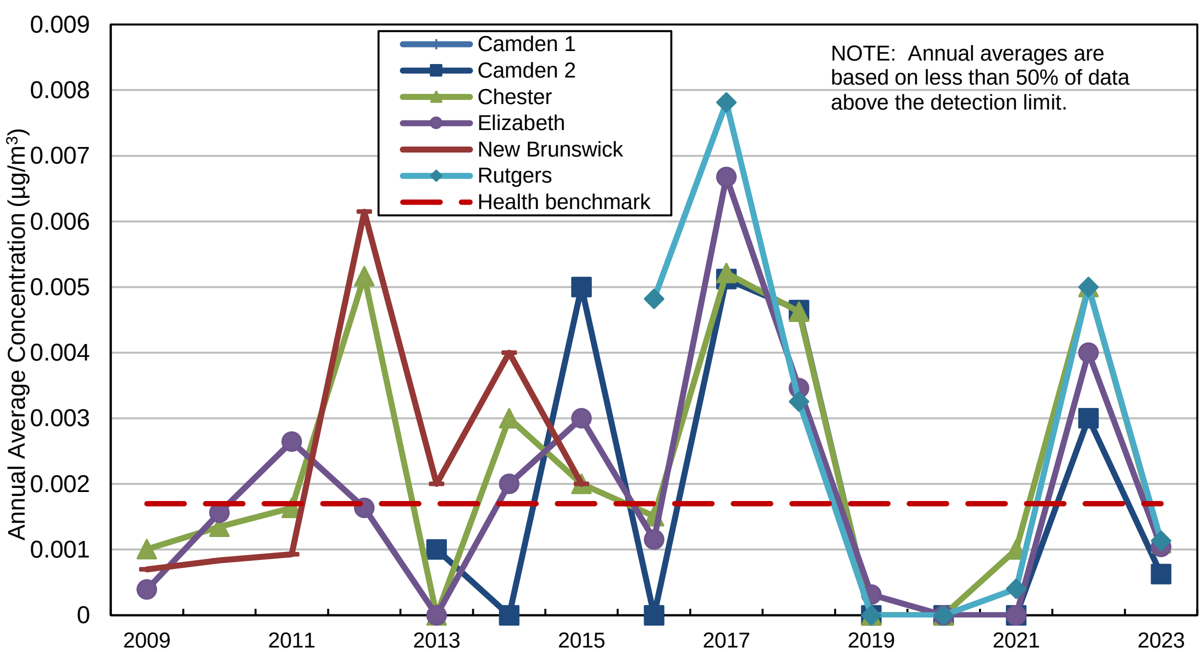
As seen in Figure 10-10, **Chloromethane** (also known as methyl chloride) levels have remained relatively stable from year to year, and all the sites show similar levels. It was once commonly used as a refrigerant and in the chemical industry, but was phased out because of its toxicity. According to the USEPA's 2014 National Emissions Inventory, about 73% of the Chloromethane in New Jersey's air is from nonpoint sources, primarily waste disposal, while 27% is from point sources.

Figure 10-10
CHLOROMETHANE (Methyl Chloride) – New Jersey Monitored Concentrations



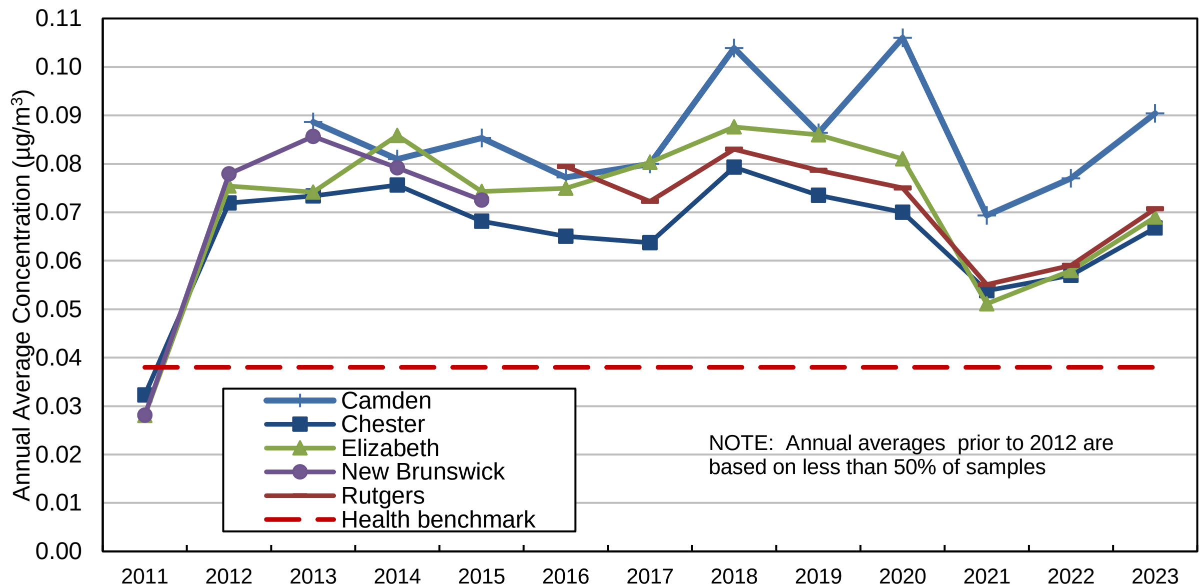
1,2-Dibromoethane (also known as ethylene dibromide) (Figure 10-11) is currently used as a pesticide in the treatment of felled logs for bark beetles and termites, and control of wax moths in beehives. It was once used as an additive to leaded gasoline and as a soil and grain fumigant, but those uses have been banned by USEPA. Most of the monitoring results fall below the detection limit, so the data in the graph is fairly uncertain.

Figure 10-11
1,2-DIBROMOETHANE (Ethylene Dibromide) – New Jersey Monitored Concentrations



1,2-Dichloroethane (also known as Ethylene Dichloride) (Figure 10-12) is primarily used in the production of chemicals, as a solvent, dispersant and wetting and penetrating agent. The increase in concentrations after 2011 is related to an improvement in the laboratory detection limit, resulting in over 90% of samples having detectable levels. The 2014 National Emissions Inventory estimates that 93% of 1,2-Dichloroethane in New Jersey's air is from point sources, and 7% from nonpoint sources.

Figure 10-12
1,2-DICHLOROETHANE (Ethylene Dichloride) – New Jersey Monitored Concentrations



Formaldehyde (Figure 10-13) is a ubiquitous pollutant that is often found at higher concentrations indoors rather than outdoors because of its use in many consumer goods. It is used in the production of fertilizer, paper, plywood, urea-formaldehyde resins, and many other products. In New Jersey the primary emitters of formaldehyde are mobile sources, although high outdoor levels are mostly the result of secondary formation. In 2014, concentrations at the New Brunswick site were consistently higher than at the other monitors, although levels subsequently dropped to the range of the other monitoring sites.

Figure 10-13
FORMALDEHYDE – New Jersey Monitored Concentrations

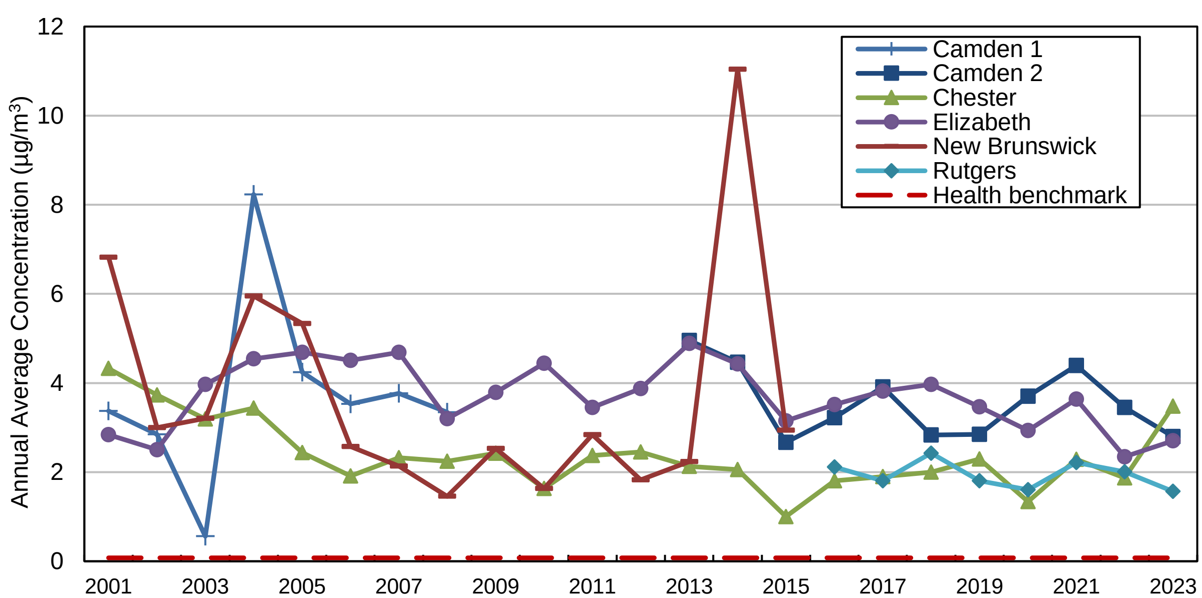


Table 10-4
CAMDEN SPRUCE STREET – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
1	Acetaldehyde	1.151	1.040	3.240	2.074	1.874	5.838	100	**4.6**
2	Acetone	0.880	0.882	2.010	2.091	2.094	4.775	100	*0.0001*
3	Acetonitrile	0.408	0.263	6.680	0.686	0.442	11.216	91	*0.01*
4	Acetylene	0.791	0.759	1.650	0.843	0.808	1.757	100	
5	Acrolein	0.273	0.234	0.832	0.627	0.537	1.908	100	***31.4***
6	Acrylonitrile	*0.003*	0	0.048	*0.007*	0	0.105	17	0.4
7	tert-Amyl Methyl Ether	*0.0005*	0	0.024	*0.002*	0	0.100	7	
8	Benzaldehyde	0.032	0.027	0.114	0.138	0.118	0.495	100	
9	Benzene	0.224	0.189	0.760	0.715	0.604	2.428	100	**5.5**
10	Bromochloromethane	0.002	0.002	0.004	0.009	0.01	0.019	63	*0.0002*
11	Bromodichloromethane	*0.001*	0	0.003	*0.005*	0	0.022	44	0.2
12	Bromoform	0.002	0.002	0.003	0.016	0.016	0.033	100	0.02
13	Bromomethane	0.042	0.011	0.576	0.162	0.043	2.237	100	*0.03*
14	1,3-Butadiene	0.020	0.014	0.113	0.043	0.031	0.250	98	**1.3**
15	Butyraldehyde	0.069	0.062	0.173	0.203	0.184	0.510	100	
16	Carbon Disulfide	0.020	0.015	0.117	0.063	0.048	0.364	100	*0.0001*
17	Carbon Tetrachloride	0.079	0.079	0.094	0.497	0.499	0.593	100	**2.9**
18	Chlorobenzene	*0.0003*	0	0.010	*0.001*	0	0.046	3	*0.000001*
19	Chloroethane	0.027	0.018	0.215	0.071	0.046	0.567	97	*0.000007*
20	Chloroform	0.025	0.022	0.044	0.120	0.109	0.216	100	**2.8**
21	Chloromethane	0.489	0.485	0.586	1.009	1.001	1.210	100	**1.8**
22	Chloroprene	*0.0001*	0	0.002	*0.0003*	0	0.007	5	0.1
23	Crotonaldehyde	*0.004*	0	0.022	*0.012*	0	0.064	43	
24	Dibromochloromethane	0.001	0.0004	0.002	0.004	0.003	0.017	88	0.1
25	1,2-Dibromoethane	*0.0001*	0	0.002	*0.001*	0	0.015	12	0.4
26	m-Dichlorobenzene	*0.0003*	0	0.002	*0.002*	0	0.013	49	
27	o-Dichlorobenzene	0.0004	0.0003	0.002	0.002	0.002	0.014	58	*0.00001*
28	p-Dichlorobenzene	0.009	0.006	0.040	0.053	0.037	0.241	100	0.6
29	Dichlorodifluoromethane	0.524	0.511	0.822	2.590	2.527	4.065	100	*0.03*
30	1,1-Dichloroethane	*0.0001*	0	0.002	*0.0005*	0	0.008	10	0.001
31	1,2-Dichloroethane	0.022	0.020	0.069	0.090	0.081	0.281	100	**2.4**
32	1,1-Dichloroethylene	0.001	0.001	0.003	0.005	0.005	0.013	78	*0.00002*
33	cis-1,2-Dichloroethylene	*0.00002*	0	0.001	*0.0001*	0	0.004	2	
34	trans-1,2-Dichloroethylene	0.004	0.003	0.017	0.017	0.012	0.069	93	
35	Dichloromethane	0.151	0.140	0.473	0.526	0.486	1.643	100	0.01
36	1,2-Dichloropropane	*0*	0	0	*0*	0	0	0	
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.017	0.017	0.023	0.120	0.117	0.158	100	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.058	0.043	0.218	0.251	0.186	0.947	100	0.6
42	Ethyl tert-Butyl Ether	0.005	0	0.013	0.009	0.01	0.024	83	
43	Formaldehyde	2.279	1.895	5.680	2.799	2.327	6.975	100	**36.4**
44	Hexachlorobutadiene	0.0004	0.0003	0.004	0.004	0.003	0.043	86	0.1
45	Hexaldehyde	0.043	0.036	0.130	0.175	0.146	0.533	100	

Continued

Table 10-4 (continued)
CAMDEN SPRUCE STREET – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean (ppbv)	Annual Median (ppbv)	24-Hour Max. (ppbv)	Annual Mean (µg/m³)	Annual Median (µg/m³)	24-Hour Max. (µg/m³)	% Detected	Annual Mean Risk Ratio
46	Methyl Ethyl Ketone	0.094	0.091	0.274	0.278	0.269	0.808	98	*0.0001*
47	Methyl Isobutyl Ketone	0.022	0.017	0.109	0.091	0.071	0.447	71	*0.00003*
48	Methyl Methacrylate	*0*	0	0	*0*	0	0	0	
49	Methyl tert-Butyl Ether	*0*	0	0	*0*	0	0	0	
50	n-Octane	0.060	0.043	0.276	0.280	0.199	1.289	98	
51	Propionaldehyde	0.150	0.131	0.322	0.356	0.311	0.765	100	*0.04*
52	Propylene	1.546	1.370	5.360	2.660	2.358	9.225	100	*0.001*
53	Styrene	0.061	0.038	0.388	0.259	0.160	1.653	100	0.1
54	1,1,2,2-Tetrachloroethane	*0.0002*	0	0.002	*0.001*	0	0.012	20	0.1
55	Tetrachloroethylene	0.021	0.015	0.174	0.141	0.103	1.180	100	0.9
56	Toluene	0.397	0.286	1.620	1.498	1.078	6.105	100	*0.004*
57	1,2,4-Trichlorobenzene	0.001	0.001	0.007	0.010	0.007	0.051	98	*0.01*
58	1,1,1-Trichloroethane	0.002	0.002	0.009	0.013	0.010	0.047	100	*0.00001*
59	1,1,2-Trichloroethane	*0*	0	0	*0*	0	0	0	
60	Trichloroethylene	0.004	0.004	0.016	0.021	0.021	0.084	70	0.1
61	Trichlorofluoromethane	0.347	0.273	1.390	1.952	1.534	7.809	100	*0.003*
62	Trichlorotrifluoroethane	0.076	0.075	0.111	0.586	0.573	0.851	100	*0.00002*
63	1,2,4-Trimethylbenzene	0.070	0.041	0.312	0.344	0.199	1.534	100	*0.01*
64	1,3,5-Trimethylbenzene	0.015	0.009	0.090	0.073	0.042	0.442	100	*0.001*
65	Valeraldehyde	0.044	0.042	0.230	0.156	0.148	0.810	97	
66	Vinyl Chloride	0.004	0.002	0.036	0.010	0.004	0.092	73	0.1
67	m,p-Xylene	0.169	0.116	0.713	0.733	0.504	3.096	100	*0.01*
68	o-Xylene	0.068	0.048	0.281	0.293	0.209	1.220	100	*0.003*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

Table 10-5
CHESTER – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
1	Acetaldehyde	0.830	0.659	2.220	1.495	1.186	4.000	100	**3.3**
2	Acetone	0.783	0.737	1.740	1.860	1.751	4.133	100	*0.0001*
3	Acetonitrile	2.394	0.436	55.700	4.019	0.732	93.523	98	*0.1*
4	Acetylene	0.453	0.408	1.090	0.482	0.434	1.161	100	
5	Acrolein	0.255	0.185	1.110	0.585	0.424	2.545	100	***29.3***
6	Acrylonitrile	*0.003*	0	0.047	*0.006*	0	0.103	21	0.4
7	tert-Amyl Methyl Ether	*0.0001*	0	0.001	*0.0003*	0	0.005	10	
8	Benzaldehyde	0.039	0.020	0.140	0.168	0.087	0.608	100	
9	Benzene	0.132	0.116	0.661	0.420	0.369	2.112	100	**3.2**
10	Bromochloromethane	0.002	0.002	0.004	0.009	0.012	0.020	64	*0.0002*
11	Bromodichloromethane	*0.0003*	0	0.003	*0.002*	0	0.017	31	0.1
12	Bromoform	0.001	0.001	0.003	0.014	0.013	0.035	97	0.02
13	Bromomethane	0.013	0.009	0.190	0.052	0.034	0.738	100	*0.01*
14	1,3-Butadiene	0.006	0.004	0.026	0.012	0.009	0.057	97	0.4
15	Butyraldehyde	0.037	0.029	0.124	0.110	0.086	0.366	97	
16	Carbon Disulfide	0.020	0.013	0.144	0.061	0.039	0.448	100	*0.0001*
17	Carbon Tetrachloride	0.079	0.079	0.102	0.497	0.498	0.642	100	**2.9**
18	Chlorobenzene	*0*	0	0	*0*	0	0	0	
19	Chloroethane	0.017	0.013	0.066	0.045	0.035	0.175	98	*0.000005*
20	Chloroform	0.020	0.019	0.040	0.099	0.092	0.193	100	**2.3**
21	Chloromethane	0.481	0.479	0.622	0.993	0.989	1.284	100	**1.8**
22	Chloroprene	*0.0001*	0	0.001	*0.0002*	0	0.004	7	0.1
23	Crotonaldehyde	*0.003*	0	0.021	*0.008*	0	0.059	27	
24	Dibromochloromethane	0.0003	0.0003	0.002	0.003	0.003	0.014	76	0.1
25	1,2-Dibromoethane	*0.0001*	0	0.001	*0.001*	0	0.010	26	0.6
26	m-Dichlorobenzene	0.0004	0.0002	0.005	0.002	0.001	0.029	53	
27	o-Dichlorobenzene	0.0004	0.0002	0.006	0.002	0.001	0.038	60	*0.00001*
28	p-Dichlorobenzene	0.002	0.002	0.015	0.014	0.009	0.088	100	0.2
29	Dichlorodifluoromethane	0.515	0.512	0.654	2.549	2.532	3.234	100	*0.03*
30	1,1-Dichloroethane	*0.0001*	0	0.001	*0.0004*	0	0.005	9	0.001
31	1,2-Dichloroethane	0.017	0.017	0.025	0.067	0.069	0.102	100	**1.8**
32	1,1-Dichloroethylene	0.001	0.001	0.002	0.004	0.004	0.009	84	*0.00002*
33	cis-1,2-Dichloroethylene	*0*	0	0	*0*	0	0	0	
34	trans-1,2-Dichloroethylene	0.010	0.002	0.468	0.042	0.006	1.856	81	
35	Dichloromethane	0.134	0.121	0.329	0.464	0.419	1.143	100	0.01
36	1,2-Dichloropropane	*0*	0	0	*0*	0	0	0	
37	cis-1,3-Dichloropropylene	*0.00001*	0	0.001	*0.0001*	0	0.004	2	0.0003
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.018	0.018	0.022	0.123	0.122	0.157	100	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.017	0.012	0.099	0.072	0.054	0.431	100	0.2
42	Ethyl tert-Butyl Ether	*0.001*	0	0.008	*0.001*	0	0.014	34	
43	Formaldehyde	2.832	1.525	10.200	3.478	1.873	12.526	100	**45.2**
44	Hexachlorobutadiene	0.0004	0.0003	0.002	0.004	0.003	0.017	86	0.1
45	Hexaldehyde	0.075	0.036	0.262	0.307	0.147	1.073	100	

Continued

Table 10-5 (continued)
CHESTER – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m^3				
46	Methyl Ethyl Ketone	0.069	0.067	0.189	0.204	0.196	0.557	100	*0.00004*
47	Methyl Isobutyl Ketone	0.011	0.010	0.088	0.046	0.042	0.359	69	*0.00002*
48	Methyl Methacrylate	*0*	0	0	*0*	0	0	0	
49	Methyl tert-Butyl Ether	*0*	0	0	*0*	0	0	0	
50	n-Octane	0.016	0.015	0.060	0.077	0.072	0.282	85	
51	Propionaldehyde	0.114	0.099	0.259	0.271	0.234	0.615	100	*0.03*
52	Propylene	0.503	0.436	1.180	0.865	0.750	2.031	100	*0.0003*
53	Styrene	0.008	0.004	0.076	0.032	0.018	0.324	97	0.02
54	1,1,2,2-Tetrachloroethane	*0.0003*	0	0.003	*0.002*	0	0.020	36	0.1
55	Tetrachloroethylene	0.008	0.006	0.066	0.054	0.038	0.446	100	0.3
56	Toluene	0.123	0.092	0.639	0.465	0.346	2.408	100	*0.001*
57	1,2,4-Trichlorobenzene	0.001	0.001	0.022	0.009	0.005	0.165	86	*0.005*
58	1,1,1-Trichloroethane	0.002	0.002	0.003	0.009	0.009	0.017	95	*0.00001*
59	1,1,2-Trichloroethane	*0.0001*	0	0.002	*0.001*	0	0.013	9	0.01
60	Trichloroethylene	*0.002*	0	0.007	*0.009*	0	0.039	44	0.05
61	Trichlorofluoromethane	0.257	0.245	0.930	1.445	1.376	5.225	100	*0.002*
62	Trichlorotrifluoroethane	0.075	0.075	0.097	0.573	0.576	0.744	100	*0.00002*
63	1,2,4-Trimethylbenzene	0.014	0.010	0.064	0.068	0.051	0.313	95	*0.001*
64	1,3,5-Trimethylbenzene	0.002	0.002	0.014	0.012	0.010	0.066	98	*0.0002*
65	Valeraldehyde	0.026	0.027	0.069	0.091	0.094	0.242	92	
66	Vinyl Chloride	*0.0005*	0	0.003	*0.001*	0	0.007	36	0.01
67	m,p-Xylene	0.037	0.029	0.236	0.160	0.126	1.025	100	*0.002*
68	o-Xylene	0.016	0.012	0.106	0.069	0.053	0.460	100	*0.001*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

Table 10-6
ELIZABETH – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
1	Acetaldehyde	0.962	0.780	2.560	1.733	1.405	4.613	100	**3.9**
2	Acetone	1.014	0.915	2.730	2.408	2.174	6.485	100	*0.0001*
3	Acetonitrile	0.396	0.337	1.700	0.665	0.566	2.854	79	*0.01*
4	Acetylene	0.930	0.745	2.110	0.991	0.793	2.247	100	
5	Acrolein	0.317	0.251	1.280	0.728	0.576	2.935	100	***36.4***
6	Acrylonitrile	*0.006*	0	0.053	*0.014*	0	0.115	41	0.9
7	tert-Amyl Methyl Ether	*0.0001*	0	0.002	*0.0003*	0	0.007	12	
8	Benzaldehyde	0.025	0.019	0.137	0.110	0.083	0.595	100	
9	Benzene	0.252	0.230	0.716	0.804	0.735	2.287	100	**6.2**
10	Bromochloromethane	0.0017	0.002	0.004	0.009	0.012	0.020	68	*0.0002*
11	Bromodichloromethane	*0.001*	0	0.005	*0.004*	0	0.034	41	0.2
12	Bromoform	0.002	0.002	0.005	0.020	0.018	0.048	100	0.02
13	Bromomethane	0.011	0.009	0.084	0.044	0.036	0.324	100	*0.01*
14	1,3-Butadiene	0.026	0.023	0.115	0.057	0.050	0.254	100	**1.7**
15	Butyraldehyde	0.039	0.028	0.296	0.116	0.082	0.873	100	
16	Carbon Disulfide	0.019	0.016	0.054	0.058	0.049	0.169	100	*0.0001*
17	Carbon Tetrachloride	0.078	0.079	0.104	0.493	0.499	0.654	100	**2.9**
18	Chlorobenzene	*0.0001*	0	0.007	*0.001*	0	0.030	2	*0.000001*
19	Chloroethane	0.022	0.015	0.105	0.059	0.041	0.277	100	*0.000006*
20	Chloroform	0.030	0.027	0.076	0.147	0.133	0.371	100	**3.4**
21	Chloromethane	0.488	0.481	0.674	1.008	0.993	1.392	100	**1.8**
22	Chloroprene	*0*	0	0	*0*	0	0	0	
23	Crotonaldehyde	*0.004*	0	0.015	*0.010*	0	0.042	46	
24	Dibromochloromethane	0.001	0.001	0.002	0.005	0.004	0.020	97	0.1
25	1,2-Dibromoethane	*0.0001*	0	0.004	*0.001*	0	0.028	19	0.6
26	m-Dichlorobenzene	0.001	0.0003	0.016	0.004	0.002	0.097	66	
27	o-Dichlorobenzene	0.001	0.0005	0.020	0.005	0.003	0.121	81	*0.00003*
28	p-Dichlorobenzene	0.009	0.007	0.035	0.053	0.040	0.210	100	0.6
29	Dichlorodifluoromethane	0.510	0.506	0.646	2.521	2.502	3.195	100	*0.03*
30	1,1-Dichloroethane	*0.0001*	0	0.002	*0.0005*	0	0.008	14	0.001
31	1,2-Dichloroethane	0.017	0.017	0.025	0.069	0.070	0.101	98	**1.8**
32	1,1-Dichloroethylene	0.001	0.001	0.003	0.003	0.004	0.011	66	*0.00002*
33	cis-1,2-Dichloroethylene	*0.0002*	0	0.005	*0.001*	0	0.018	7	
34	trans-1,2-Dichloroethylene	0.005	0.003	0.070	0.019	0.012	0.276	93	
35	Dichloromethane	0.179	0.170	0.480	0.623	0.591	1.667	100	0.01
36	1,2-Dichloropropane	*0*	0	0	*0*	0	0	0	
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.016	0.017	0.020	0.111	0.116	0.143	97	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.065	0.055	0.222	0.282	0.239	0.964	100	0.7
42	Ethyl tert-Butyl Ether	*0.001*	0	0.010	*0.002*	0	0.017	25	
43	Formaldehyde	2.203	1.660	7.400	2.705	2.039	9.088	100	**35.1**
44	Hexachlorobutadiene	0.0005	0.0003	0.005	0.005	0.003	0.048	92	0.1
45	Hexaldehyde	0.135	0.064	0.497	0.552	0.262	2.036	98	

Continued

Table 10-6 (continued)
ELIZABETH – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			μg/m³				
46	Methyl Ethyl Ketone	0.097	0.087	0.370	0.286	0.255	1.091	100	*0.0001*
47	Methyl Isobutyl Ketone	0.019	0.020	0.081	0.080	0.080	0.333	73	*0.00003*
48	Methyl Methacrylate	*0*	0	0	*0*	0	0	0	
49	Methyl tert-Butyl Ether	*0*	0	0	*0*	0	0	0	
50	n-Octane	0.071	0.049	0.400	0.332	0.231	1.869	100	
51	Propionaldehyde	0.114	0.101	0.338	0.271	0.240	0.803	100	*0.03*
52	Propylene	1.398	1.103	4.050	2.406	1.897	6.970	100	*0.001*
53	Styrene	0.023	0.015	0.088	0.097	0.064	0.376	93	0.1
54	1,1,2,2-Tetrachloroethane	*0.0003*	0	0.009	*0.002*	0	0.060	17	0.1
55	Tetrachloroethylene	0.017	0.015	0.052	0.114	0.101	0.351	100	0.7
56	Toluene	0.415	0.332	1.760	1.565	1.251	6.633	100	*0.004*
57	1,2,4-Trichlorobenzene	0.003	0.001	0.093	0.022	0.007	0.692	95	*0.01*
58	1,1,1-Trichloroethane	0.002	0.002	0.006	0.011	0.011	0.031	95	*0.00001*
59	1,1,2-Trichloroethane	*0.0003*	0	0.013	*0.001*	0	0.070	3	0.02
60	Trichloroethylene	0.005	0.005	0.028	0.024	0.024	0.149	77	0.1
61	Trichlorofluoromethane	0.256	0.246	0.532	1.436	1.382	2.989	100	*0.002*
62	Trichlorotrifluoroethane	0.077	0.075	0.111	0.587	0.572	0.851	100	*0.00002*
63	1,2,4-Trimethylbenzene	0.054	0.047	0.194	0.267	0.231	0.954	100	*0.004*
64	1,3,5-Trimethylbenzene	0.012	0.010	0.071	0.060	0.047	0.348	100	*0.001*
65	Valeraldehyde	0.033	0.020	0.210	0.117	0.069	0.740	97	
66	Vinyl Chloride	0.001	0.0006	0.005	0.002	0.002	0.012	53	0.02
67	m,p-Xylene	0.179	0.146	0.783	0.779	0.634	3.400	100	*0.01*
68	o-Xylene	0.071	0.060	0.269	0.310	0.261	1.168	100	*0.003*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

Table 10-7
RUTGERS – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
1	Acetaldehyde	0.550	0.479	1.750	0.991	0.863	3.153	100	**2.2**
2	Acetone	0.807	0.823	2.050	1.916	1.955	4.870	100	0.0001
3	Acetonitrile	1.740	0.300	46.000	2.921	0.504	77.236	73	0.05
4	Acetylene	0.589	0.541	1.340	0.627	0.576	1.427	100	
5	Acrolein	0.268	0.218	0.843	0.616	0.500	1.933	100	***30.8***
6	Acrylonitrile	0.006	0.003	0.046	0.012	0.005	0.100	50	0.8
7	tert-Amyl Methyl Ether	*0.0001*	0	0.001	*0.0002*	0	0.005	7	
8	Benzaldehyde	0.017	0.013	0.061	0.072	0.056	0.264	100	
9	Benzene	0.167	0.158	0.604	0.532	0.505	1.930	100	**4.1**
10	Bromochloromethane	0.002	0.002	0.004	0.009	0.012	0.019	64	*0.0002*
11	Bromodichloromethane	*0.001*	0	0.003	*0.005*	0	0.019	46	0.2
12	Bromoform	0.002	0.002	0.004	0.017	0.016	0.039	100	0.02
13	Bromomethane	0.010	0.009	0.023	0.037	0.035	0.089	100	0.01
14	1,3-Butadiene	0.011	0.009	0.052	0.024	0.021	0.116	97	0.7
15	Butyraldehyde	0.027	0.023	0.078	0.080	0.068	0.229	98	
16	Carbon Disulfide	0.020	0.015	0.124	0.063	0.047	0.386	100	0.0001
17	Carbon Tetrachloride	0.078	0.080	0.101	0.488	0.500	0.635	100	**2.9**
18	Chlorobenzene	*0*	0	0	*0*	0	0	0	
19	Chloroethane	0.028	0.017	0.468	0.073	0.044	1.235	98	0.000007
20	Chloroform	0.027	0.025	0.065	0.132	0.121	0.317	100	**3.1**
21	Chloromethane	0.491	0.483	0.641	1.015	0.997	1.324	100	**1.8**
22	Chloroprene	*0.00005*	0	0.001	*0.0002*	0	0.005	3	0.1
23	Crotonaldehyde	*0.003*	0	0.038	*0.009*	0	0.110	42	
24	Dibromochloromethane	0.0005	0.0004	0.002	0.004	0.003	0.015	86	0.1
25	1,2-Dibromoethane	*0.0001*	0	0.002	*0.001*	0	0.012	32	0.7
26	m-Dichlorobenzene	0.001	0.0003	0.006	0.003	0.002	0.037	64	
27	o-Dichlorobenzene	0.001	0.0003	0.003	0.003	0.002	0.019	73	0.00002
28	p-Dichlorobenzene	0.005	0.004	0.018	0.029	0.023	0.106	100	0.3
29	Dichlorodifluoromethane	0.516	0.509	0.649	2.550	2.517	3.210	100	*0.03*
30	1,1-Dichloroethane	*0.0001*	0	0.002	*0.0003*	0	0.006	7	0.0005
31	1,2-Dichloroethane	0.017	0.018	0.027	0.071	0.071	0.109	100	**1.9**
32	1,1-Dichloroethylene	0.001	0.001	0.003	0.005	0.004	0.013	90	0.00002
33	cis-1,2-Dichloroethylene	*0*	0	0	*0*	0	0	0	
34	trans-1,2-Dichloroethylene	0.002	0.002	0.007	0.008	0.007	0.028	76	
35	Dichloromethane	0.470	0.143	16.100	1.633	0.497	55.927	100	0.02
36	1,2-Dichloropropane	*0*	0	0	*0*	0	0	0	
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.018	0.017	0.023	0.124	0.122	0.164	100	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.034	0.027	0.164	0.146	0.119	0.712	100	0.4
42	Ethyl tert-Butyl Ether	*0.00004*	0	0.001	*0.0001*	0	0.002	3	
43	Formaldehyde	1.276	0.989	3.800	1.567	1.215	4.667	100	**20.4**
44	Hexachlorobutadiene	0.0004	0.0003	0.002	0.005	0.003	0.016	90	0.1
45	Hexaldehyde	0.063	0.044	0.243	0.259	0.179	0.995	100	

Continued

Table 10-7 (continued)
RUTGERS – 2023 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean (ppbv)	Annual Median (ppbv)	24-Hour Max. (ppbv)	Annual Mean (µg/m^3)	Annual Median (µg/m^3)	24-Hour Max. (µg/m^3)	% Detected	Annual Mean Risk Ratio
46	Methyl Ethyl Ketone	0.092	0.092	0.270	0.272	0.270	0.796	98	0.0001
47	Methyl Isobutyl Ketone	0.014	0.013	0.059	0.057	0.053	0.243	71	0.00002
48	Methyl Methacrylate	*0*	0	0	*0*	0	0	0	
49	Methyl tert-Butyl Ether	*0*	0	0	*0*	0	0	0	
50	n-Octane	0.026	0.024	0.063	0.120	0.111	0.295	91	
51	Propionaldehyde	0.092	0.071	0.251	0.218	0.168	0.596	100	0.03
52	Propylene	0.650	0.587	1.680	1.118	1.010	2.891	100	0.0004
53	Styrene	0.020	0.010	0.285	0.085	0.040	1.214	97	0.05
54	1,1,2,2-Tetrachloroethane	*0.0002*	0	0.002	*0.001*	0	0.013	19	0.1
55	Tetrachloroethylene	0.010	0.008	0.036	0.070	0.052	0.242	100	0.4
56	Toluene	0.412	0.171	11.700	1.552	0.644	44.092	100	0.004
57	1,2,4-Trichlorobenzene	0.002	0.001	0.013	0.014	0.007	0.096	95	0.01
58	1,1,1-Trichloroethane	0.002	0.002	0.006	0.011	0.010	0.033	97	0.00001
59	1,1,2-Trichloroethane	*0*	0	0	*0*	0	0	0	
60	Trichloroethylene	0.004	0.004	0.008	0.020	0.020	0.041	85	0.1
61	Trichlorofluoromethane	0.251	0.249	0.317	1.410	1.399	1.781	100	0.002
62	Trichlorotrifluoroethane	0.077	0.075	0.112	0.587	0.577	0.858	100	0.00002
63	1,2,4-Trimethylbenzene	0.024	0.021	0.084	0.120	0.105	0.413	100	0.002
64	1,3,5-Trimethylbenzene	0.006	0.005	0.020	0.028	0.023	0.099	100	0.0005
65	Valeraldehyde	0.020	0.019	0.053	0.071	0.068	0.186	97	
66	Vinyl Chloride	0.001	0.001	0.007	0.003	0.003	0.018	71	0.03
67	m,p-Xylene	0.078	0.064	0.329	0.340	0.280	1.429	100	*0.003*
68	o-Xylene	0.032	0.026	0.117	0.139	0.114	0.508	100	0.001

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

In 2023, samples of the chemicals in Table 10-8 were never detected at the monitoring location specified. However, these pollutants may be present in the air at levels the lab cannot measure. Chemical-specific average detection limits can be found in Table 10-9.

Table 10-8
Air Toxics with 100% Non-Detects in 2023

Pollutant		CAS No.	Camden	Chester	Elizabeth	Rutgers
1	Chlorobenzene	108-90-7		X		X
2	Chloroprene	126-99-8			X	
3	1,2-Dibromoethane	106-93-4				
4	1,1-Dichloroethane	75-34-3				
5	cis-1,2-Dichloroethylene	156-59-2		X		
6	1,2-Dichloropropane	78-87-5	X	X	X	X
7	cis-1,3-Dichloropropylene	10061-01-5	X		X	X
8	trans-1,3-Dichloropropylene	10061-02-6	X	X	X	X
9	Ethyl Acrylate	140-88-5	X	X	X	X
10	Methyl Methacrylate	1634-04-4	X	X	X	X
11	Methyl tert-Butyl Ether	79-34-5	X	X	X	X
12	1,1,2-Trichloroethane	79-00-5	X			X

Table 10-9
2023 Air Toxics Detection Limits and Health Benchmarks

	Pollutant	CAS No.	Detection Limit (ppbv)	Detection Limit (µg/m³)	Health Bench-mark (µg/m³)
1	Acetaldehyde	75-07-0	0.184	0.332	0.45
2	Acetone	67-64-1	0.692	1.644	*31000*
3	Acetonitrile	75-05-8	0.033	0.055	*60*
4	Acetylene	74-86-2	0.015	0.016	
5	Acrolein	107-02-8	0.083	0.189	*0.02*
6	Acrylonitrile	107-13-1	0.012	0.025	0.015
7	tert-Amyl Methyl Ether	994-05-8	0.013	0.053	
8	Benzaldehyde	100-52-7	0.026	0.111	
9	Benzene	71-43-2	0.010	0.032	0.13
10	Bromochloromethane	74-97-5	0.009	0.048	*40*
11	Bromodichloromethane	75-27-4	0.009	0.060	0.027
12	Bromoform	75-25-2	0.011	0.112	0.91
13	Bromomethane	74-83-9	0.021	0.083	*5*
14	1,3-Butadiene	106-99-0	0.022	0.049	0.033
15	Butyraldehyde	123-72-8	0.043	0.126	
16	Carbon Disulfide	75-15-0	0.017	0.052	*700*
17	Carbon Tetrachloride	56-23-5	0.008	0.047	0.17
18	Chlorobenzene	108-90-7	0.008	0.038	*1000*
19	Chloroethane	75-00-3	0.014	0.036	*10000*
20	Chloroform	67-66-3	0.013	0.065	0.043
21	Chloromethane	74-87-3	0.010	0.020	0.56
22	Chloroprene	126-99-8	0.012	0.045	0.002
23	Crotonaldehyde	123-73-9	0.029	0.082	
24	Dibromochloromethane	124-48-1	0.019	0.164	0.037
25	1,2-Dibromoethane	106-93-4	0.007	0.051	0.0017
26	m-Dichlorobenzene	541-73-1	0.037	0.222	
27	o-Dichlorobenzene	95-50-1	0.036	0.219	*200*
28	p-Dichlorobenzene	106-46-7	0.037	0.220	0.091
29	Dichlorodifluoromethane	75-71-8	0.006	0.030	*100*
30	1,1-Dichloroethane	75-34-3	0.014	0.057	0.63
31	1,2-Dichloroethane	107-06-2	0.012	0.047	0.038
32	1,1-Dichloroethylene	75-35-4	0.016	0.063	*200*
33	cis-1,2-Dichloroethylene	156-59-2	0.013	0.052	
34	trans-1,2-Dichloroethylene	156-60-5	0.004	0.017	
35	Dichloromethane	75-09-2	0.047	0.163	77
36	1,2-Dichloropropane	78-87-5	0.022	0.099	0.1
37	cis-1,3-Dichloropropylene	10061-01-5	0.004	0.016	0.25
38	trans-1,3-Dichloropropylene	10061-02-6	0.008	0.037	0.25
39	Dichlorotetrafluoroethane	76-14-2	0.005	0.037	
40	Ethyl Acrylate	140-88-5	0.008	0.032	*8*
41	Ethylbenzene	100-41-4	0.013	0.056	0.4
42	Ethyl tert-Butyl Ether	637-92-3	0.009	0.016	
43	Formaldehyde	50-00-0	0.035	0.148	0.0002
44	Hexachlorobutadiene	87-68-3	0.247	0.303	0.077
45	Hexaldehyde	66-25-1	0.036	0.387	0.045

Continued

Table 10-9 (continued)
Air Toxics Detection Limits and Health Benchmarks

Pollutant		CAS No.	Detection Limit (ppbv)	Detection Limit (µg/m³)	Health Bench-mark (µg/m³)
46	Methyl Ethyl Ketone	78-93-3	0.196	0.578	*5000*
47	Methyl Isobutyl Ketone	108-10-1	0.058	0.237	*3000*
48	Methyl Methacrylate	80-62-6	0.033	0.135	*700*
49	Methyl tert-Butyl Ether	1634-04-4	0.010	0.036	3.8
50	n-Octane	111-65-9	0.026	0.121	
51	Propionaldehyde	123-38-6	0.079	0.187	*8*
52	Propylene	115-07-1	0.027	0.046	*3000*
53	Styrene	100-42-5	0.027	0.116	1.8
54	1,1,2,2-Tetrachloroethane	79-34-5	0.019	0.130	0.017
55	Tetrachloroethylene	127-18-4	0.009	0.058	0.16
56	Toluene	108-88-3	0.030	0.115	*420*
57	1,2,4-Trichlorobenzene	120-82-1	0.079	0.588	*2*
58	1,1,1-Trichloroethane	71-55-6	0.010	0.052	*1000*
59	1,1,2-Trichloroethane	79-00-5	0.004	0.022	0.063
60	Trichloroethylene	79-01-6	0.007	0.037	0.2
61	Trichlorofluoromethane	75-69-4	0.010	0.053	*700*
62	Trichlorotrifluoroethane	76-13-1	0.021	0.161	*30000*
63	1,2,4-Trimethylbenzene	95-63-6	0.032	0.157	*60*
64	1,3,5-Trimethylbenzene	108-67-8	0.032	0.155	*60*
65	Valeraldehyde	110-62-3	0.013	0.044	
66	Vinyl chloride	75-01-4	0.005	0.013	0.11
67	m,p-Xylene	108-38-3 106-42-3	0.042	0.182	*100*
68	o-Xylene	95-47-6	0.024	0.102	*100*

- **Detection limits** are from ERG (Eastern Research Group), Morrisville, NC., EPA contract laboratory.
- **Health benchmark** - the chemical-specific air concentration above which there may be human health concerns. Not available for all chemicals. Those presented here are for long-term exposure.
- For a carcinogen (cancer-causing chemical), the health benchmark is set at the air concentration that would cause no more than a one-in-a-million increase in the likelihood of getting cancer, even after a lifetime of exposure.
- For a noncarcinogen, the health benchmark is the maximum air concentration to which exposure is likely to cause no harm, even if that exposure occurs on a daily basis for a lifetime.
- Health benchmarks in *italics* are based on noncancer effects.
- Health benchmarks are from *Toxicity Values for Inhalation Exposure*, NJDEP Bureau of Evaluation & Planning, April 2023.

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2023 PAMS Summary

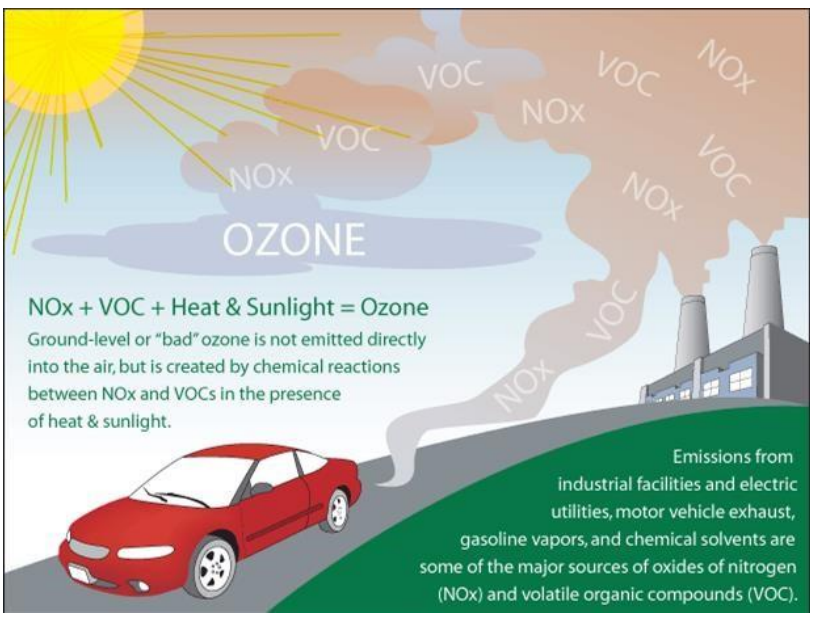
New Jersey Department of Environmental Protection

Photochemical Assessment Monitoring

Most ground-level ozone (O_3) is formed when volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) react in the presence of sunlight, as shown in Figure 11-1. Therefore, to effectively evaluate strategies for reducing ozone levels, it is necessary to measure these ozone-forming pollutants, also known as precursor pollutants. The Photochemical Assessment Monitoring Stations (PAMS) network was established by the U.S. Environmental Protection Agency (USEPA) for this purpose. Data from the PAMS network is used to better characterize the nature and extent of the ozone problem, track VOC and NO_x emissions, assess air quality trends, and make planning decisions.

PAMS monitor both criteria and non-criteria pollutants. These include ozone, nitric oxide (NO), nitrogen dioxide (NO_2), total reactive oxides of nitrogen (NO_y), and specific VOCs, such as several that are carbonyls and are important in ozone formation. In addition, the measurement of specific weather parameters is required at all PAMS: wind speed and direction; temperature; barometric pressure; relative humidity; precipitation; solar radiation; UV radiation; and mixing layer height. The VOCs and carbonyls are measured only during peak ozone season, from June 1st to August 31st each year. The PAMS VOC and carbonyl data is the focus of this section of the annual Air Quality Report.

Figure 11-1
Ozone Formation

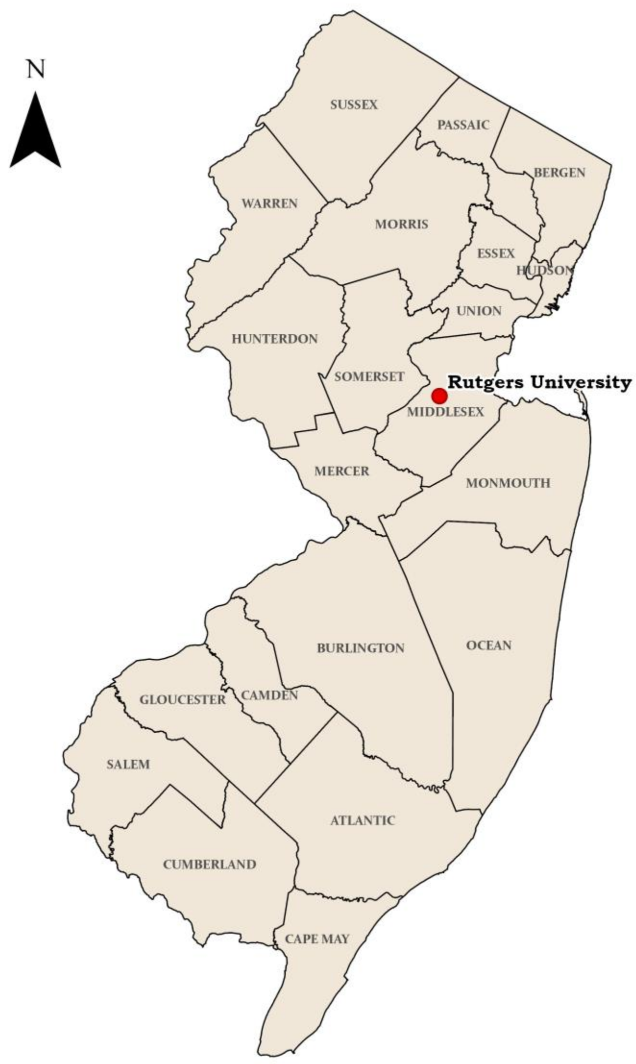


https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#wwh

In 2015, USEPA revised the National Ambient Air Quality Standard (NAAQS) for ozone, including the requirements for monitoring. This led to an overhaul of the PAMS program, with changes to the methodology for measuring the PAMS target pollutants and also to the locations of PAMS sites in the U.S. To support the implementation, USEPA designated specific equipment for the continuous hourly measurement of ozone precursor VOCs, provided funding to the states for purchasing the equipment, and set a date of June 1, 2021, to begin monitoring using the approved instruments. NJDEP purchased the new instruments in 2018, evaluated and tested them through 2020, and met the deadline of June 1, 2021, for measuring the target VOCs.

New Jersey once had three PAMS sites around the state. Currently, its sole PAMS station is on Rutgers University agricultural land in East Brunswick.

Figure 11-2
2023 Photochemical Assessment Monitoring Station



New Jersey collects samples using the Markes-Agilent system, which electrically cools and freezes humidified air, allowing the detection of more polar compounds, and the reporting of concentrations of both alpha- and beta-pinenes. The concentrations of the 2023 PAMS target compounds are presented in Table 11-1 below.

Table 11-1
2023 PAMS Target Compounds in New Jersey
Annual Average and Hourly Maximum Concentrations
Parts per Billion Carbon (ppbC)
Parts per Billion by Volume (ppbv)
Micrograms per Cubic Meter (µg/m³)

Compound	Annual Average			Hourly Maximum		
	ppbC	ppbv	µg/m³	ppbC	ppbv	µg/m³
Acetylene	0.29	0.14	1.15	2.30	1.15	0.15
Benzene	0.91	0.15	1.94	11.65	1.94	0.48
1,3-Butadiene	0.05	0.01	0.42	1.66	0.42	0.03
n-Butane	1.92	0.48	8.51	34.04	8.51	1.14
1-Butene	0.18	0.05	0.46	1.84	0.46	0.11
c-2 Butene	0.02	0.01	0.07	0.29	0.07	0.01
t-2 Butene	0.01	0.00	0.11	0.42	0.11	0.00
Cyclohexane	0.15	0.03	1.47	8.81	1.47	0.09
Cyclopentane	0.06	0.01	0.38	1.91	0.38	0.04
n-Decane	0.09	0.01	0.07	0.71	0.07	0.05
m-Diethylbenzene	0.00	0.00	0.03	0.33	0.03	0.00
p-Diethylbenzene	0.02	0.00	0.04	0.43	0.04	0.01
2 2-Dimethylbutane	0.08	0.01	0.18	1.08	0.18	0.04
2 3-Dimethylbutane	0.18	0.03	0.34	2.05	0.34	0.11
2 3-Dimethylpentane	0.09	0.01	0.12	0.85	0.12	0.05
2 4-Dimethylpentane	0.07	0.01	0.13	0.88	0.13	0.04
n-Dodecane	0.02	0.00	0.40	4.74	0.40	0.01
Ethane	7.04	3.52	8.81	17.62	8.81	4.33
Ethylbenzene	0.22	0.03	0.17	1.34	0.17	0.12
Ethylene	1.07	0.54	11.45	22.89	11.45	0.61
m-Ethyltoluene	0.14	0.02	0.12	1.04	0.12	0.08
o-Ethyltoluene	0.03	0.00	0.04	0.36	0.04	0.02
p-Ethyltoluene	0.28	0.03	0.31	2.82	0.31	0.15
Hexane	0.45	0.07	0.63	3.77	0.63	0.26
1-Hexene	0.04	0.01	0.16	0.93	0.16	0.02
n-Heptane	0.24	0.03	0.42	2.92	0.42	0.14
Isobutane	0.73	0.18	4.04	16.14	4.04	0.43
Isopentane	1.84	0.37	6.36	31.79	6.36	1.09
Isoprene	3.25	0.65	4.38	21.90	4.38	1.81
Isopropylbenzene	0.04	0.00	0.12	1.06	0.12	0.02
Methylcyclohexane	0.16	0.02	0.24	1.68	0.24	0.09
Methylcyclopentane	0.18	0.03	0.27	1.64	0.27	0.10
2-Methylheptane	0.05	0.01	0.07	0.54	0.07	0.03
3-Methylheptane	0.05	0.01	0.17	1.36	0.17	0.03

Continued

Table 11-1 (continued)
2023 PAMS Target Compounds in New Jersey
Annual Average and Hourly Maximum Concentrations
Parts per Billion Carbon (ppbC)
Parts per Billion by Volume (ppbv)
Micrograms per Cubic Meter (µg/m^3)

Compound	Annual Average			Hourly Maximum		
	ppbC	ppbv	µg/m^3	ppbC	ppbv	µg/m^3
2-Methylhexane	0.31	0.04	0.43	3.02	0.43	0.18
3-Methylhexane	0.29	0.04	0.46	3.21	0.46	0.17
2-Methylpentane	0.47	0.08	0.77	4.61	0.77	0.28
3-Methylpentane	0.27	0.05	0.42	2.52	0.42	0.16
n-Nonane	0.11	0.01	0.15	1.35	0.15	0.06
n-Octane	0.12	0.02	0.43	3.42	0.43	0.07
n-Pentane	1.21	0.24	4.29	21.44	4.29	0.72
1-Pentene	0.12	0.02	0.39	1.95	0.39	0.07
c2-Pentene	0.01	0.00	0.33	1.64	0.33	0.01
t2-Pentene	0.11	0.02	0.65	3.27	0.65	0.06
a-Pinene	0.08	0.01	0.43	4.27	0.43	0.04
b-Pinene	0.01	0.00	0.11	1.09	0.11	0.01
Propane	2.94	0.98	7.98	23.94	7.98	1.77
n-Propylbenzene	0.08	0.01	0.06	0.54	0.06	0.04
Propylene	0.48	0.16	2.62	7.86	2.62	0.28
Styrene	0.09	0.01	0.08	0.61	0.08	0.05
Toluene	1.28	0.18	1.15	8.06	1.15	0.69
1 2 3-Trimethylbenzene	0.29	0.03	0.41	3.67	0.41	0.16
1 2 4-Trimethylbenzene	0.21	0.02	0.17	1.52	0.17	0.11
1 3 5-Trimethylbenzene	0.05	0.01	0.21	1.91	0.21	0.03
2 2 4-Trimethylpentane	0.50	0.06	0.68	5.41	0.68	0.29
2 3 4-Trimehtylpentane	0.14	0.02	0.12	0.99	0.12	0.08
n-Undecane	0.09	0.01	0.07	0.73	0.07	0.05
m,p-Xylene	0.54	0.07	0.54	4.30	0.54	0.30
o-Xylene	0.22	0.03	0.18	1.46	0.18	0.12
PAMHC	24.75	X	X	116.68	X	X
T-NMOC	33.05	X	X	157.20	X	X
Unknowns	6.47	X	X	59.73	X	X

The three main contributors to total PAMS hydrocarbons at the Rutgers site were ethane, isoprene and propane, as shown in the pie chart in Figure 11-3. These compounds made up more than one-third of the total measured hydrocarbons during the summer ozone season. Crude oil refining and natural gas processing are major sources of ethane and propane. Isoprene is a biogenic compound released from plants, particularly trees.

Figure 11-3
Percentage of Components of Total Non-Methane Organic Carbon (TNMOC) for the 2023 PAMS Season in New Jersey

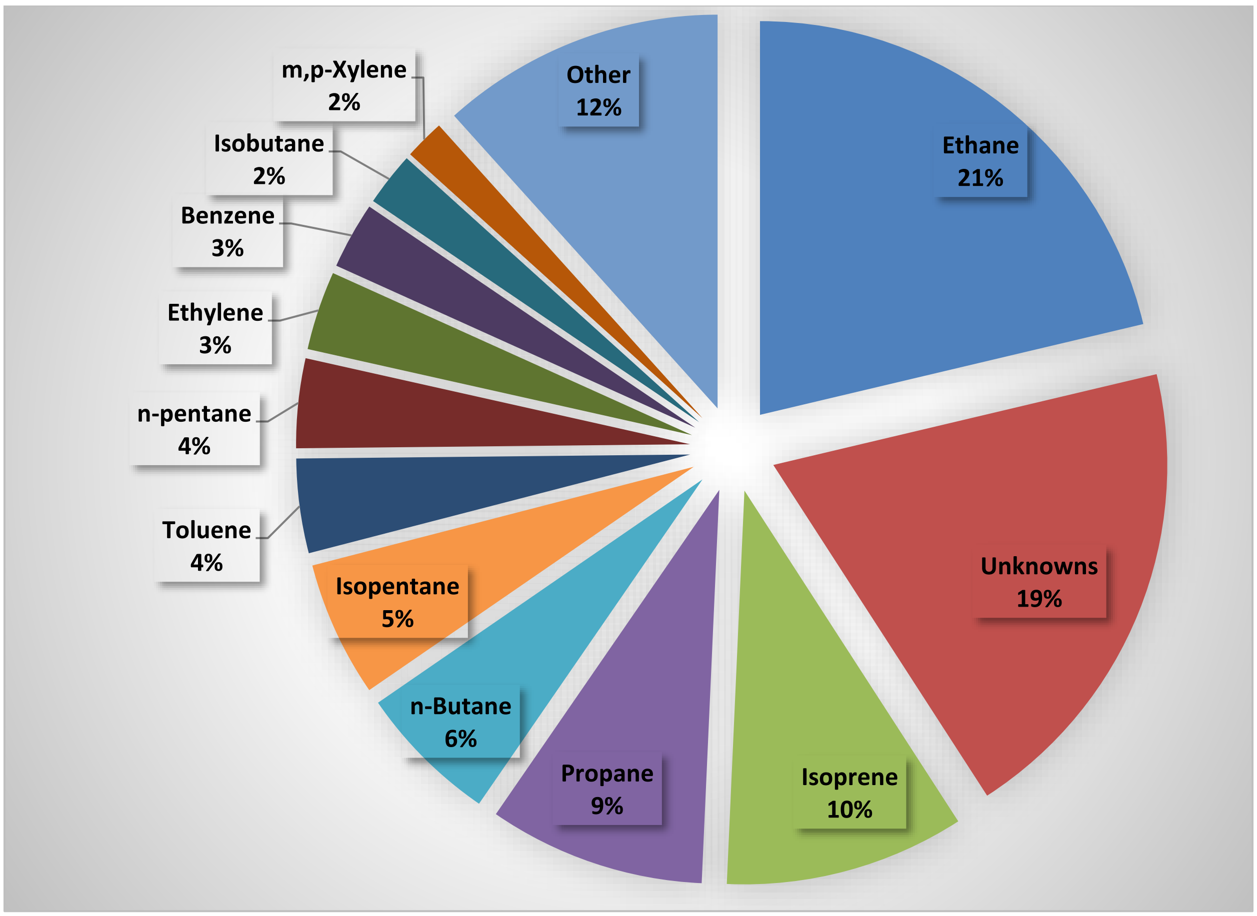


Figure 11-4 below is a comparison of the daily average concentrations of ethane, isoprene, propane, toluene, and isopentane. Figure 11-5 shows the diurnal trend for isoprene, toluene, and the average of all of the other PAMS hydrocarbons (PAMHC). Most of the anthropogenic compounds show peaks in the early morning and late evening because the mixing layer height is lower at those times. In contrast, the biogenic compounds, like isoprene, tend to peak during the day, when sunlight drives plant photosynthesis.

Figure 11-4
2023 PAMS Daily Averages for Ethane, Isoprene, Propane, Toluene, and Isopentane in New Jersey
Parts per Billion Carbon (ppbC)

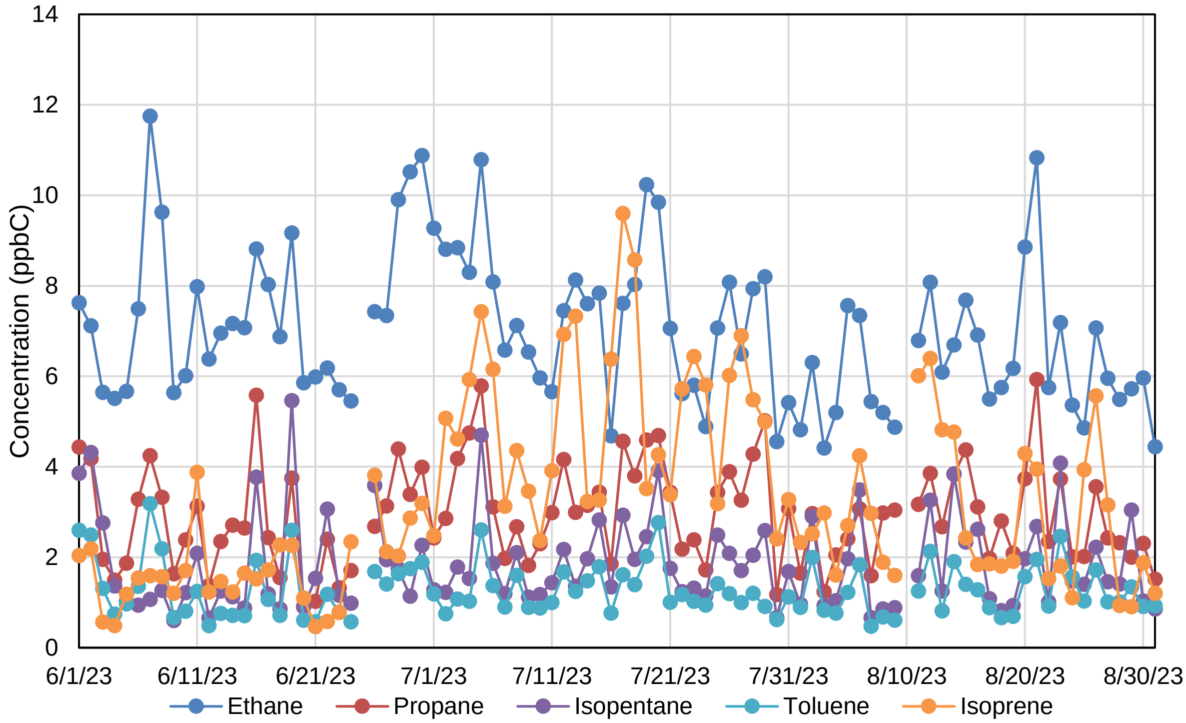
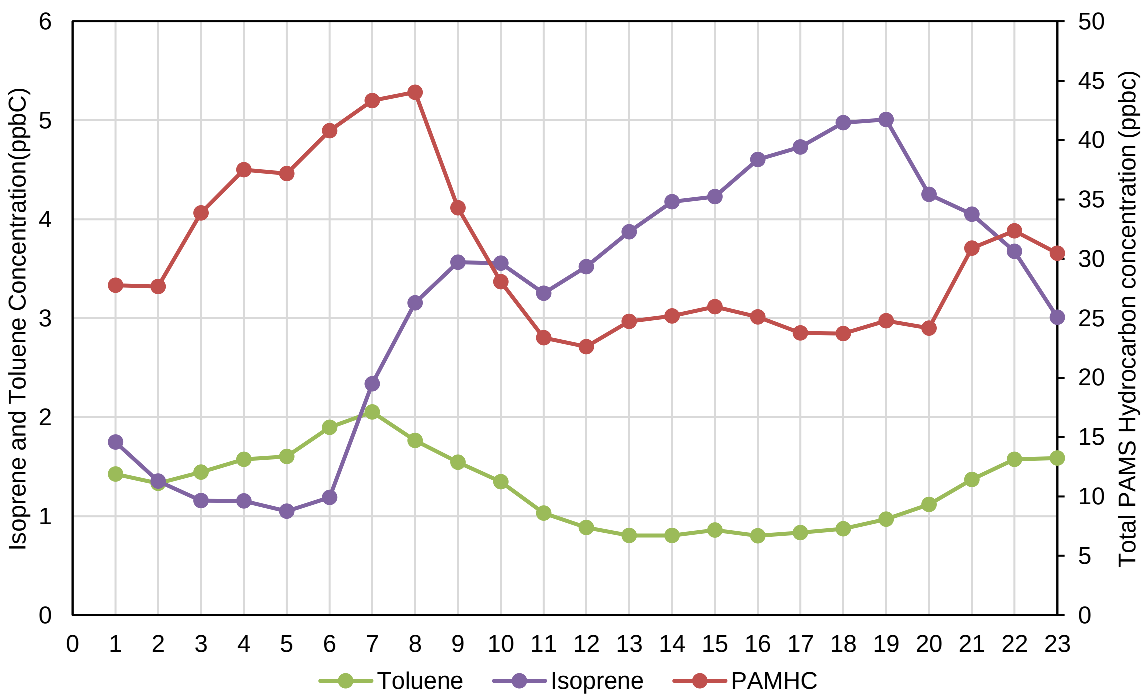
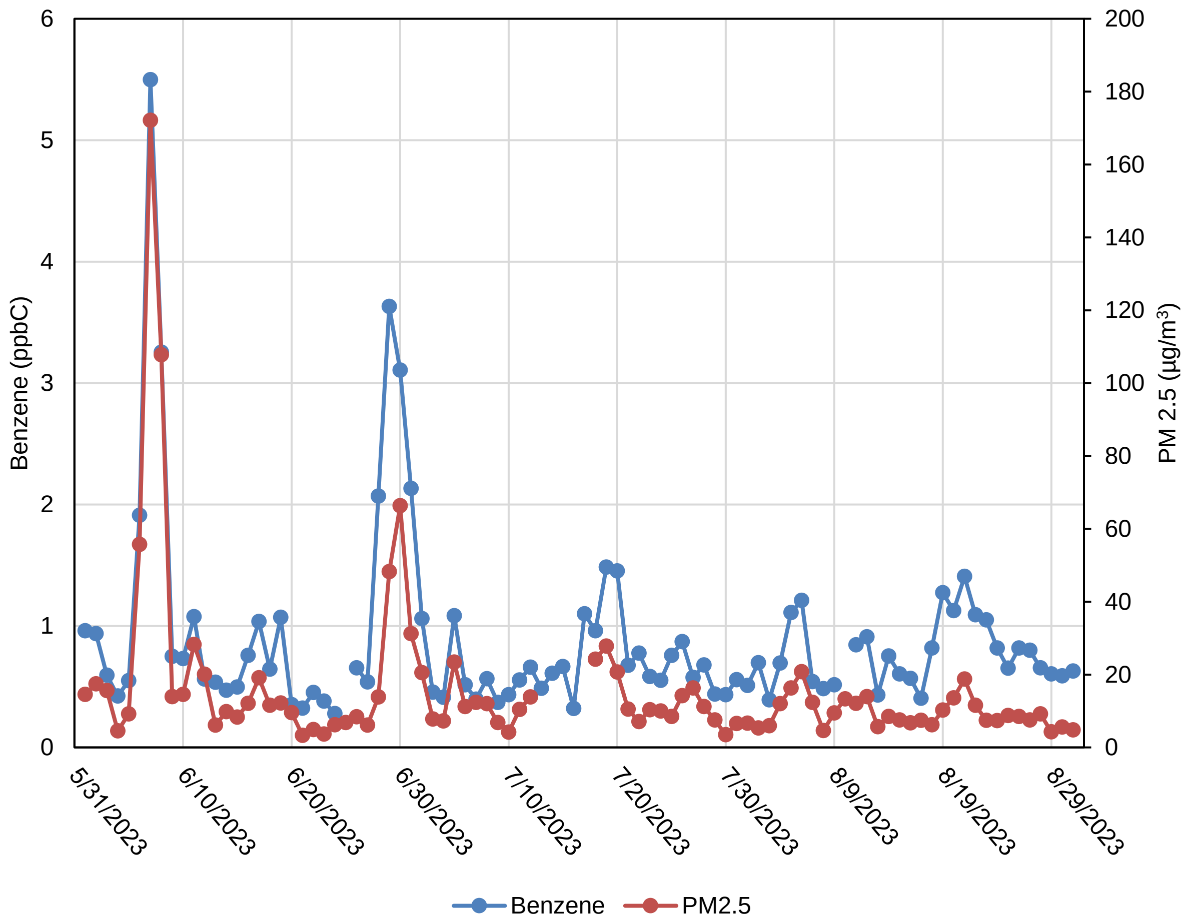


Figure 11-5
2023 PAMS Diurnal Trends in New Jersey
Hourly Average Concentrations
Parts per Billion Carbon (ppbC)



The air quality in New Jersey was impacted by the Canadian Wildfires during the summer of 2023. There was an increase in many of the PAMS target compounds but most notable was Benzene, as it is a byproduct of biomass combustion. There were 2 large PM2.5 smoke events (June 6-8 and June 28-July 1) and these correlate with a spike in benzene concentrations. The correlation between benzene and PM2.5 can be seen in Figure 11-6.

Figure 11-6
2023 Daily Benzene and PM2.5 Concentrations in New Jersey
Parts per Billion Carbon (ppbC) and Micrograms per Cubic Meter (µg/m³)

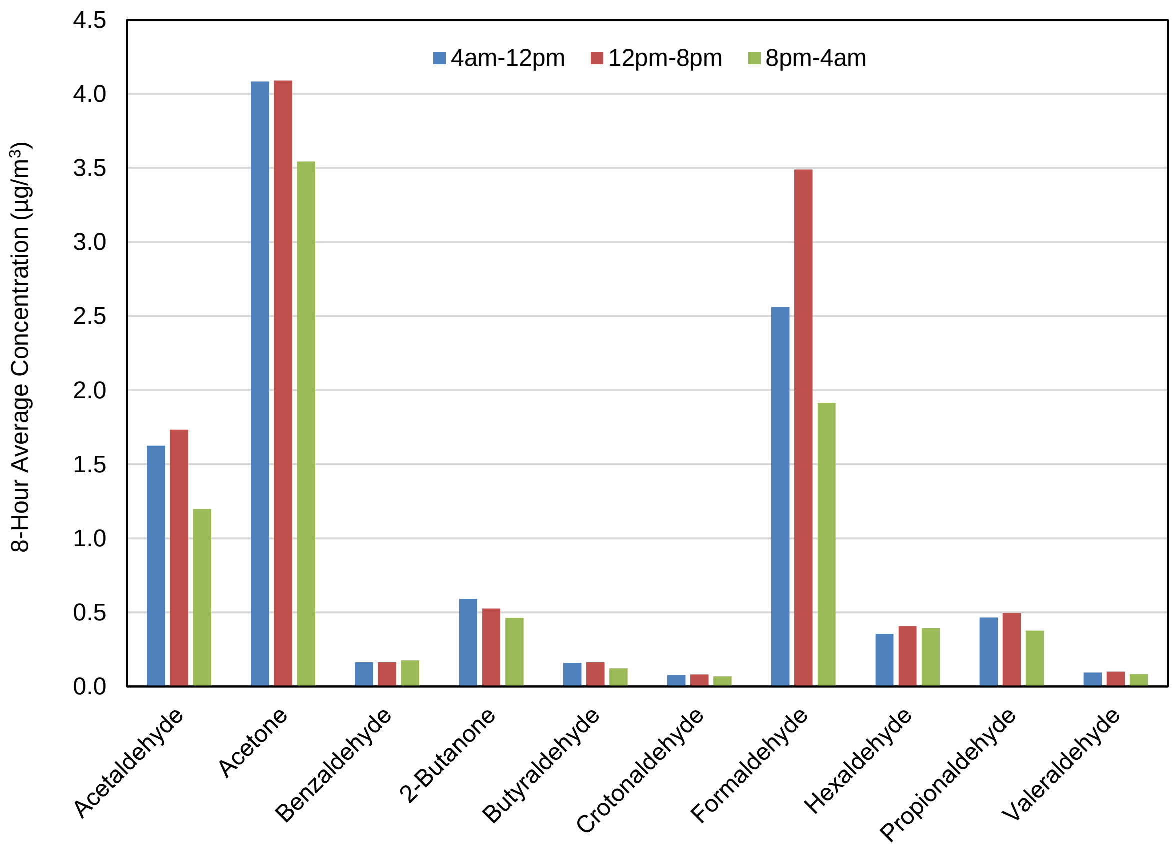


Carbonyls, a subset of VOCs, are also measured at the PAMS site during the summer. Every third day, three consecutive 8-hour samples are collected on cartridges, beginning at 4 am. These are sent to a laboratory for analysis according to USEPA's Method TO-11A protocols. Average daily concentrations for each of the ten carbonyls are shown in Table 11-2. The three carbonyls with the highest concentrations were acetone, formaldehyde, and acetaldehyde. All three of these showed higher concentrations during the afternoon. In general, the overnight hours had the lowest concentrations for most of the carbonyls (Figure 11-7).

Table 11-2
2023 PAMS 8-Hour Average Carbonyl Concentrations in New Jersey
Micrograms per Cubic Meter (µg/m^3)

Carbonyl	4 am-12 pm	12 pm-8 pm	8 pm-4 am	Overall Average
Acetaldehyde	1.63	1.73	1.20	1.52
Acetone	4.08	4.09	3.55	3.91
Benzaldehyde	0.16	0.16	0.18	0.17
2-Butanone	0.59	0.53	0.46	0.53
Butyraldehyde	0.16	0.16	0.12	0.15
Crotonaldehyde	0.08	0.08	0.07	0.08
Formaldehyde	2.56	3.49	1.92	2.66
Hexaldehyde	0.36	0.41	0.39	0.39
Propionaldehyde	0.47	0.50	0.38	0.45
Valeraldehyde	0.09	0.10	0.08	0.09

Figure 11-7
2023 PAMS 8-Hour Average Carbonyl Concentrations in New Jersey
Micrograms per Cubic Meter (µg/m^3)



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Appendix A
2023 Air Monitoring Sites

New Jersey Department of Environmental Protection

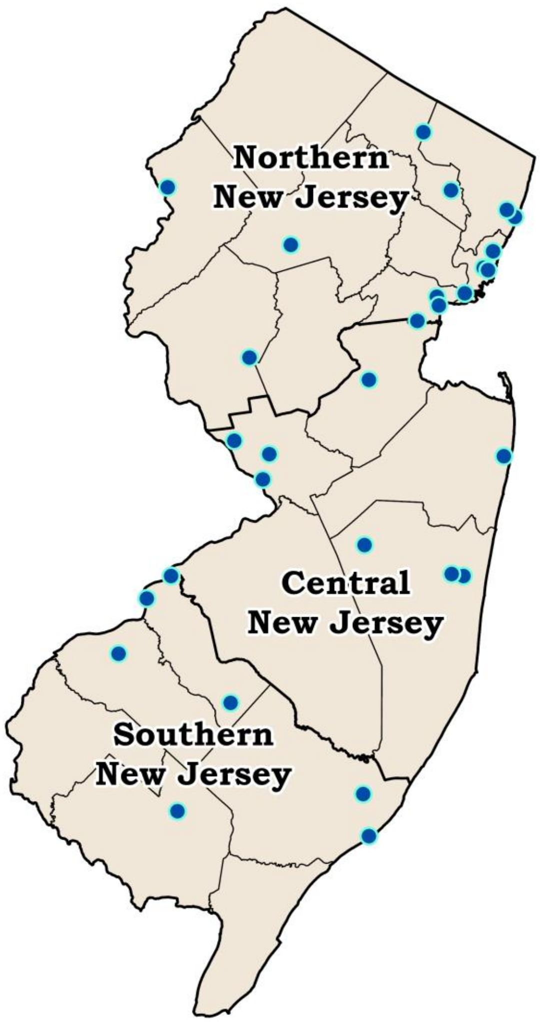


FIGURE A-1
2023 NORTHERN NEW JERSEY
AIR MONITORING SITES

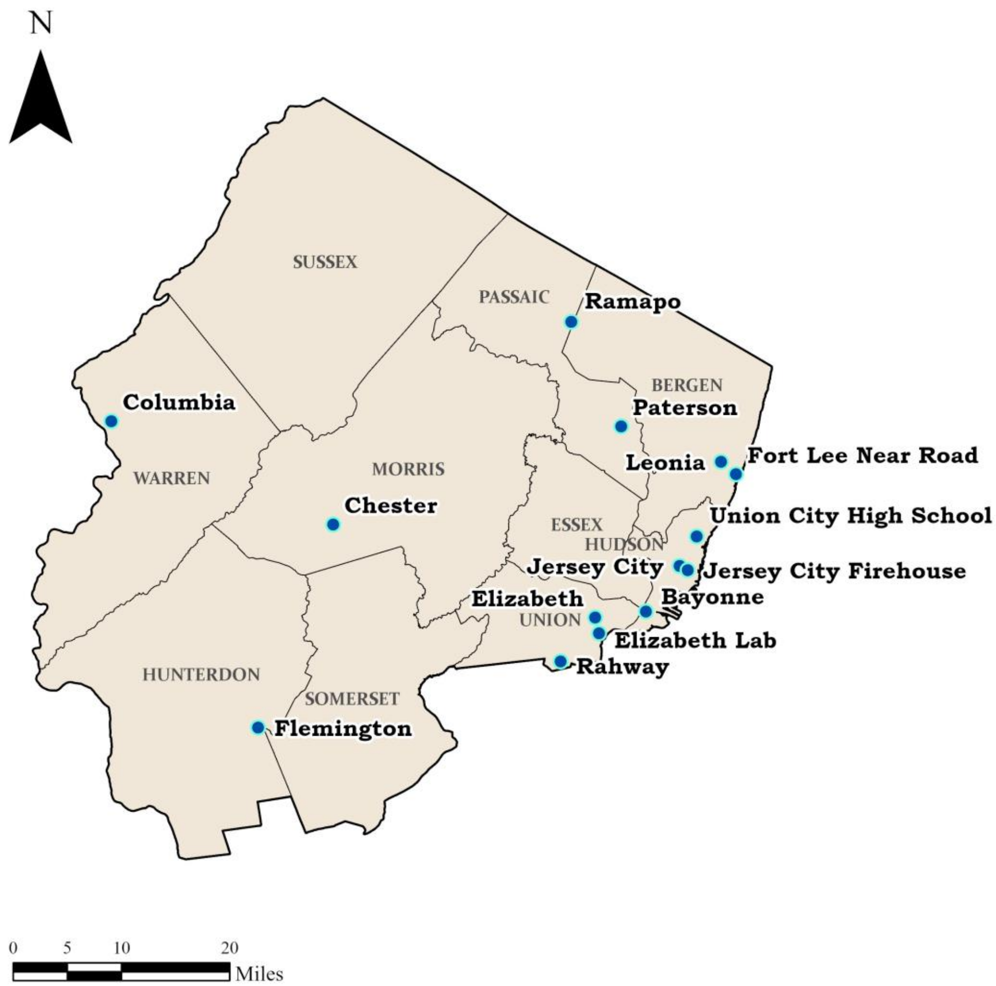


Table A-1
2023 Northern New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
BERGEN	Fort Lee Near Road	34 003 0010	CO, NO_x, $PM_{2.5\ beta}$, BTEX, BC, Met	40.853550	-73.966180	Hoyt Ave & Hudson St, south of toll plaza
	Leonia	34 003 0006	O_3	40.870436	-73.991994	Overpeck Park, 40 Fort Lee Road
HUDSON	Bayonne	34 017 0006	NO_X, O_3, SO_2, BTEX, BC, Met	40.670250	-74.126081	Veterans Park, Park Rd at end of W. 25th St.
	Jersey City	34 017 1002	CO, NO_x, SO_2	40.731645	-74.066308	2828 John F. Kennedy Boulevard
	Jersey City Firehouse	34 017 1003	$PM_{2.5}$, $PM_{2.5\ beta}$, PM_{10}	40.725454	-74.052290	Jersey City Fire Dept. Engine 5/Ladder 6, 355 Newark Avenue
	Union City High School	34 017 0008	$PM_{2.5\ beta}$	40.770908	-74.036218	2500 John F. Kennedy Blvd.
HUNTERDON	Flemington	34 019 0001	O_3, Met, $PM_{2.5\ beta}$	40.515262	-74.806671	Raritan Twp. Municipal Utilities Authority, 365 Old York Road
MORRIS	Chester	34 027 3001	NO_X, O_3, SO_2, $PM_{2.5}$, Toxics, Spec	40.787628	-74.676301	Department of Public Works Bldg. #1, 50 North Road
PASSAIC	Paterson	34 031 0005	$PM_{2.5\ beta}$	40.918381	-74.168092	Paterson Board of Health, 176 Broadway
	Ramapo	34 031 5001	O_3	41.058617	-74.255544	Ramapo Station Fire Tower, Ramapo Park Drive, Wanaque
UNION	Elizabeth	34 039 0003	CO, SO_2	40.662493	-74.214800	7 Broad Street
	Elizabeth Lab	34 039 0004	CO, NO_X, SO_2, Met, $PM_{2.5}$, $PM_{2.5\ beta}$, Toxics, Hg, Spec, BTEX, BC	40.641440	-74.208365	New Jersey Turnpike Interchange 13 Toll Plaza
	Rahway	34 039 2003	$PM_{2.5\ beta}$	40.603943	-74.276174	Rahway Fire Department, 1300 Main Street
WARREN	Columbia	34 041 0007	NO_X, O_3, SO_2, Met, $PM_{2.5\ beta}$	40.924580	-75.067815	Columbia Wildlife Management Area, 105 Delaware Road, Knowlton Twp.

[1] See abbreviations and acronyms in Table A-4 (page A-8).

FIGURE A-2
2023 CENTRAL NEW JERSEY
AIR MONITORING SITES

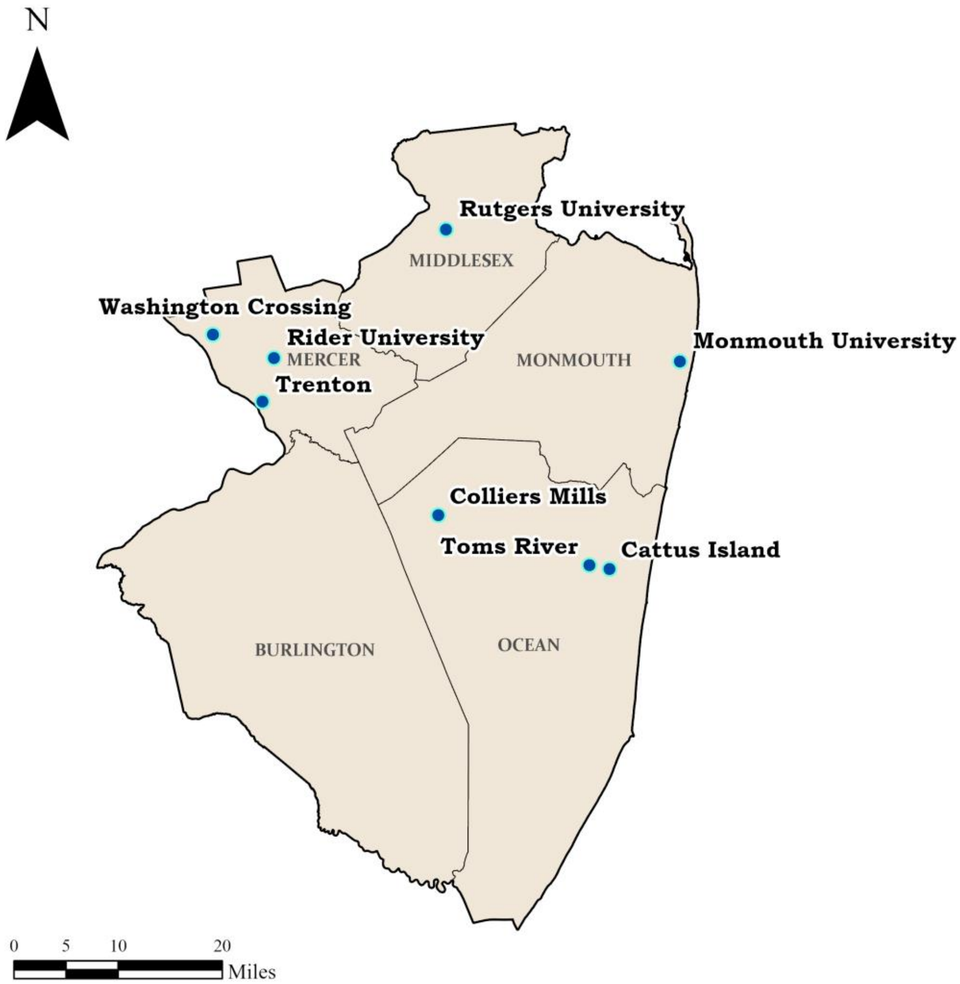


Table A-2
2023 Central New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
MERCER	Rider University	34 021 0005	O_3, Met, $PM_{2.5\ beta}$	40.283092	-74.742644	Athletic Fields, off of 2083 Lawrenceville Rd, Lawrence Twp.
	Trenton Library	34 021 0008	$PM_{2.5\ beta}$	40.222411	-74.763167	120 Academy Street
	Washington Crossing	N/A	O_3, ACID	40.315359	-74.853613	Washington Crossing State Park, Philips Farm Group Area, 1239 Bear Tavern Rd.,Titusville
MIDDLESEX	Rutgers University	34 023 0011	NO_2, NO, NO_y, O_3, PAMS, $PM_{2.5}$, $PM_{2.5\ beta}$, Toxics, Spec, Hg, Met	40.462182	-74.429439	Vegetable Farm 3, 67 Ryders Lane, East Brunswick
MONMOUTH	Monmouth University	34 025 0005	O_3	40.277647	-74.005100	Edison Science Hall, off of 400 Cedar Avenue, West Long Branch
OCEAN	Cattus Island	N/A	ACID	39.989636	-74.134132	Cattus Island County Park behind Administrative Office, end of Bandon Road, Toms River
	Colliers Mills	34 029 0006	O_3	40.064830	-74.444050	JPTD Training Center, south of Success Rd., east of Hawkin Rd., Jackson Twp.
	Toms River	34 029 2002	$PM_{2.5\ beta}$	39.994908	-74.170447	Hooper Avenue Elementary School, 1517 Hooper Avenue

[1] See abbreviations and acronyms in Table A-4 (page A-8).

FIGURE A-3
2023 SOUTHERN NEW JERSEY
AIR MONITORING SITES

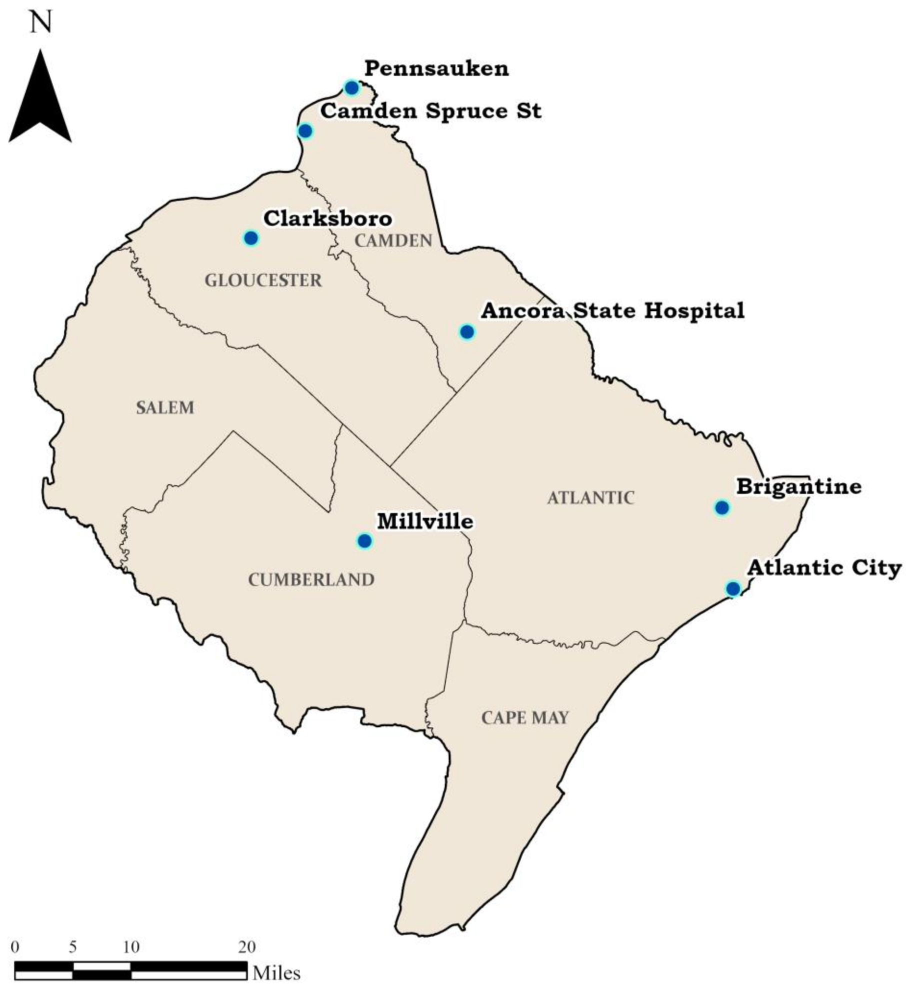


Table A-3
2023 Southern New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
ATLANTIC	Atlantic City	34 001 1006	$PM_{2.5}$, $PM_{2.5\ beta}$	39.363260	-74.431000	Atlantic Cape Community College, 1535 Bacharach Boulevard
	Brigantine	34 001 0006	Visibility, O_3, SO_2, $PM_{2.5}$, $PM_{2.5\ beta}$, ACID[2]	39.464872	-74.448736	Edwin B. Forsythe National Wildlife Refuge Visitor Center, 800 Great Creek Road, Galloway
CAMDEN	Ancora State Hospital	34 007 1001	O_3	39.684250	-74.861491	301 Spring Garden Road, Hammonton
	Camden Spruce Street	34 007 0002	CO, NO_X, O_3, SO_2, $PM_{2.5}$, $PM_{2.5\ beta}$, PM_{10}, Spec, BTEX, BC, Toxics, Met	39.934446	-75.125291	266-298 Spruce Street
	Pennsauken	34 007 1007	$PM_{2.5}$, $PM_{2.5\ beta}$	39.989036	-75.050008	Camden Water Inc., 8999 Zimmerman Ave.
CUMBERLAND	Millville	34 011 0007	NO_X, O_3, $PM_{2.5\ beta}$	39.422273	-75.025204	Behind 4401 S. Main Road
GLOUCESTER	Clarksboro	34 015 0002	O_3, $PM_{2.5}$, $PM_{2.5\ beta}$	39.800339	-75.212119	Shady Lane Nursing Home, 256 County House Road

[1] See abbreviations and acronyms in Table A-4 (page A-8).
[2] United States Fish and Wildlife Service-Air Quality Branch (USFWS-AQB) is responsible for ACID sample collection.

Table A-4
Abbreviations & Acronyms

ACID	Acid deposition
AQS	Air Quality System (USEPA's ambient air quality data repository)
BC	Black carbon measured by aethalometer
BTEX	Measurement of benzene, toluene, ethylbenzene and xylenes
CO	Carbon monoxide
Hg	Mercury
Met	Meteorological parameters
NO_X	Nitrogen dioxide and nitric oxide
NOy	Total reactive oxides of nitrogen
O_3	Ozone
PAMS	Photochemical Assessment Monitoring Station, measures ozone precursors
Pb	Lead
$PM_{2.5\ beta}$	Real-time $PM_{2.5}$ analyzer
$PM_{2.5}$	Fine particles (2.5 microns or less) collected by a Federal Reference Method $PM_{2.5}$ filter sampler
PM_{10}	Inhalable particles (10 microns or less) collected by a Federal Reference Method PM_{10} filter sampler
SO_2	Sulfur dioxide
Spec	Speciated fine particles (2.5 microns or less)
Toxics	Air toxics
Visibility	Measured by nephelometer

Appendix B: 2023 Fine Particulate Speciation Summary

New Jersey Department of Environmental Protection

CHEMICAL SPECIATION NETWORK

The data presented in this section is collected as part of the U.S Environmental Protection Agency Chemical Speciation Network. This program uses 24-hour filter-based $PM_{2.5}$ samples to determine the concentrations of the chemicals (metals, ions and carbon compounds) that make up the particles. Teflon filters are analyzed for 33 elements, nylon filters are analyzed for ions, and quartz filters are analyzed for carbon. For details, see https://www.epa.gov/amtic/chemical-speciation-network-csn.

New Jersey has been collecting this data since 2001, as indicated in Table B-1. A map of the current monitoring locations can be seen in Figure B-1.

Table B-1
Speciation Monitoring in New Jersey

Monitoring Site	Location	Start	End	Frequency
Camden Lab (Camden 1)	Copewood & Davis Sts.	2001	2008	---
Camden Spruce St (Camden 2)	266-298 Spruce St.	2013		Every 6th day
Chester	50 North Rd.	2001		Every 6th day
Elizabeth Lab	NJ Turnpike Exit 13 Toll Plaza	2001		Every 3rd day
Newark Firehouse**	360 Clinton Ave.	2010	2022	Every 3rd day
New Brunswick*	Log Cabin Rd.	2001	2015	---
Rutgers*	67 Ryders Lane	2016		Every 3rd day

*Also has a co-located monitor for quality assurance.
**Note that the Newark Firehouse station was shut down on 9/26/2022. The NJDEP plans to resume speciation monitoring in Newark at a new site in 2025.

A 24-hour sample is collected every third or sixth day, and sent to USEPA's contract laboratory for analysis. Tables B-2 through B-6 present the 2023 averages, maximums, and the percent of samples detected. Some analytes are regularly below the limit detectable by the lab. In Tables B-2 through B-5, annual averages in italics have been calculated with fewer than 50% of samples detected. The most recent detection limits are listed in Table B-6.

TRENDS

Trends in the concentrations of elemental carbon and organic carbon are shown in Figure B-2 and B-3. Nitrate and sulfate concentrations can be found in Figures B-4 and B-5.

Carbon compounds make up a large portion of particulate matter. They are released into the air primarily from combustion of fuels. Significant sources of elemental carbon are on-road vehicles and non-road equipment. While these sources also emit substantial quantities of organic carbon, other major sources of organic carbon include the burning of wood and other solid fuels.

Nitrate and sulfate are other major components of ambient particles. They are mostly formed by chemical reactions in the atmosphere by nitrogen and sulfur compounds emitted by fuel combustion. In addition to contributing to health effects as particulate matter, they affect visibility and cause acidification of surface water, rain and soil.

Figure B-1
2023 Fine Particulate Speciation Monitoring Network

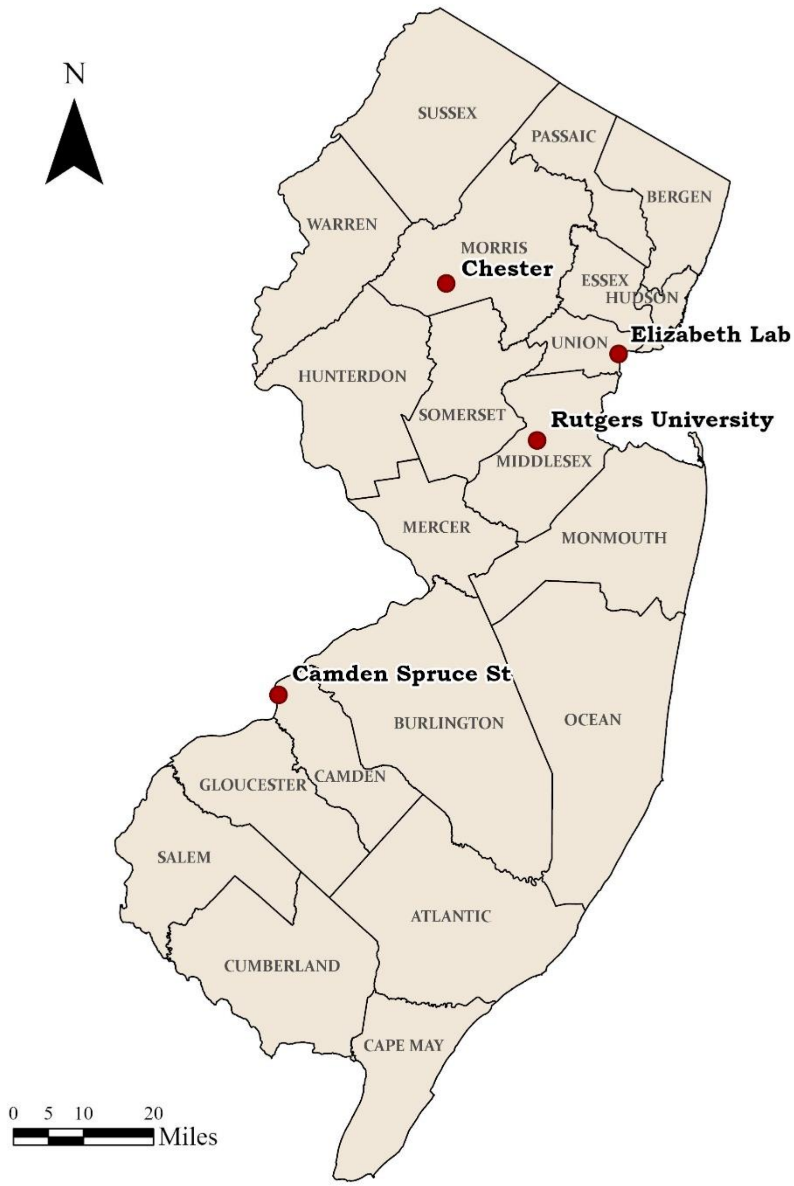


Table B-2
2023 Fine Particulate Speciation Concentrations
CAMDEN SPRUCE STREET NJ
Micrograms per Cubic Meter (µg/m³)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.033	0.146	90
2	Ammonium Ion	0.402	2.306	100
3	Antimony	0.005	0.026	52
4	Arsenic	*0.00001*	*0.0001*	28
5	Barium	0.009	0.060	59
6	Bromine	*0.002*	*0.038*	47
7	Cadmium	0.005	0.030	62
8	Calcium	0.053	0.279	100
9	Carbon, Elemental	0.623	2.059	100
10	Carbon, Organic	2.681	14.220	100
11	Cerium	0.013	0.058	67
12	Cesium	*0.005*	*0.045*	41
13	Chloride	0.513	3.639	100
14	Chlorine	0.090	1.756	98
15	Chromium	0.003	0.035	76
16	Cobalt	*0.000*	*0.002*	31
17	Copper	0.004	0.064	69
18	Indium	0.004	0.018	50
19	Iron	0.129	0.812	95
20	Lead	0.005	0.033	76
21	Magnesium	0.025	0.147	59
22	Manganese	0.004	0.024	81
23	Nickel	0.001	0.016	79
24	Nitrate	1.228	6.034	100
25	Phosphorus	0.000	0.005	84
26	Potassium	0.151	1.547	100
27	Potassium Ion	0.139	1.645	100
28	Rubidium	0.001	0.006	55
29	Selenium	*0.001*	*0.007*	45
30	Silicon	0.063	0.346	98
31	Silver	0.004	0.023	50
32	Sodium	0.087	0.617	57
33	Sodium Ion	0.097	0.563	98
34	Strontium	0.001	0.037	50
35	Sulfate	0.925	2.401	100
36	Sulfur	0.322	0.768	100
37	Tin	0.003	0.014	53
38	Titanium	0.004	0.014	95
39	Vanadium	*0.000*	*0.002*	19
40	Zinc	0.025	0.179	100
41	Zirconium	0.004	0.017	66

Table B-3
2023 Fine Particulate Speciation Concentrations
CHESTER NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.017	0.091	55
2	Ammonium Ion	0.228	2.168	100
3	Antimony	*0.003*	*0.021*	42
4	Arsenic	*0*	*0.00004*	27
5	Barium	0.008	0.054	60
6	Bromine	*0.0002*	*0.003*	11
7	Cadmium	*0.003*	*0.016*	49
8	Calcium	0.019	0.090	98
9	Carbon, Elemental	0.230	0.854	96
10	Carbon, Organic	2.271	23.006	96
11	Cerium	0.009	0.053	58
12	Cesium	*0.004*	*0.024*	44
13	Chloride	0.030	0.140	95
14	Chlorine	0.002	0.014	58
15	Chromium	0.001	0.005	62
16	Cobalt	*0.0004*	*0.003*	45
17	Copper	*0.001*	*0.011*	47
18	Indium	0.005	0.029	55
19	Iron	0.028	0.117	95
20	Lead	0.003	0.018	55
21	Magnesium	*0.013*	*0.084*	47
22	Manganese	0.001	0.004	60
23	Nickel	0.001	0.003	69
24	Nitrate	0.878	7.643	100
25	Phosphorus	0.0002	0.006	56
26	Potassium	0.051	0.382	98
27	Potassium Ion	0.052	0.379	98
28	Rubidium	0.001	0.007	64
29	Selenium	*0.001*	*0.004*	45
30	Silicon	0.035	0.227	93
31	Silver	0.003	0.016	51
32	Sodium	*0.025*	*0.141*	38
33	Sodium Ion	0.021	0.193	98
34	Strontium	*0.001*	*0.006*	47
35	Sulfate	0.709	1.997	100
36	Sulfur	0.240	0.680	100
37	Tin	0.004	0.024	60
38	Titanium	0.002	0.014	64
39	Vanadium	*0.0001*	*0.001*	20
40	Zinc	0.007	0.020	98
41	Zirconium	0.003	0.024	55

Table B-4
2023 Fine Particulate Speciation Concentrations
ELIZABETH LAB NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.033	0.182	81
2	Ammonium Ion	0.344	2.644	99
3	Antimony	0.004	0.037	61
4	Arsenic	*0*	*0.00005*	31
5	Barium	0.019	0.250	70
6	Bromine	*0.0005*	*0.006*	28
7	Cadmium	0.004	0.020	51
8	Calcium	0.036	0.108	100
9	Carbon, Elemental	0.698	2.326	87
10	Carbon, Organic	2.161	16.639	88
11	Cerium	0.010	0.074	54
12	Cesium	0.006	0.044	46
13	Chloride	0.120	1.042	100
14	Chlorine	0.015	0.579	91
15	Chromium	0.003	0.022	78
16	Cobalt	0.0002	0.003	26
17	Copper	0.005	0.182	86
18	Indium	*0.003*	*0.021*	46
19	Iron	0.146	0.339	97
20	Lead	0.003	0.013	71
21	Magnesium	0.022	0.372	59
22	Manganese	0.003	0.014	79
23	Nickel	0.002	0.010	86
24	Nitrate	1.258	8.786	100
25	Phosphorus	0.0007	0.009	73
26	Potassium	0.090	4.010	100
27	Potassium Ion	0.085	4.388	99
28	Rubidium	0.0009	0.006	56
29	Selenium	*0.0007*	*0.006*	48
30	Silicon	0.061	0.268	98
31	Silver	0.004	0.022	51
32	Sodium	0.062	0.708	58
33	Sodium Ion	0.062	0.623	98
34	Strontium	0.002	0.100	60
35	Sulfate	0.915	5.078	100
36	Sulfur	0.319	1.526	100
37	Tin	0.004	0.028	53
38	Titanium	0.006	0.037	96
39	Vanadium	*0.0004*	*0.012*	27
40	Zinc	0.016	0.062	100
41	Zirconium	0.006	0.027	64

Table B-5
2023 Fine Particulate Speciation Concentrations
RUTGERS UNIVERSITY NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.032	0.219	79
2	Ammonium Ion	0.235	2.116	100
3	Antimony	0.005	0.023	56
4	Arsenic	*0.00001*	*0.0001*	36
5	Barium	0.015	0.130	64
6	Bromine	*0.0003*	*0.004*	24
7	Cadmium	0.004	0.019	57
8	Calcium	0.022	0.104	100
9	Carbon, Elemental	0.352	2.604	98
10	Carbon, Organic	2.875	39.355	98
11	Cerium	0.010	0.090	50
12	Cesium	*0.007*	*0.040*	48
13	Chloride	0.078	0.689	100
14	Chlorine	0.013	0.697	82
15	Chromium	0.002	0.025	66
16	Cobalt	*0.0002*	*0.002*	26
17	Copper	0.002	0.096	60
18	Indium	no data	no data	no data
19	Iron	0.052	0.189	93
20	Lead	0.004	0.065	60
21	Magnesium	0.018	0.184	53
22	Manganese	0.003	0.066	70
23	Nickel	0.001	0.008	70
24	Nitrate	0.950	7.294	100
25	Phosphorus	0.0005	0.005	74
26	Potassium	0.075	2.039	100
27	Potassium Ion	0.075	2.323	99
28	Rubidium	0.001	0.006	52
29	Selenium	0.001	0.007	50
30	Silicon	0.045	0.265	97
31	Silver	0.003	0.017	50
32	Sodium	0.047	0.548	51
33	Sodium Ion	0.046	0.440	99
34	Strontium	*0.001*	*0.040*	43
35	Sulfate	0.787	3.059	100
36	Sulfur	0.263	0.871	100
37	Tin	*0.004*	*0.028*	48
38	Titanium	0.003	0.017	86
39	Vanadium	*0.0001*	*0.002*	23
40	Zinc	0.012	0.104	100
41	Zirconium	0.005	0.027	65

Table B-6
CSN Average Minimum Detection Limits (MDL) (µg/m³)

	Species	MDL (µg/m³)
1	Aluminum	0.023
2	Ammonium Ion	0.013
3	Antimony	0.016
4	Arsenic	0.0001
5	Barium	0.028
6	Bromine	0.0001
7	Cadmium	0.014
8	Calcium	0.010
9	Carbon, Elemental	0.0003
10	Carbon, Organic	0.644
11	Cerium	0.036
12	Cesium	0.027
13	Chloride	0.025
14	Chlorine	0.004
15	Chromium	0.002
16	Cobalt	0.002
17	Copper	0.004
18	Indium	0.015
19	Iron	0.009
20	Lead	0.007
21	Magnesium	0.045
22	Manganese	0.003
23	Nickel	0.001
24	Nitrate	0.039
25	Phosphorus	0.002
26	Potassium	0.005
27	Potassium Ion	0.013
28	Rubidium	0.003
29	Selenium	0.003
30	Silicon	0.014
31	Silver	0.013
32	Sodium	0.081
33	Sodium Ion	0.014
34	Strontium	0.003
35	Sulfate	0.029
36	Sulfur	0.001
37	Tin	0.016
38	Titanium	0.003
39	Vanadium	0.001
40	Zinc	0.002
41	Zirconium	0.014

Most recent detection limit information from: Chemical Speciation Network (CSN) Annual Quality Report, prepared by Air Quality Research Center, University of California, Davis, pp. 32-33, 01/31/2023.
https://www.epa.gov/system/files/documents/2023-02/CSN_2021AnnualQualityReport.pdf

Figure B-2
ELEMENTAL CARBON – New Jersey Monitored Concentrations

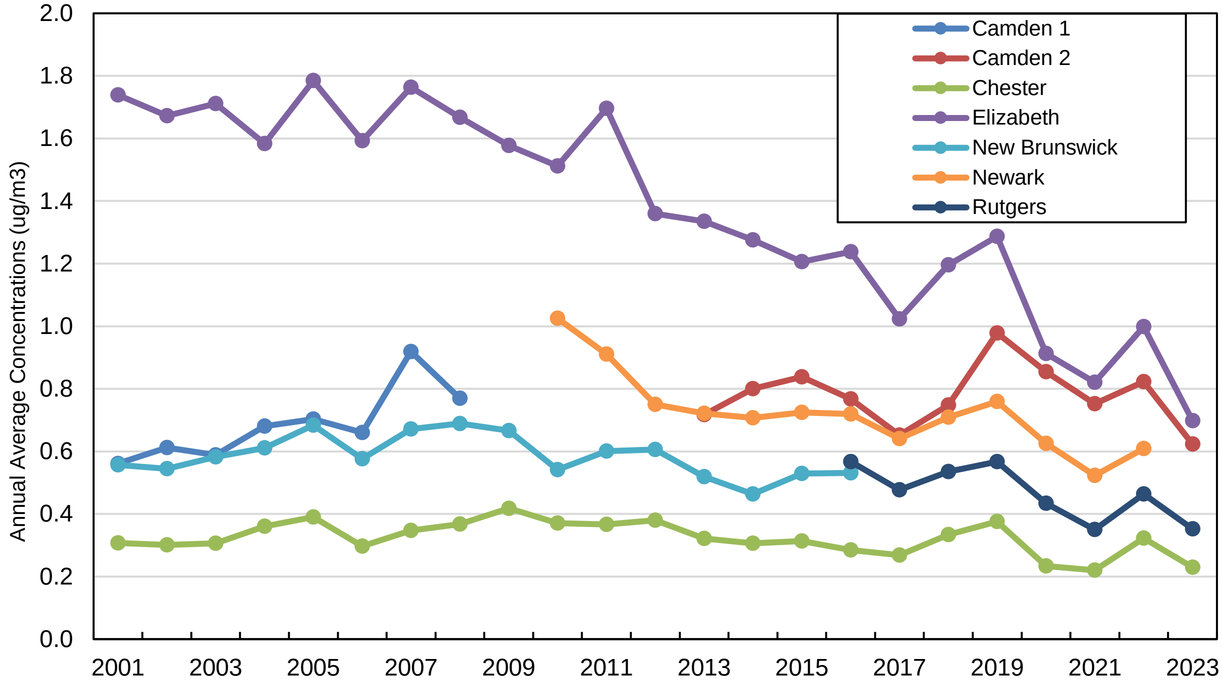


Figure B-3
ORGANIC CARBON – New Jersey Monitored Concentrations

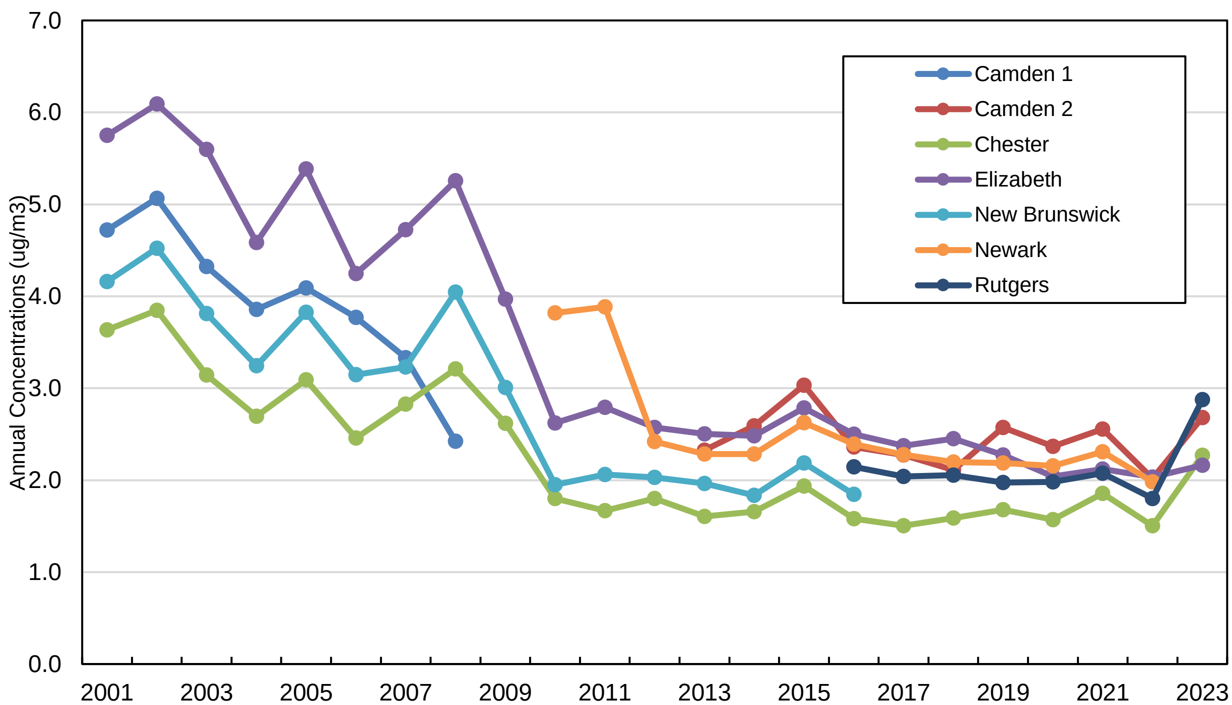


Figure B-4
NITRATE – New Jersey Monitored Concentrations

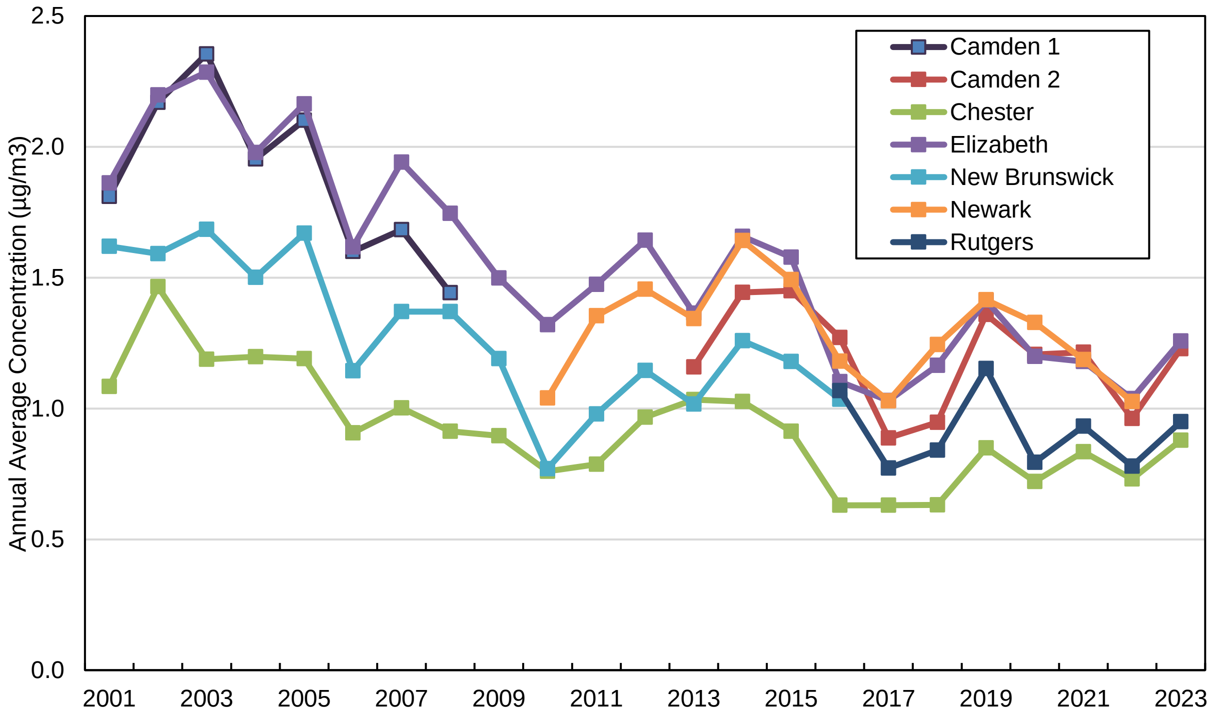
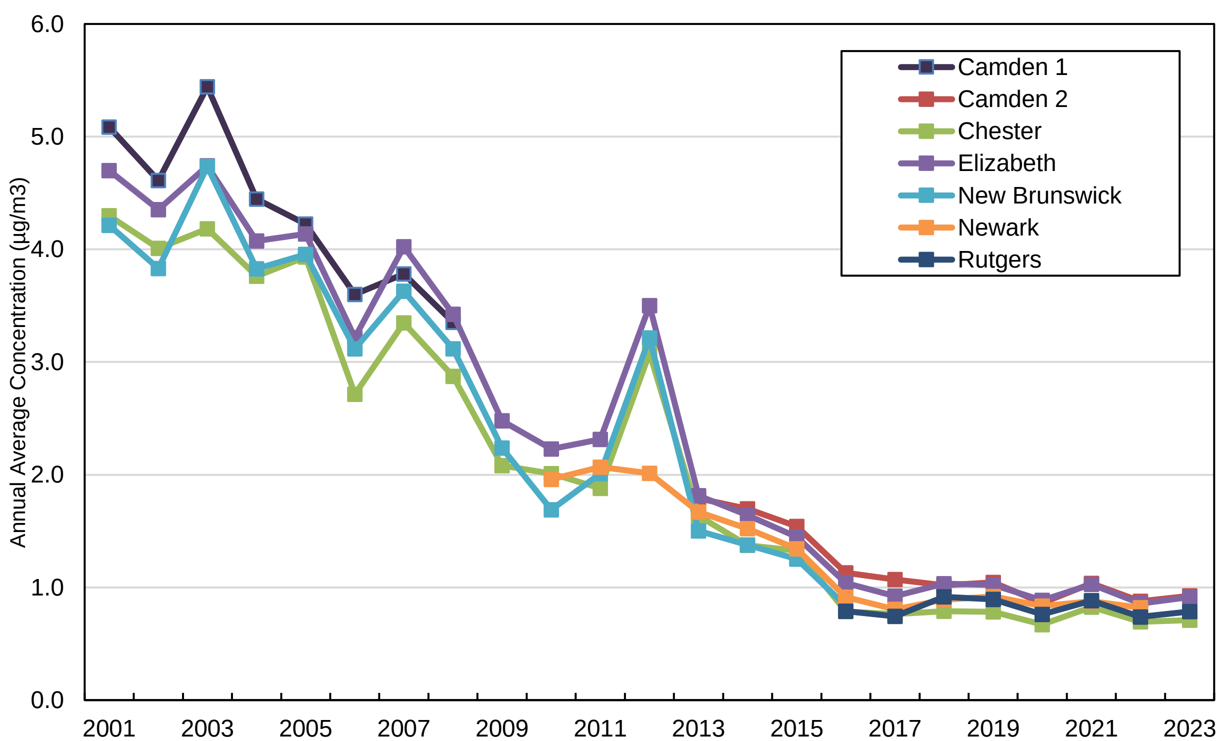


Figure B-5
SULFATE – New Jersey Monitored Concentrations



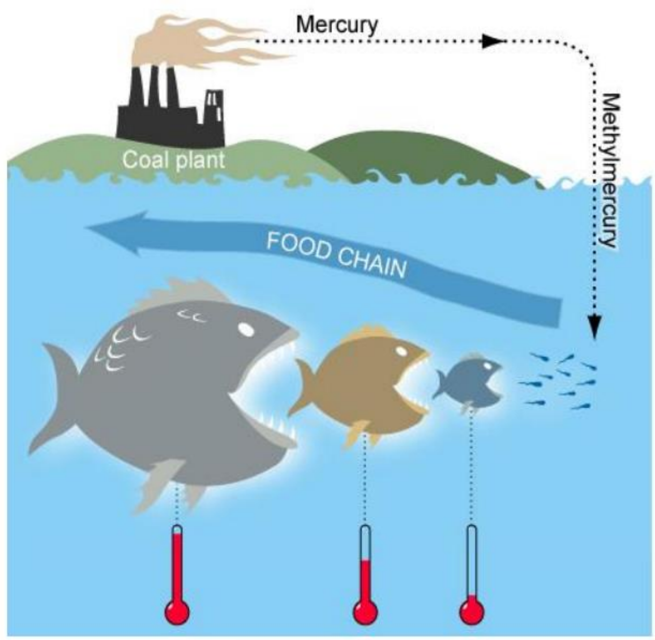
Appendix C: 2023 Mercury Summary

New Jersey Department of Environmental Protection

Background and Sources

Mercury is a naturally occurring element that can become airborne through both natural processes, such as volcanic activity, and by human activity. Mining, combustion of fossil fuels (particularly coal), non-ferrous metal production, and cement production are the largest contributors to mercury emissions. The main sources of gaseous elemental mercury (GEM) and gaseous oxidized mercury (GOM) in New Jersey are from coal combustion, smelting and fuel combustion. Particulate bound mercury (PBM) is emitted by a variety of combustion sources (coal, wood, and oil) throughout New Jersey and beyond its borders.

After emission, mercury can stay entrained in air masses for up to 6 months and span thousands of miles before being deposited back to the earth's surface either through rainfall or dry deposition. Once back to the surface mercury can be re-entrained into the air or changed into methylmercury by micro-organisms and bioaccumulate in the food chain.



Source: NADP

Health Effects

Mercury is a toxic pollutant that particularly leaves developing fetuses and children at risk for nervous system effects and complications in brain development. However, most exposure is not directly related to atmospheric concentrations. Atmospheric mercury eventually enters the food chain through deposition on land and water where it can be transformed into Methyl Mercury, a neurotoxin. Methyl Mercury bioaccumulates in the food chain and is then ingested by eating contaminated fish and shellfish

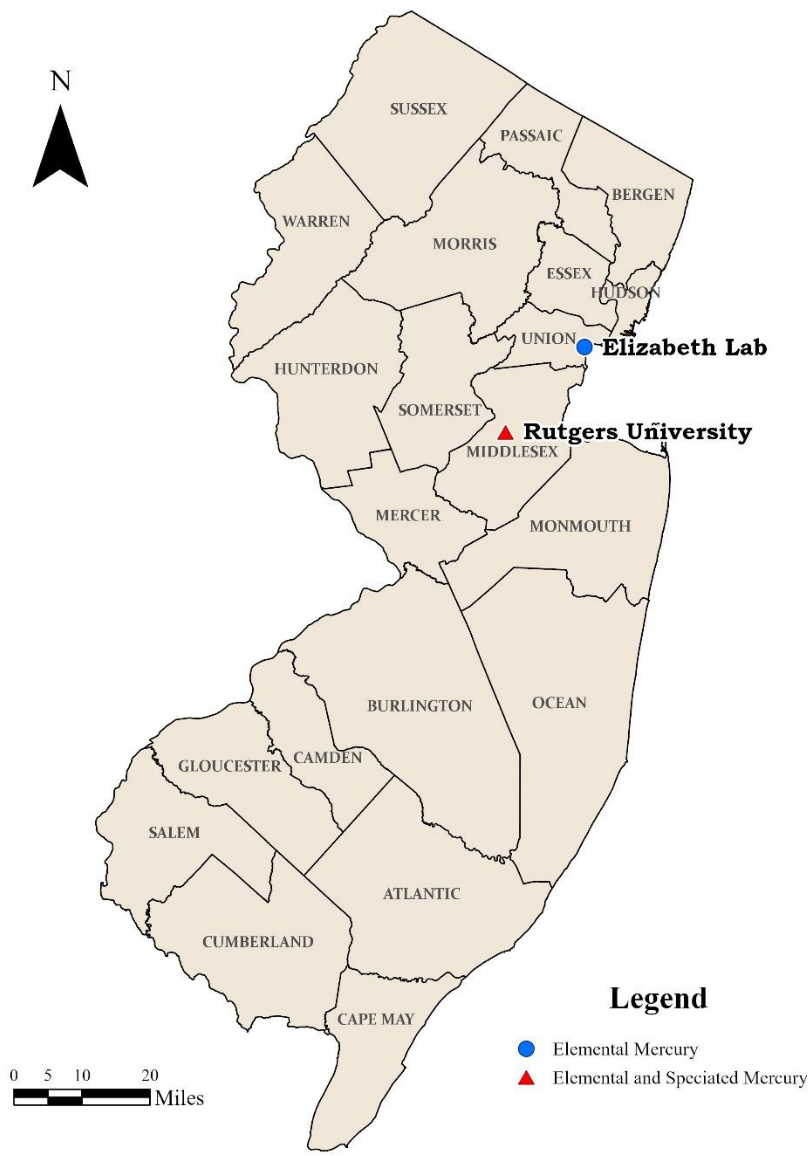
Mercury Monitoring Network

New Jersey operates two atmospheric mercury analyzers, one at Elizabeth Lab and the other at Rutgers University. These are part of the Atmospheric Mercury Network (AMNet) one of the networks operated by the National Acid Deposition Program (NADP), a cooperative effort of federal state, tribal and local governmental agencies. Both sites operate TEKRAN samplers, however Elizabeth Lab only collects gaseous elemental mercury (GEM), whereas Rutgers University collects all three species of atmospheric mercury: GEM, gaseous oxidized mercury (GOM), and particulate bound mercury (PBM), collectively referred to as speciated mercury. All data collected is sent to AMNet for review, quality control, and certification. The mercury monitoring stations are shown in Figure C-1.

The full speciation monitoring cycle involves a 2-hour sampling period during which ambient GEM data is generated, measuring concentrations in nanograms per cubic meter(ng/m^3) while GOM and PBM are collected and concentrated on specialized glassware. During the third hour of the cycle, GOM and PBM are sequentially desorbed at high temperatures and analyzed and measured in picograms per cubic meter (pg/m^3), after which the system returns to sampling temperature prior to the beginning of the next cycle.

New Jersey also operates a rain collector at Rutgers Garden site as part of the Mercury Deposition Network (MDN). Deposition is collected with an Aerochem model sampler that opens during precipitation events and follows a sampling line of a glass funnel and thistle to a collection bottle that has hydrochloric acid solution to preserve the mercury. Precipitation samples are collected weekly and shipped to the analytical laboratory at Wisconsin State Laboratory of Hygiene for mercury analysis. Mercury deposition is measured by the amount or mass of mercury in micrograms transferred to a square meter of ground in one week ($\mu g/m^2$) and is calculated by multiplying the mercury concentration by the amount of rainfall in meters.

FIGURE C-1
2023 MERCURY MONITORING NETWORK



MERCURY LEVELS, 2016-2023

Table C-1 shows the annual speciated mercury concentrations at the Rutgers University station and Table C-2 shows the annual concentrations of gaseous elemental mercury only at the Elizabeth Lab station. The past 4 years have been analyzed for diurnal trends with both sites showing higher concentrations of gaseous elemental mercury in the overnight hours as well as an additional peak for the evening rush hour in the Elizabeth site, see Figure C-2. Rutgers University showed a drop in mercury concentrations over the summer, especially for the speciated mercury whereas elemental mercury shows the opposite, with both sites having peak concentrations during the summer months (Figure C-3 and Figure C-4). When looking at the trend lines for mercury concentrations since 2016 there is little identifiable trend either up or down in any of the mercury concentrations that are being monitored in NJ, both atmospheric levels as well as the wet deposition (Figures C-5 to C-7).

Table C-1
2016-2023 Mercury Concentrations at Rutgers University Station
Gaseous Elemental, Gaseous Oxidized and Particulate Bound Mercury
Nanograms per cubic meter (ng/m^3), picograms per cubic meter (pg/m^3)

Year	GEM (ng/m^3)	GOM (pg/m^3)	PBM (pg/m^3)
2016	1.622	3.173	3.989
2017	1.711	3.235	4.538
2018	1.552	2.164	4.961
2019	1.474	1.988	6.969
2020	1.438	3.444	6.236
2021	1.466	1.694	4.718
2022	1.407	1.588	6.411
2023	1.415	2.127	5.572

Table C-2
2016-2023 Mercury Concentrations at Elizabeth Lab Station
Gaseous Elemental Mercury
Nanograms per cubic meter (ng/m^3)

Year	GEM (ng/m^3)
2016	2.17
2017	4.32
2018	3.79
2019	2.26
2020	3.23
2021	3.25
2022	2.85
2023	3.12

Figure C-2
Diurnal Trends of Gaseous Elemental Mercury at Rutgers University And Elizabeth Lab, 2020-2023
Nanograms per Cubic Meter (ng/m^3)

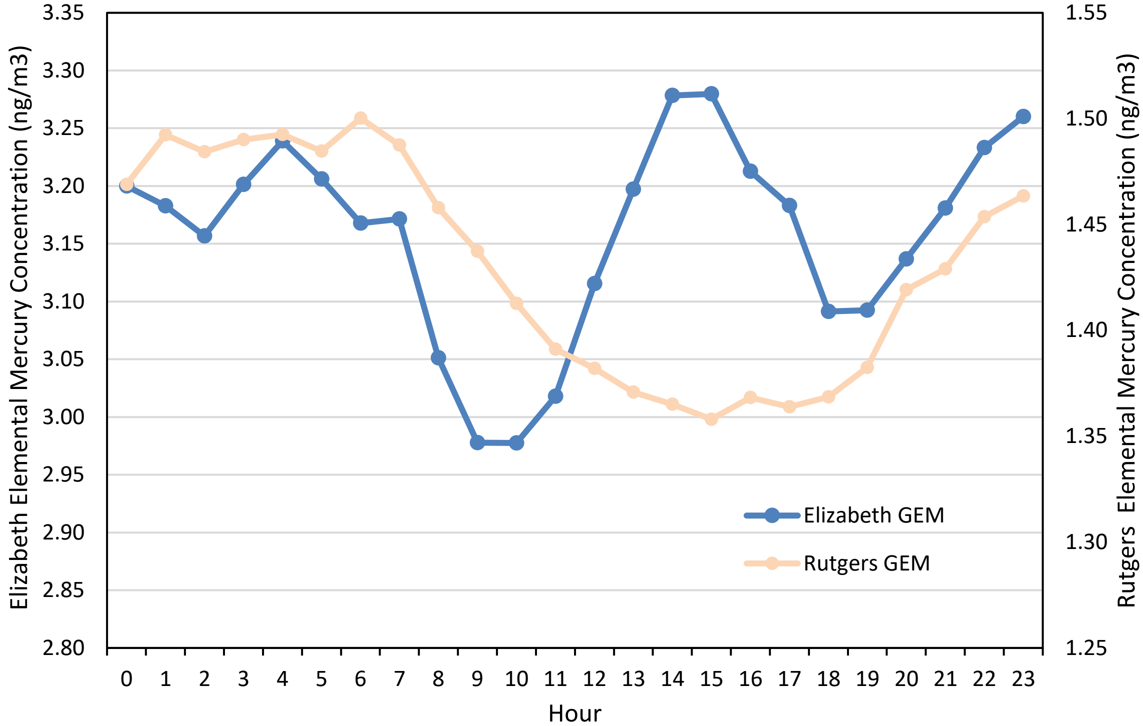


Figure C-3
Seasonal Trends of Gaseous Elemental, Gaseous Oxidized and Particulate Bound Mercury at Rutgers University, 2020-2023
Nanograms per Cubic Meter (ng/m^3), Picograms per Cubic Meter (pg/m^3)

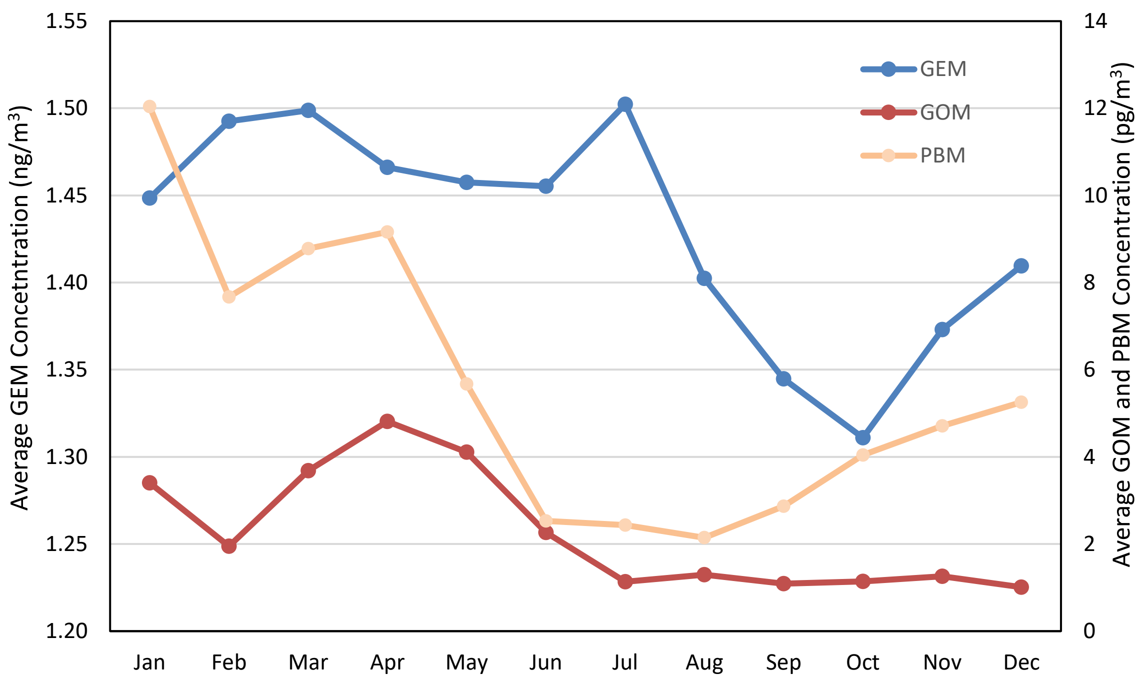


Figure C-4
Seasonal Trends of Gaseous Elemental Mercury at Elizabeth Lab, 2020-2023
Nanograms per Cubic Meter (ng/m³)

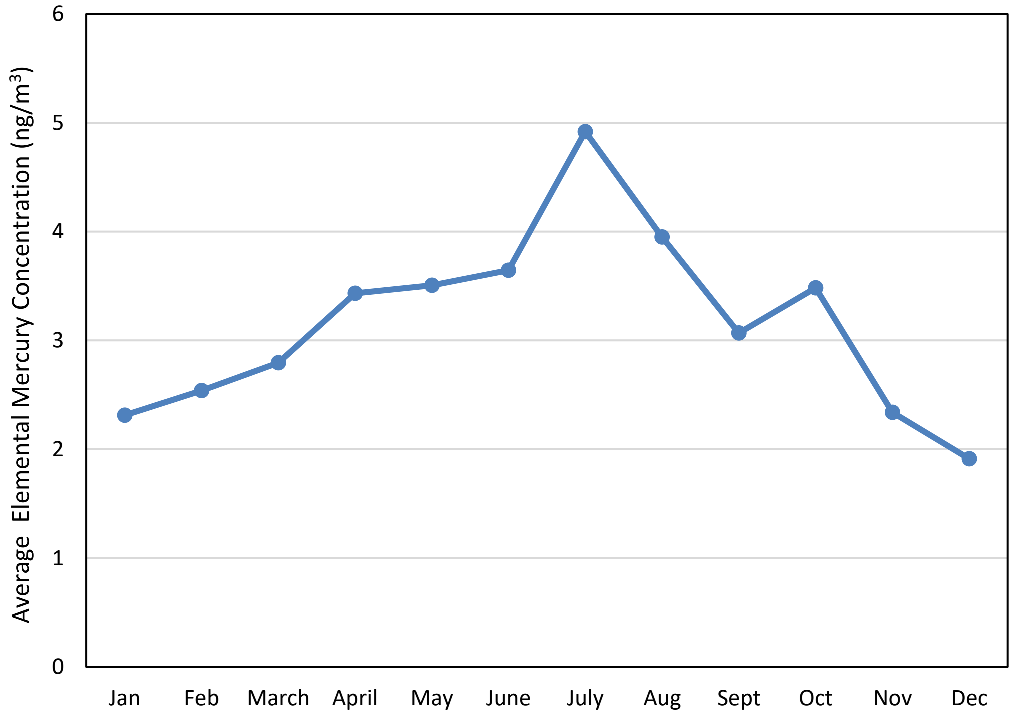


Figure C-5
Trends of Gaseous Elemental Mercury in New Jersey, 2016-2023
Nanograms per Cubic Meter (ng/m³)

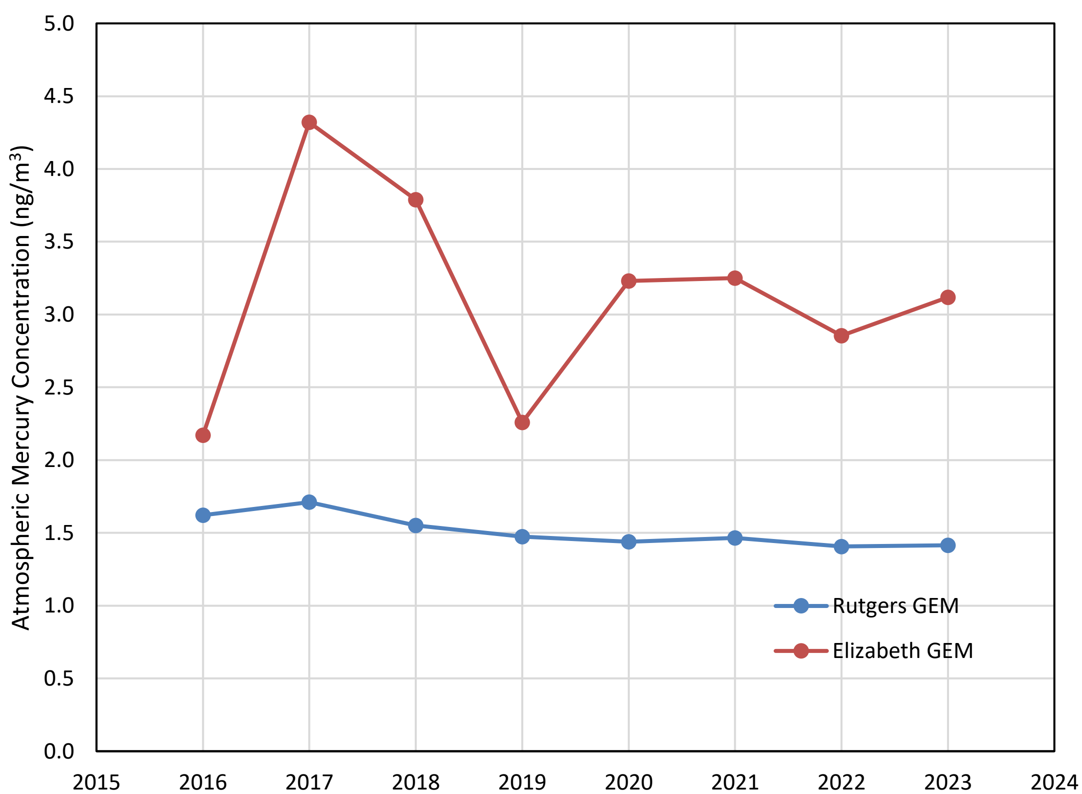


Figure C-6
Trends of Speciated Mercury at Rutgers University, 2016-2023
Nanograms per Cubic Meter (ng/m³)

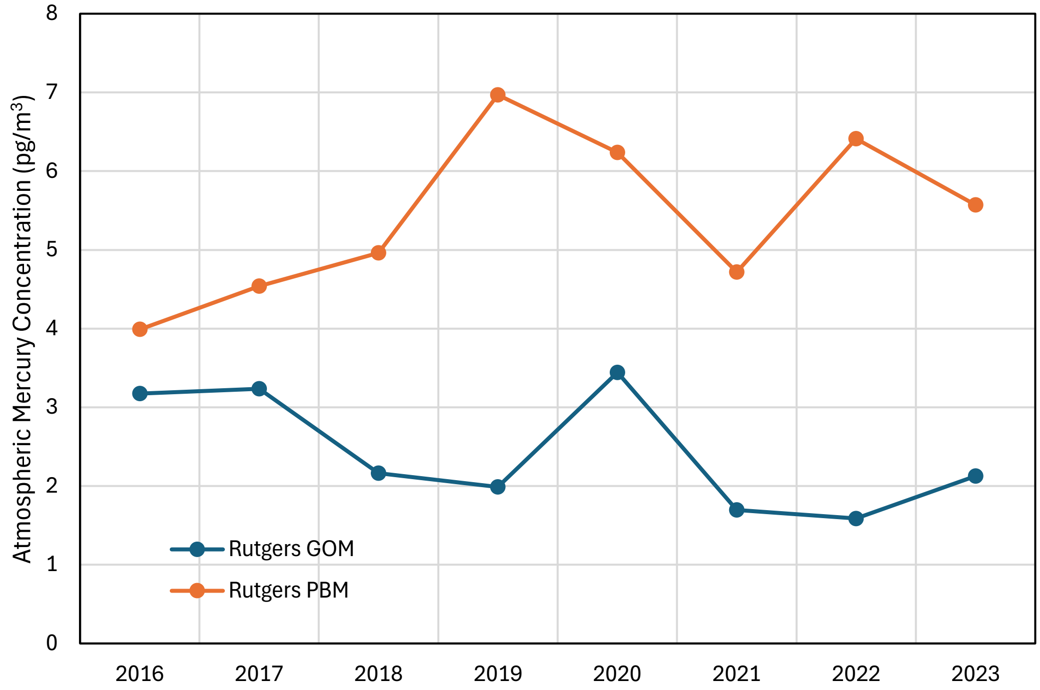
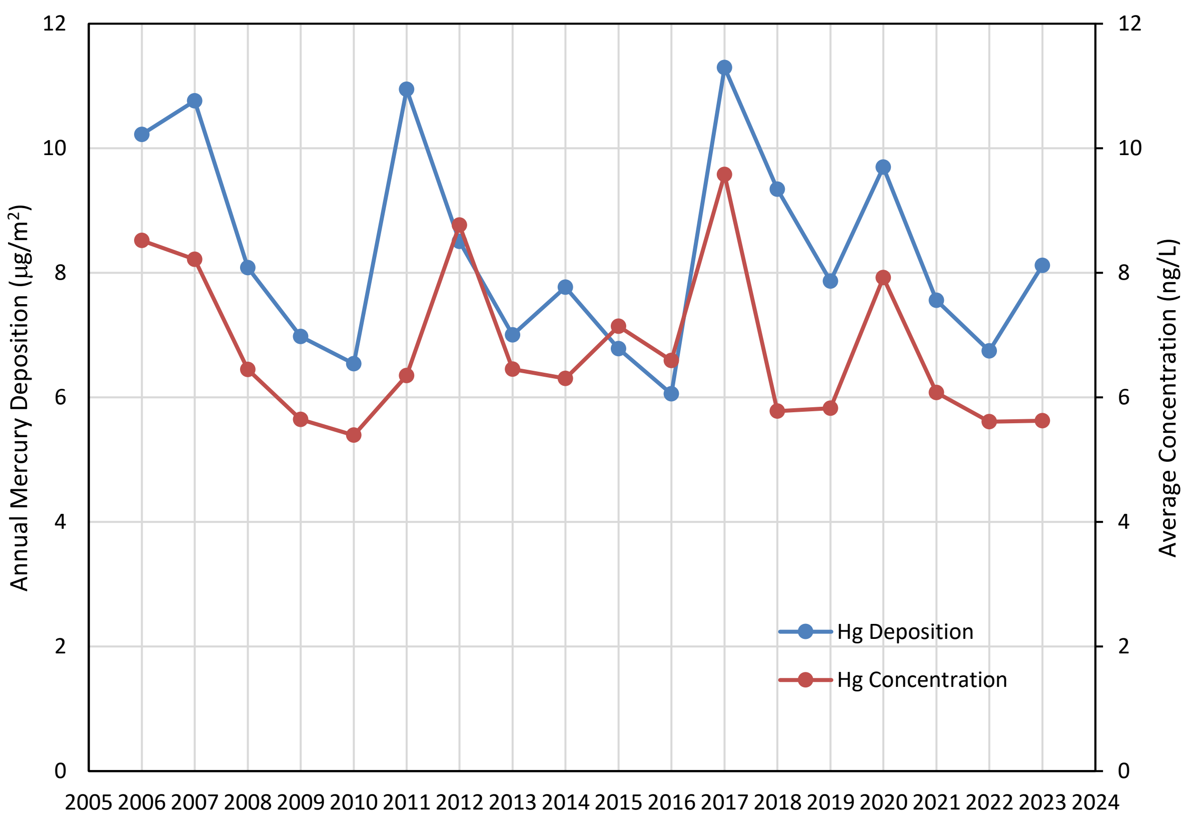


Figure C-7
Trends of Mercury Deposition in Rainwater at Rutgers University, 2006-2023
Micrograms per Square Meter (μg/m²), Nanograms per liter (ng/L)



ESTIMATING HEALTH RISK

The effects on human health resulting from exposure to specific air toxics can be estimated by using chemical-specific **health benchmarks**. These are based on toxicity values developed by the USEPA and other agencies, using animal or human health studies. For carcinogens, which are chemicals suspected of causing cancer, the health benchmark is the concentration of the pollutant that corresponds to a one-in-one-million increase in the risk of getting cancer if a person was to breathe that concentration over his or her entire lifetime. The health benchmark for a noncarcinogen is the air concentration at which no adverse health effect is expected to occur, even if a person is exposed to that concentration on a daily basis for a lifetime (this is also known as a reference concentration). Because of a lack of toxicity studies, not all air toxics have health benchmarks. While the EPA did not classify the potential of elemental mercury to cause cancer in humans, it established a reference concentration for the inhalation of elemental mercury at 0.3 micrograms per cubic meter ($\mu g/m^3$).

A **risk ratio** can be used to quantify risk from exposure to a specific chemical. This is calculated by dividing the annual average air concentration of a chemical by its long-term health benchmark. If the risk ratio is less than one, the air concentration should not pose a health risk. If it is greater than one, it may be of concern. The risk ratio also indicates how much higher or lower the estimated air concentration is compared to the health benchmark. Identifying problematic chemicals helps regulatory agencies focus their efforts to reduce emissions and exposure.

The elemental mercury risk ratios at Elizabeth Lab and Rutgers University are shown in Table C-3. Both risk ratios are well below one.

Table C-3
2023 Risk Ratios for Elemental Mercury at Elizabeth Lab and Rutgers University

Station	2023 Annual Average Gaseous Elemental Mercury Concentration ($\mu g/m^3$)	Elemental Mercury Health Benchmark ($\mu g/m^3$)	Risk Ratio
Elizabeth Lab	0.0014	0.3	0.01
Rutgers University	0.0031	0.3	0.005

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Appendix D: Glossary

New Jersey Department of Environmental Protection

GLOSSARY OF AIR MONITORING ABBREVIATIONS AND TERMS

Air Quality Index (AQI) – a national rating system for reporting daily air quality to the public

Air toxics – air pollutants that may cause adverse health effects in humans, but do not have a NAAQS

Ambient air – air in outdoor areas that are accessible to the general public

AQS – Air Quality System, USEPA's nationwide database for air quality data

BAM – NJDEP Bureau of Air Monitoring

CAMNET – a network of real-time cameras established to raise public awareness of the effects of air pollution on visibility.

Canister – a stainless steel container used for collecting an air sample to be analyzed in a lab.

Carcinogen – a chemical which may cause cancer

CO – Carbon monoxide, a criteria pollutant

Continuous monitor – an instrument that collects data around the clock, throughout the year, and transmits the data to a central data acquisition system every minute or hour.

Criteria pollutant – an air pollutant for which a National Ambient Air Quality Standard (NAAQS) has been set (ozone, particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide & lead).

CSN – USEPA's Chemical Speciation Network

Design value (DV) – a pollutant-specific statistic applied to air monitoring data that determines whether a National Ambient Air Quality Standard is being met or exceeded

Detection limit – lowest quantity of a chemical that can be reliably measured by a laboratory method or sampling instrument

Fine particles – see $PM_{2.5}$

Hazardous Air Pollutant (HAP) – an "air toxic" pollutant that is listed in the 1990 Clean Air Act Amendments and is subject to emissions limits for specific source types.

Health benchmark – a chemical-specific air concentration above which there may be human health concerns

Inhalable particles – see PM_{10}

Lead – see Pb

Manual sampler – an instrument that collects an air sample over a specific time period on a filter, adsorbent cartridge or canister, which is then manually retrieved for analysis.

Median – the middle value in a list of numerical values, sorted in ascending or descending order

NAAQS – National Ambient Air Quality Standard; for specific air pollutants, a concentration allowable in ambient air.

NJAAQS – New Jersey Ambient Air Quality Standard; for specific air pollutants, a concentration allowable in ambient air (N.J. Administrative Code, Title 7, Chapter 27, Subchapter 13).

NJDEP – New Jersey Department of Environmental Protection

NO – Nitric oxide

NO_2 – Nitrogen dioxide, a criteria pollutant

NO_x – Oxides of nitrogen

NO_y – Total reactive oxides of nitrogen

O_3 – Ozone, a criteria pollutant

Ozone precursors – a group of volatile organic compounds (VOCs) that affect ozone formation and destruction in the atmosphere; also called PAMS pollutants.

PAMS – Photochemical Assessment Monitoring Station; a site which measures ozone precursors.

Particulate matter (PM)– a complex mix of liquid and/or solid particles in the atmosphere

Pb – Lead, a criteria pollutant and a HAP

$PM_{2.5}$ – Fine particles, 2.5 micrometers in aerodynamic diameter or smaller; a criteria pollutant

PM_{10} – Inhalable particles, 10 micrometers in aerodynamic diameter or smaller; a criteria pollutant

$PM_{2.5}$-Speciation – a group of elements, ionic compounds and carbon compounds that are analyzed from fine particles.

ppb - parts per billion, a concentration measurement usually used for gaseous pollutants

ppm – parts per million, a concentration measurement usually used for gaseous pollutants

Real-time – a system in which data is collected and (almost) immediately presented, usually every hour.

Risk ratio – a chemical-specific air concentration divided by its health benchmark; ratios greater than one may indicate a public health concern

SO_2 – Sulfur dioxide, a criteria pollutant

USEPA - United States Environmental Protection Agency

VOC – Volatile organic compound, a carbon-based chemical compound that is normally gaseous

$\mu g/m^3$ - micrograms per cubic meter, a concentration measurement, usually used for particulate matter and air toxics