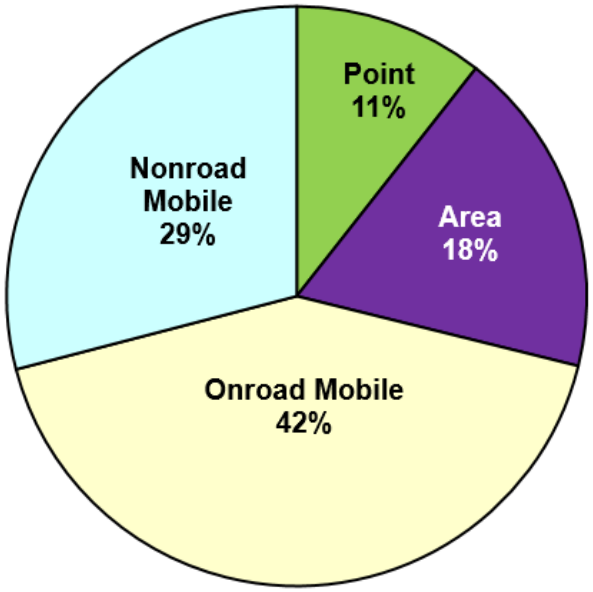
2016 Nitrogen Dioxide Summary

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 (NOx). 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 NOx 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 NOx in New Jersey in 2017 is shown in Figure 6-1. Because much of the NOx in the air is emitted by motor vehicles, concentrations tend to peak during the morning and afternoon rush hours. This is shown in Figure 6-2.

Figure 6-1
2017 New Jersey NOx Projected Emissions



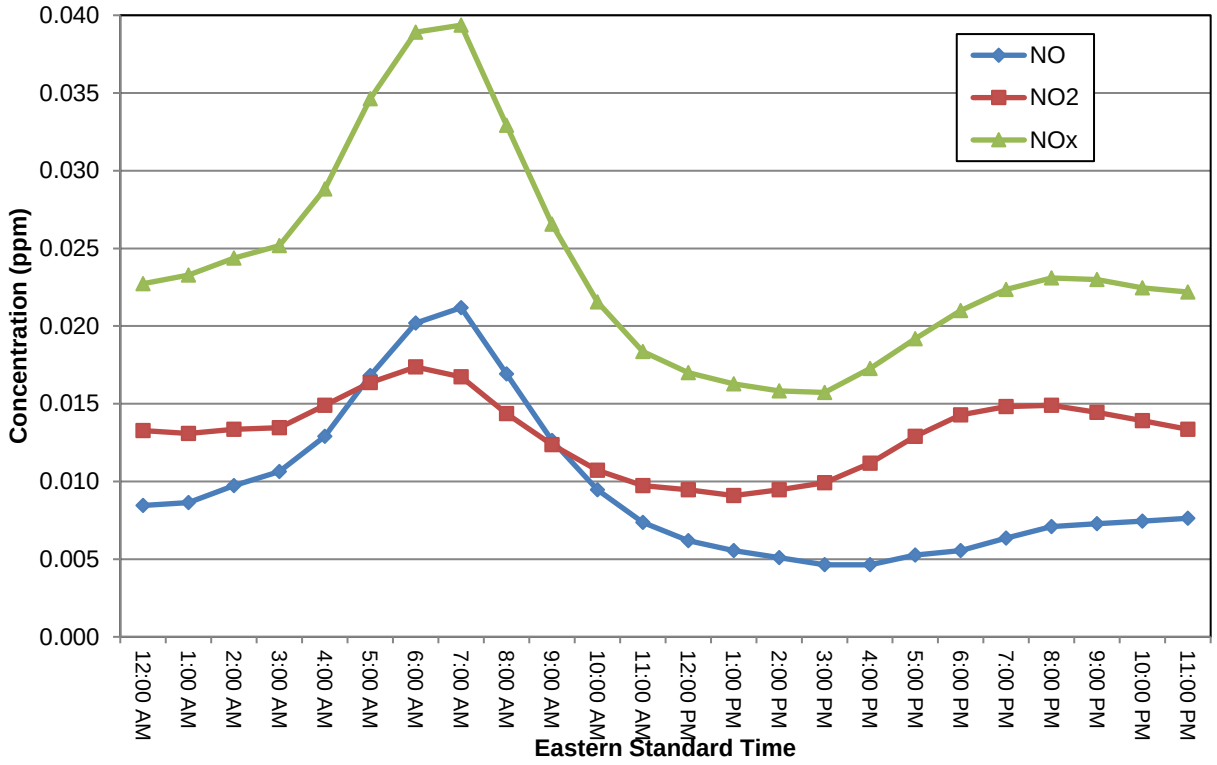
Inventory Source: MARAMA 2017 BETA2

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 department visits and hospital admissions for respiratory issues, especially asthma. Individuals who spend time on or near major roadways can experience high 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.

Figure 6-2
2016 Nitrogen Oxides Concentrations in New Jersey
1-Hour Average Hourly Variation
Parts per Million (ppm)



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 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. The primary and secondary annual NAAQS for NO_2 are the same, a calendar year average concentration of 0.053 parts per million (ppm). The 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 and the averaging time is any 12-month period (a rolling average) instead of a calendar year. In 2010, a 1-hour NO_2 NAAQS of 0.100 ppm was established. Table 6-1 provides a summary of the NO_2 standards.

Table 6-1
National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO_2)
Micrograms per Cubic Meter ($\mu g/m^3$)
Parts per Million (ppm)
Parts per Billion (ppb)

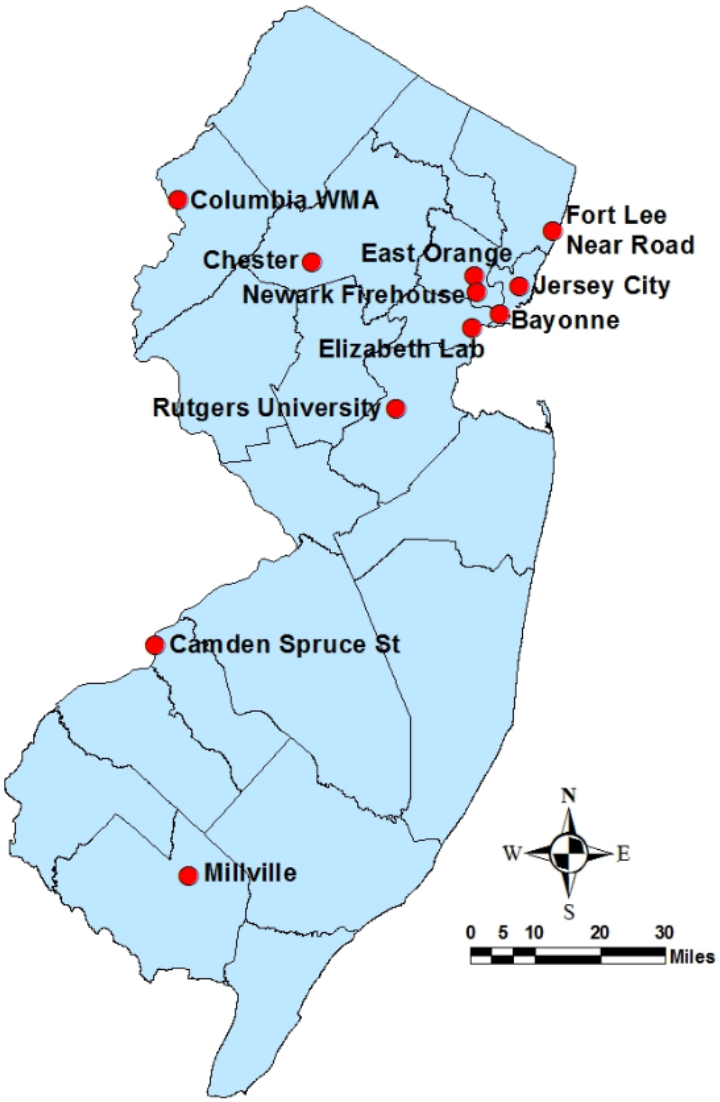
Averaging Period	Type	National	New Jersey
12-Month	Primary & secondary	---	100 $\mu g/m^3$ (0.053 ppm)
Annual	Primary & secondary	53 ppb (0.053 ppm)	---
1-Hour	Primary	100 ppb (0.100 ppm)	---

A state or other area is in compliance with a NAAQS when it meets the design value. For the annual standard, the annual average is the design value. However, for the 1-hour NO_2 standard, the NAAQS is met when the 3-year average of the 98th percentile of the daily maximum 1-hour NO_2 concentrations is less than 0.100 ppm. This statistic is calculated by first obtaining the maximum 1-hour average NO_2 concentrations for each day at each monitor. Then the 98th 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 98th-percentile values is the design value.

NO_2 Monitoring Network

NJDEP monitored NO_2 levels at 11 locations in 2016. These sites are shown in Figure 6-3. The East Orange monitoring station was shut down in July 2016, because of duplication of efforts. The Millville NOx monitor was temporarily shut down, from February to late June. The Jersey City NOx monitor was added in January 2016.

Figure 6-3
2016 Nitrogen Dioxide Monitoring Network



NO_2 LEVELS IN 2016

None of New Jersey's monitoring sites exceeded the annual or 1-hour NO_2 NAAQS in 2016. Newark Firehouse had the highest daily maximum 1-hour concentration at 0.095 ppm (see Table 6-2). The 98th percentile values are given in Table 6-2 and Figure 6-4 for each monitoring station. The design value for NO_2, which determines whether or not there is a violation of the NAAQS, is actually the 3-year average of the 98th percentile of the 1-hour daily maximum concentrations. The 2014-2016 design value for each site is given in Table 6-2 and Figure 6-5. The site with the highest design value for 2014-2016 was Elizabeth Lab, with 0.065 ppm. The three-year averages for East Orange, Fort Lee Near Road, Jersey City, Millville, and Rutgers University stations could not be calculated because of incomplete data for certain years (see Table 6-2 footnotes).

The highest running 12-month average concentration of NO_2 was 0.023 ppm at the Jersey City site, located in the Journal Square section of Jersey City. The highest calendar-year average NO_2 concentration of 0.020 ppm occurred at both the Jersey City and Elizabeth Lab sites. Elizabeth Lab is located at Exit 13 of the New Jersey Turnpike.

Table 6-2
2016 Nitrogen Dioxide Concentrations in New Jersey
1-Hour and 12-Month Averages
Parts per Million (ppm)

Monitoring Site	1-Hour Average (ppm)				12-Month Maximum Average (ppm)	
	Daily Maximum	2nd Highest Daily Max.	98th %-ile	2014-2016 98th%-ile 3-year Avg.	Highest Running 12-Month	Calendar Year
Bayonne	0.073	0.070	0.058	0.059	0.016	0.016
Camden Spruce Street	0.061	0.058	0.052	0.051	0.013	0.012
Chester	0.059	0.043	0.032	0.034	0.003	0.003
Columbia	0.076	0.064	0.048	0.050	0.012	0.011
East Orange	0.060	0.060	0.059	a	0.017	0.016
Elizabeth Lab	0.074	0.068	0.059	0.065	0.022	0.020
Fort Lee Near Road	0.080	0.065	0.055	b	0.019	0.018
Jersey City	0.084	0.082	0.051	c	0.023	0.020
Millville	0.039	0.037	0.033	d	0.007	0.006
Newark Firehouse	0.095	0.070	0.058	0.062	0.016	0.015
Rutgers University	0.053	0.049	0.039	e	0.010	0.008

a East Orange site shut down July 2016.
b Fort Lee Near Road site began operating March 2014.
c Jersey City site began operating January 2016.
d Millville temporarily shut down February 2016 to June 2016.
e Rutgers University temporarily shut down for site renovations April 2015 to June 2015.

Figure 6-4
2016 Nitrogen Dioxide Concentrations in New Jersey
Daily Maximum 1-Hour Values
Parts per Million (ppm)

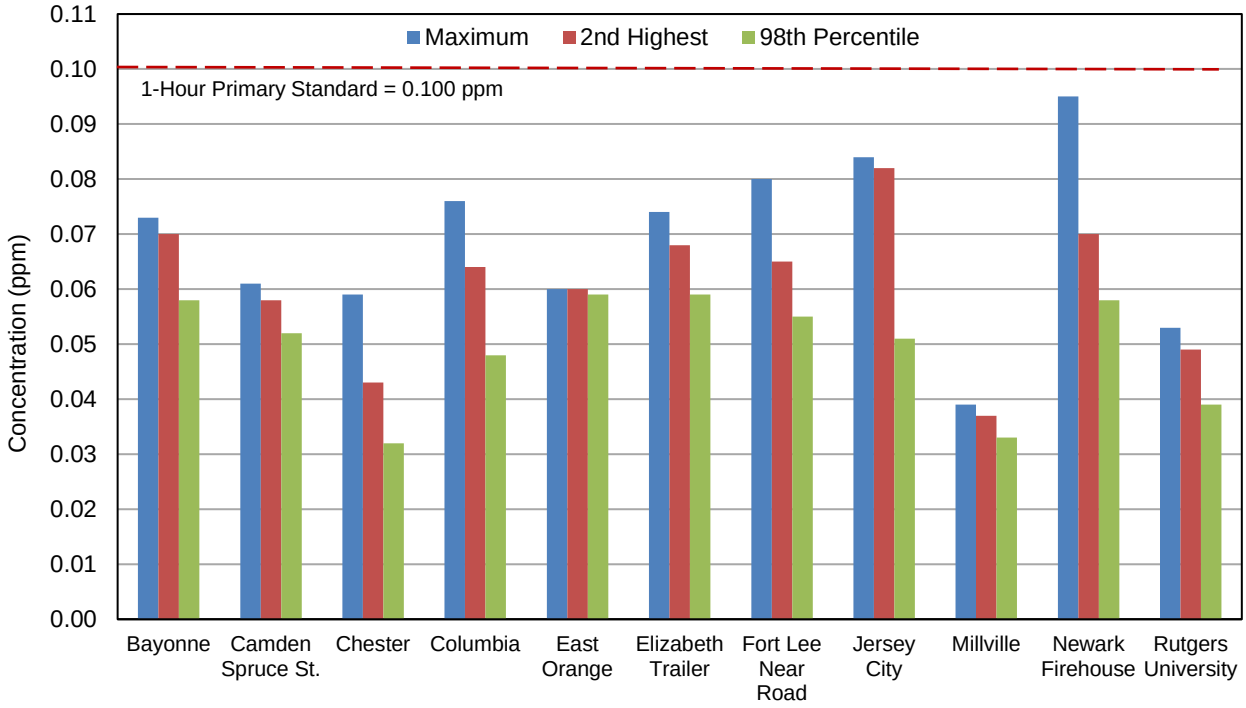
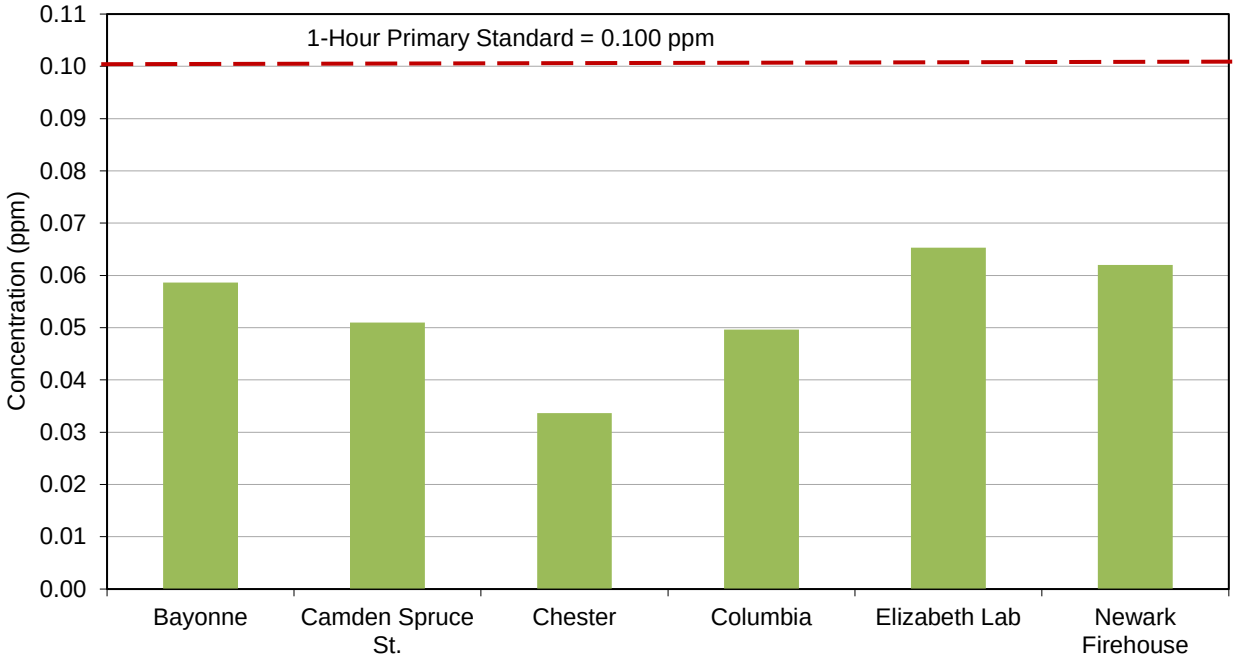


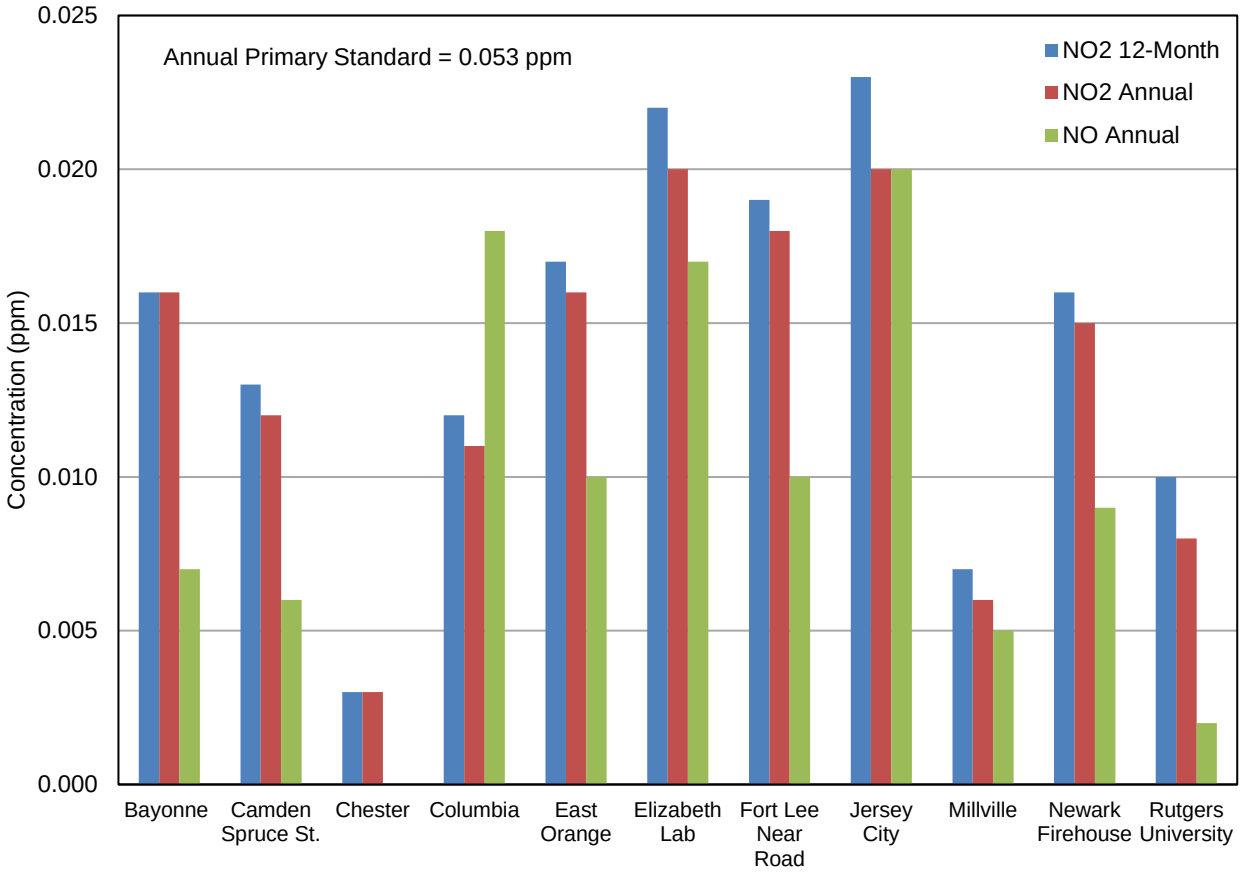
Figure 6-5
2016 Nitrogen Dioxide Design Values in New Jersey
3-Year Average of the 98th Percentile Daily Maximum 1-Hour Concentrations (2014-2016)
Parts per Million (ppm)



Note: East Orange, Ft. Lee Near Road, Jersey City, Millville, and Rutgers University sites do not have enough data to calculate a 2014-2016 average.

Figure 6-6 shows the highest rolling 12-month average concentrations of NO_2, and calendar year annual average concentrations for nitrogen dioxide and nitric oxide at each monitoring site. The annual NAAQS is 0.053 ppm (or 53 parts per billion), but there is no standard for NO. The New Jersey monitoring stations that measure NO_2 levels also measure NO and NOx levels. NOx levels are approximately the sum of the NO_2 and NO concentrations. The concentration of NO tends to be lower than NO_2, because as it is emitted it quickly reacts with other air pollutants (particularly ozone) and converts to NO_2. The higher concentration at the Columbia monitor is believed to result from its proximity to Interstate 80, which is a source of NO emissions from vehicles, and the site's relatively low levels of other pollutants that would otherwise trigger conversion of NO to NO_2.

Figure 6-6
2016 Nitrogen Dioxide & Nitric Oxide Concentrations in New Jersey
Rolling 12-Month and Calendar-Year Annual Averages
Parts per Million (ppm)

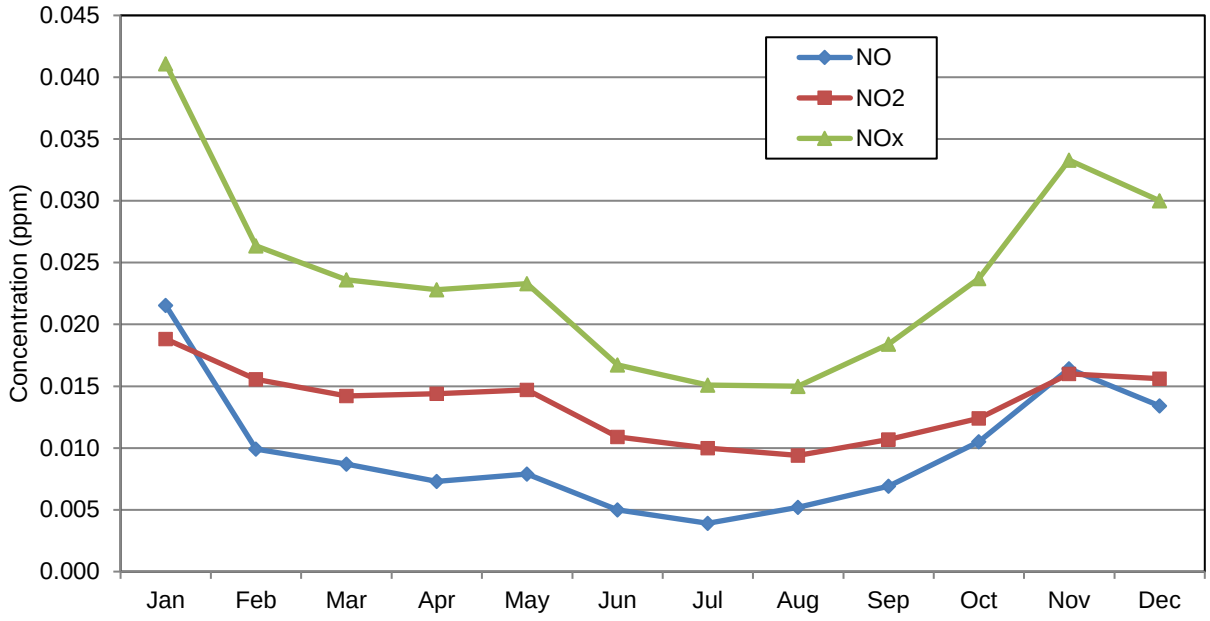


Note: The annual average concentration of NO at Chester was 0.000 ppm.

NOx Trends

Figure 6-7 shows that NOx concentrations tend to be higher in the winter than in the summer. This is due in part to building heating, and to weather conditions that are more prevalent in the colder months of the year, such as poorer local dispersion conditions caused by light winds.

Figure 6-7
2016 Nitrogen Oxides Concentrations in New Jersey
Average Monthly Variation
Parts per Million (ppm)



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 6-8 shows the highest statewide annual average concentrations recorded from 1990 to 2016 in the form of a trend line. 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 these 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 NOx emissions.

Figure 6-9 shows the highest 98th percentile values of the daily maximum one-hour concentrations of NO_2 for the years 2000 to 2016 in New Jersey. Although the highest value exceeded the 1-hour NAAQS of 0.100 in 2000, there has not been an exceedance of the standard since then.

Figure 6-10 shows the New Jersey design values for the 1-hour NAAQS for the years 2000-2016. The design value, which determines compliance with the 1-hour NO_2 NAAQS, is the highest 3-year average of the 98th percentile values of the daily maximum one-hour concentrations at each New Jersey monitoring site. New Jersey has not violated the 1-hour NAAQS since it was implemented by USEPA in 2010.

Figure 6-8
Nitrogen Dioxide Concentrations in New Jersey, 1990-2016
Highest Annual (Calendar Year) Averages
Parts per Million (ppm)

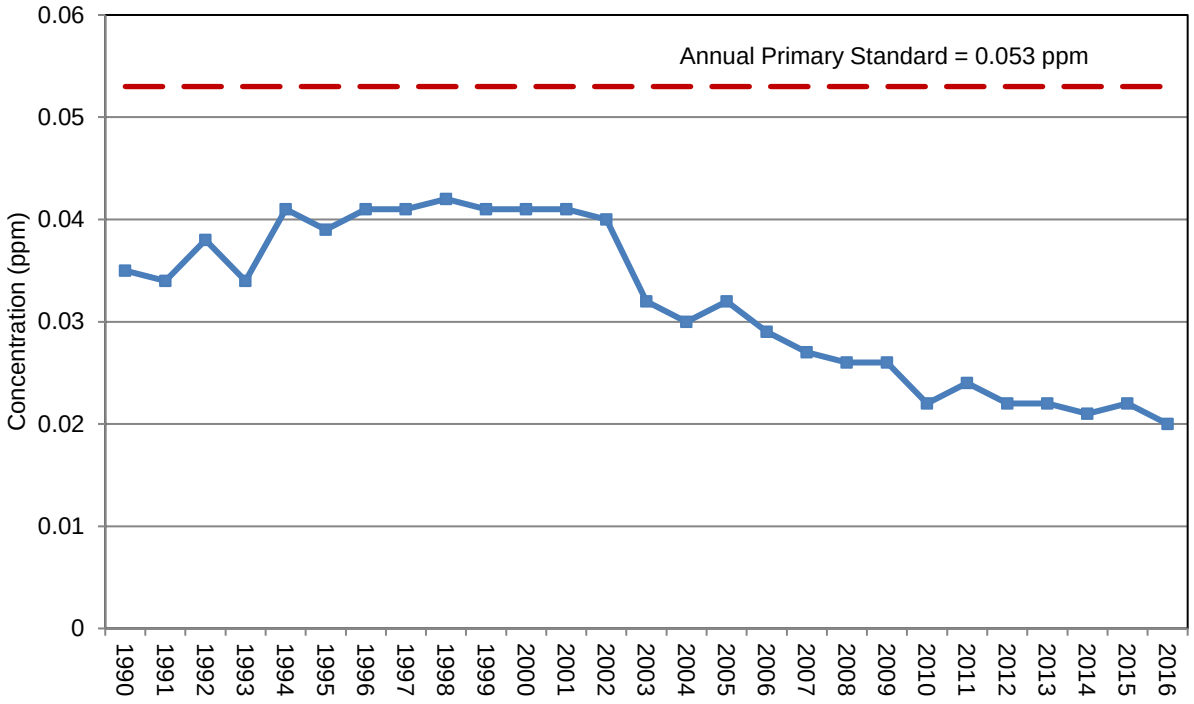


Figure 6-9
Nitrogen Dioxide Concentrations in New Jersey, 2000-2016
98th Percentile of the Daily Maximum 1-Hour Concentrations
Parts per Million (ppm)

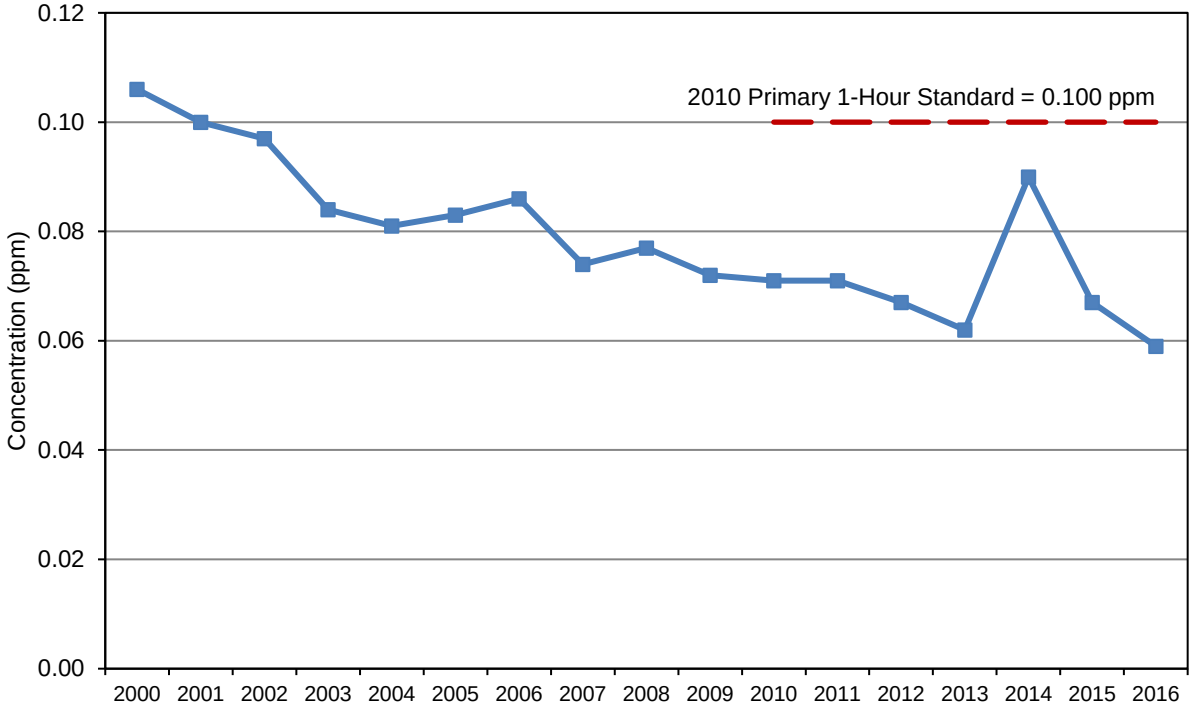
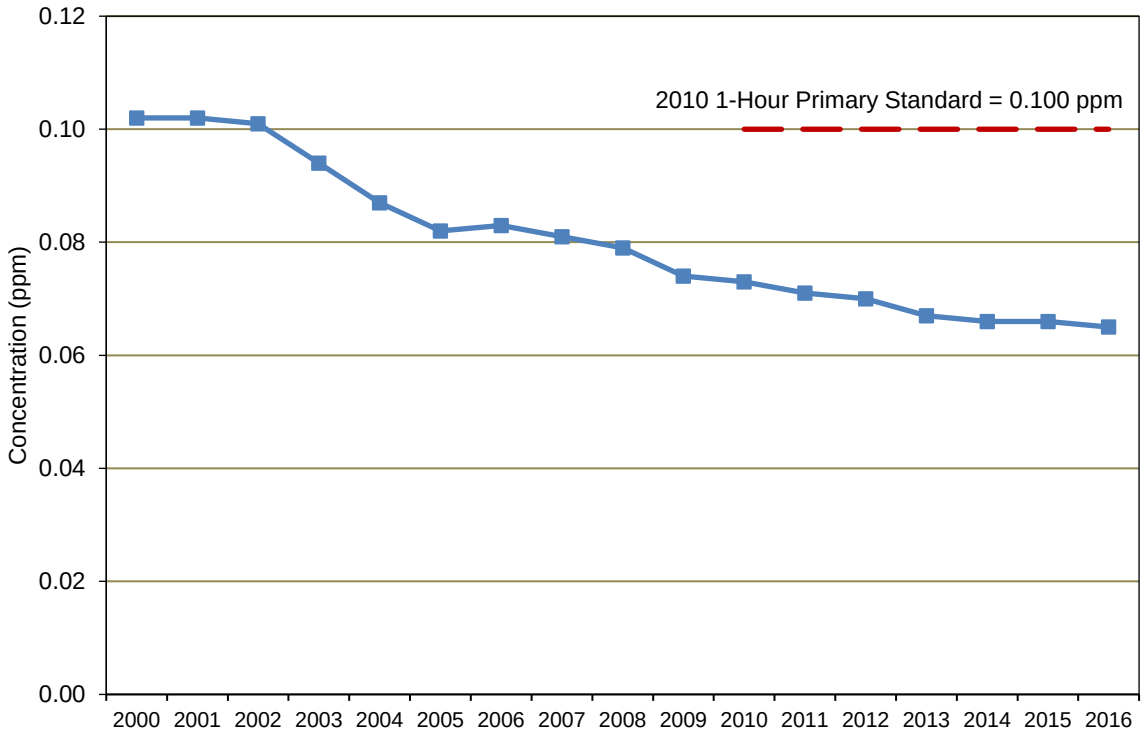


Figure 6-10
Nitrogen Dioxide Design Value Trend in New Jersey, 2000-2016
3-Year Average of the 98th Percentile Daily Maximum 1-Hour Concentrations
Parts per Million (ppm)



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