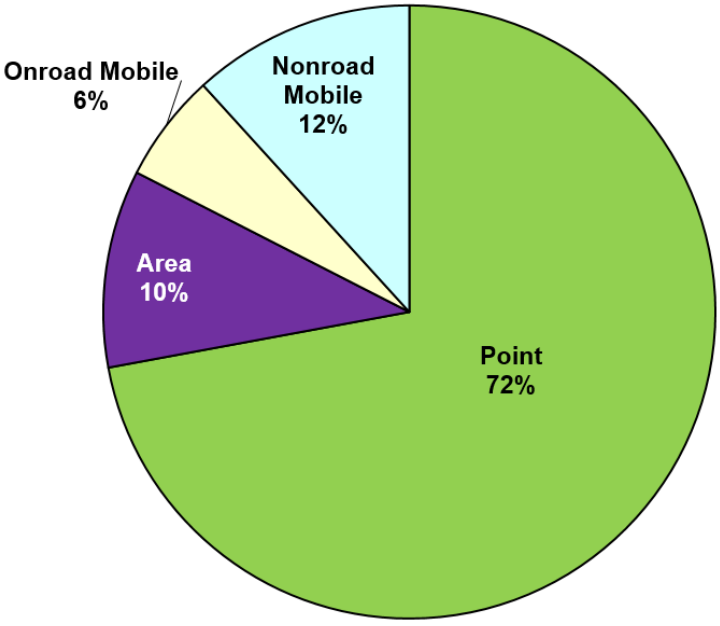
2017 Sulfur Dioxide Summary

New Jersey Department of Environmental Protection

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.

Figure 7-1
2017 New Jersey SO_2 Projected Emissions



Inventory Source: MARAMA 2017 BETA2

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.

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 expressed in micrograms per cubic meter ($\mu g/m^3$) as well as ppm, and 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.

Table 7-1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide (SO_2)
Parts per Billion (ppb)
Parts per Million (ppm)
Micrograms per Cubic Meter ($\mu g/m^3$)

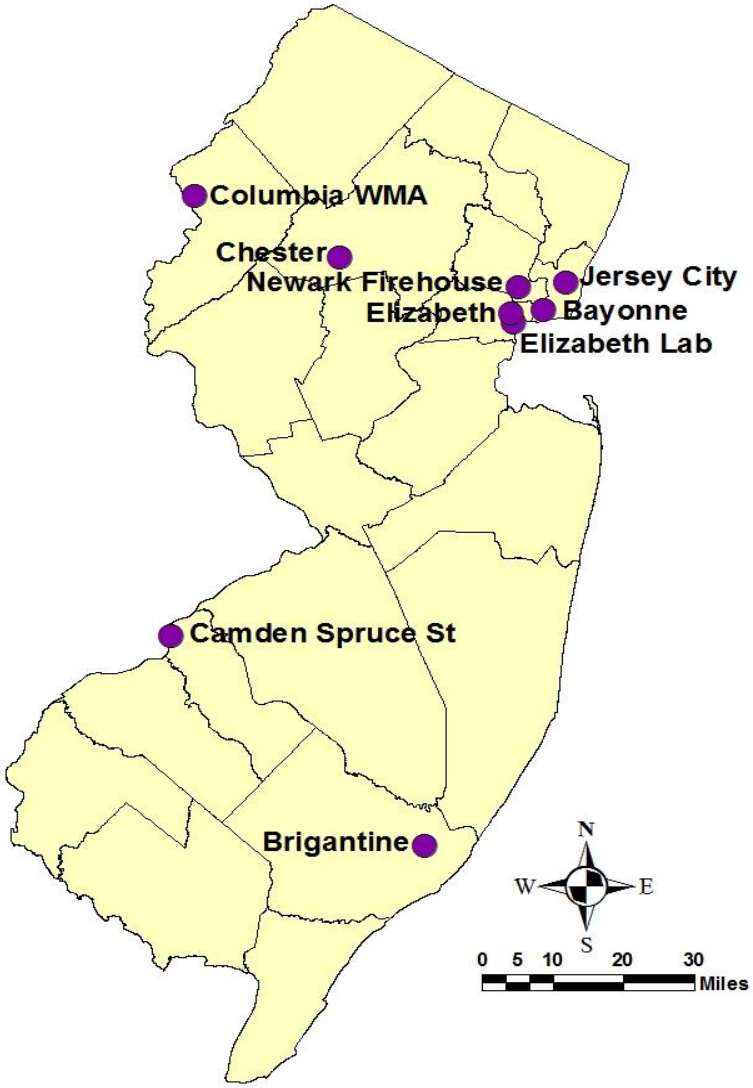
Averaging Period	Type	National	New Jersey[a]
1–hour[b]	Primary	75 ppb	---
3–hours	Secondary	0.5 ppm[c]	1300 $\mu g/m^3$ (0.5 ppm)
24–hours[d]	Primary	---	365 $\mu g/m^3$ (0.14 ppm)
24–hours[d]	Secondary	---	260 $\mu g/m^3$ (0.10 ppm)
12–months	Primary	---	80 $\mu g/m^3$ (0.03 ppm)
12–months	Secondary	---	60 $\mu g/m^3$ (0.02 ppm)

[a] Based on running averages, over any 12 consecutive months in a year.
[b] To meet this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour averages at each monitor within the state must not exceed 75 ppb.
[c] Based on successive non-overlapping blocks, beginning at midnight each day.
[d] Not to be exceeded more than once in a year.

SO_2 Monitoring Network

The New Jersey Department of Environmental Protection (NJDEP) monitored SO_2 levels at nine locations in 2017. These sites are shown in Figure 7-2. Two sites, Brigantine and Newark Firehouse, measure SO_2 concentrations at trace levels, down to a ten-thousandth part per million (0.0000 ppm). The other sites measure SO_2 concentrations to the thousandth of a part per million (0.000 ppm).

Figure 7-2
2017 Sulfur Dioxide
Monitoring Network



SO_2 Levels in 2017

In 2017, there were no exceedances of the 1-hour NAAQS of 75 ppb. See Table 7-2 and Figures 7-3 and 7-4. Camden Spruce Street had the highest 1-hour value of 10 ppb. However, the highest 99th percentile value of 5 ppb was recorded at Jersey City. The highest design value, the 3-year average of the 99th-percentile of the daily maximum 1-hour SO_2 concentrations, was 10 ppb at Camden Spruce Street. This is the result of some very high values recorded at the Camden site in 2016, including two exceedances of the NAAQS, possibly due to port activity on the Delaware River.

There were no exceedances of the 3-hour secondary standard of 0.5 ppm. The highest value of 0.007 ppm, recorded at Jersey City, was the same when calculated using non-overlapping 3-hour blocks, as required by the NAAQS, or when calculated using running 3-hour averages, as specified by the NJAAQS. Results are shown in Table 7-3 and Figure 7-5.

No monitoring sites had exceedances of the 24-hour or 12-month New Jersey SO_2 standards during 2017. The highest and second-highest 24-hour average concentrations were 0.005 and 0.004 ppm, measured at the Jersey City monitoring station. The highest 12-month running average concentration of 0.00069 ppm was also recorded at Jersey City. See Tables 7-4 and 7-5, and Figures 7-6 and 7-7 for data for the other monitoring sites.

Table 7-2
2017 Sulfur Dioxide Concentrations in New Jersey
Daily Maximum and 99th Percentile 1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)			2015-2017 Design Value[a]
	Highest Daily Maximum	2nd-Highest Daily Maximum	99th Percentile Daily Maximum	
Bayonne	8	6	4	4
Brigantine	4.6	4.1	3.1	4
Camden Spruce St.	10	5	4	10
Chester	5	5	3	5
Columbia	5	5	4	6
Elizabeth	4	4	4	4
Elizabeth Lab	9	6	3	8
Jersey City	8	7	5	4
Newark Firehouse	8	6.9	2.5	4

[a] 3-Year (2015-2017) average of the 99th percentile 1-hour daily maximum concentrations.

Figure 7-3
2017 Sulfur Dioxide Concentrations in New Jersey
1-Hour Averages
Parts per Billion (ppb)

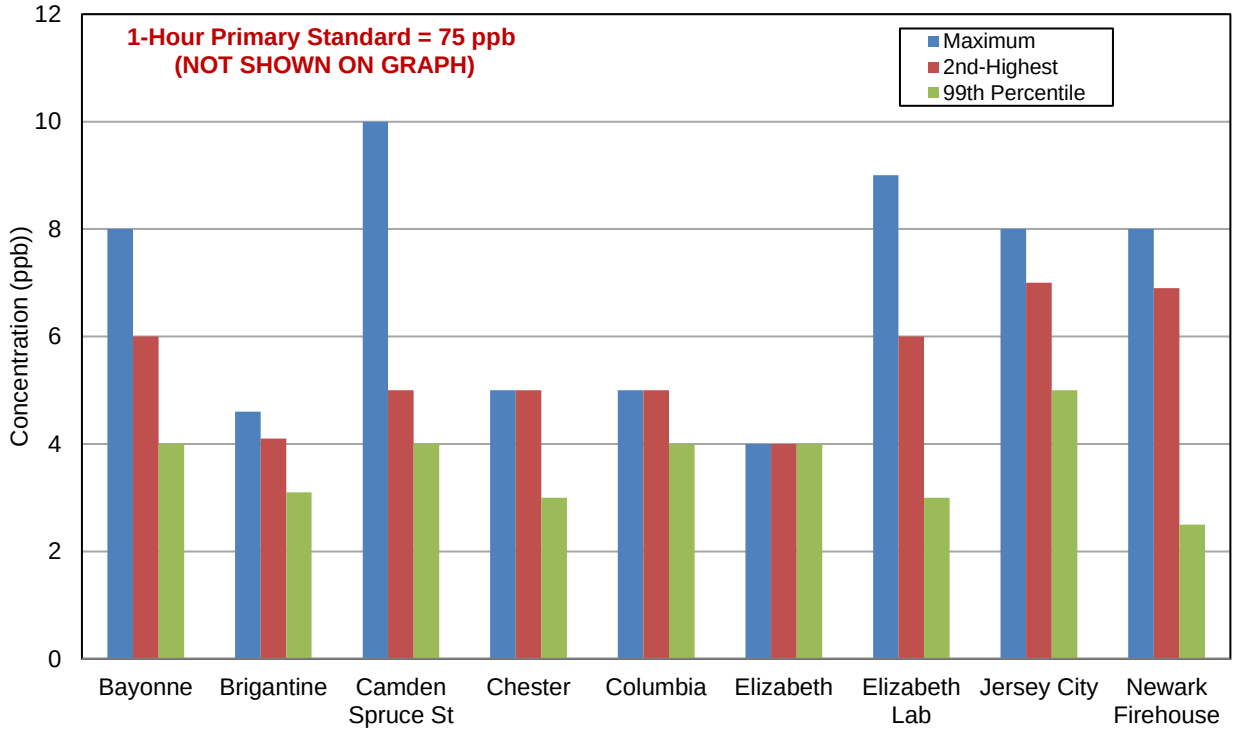


Figure 7-4
New Jersey Sulfur Dioxide Design Values for 2015-2017
3-Year Average of the 99th Percentile of the 1-Hour Daily Maximum Concentrations
Parts per Billion (ppb)

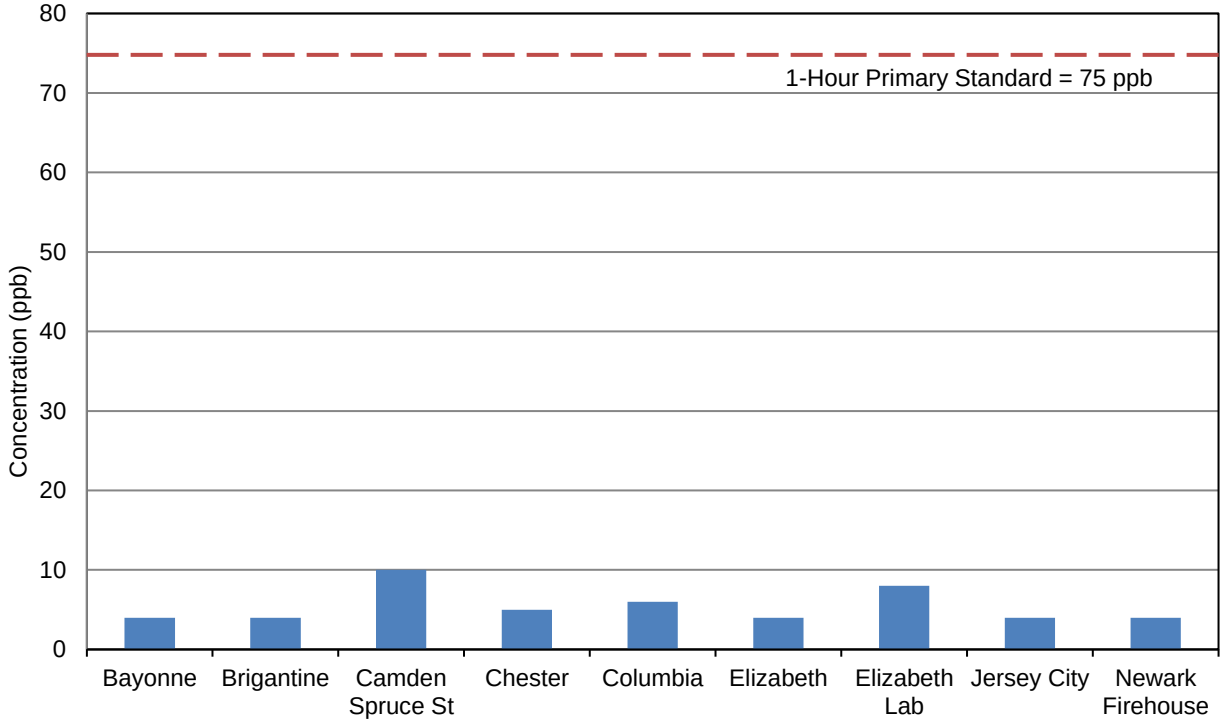


Table 7-3
2017 Sulfur Dioxide Concentrations in New Jersey
3-Hour Averages
Parts per Million (ppm)

Monitoring Site	3-Hour Average Concentrations			
	Block[a]		Running[b]	
	Maximum	2nd-Highest	Maximum	2nd-Highest*
Bayonne	0.003	0.003	0.004	0.003
Brigantine	0.0021	0.002	0.0022	0.0021
Camden Spruce	0.002	0.002	0.003	0.003
Chester	0.004	0.002	0.004	0.002
Columbia	0.003	0.003	0.004	0.003
Elizabeth	0.003	0.003	0.003	0.003
Elizabeth Trailer	0.005	0.003	0.005	0.004
Jersey City	0.007	0.006	0.007	0.007
Newark Firehouse	0.0045	0.0026	0.0045	0.0026

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

Figure 7-5
2017 Sulfur Dioxide Concentrations in New Jersey
2nd Highest 3-Hour Averages
Parts per Million (ppm)

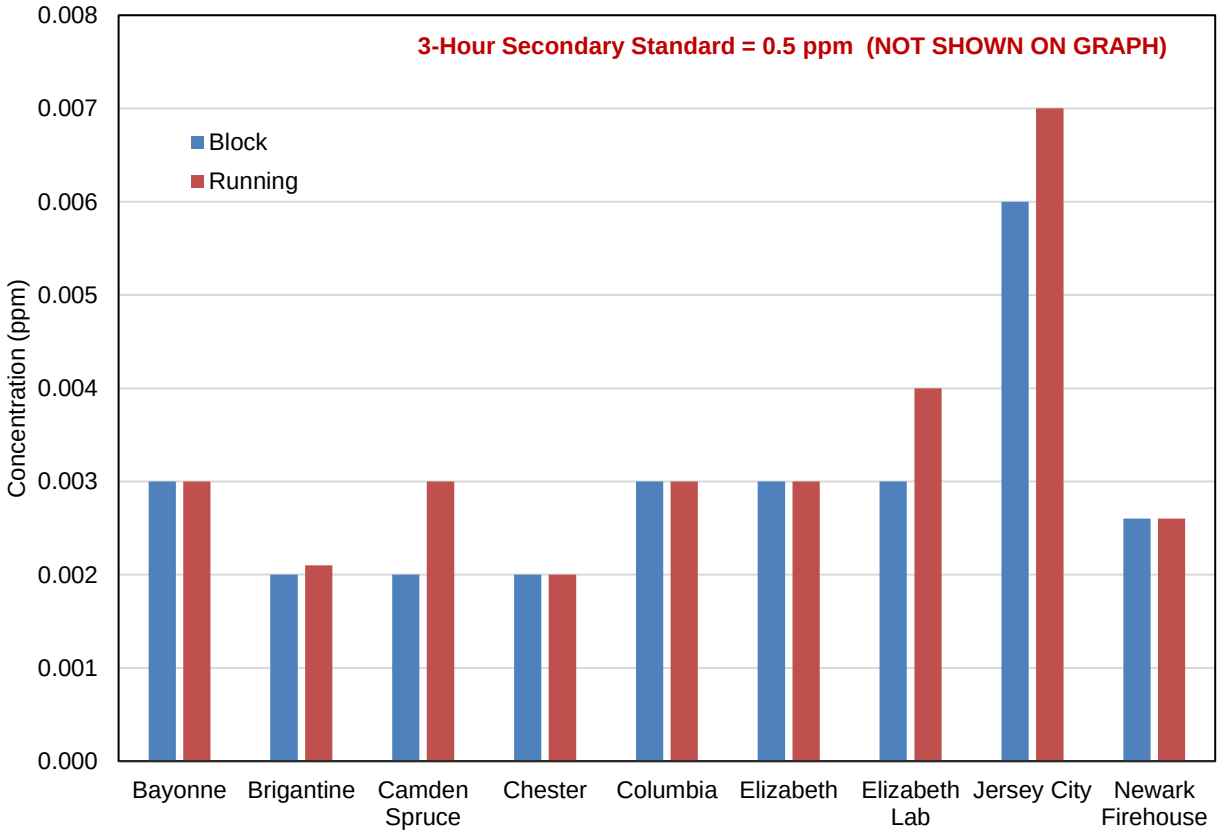


Table 7-4
2017 Sulfur Dioxide Concentrations in New Jersey
24-Hour Averages
Parts per Million (ppm)

Monitoring Site	24-Hour Running Average	
	Maximum	2nd Highest (Non-overlapping)
Bayonne	0.001	0
Brigantine	0.0009	0.0008
Camden Spruce St.	0.001	0.001
Chester	0.001	0.001
Columbia	0.002	0.002
Elizabeth	0.002	0.002
Elizabeth Lab	0.001	0.001
Jersey City	0.005	0.004
Newark Firehouse	0.0012	0.001

Figure 7-6
2016 Sulfur Dioxide Concentrations in New Jersey
2nd-Highest 24-Hour Averages
Parts per Million (ppm)

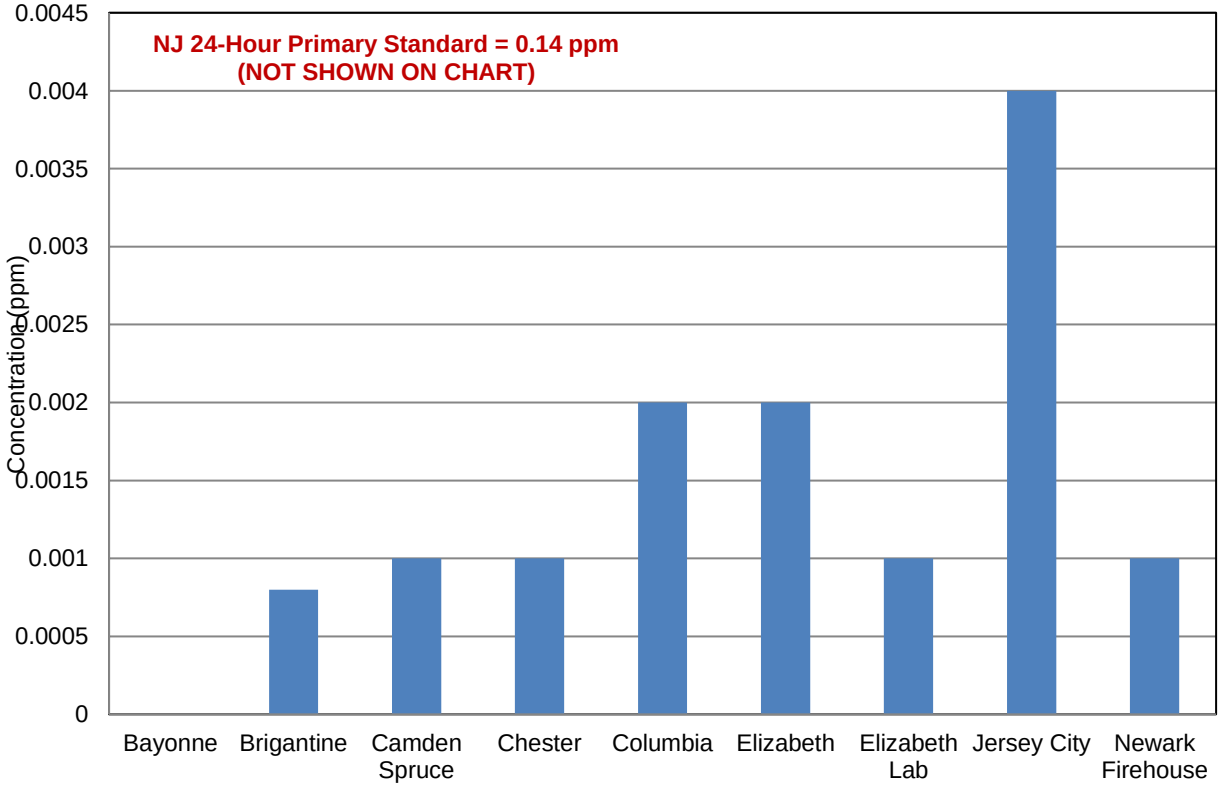
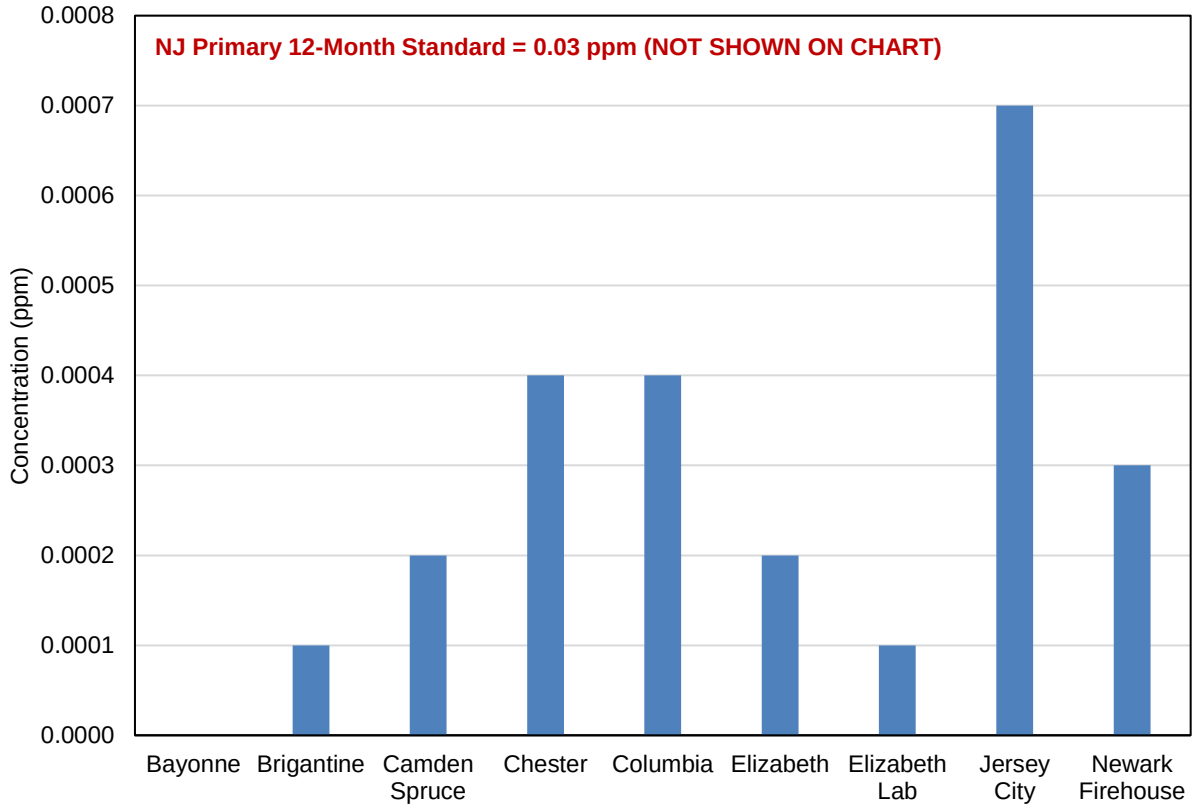


Table 7-5
2017 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)

Monitoring Site	Maximum 12-Month Running Average
Bayonne	0.0000
Brigantine	0.0001
Camden Spruce St.	0.0002
Chester	0.0004
Columbia	0.0004
Elizabeth	0.0002
Elizabeth Lab	0.0001
Jersey City	0.0007
Newark Firehouse	0.0003

Figure 7-7
2017 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 7-8 shows the second-highest daily average concentrations of SO_2 recorded in New Jersey each year since 1975. 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 99th percentile 1-hour SO_2 concentration in 2010 (shown in Figure 7-9) 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 7-10 shows the trend in the design value, the value that determines compliance with the NAAQS. The design value for the 1-hour NAAQS is the 3-year average of the 99th percentile of the daily maximum 1-hour concentrations of SO_2 at each site. The values presented are the highest statewide for a given year.

Figure 7-8
Sulfur Dioxide Trend in New Jersey, 1975-2017
2nd-Highest 24-Hour Average Concentrations
Parts per Million (ppm)

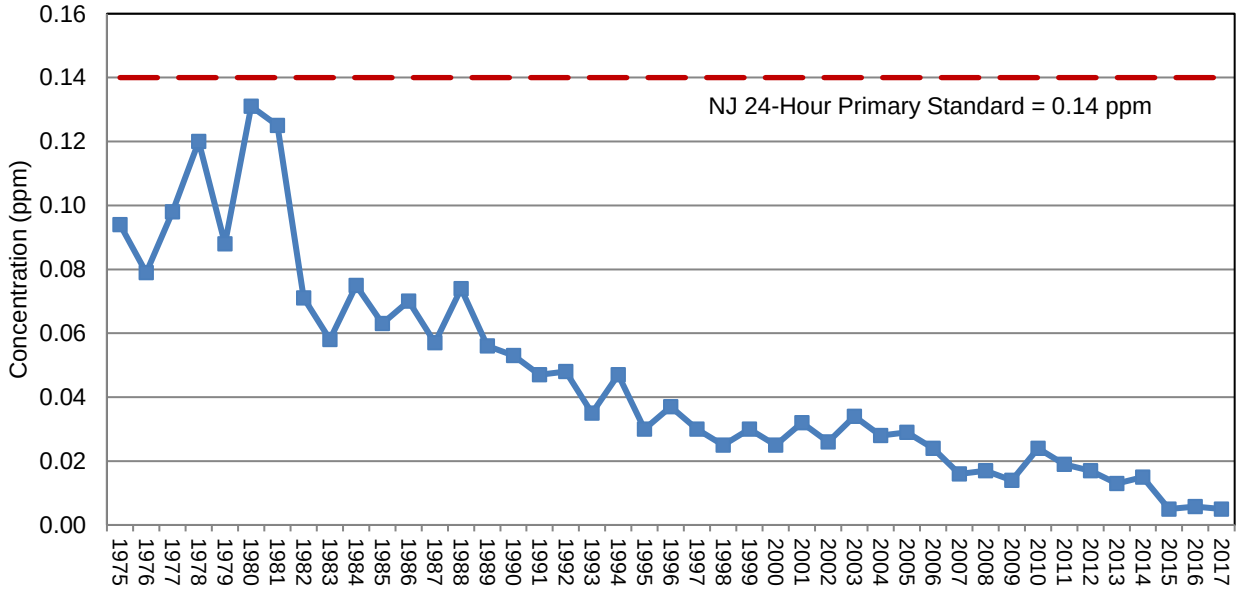


Figure 7-9
Sulfur Dioxide Trend in New Jersey, 2000-2017
99th Percentile of the Daily Maximum 1-Hour Concentrations
Parts per Million (ppm)

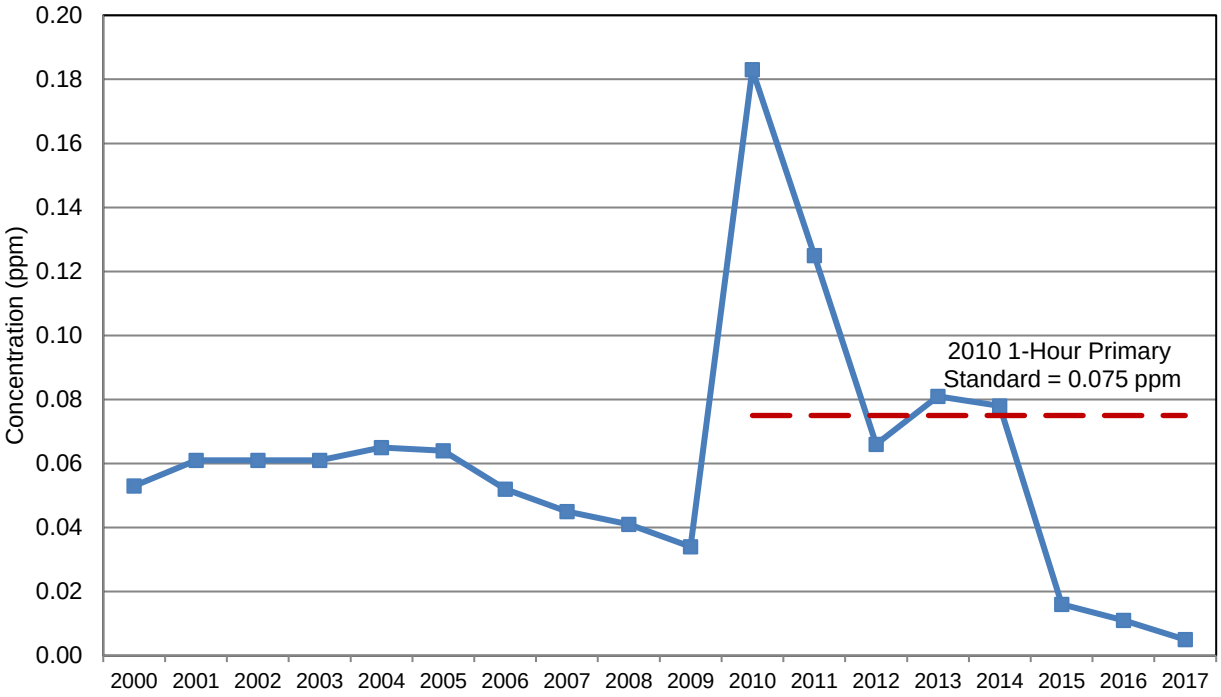
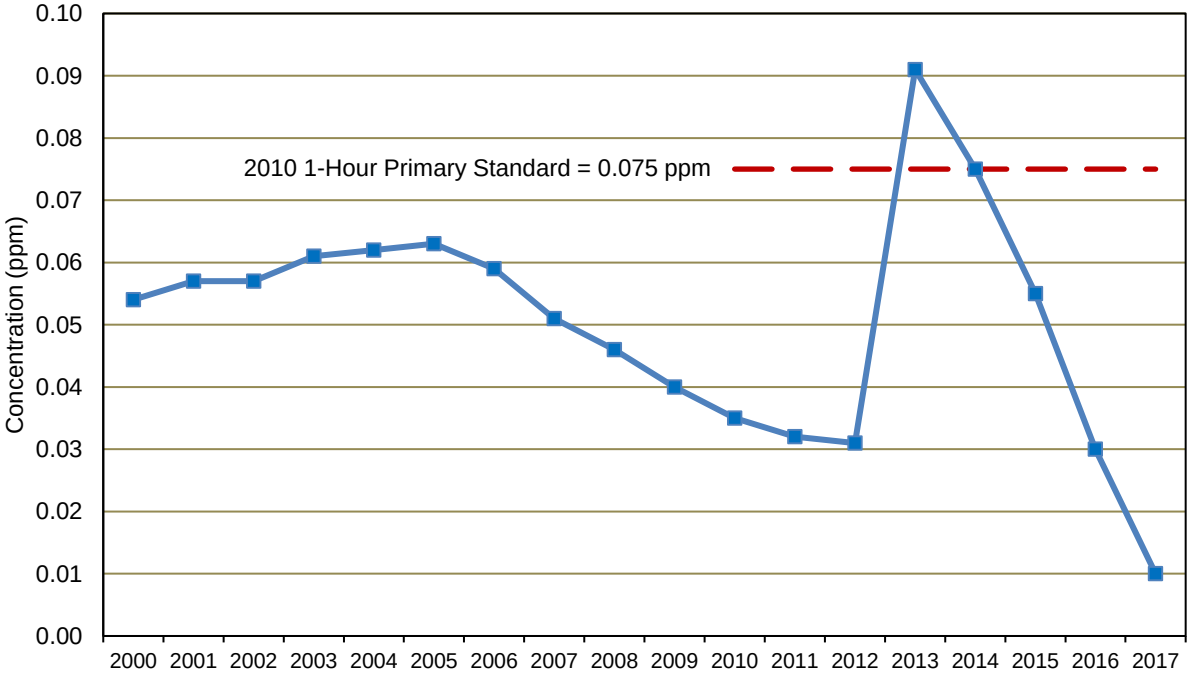


Figure 7-10
Sulfur Dioxide Design Value Trend in New Jersey, 2000-2017
3-Year Average of the 99th Percentile Daily Maximum 1-Hour Concentrations
Parts per Million (ppm)



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