2009 Sulfur Dioxide Summary

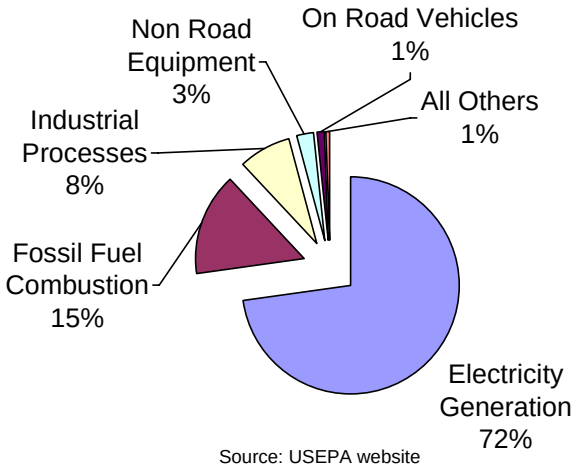
New Jersey Department of Environmental Protection

Nature and 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 can be formed when fuels containing sulfur are burned, or when gasoline is extracted from oil. Most of the sulfur dioxide released into the air comes from electric utilities, especially those that burn coal with high sulfur content. Sulfur is found in raw materials such as crude oil, coal, and ores that contain metals such as aluminum, copper, zinc, lead and iron. Industrial facilities that derive their products from these materials may also release SO_2. A pie chart summarizing the major sources of SO_2 is shown in Figure 1.

Figure 2 (page 2) shows that SO_2 concentrations in New Jersey are generally higher in the winter than in the summer due to higher emissions from space heating and other sources. As shown in Figure 3 (page 2), SO_2 levels tend to peak in mid to late morning as emissions accumulate prior to being more effectively dispersed when wind speeds increase and atmospheric mixing increases later in the day.

Figure 1
National Summary
SO_2 Emissions by Source Sector



Source: USEPA website
HTTP://WWW.EPA.GOV/AIR/EMISSIONS/SO2.HTM
2005 data.

Health and Environmental Effects

Sulfur dioxide causes irritation of the mucous membranes. This is probably the result of the action of sulfurous acid that is formed when the highly soluble SO_2 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 belonging to these sensitive groups and those who are active outdoors may have trouble breathing. The International Agency for Research on Cancer (IARC) evaluated SO_2 and based on available information, determined that no conclusion can be made as to the carcinogenicity of SO_2 to human beings.

Sulfur dioxide reacts with other gases and particles in the air to form sulfates that can be harmful to people and the environment. Sulfate particles are the major cause of reduced visibility in the eastern United States. SO_2 can also react with other substances in the air to form 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 eventually speeds up the decay of building materials and paints.

Standards

There are three National Ambient Air Quality Standards (NAAQS) for SO_2. There is an annual average health standard of 0.03 parts per million (ppm). This is based on a calendar year average of continuously monitored levels. There is also a 24-hour average health based standard of 0.14 ppm which is not to be exceeded more than once a year, and a secondary (welfare based) standard of 0.5 ppm, 3-hour average concentration that is also not to exceeded more than once per year.

New Jersey has also set state air quality standards for SO_2. They are similar to the federal standards but are

expressed in micrograms per cubic meter ($\mu g/m^3$) instead of ppm. They are also based on rolling averages rather than block averages. So, for example, the state's primary 12-month standard is based on any twelve-month average recorded during the year, while the federal standard is based solely on the calendar year average. The state also has secondary 12-month, 24-hour, and 3-hour average standards. Table 1 summarizes the NAAQS and the New Jersey Ambient Air Quality Standards (NJAAQS) for SO_2.

Figure 2
Sulfur Dioxide – New Jersey
2009 Monthly Variation
Parts Per Million (ppm)

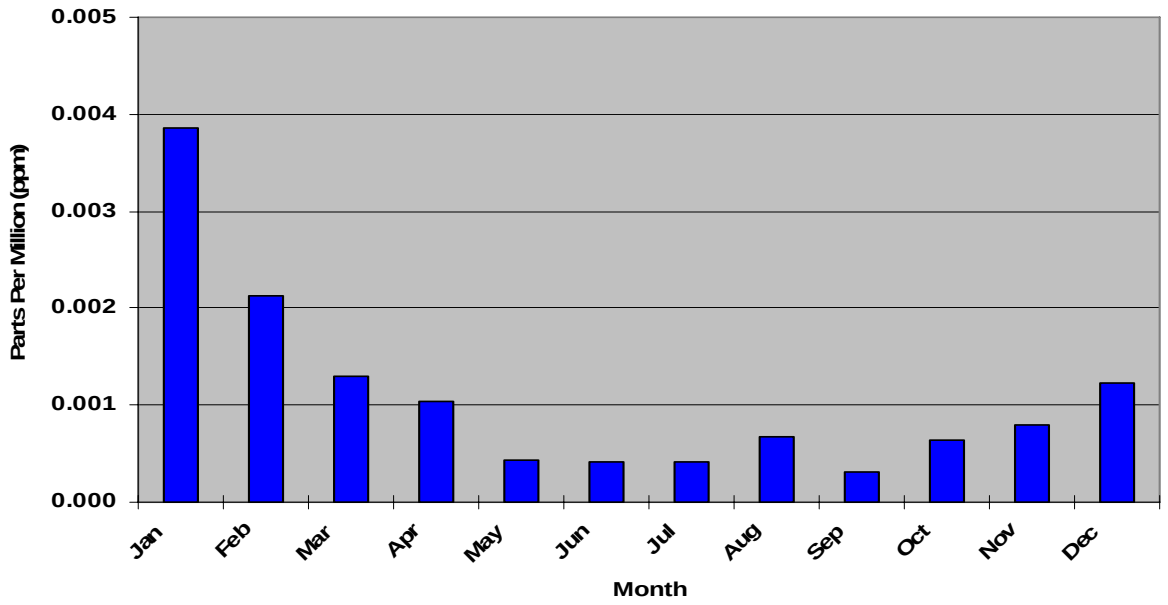


Figure 3
Sulfur Dioxide – New Jersey
2009 Hourly Variation
Parts Per Million (ppm)

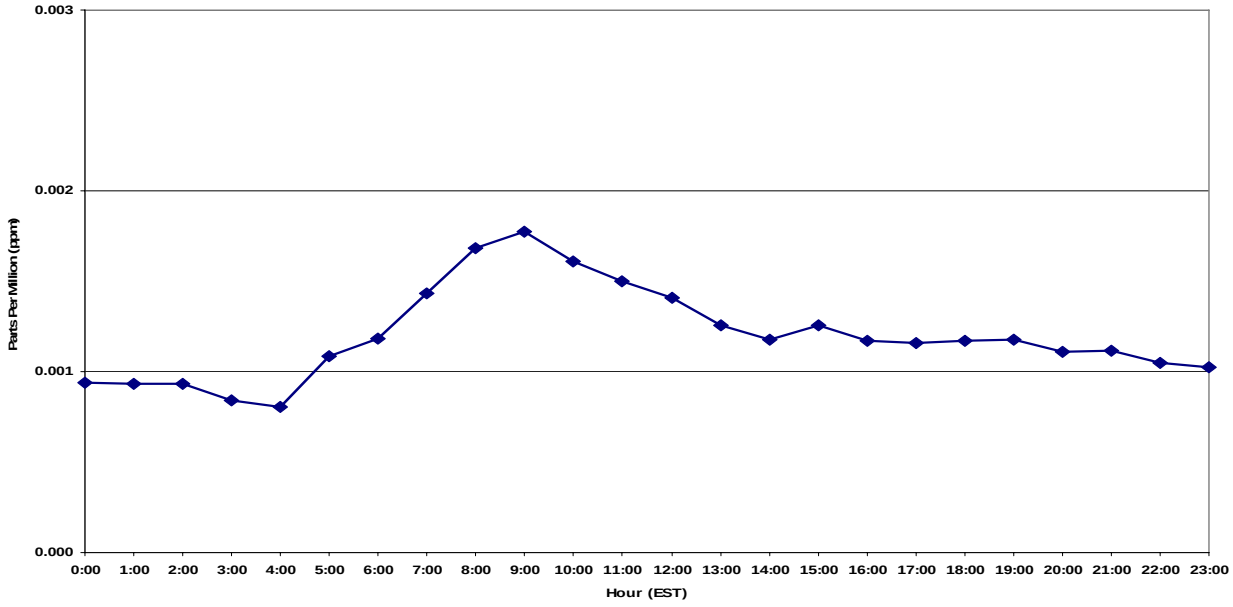


Table 1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide
Parts Per Million (ppm)
Micrograms Per Cubic Meter (µg/m^3)

Averaging Period	Type	New Jersey	National[a]
12-month average	Primary	80 µg/m^3 (0.03 ppm)	0.03 ppm
12-month average	Secondary	60 µg/m^3 (0.02 ppm)	---
24-hour average	Primary	365 µg/m^3 (0.14 ppm)	0.14 ppm
24-hour average	Secondary	260 µg/m^3 (0.10 ppm)	---
3-hour average	Secondary	1300 µg/m^3 (0.5 ppm)	0.5 ppm

[a] – National standards are block averages rather than moving averages.

MONITORING LOCATIONS

The state monitored SO_2 levels at 13 locations in 2009. These sites are shown in Figure 4. Monitoring location changes included the start up of the Newark Firehouse site on June 1, 2009, and the shutdown of the Burlington site on December 29, 2009 because the NJDEP permanently lost access to the location.

SO_2 LEVELS IN 2009

None of the monitoring sites recorded exceedances of the primary or secondary SO_2 standards during 2009. The maximum 12-month average concentration recorded was 0.003 ppm at the Bayonne, Elizabeth Lab, and Jersey City sites. The maximum 24-hour average level recorded was 0.018 ppm at the Ancora State Hospital site. The highest 3-hour average recorded was 0.036 ppm at the Burlington site. Summaries of the 2009 data are provided in Tables 2 and 3 (page 4), and Figures 5 and 6 (page 5).

Figure 4
2009 Sulfur Dioxide
Monitoring Network

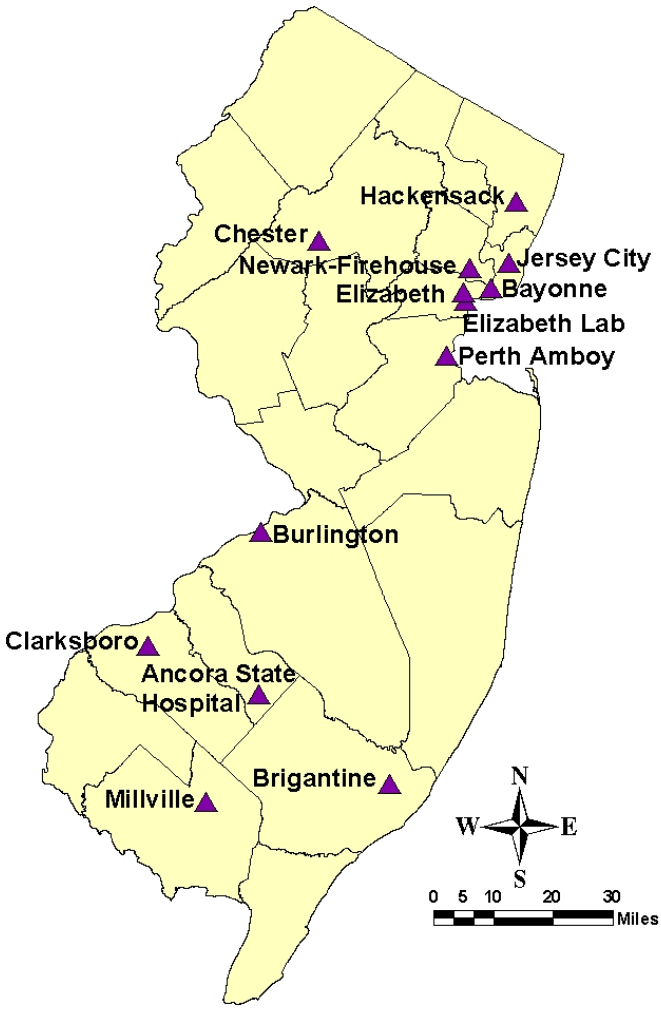


Table 2
2009 Sulfur Dioxide Data
3-Hour and Annual Averages
Parts Per Million (ppm)

Monitoring Sites	3-Hour Average Maximum	3-Hour Average 2nd Highest [b]	12-Month Average Maximum	Calendar Year Average
Ancora State Hospital	0.026	0.024	0.001	0.000
Bayonne	0.028	0.027	0.003	0.002
Brigantine	0.021	0.018	0.001	0.000
Burlington	0.036	0.030	0.002	0.001
Chester	0.031	0.031	0.001	0.001
Clarksboro	0.025	0.024	0.002	0.002
Elizabeth	0.023	0.021	0.002	0.001
Elizabeth Lab	0.031	0.028	0.003	0.002
Hackensack	0.023	0.021	0.001	0.001
Jersey City	0.027	0.026	0.003	0.002
Millville	0.021	0.019	0.001	0.001
Newark Firehouse (c)	0.017	0.016	-----	-----
Perth Amboy	0.017	0.016	0.002	0.001

[b] – Based on non-overlapping 3 – hour moving averages.

[c] – Station started collecting data June 2009 and does not have sufficient amount of data to calculate 12-Month and Calendar Year averages.

Table 3
2009 Sulfur Dioxide Data
24-Hour and Daily Averages
Parts Per Million (ppm)

Monitoring Sites	24-Hour Average Maximum	24-Hour Average 2nd Highest [b]	Daily Average Maximum	Daily Average 2nd Highest
Ancora State Hospital	0.018	0.010	0.015	0.007
Bayonne	0.016	0.015	0.014	0.012
Brigantine	0.012	0.009	0.010	0.008
Burlington	0.015	0.012	0.013	0.012
Chester	0.013	0.012	0.012	0.012
Clarksboro	0.017	0.013	0.014	0.012
Elizabeth	0.011	0.011	0.010	0.010
Elizabeth Lab	0.012	0.011	0.010	0.010
Hackensack	0.009	0.009	0.009	0.008
Jersey City	0.017	0.015	0.017	0.014
Millville	0.013	0.008	0.012	0.008
Newark Firehouse (c)	0.007	0.007	0.007	0.007
Perth Amboy	0.011	0.010	0.011	0.010

[b] – Based on non-overlapping 24 – hour moving averages.

[c] – Station started collecting data June 2009.

Figure 5
2009 Sulfur Dioxide Concentrations
Highest and 2nd Highest 24-Hour Averages
Parts Per Million (ppm)

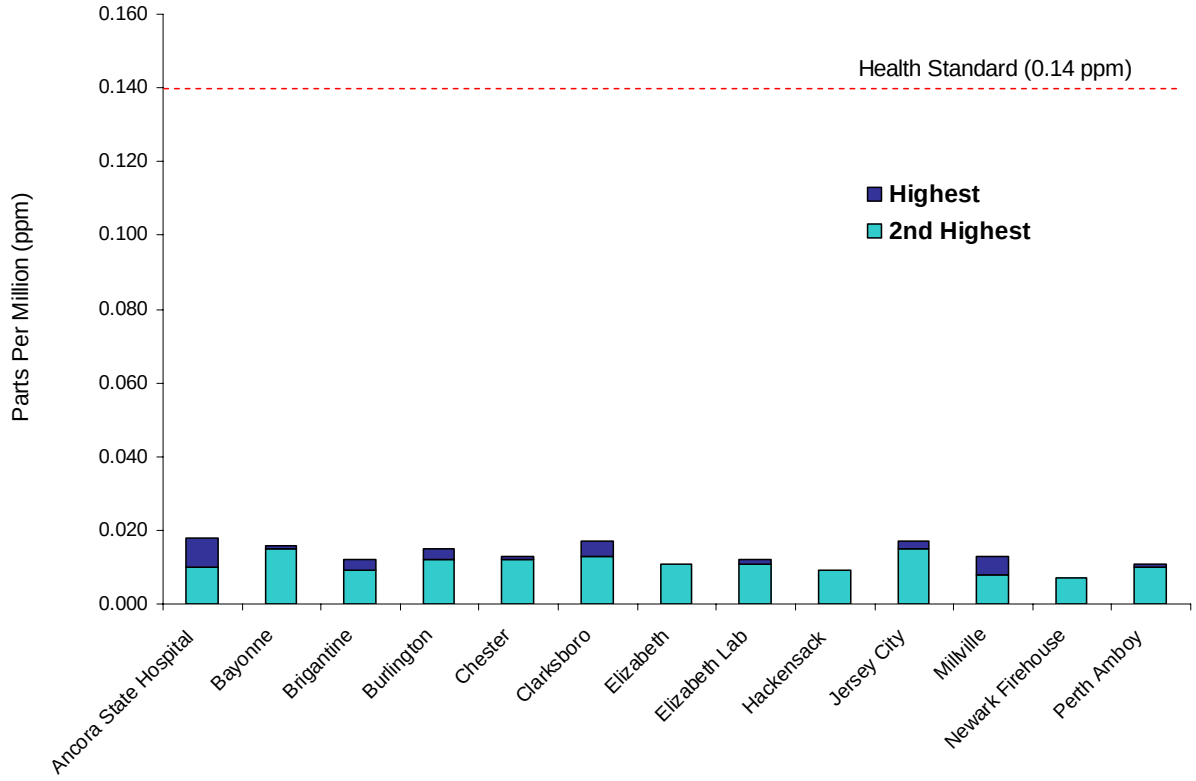
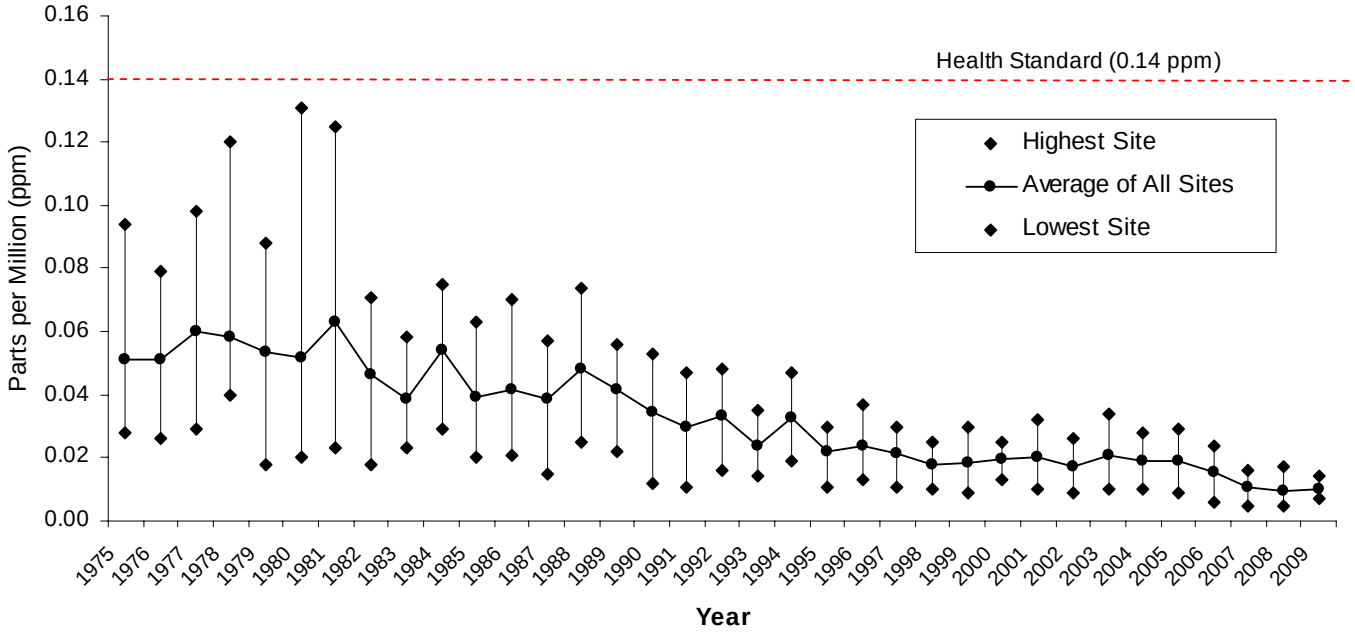


Figure 6
1975 - 2009 Sulfur Dioxide Concentrations
Second Highest Daily Average
Parts Per Million (ppm)

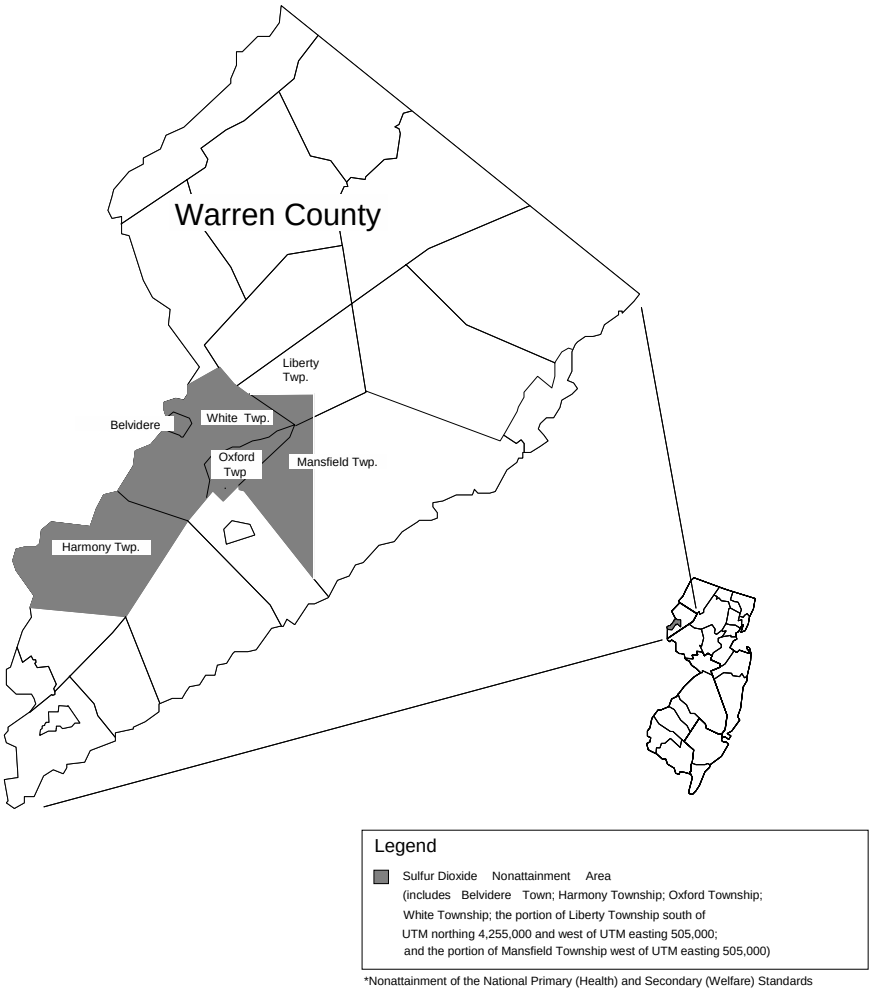


TRENDS

Since the implementation of regulations requiring the use of low sulfur fuels in New Jersey, SO_2 concentrations have improved significantly. The last time an exceedance of any of the National SO_2 standards was recorded in the state was in 1980. A trend graph of SO_2 levels showing the daily average concentrations recorded since 1975 from the highest, average, and lowest of all sites is shown in Figure 6 (page 5). The graph uses the second highest daily average, as this is the value that determines if the national health standard is being met (one exceedance per site is allowed each year).

Although there has not been a measured exceedance of the NAAQS in over two decades, there is still a small area of New Jersey that is classified as a non-attainment area for SO_2. This is the result of air quality modeling studies that predicted non-attainment of the standard within a small area of Warren County. The area is shown below in the map in Figure 7.

Figure 7
Sulfur Dioxide Non-attainment Areas in New Jersey



*Nonattainment of the National Primary (Health) and Secondary (Welfare) Standards

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