



2013 Sulfur Dioxide Summary

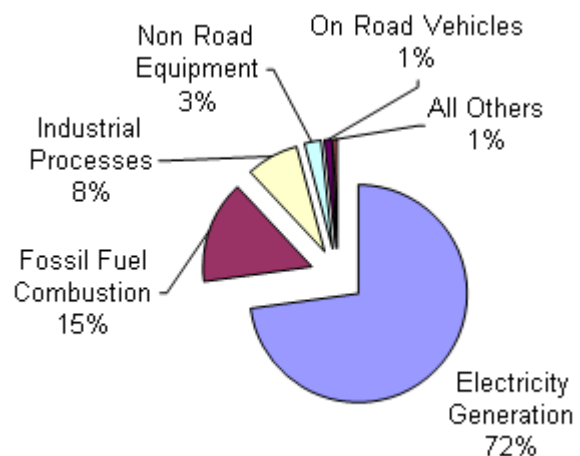
New Jersey Department of Environmental Protection

NATURE AND SOURCES

Sulfur dioxide (SO₂) is a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO₂ 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 SO₂. A pie chart summarizing the major sources of SO₂ is shown in Figure 1.

Figure 2 (page 2) shows that SO₂ concentrations in New Jersey are generally higher in the winter than in the summer due to higher emissions from space heating and other sources, but peak SO₂ daily levels can occur any time during the year. As shown in Figure 3 (page 2), SO₂ 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
SO₂ Emissions by Source Category



SOURCE: USEPA WEBSITE
[HTTP://WWW.EPA.GOV/AIR/EMISSIONS/SO2.HTM](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 SO₂ dissolves at the surface of the membranes. Groups that are especially susceptible to the harmful health effects of SO₂ include children, the elderly, and people with heart or lung disorders such as asthma. When SO₂ 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 SO₂ and based on available information, determined that no conclusion can be made as to the carcinogenicity of SO₂ to human beings (IARC, 1992).

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. SO₂ 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 can speed up the decay of building materials and paints.

Figure 2
Sulfur Dioxide – New Jersey
2013 Monthly Variation
Parts Per Million (ppm)

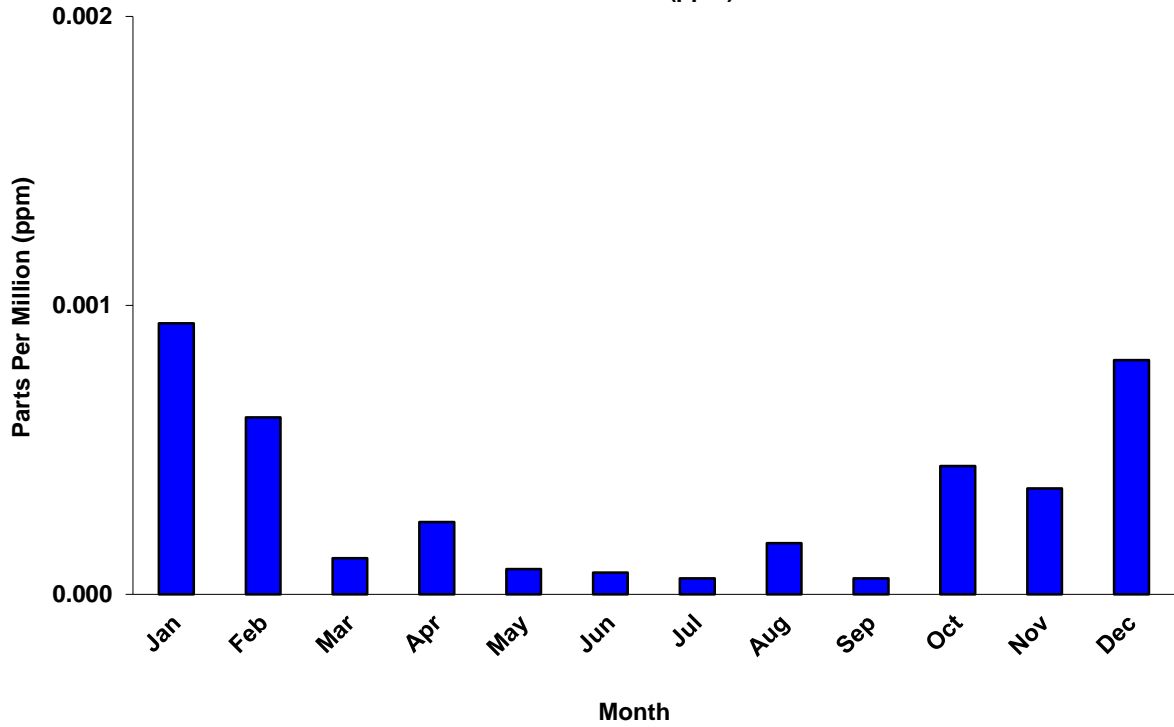
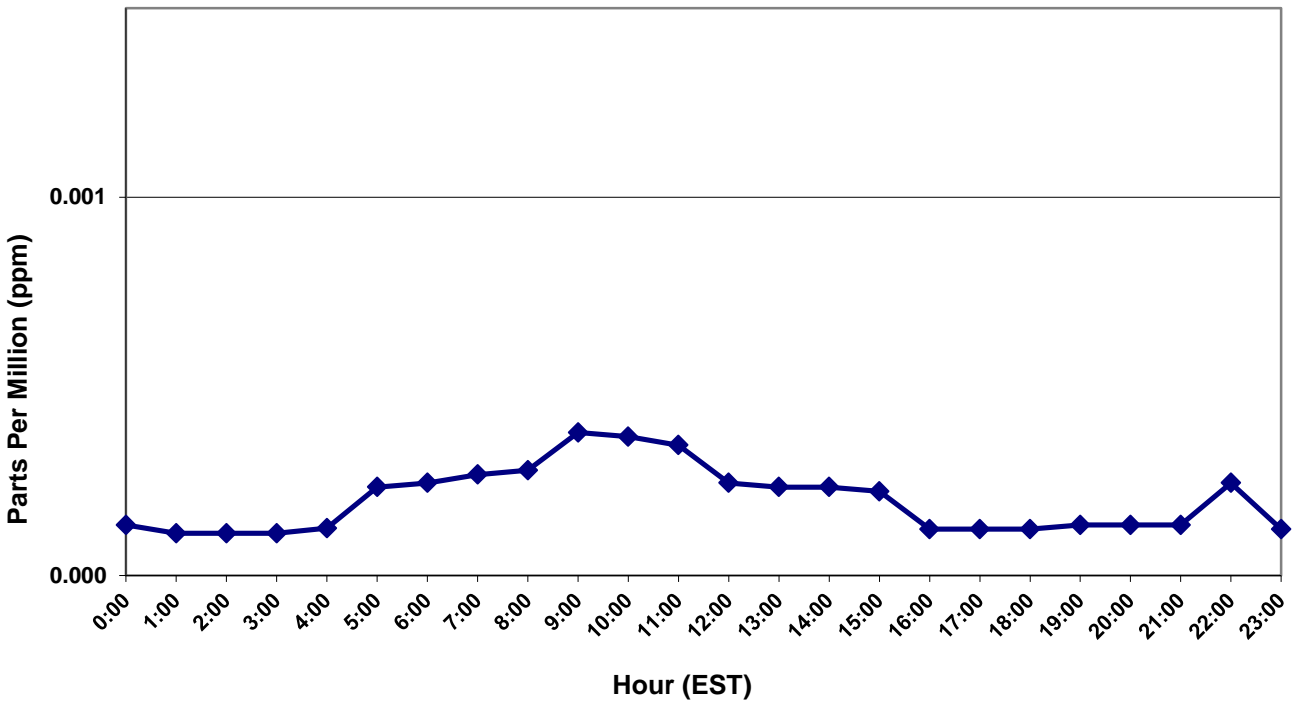


Figure 3
Sulfur Dioxide – New Jersey
2013 Hourly Variation
Parts Per Million (ppm)



STANDARDS

From 1971 through June 2010, the National Ambient Air Quality Standards (NAAQS) for SO₂ were revised three times. In June 2010, based on its review of the air quality standard for oxides of sulfur (as measured by SO₂), the United States Environmental Protection Agency (USEPA) established a new 1-hour NAAQS for SO₂ at a level of 75 parts per billion (ppb), and revoked the 24-hour average and the annual average NAAQS. The USEPA did not revoke the 3-hour secondary NAAQS. The new 1-hour standard is based on the 3-year average of the 99th percentile of 1-hour daily maximum concentrations (Federal Register, 2010). The 1971 SO₂ standards remain in effect until one year after an area is designated for the 2010 standard. In areas designated nonattainment for the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved (USEPA, 2010). The 1971 standards include 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) 3-hour average concentration standard of 0.5 ppm that is also not to be exceeded more than once per year.

New Jersey also has state air quality standards for SO₂. They are similar to the Federal standards but are expressed in micrograms per cubic meter (µg/m³) instead of ppm, and are based on rolling averages rather than block averages. This means the State's primary 12-month standard is based on any twelve-month average recorded during two consecutive years, while the Federal standard is based solely on the calendar year (block) 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 SO₂.

Table 1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide
Parts Per Million (ppm), Parts Per Billion (ppb)
Micrograms Per Cubic Meter (µg/m³)

Averaging Period	Type	New Jersey	National^a
12 – month average	Primary	80 µg/m ³ (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)	--
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
1 – hour average ^b	Primary	---	75 ppb

^a – National standards are block averages rather than moving averages.

^b – Final rule signed June 2, 2010 and effective on August 23, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hr average at each monitor within an area must not exceed 75 ppb.

MONITORING LOCATIONS

The state monitored SO₂ levels at 9 locations in 2013. These sites are shown in Figure 4. The Bayonne site was temporarily shut down in October 2012 because of damage from Superstorm Sandy and was restarted July 2013. In 2010, the NJDEP submitted to the EPA a petition under Section 126 of the Clean Air Act that showed emissions from the Portland Generating Station, located in Pennsylvania, significantly contribute to nonattainment or interfere with maintenance of the 1-hour SO₂ NAAQS. In support of this petition, NJDEP has been monitoring SO₂ concentrations at the Columbia Wildlife Management Area (WMA) station in Warren County since September 23, 2010.

SO₂ LEVELS IN 2012

In 2013, 4 exceedances of the 1-hour standard were recorded at the Columbia WMA site. The highest 99th percentile of the 1-hour daily maximum concentration for 2013 was recorded at Columbia WMA (81 ppb). The highest 3-year average of the 99th percentile of the 1-hour daily maximum SO₂ concentrations was 91 ppb, also measured at the Columbia WMA station. The Camden Spruce Street and Bayonne sites did not have sufficient data from 2011-2013 to determine whether these sites meet the 1-hour SO₂ standard.

No other monitoring sites recorded exceedances of the primary or secondary SO₂ standards during 2013. The maximum 12-month average concentration recorded was 0.001 ppm at Elizabeth Lab site. The maximum 24-hour average level recorded was 0.016 ppm at the Columbia WMA site. The highest 3-hour average recorded was 0.059 ppm at the Columbia WMA site. Summaries of the 2013 data are provided in Tables 2, 3, 4, Figure 5 and Figure 6 (pages 5 - 7),

Figure 4
2013 Sulfur Dioxide
Monitoring Network

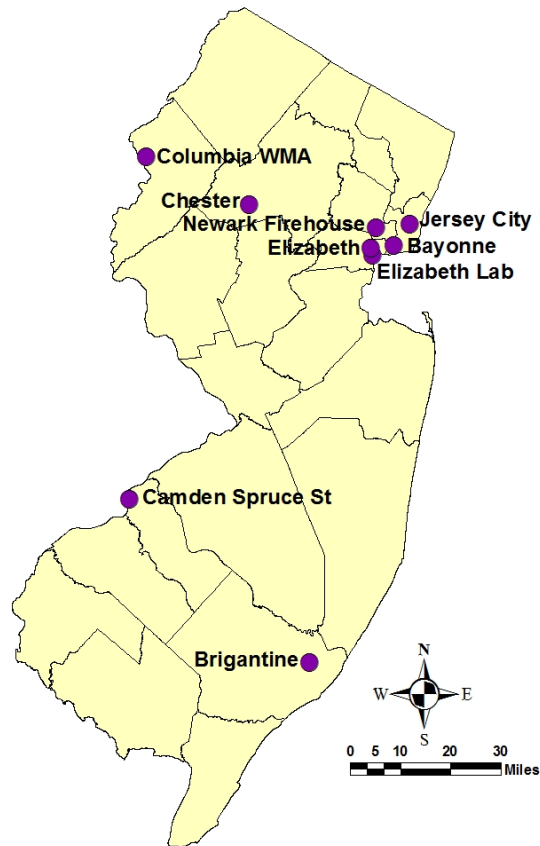


Table 2
2013 Sulfur Dioxide Data
3-Year Average of 99th Percentile
of Daily Maximum 1-Hour Average
Parts Per Billion (ppb)

Location	1-Hour Average (ppb)			3 – Year Average 2011-2013
	Highest 1-Hr Daily Maximum	2nd Highest 1-Hr Daily Maximum	99 th %-ile 1-Hr Daily Maximum	99 th %-ile 1-hr Daily Maximum
Bayonne ^c	12	10	10	---
Brigantine	13.7	7.2	6.9	6.2
Camden Spruce ^d	24	20	9	---
Chester	12	9	6	14
Columbia WMA	121	114	81	91
Elizabeth	12	7	6	10
Elizabeth Lab	22	15	14	26
Jersey City	9	9	8	14
Newark Firehouse	9.6	8.2	7.7	13.2

^c – Bayonne site temporarily shut down October 2012 due to Superstorm Sandy and restarted July 2013.

^d – Camden Spruce site started in April 2012.

Table 3
2013 Sulfur Dioxide Data
3-Hour and Annual Averages
Parts Per Million (ppm)

Monitoring Sites	3-Hour Average Maximum	3-Hour Average 2 nd Highest ^a	12-Month Average Maximum	Calendar Year Average
Bayonne ^c	0.009	0.008	---	---
Brigantine	0.0064	0.0047	0.0004	0.0004
Camden Spruce ^d	0.016	0.015	---	---
Chester	0.008	0.006	0.000	0.001
Columbia WMA	0.059	0.056	0.000	0.001
Elizabeth	0.010	0.008	0.000	0.001
Elizabeth Lab	0.012	0.011	0.001	0.001
Jersey City	0.008	0.007	0.000	0.001
Newark Firehouse	0.0073	0.0065	0.0008	0.0008

^a – Based on non-overlapping 3 – hour moving averages.

^c – Bayonne site temporarily shut down October 2012 due to Superstorm Sandy and restarted July 2013.

^d – Camden Spruce site started in April 2012, 12-month average and calendar year average not available.

Table 4
2013 Sulfur Dioxide Data
24-Hour and Daily Averages
Parts Per Million (ppm)

Monitoring Sites	24-Hour Average Maximum	24-Hour Average 2 nd Highest ^a	Daily Average Maximum	Daily Average 2 nd Highest
Bayonne ^c	0.004	0.003	0.003	0.003
Brigantine	0.0026	0.0024	0.0025	0.0022
Camden Spruce ^d	0.005	0.003	0.004	0.003
Chester	0.003	0.003	0.003	0.003
Columbia WMA	0.016	0.014	0.013	0.013
Elizabeth	0.004	0.003	0.004	0.003
Elizabeth Lab	0.007	0.006	0.007	0.006
Jersey City	0.005	0.005	0.005	0.004
Newark Firehouse	0.0042	0.0039	0.0042	0.0038

^a – Based on non-overlapping 24 – hour moving averages.

^c – Bayonne site temporarily shut down October 2012 due to Superstorm Sandy and restarted July 2013.

^d – Camden Spruce site started in April 2012.

Figure 5
Sulfur Dioxide – New Jersey
2013 – 3 Year Design Value
Parts Per Billion (ppb)

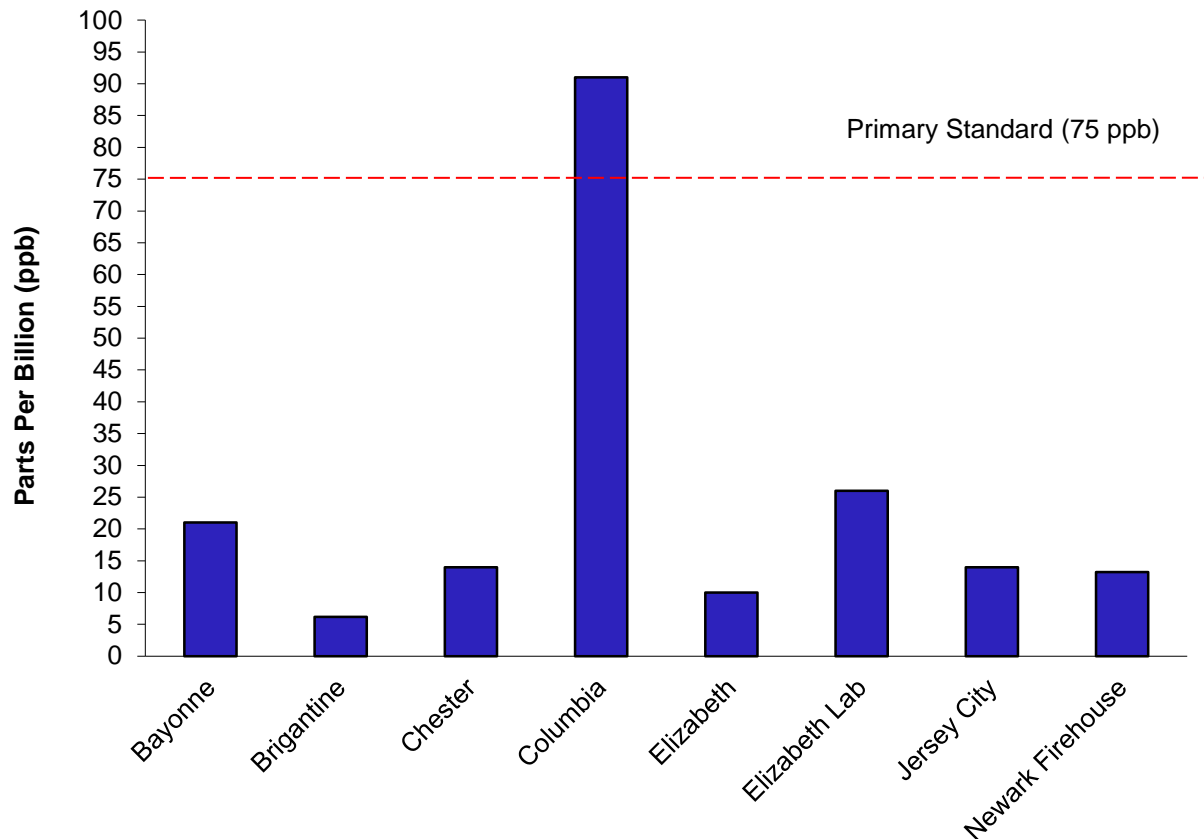
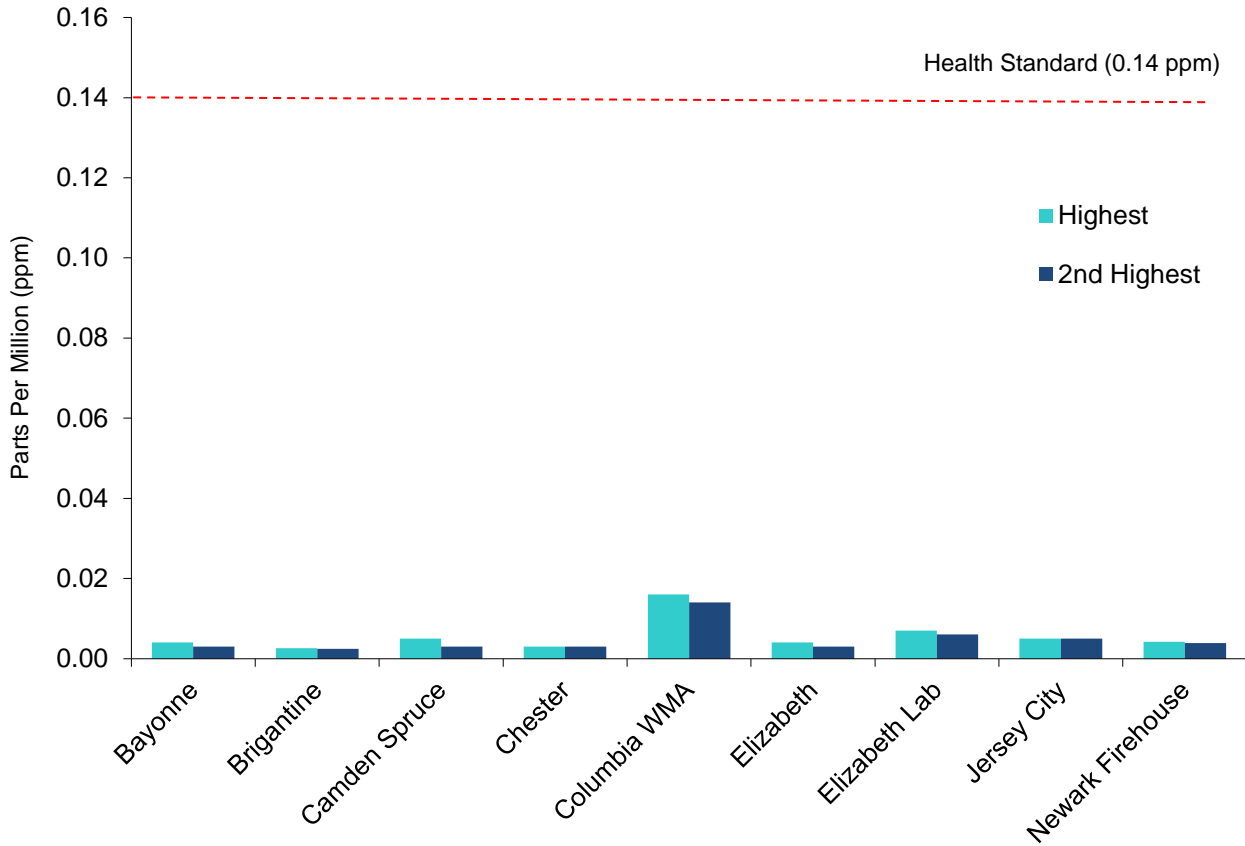


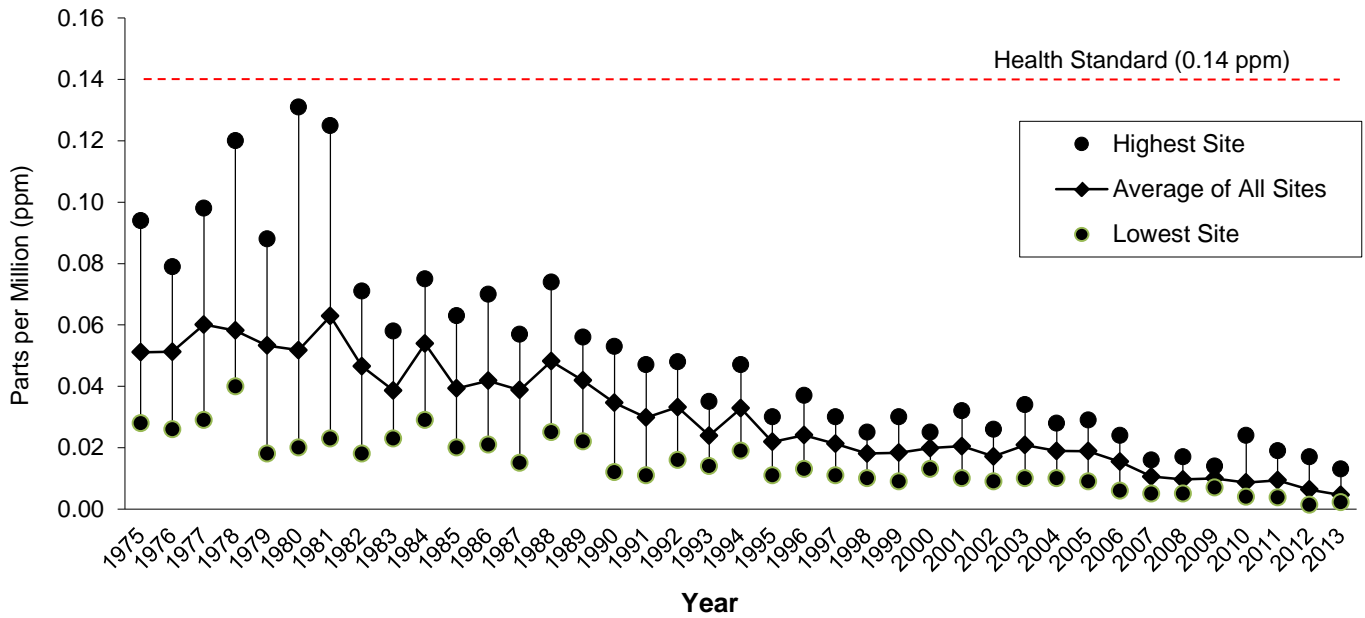
Figure 6
2013 Sulfur Dioxide Concentrations
Highest and 2nd Highest 24-Hour Averages
Parts Per Million (ppm)



TREND FOR 24-HOUR SO₂ STANDARD

Since the implementation of Federal regulations requiring the use of lower sulfur fuels nationwide, SO₂ concentrations have improved significantly. The last time an exceedance of the 3-hour, 24-hour, or 12-month NAAQS for SO₂ was recorded in the state was in 1980. A trend graph of SO₂ levels showing the daily average concentrations recorded in each year since 1975 from the highest site, average of all sites, and lowest site is provided in Figure 7 (page 8). The graph uses the second highest daily average.

Figure 7
1975 - 2013 Sulfur Dioxide Concentrations
Second Highest Daily Average
Parts Per Million (ppm)



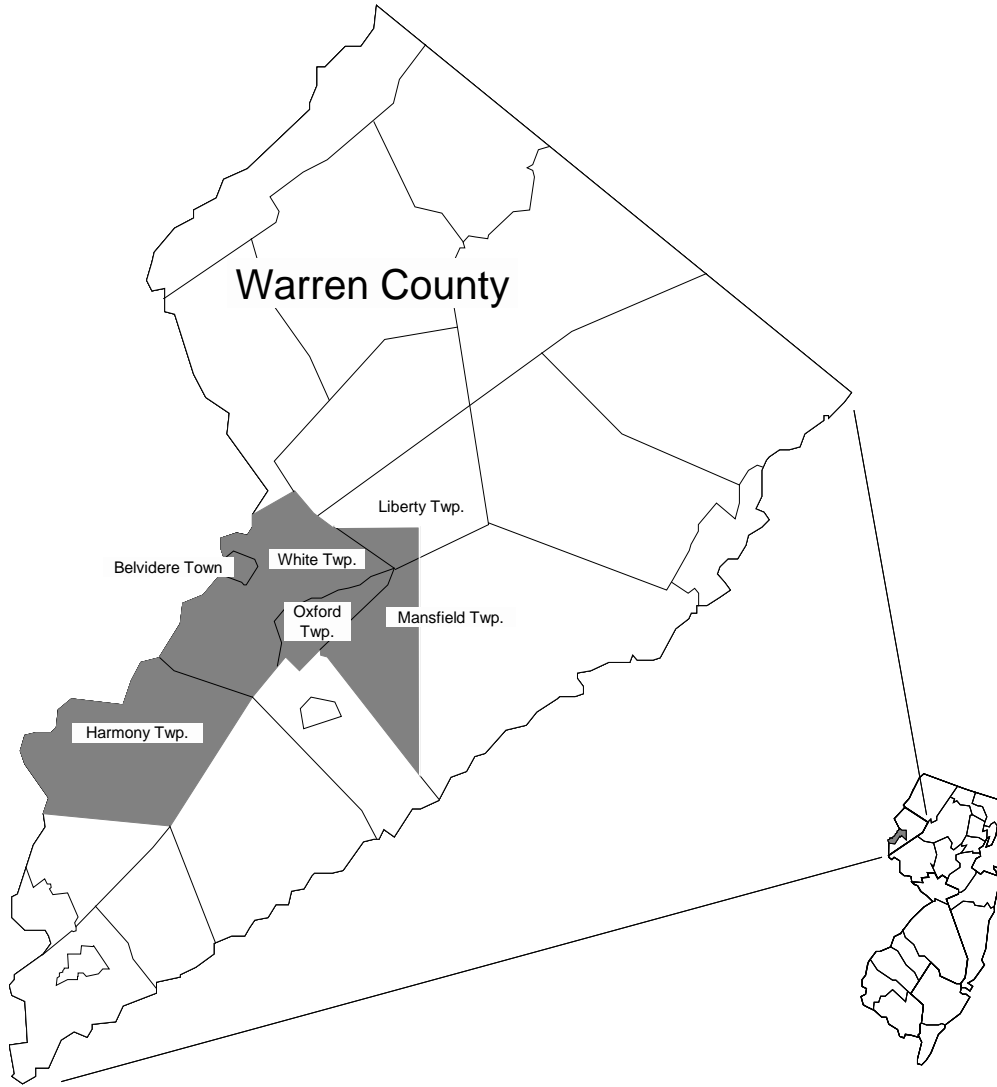
COMPLIANCE WITH THE SO₂ STANDARDS IN NEW JERSEY

There is still a small portion of New Jersey that is classified as a non-attainment area for SO₂ based on the 1971 12-month and 24-hour average ambient air quality primary standards. This is the result of air quality modeling studies that predicted non-attainment of these standards within an area of Warren County. The sources that were causing the predicted high levels no longer exist, or do not emit SO₂ at the rates they did in the past. The state is working with EPA to get the area re-designated to attainment. The area is shown in Figure 8.

On June 2, 2010, the USEPA revised the air quality standards for SO₂, establishing a new standard based on maximum 1-hour average concentrations. In September 2010, New Jersey petitioned the USEPA under Section 126 of the Clean Air Act, to take action against the Portland Power Plant in Pennsylvania as a large area of New Jersey is being influenced by SO₂ emissions from the plant and it is likely causing violations of the new 1-hour standard. This area includes all of Warren County and portions of Sussex, Morris, and Hunterdon counties. A detailed map of the affected areas can be found at <http://www.state.nj.us/dep/baqp/docs/SO2%20package.pdf>.

In support of this petition, the NJDEP established an SO₂ monitoring station in the Columbia Wildlife Management Area (WMA) in Knowlton Township, Warren County in September 2010. In October 2011, the USEPA finalized a rule to grant New Jersey's petition. This final rule requires the Portland Power Plant to reduce its SO₂ emissions such that the plant's contribution to predicted air quality standard violations will be lowered within one year, and completely eliminated within 3 years. Since the Portland Power Plant has reduced its emissions and has signed a court order to cease operations by July 2014, it is expected that Warren County and its vicinity will be able to attain the new SO₂ standard.

Figure 8
Sulfur Dioxide Non-attainment Areas* in New Jersey



Legend

- Sulfur Dioxide Nonattainment Area
(includes Belvidere Town; Harmony Township; Oxford Township;
White Township; the portion of Liberty Township south of
UTM northing 4,255,000 and west of UTM easting 505,000;
and the portion of Mansfield Township west of UTM easting 505,000).

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

REFERENCES

Air Quality Criteria for Particulate Matter and Sulfur Oxides (1982): Assessment of New Findings on Sulfur Dioxide Acute Exposure Health Effects in Asthmatic Individuals, Supplement to the Second Addendum (1986), U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Research Triangle Park, NC, 1994.

Draft Guideline Document for Ambient Monitoring of 5-minute SO₂ Concentrations, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, July 20, 2000.

Horstman, D., Roger, L. J., Kehrl, H. and Hazucha, M., *Airway Sensitivity of Asthmatics to Sulfur Dioxide*, EPA-600/J-86-282, Health Effects Research Lab, Research Triangle Park, NC, Clinical Research Branch, Environmental Monitoring and Services, Inc., Chapel Hill, NC, North Carolina University at Chapel Hill, NC, Prepared for USEPA, Research Triangle Park, NC, 1986.

How Sulfur Dioxide Affects the Way We Live, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, June 2009, URL: <http://www.epa.gov/air/urbanair/SO2>

International Agency for Research on Cancer (IARC). 1992, IARC Monographs; Vol 54.

Latest Findings on National Air Quality: 2000 Status and Trends, EPA-454/K-01-002, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, September 2001, URL: <http://www.epa.gov/air/airtrends/aqtrnd00/brochure/00brochure.pdf>.

National Air Quality and Emissions Trend Report, 1999, EPA-454/R-01-004, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 2001, URL: <http://www.epa.gov/air/airtrends/aqtrnd99/>.

National Ambient Air Quality Standards, United States Environmental Protection Agency (USEPA), Air and Radiation, 2010. URL: <http://www.epa.gov/air/criteria.html>

National Primary Ambient Air Quality Standards for Sulfur Dioxide, 40 CFR 50.4, US Government Printing Office, Washington DC, July 2001.

National Secondary Ambient Air Quality Standards for Sulfur Dioxide, 40 CFR 50.5, US Government Printing Office, Washington DC, July 2001.

Sittig, M., *Handbook of Toxic and Hazardous Chemicals and Carcinogens Third Edition, Volume 2*, Noyes Publications, Park Ridge, NJ, 1991.

"Revisions to Final Response to Petition From New Jersey Regarding SO₂ Emissions From the Portland Generating Station." *Federal Register* 76 (2011 December 22): 79574-79578.

ToxFaQs for Sulfur Dioxide, CAS# 7446-09-5, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, June 1999, URL: <http://www.atsdr.cdc.gov/tfacts116.pdf>.