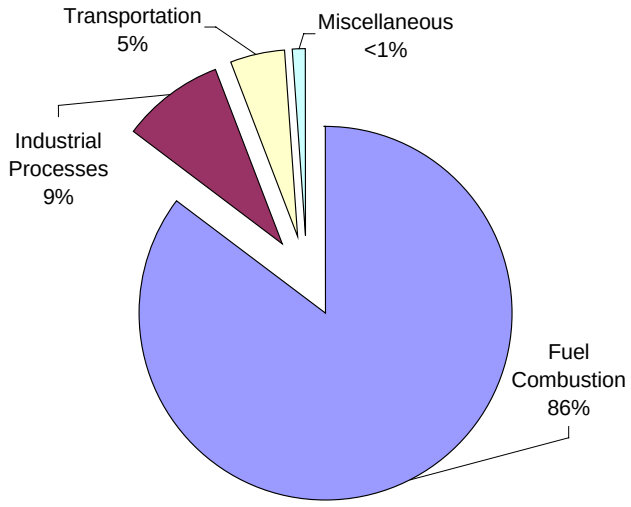
# 2002 Sulfur Dioxide Summary

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 fuel containing sulfur is 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 a 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 1**
**National Summary of 2002**
**$SO_2$ Emissions by Source Category[a]**




[a] - sums do not equal 100 due to rounding
Source: USEPA National Air Quality Emissions Trends Report, 2003 Special Studies, September 2003

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

## 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, which fall to the earth in rain and snow. Acid rain damages forests and crops, can make lakes and streams too acidic for fish, and 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 0.030 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 $SO_2$.

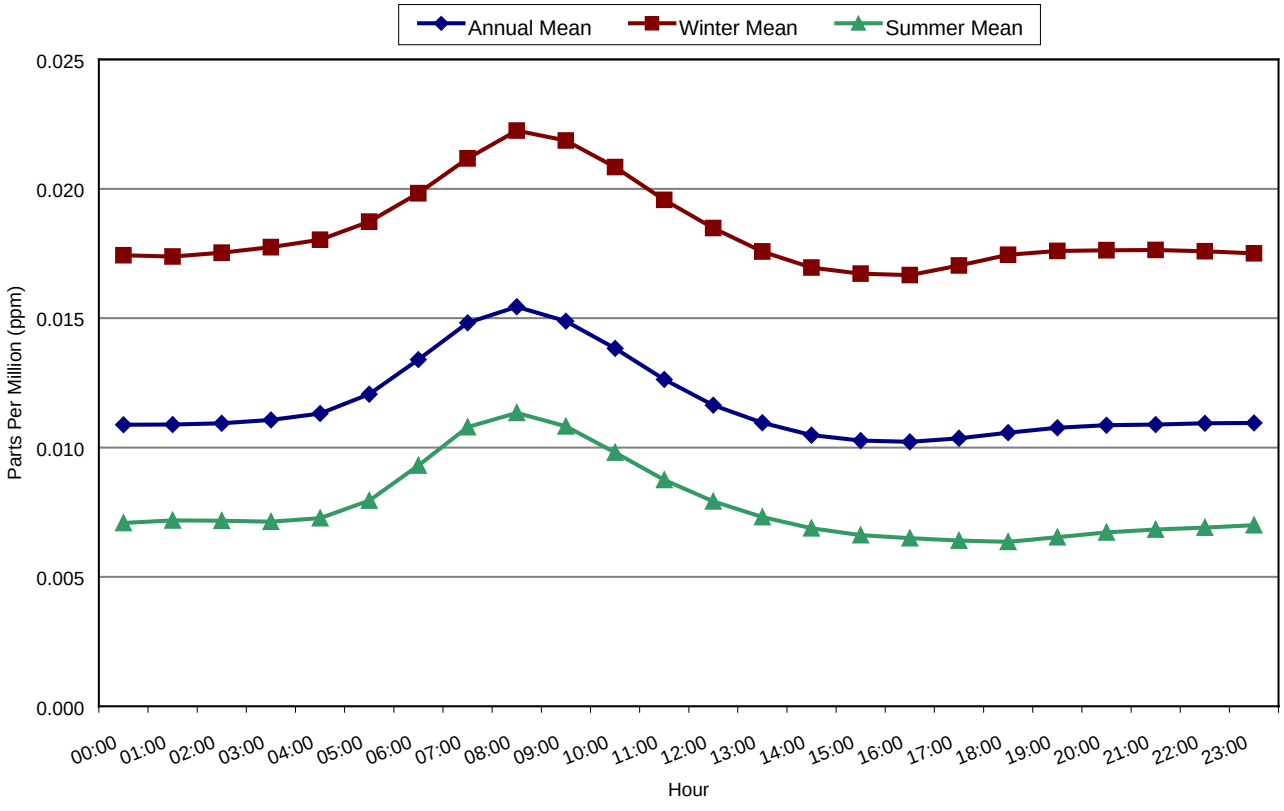
**Table 1**
**National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide**

**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) | 0.030 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

**Figure 2**
**Sulfur Dioxide Concentration - New Jersey**
**1967-1999**
**Seasonal and Hourly Variation**



## Monitoring Locations

The state monitored $SO_2$ levels at 15 locations in 2002. These sites are shown in the map in Figure 3. The Somers Point site was discontinued on March 6, 2002. Consequently, a valid 2002 annual average could not be calculated for this site.

## $SO_2$ Levels in 2002

None of the monitoring sites recorded exceedances of the primary or secondary $SO_2$ standards during 2002. The maximum annual average concentration recorded was 0.009 ppm at Exit 13 of the New Jersey Turnpike at Elizabeth Lab. The maximum 24-hour average level recorded was 0.037 ppm which was recorded in Jersey City. The highest 3-hour average recorded was 0.092 ppm also at the Exit 13 site at Elizabeth Lab. Summaries of the 2002 data are provided in Table 2, Table 3 (page 4) and Figure 4 (page 4).

**Figure 3**
**2002 Sulfur Dioxide Monitoring Network**


**Table 2**
**Sulfur Dioxide Data – 2002**
**3-Hour and Annual Averages**

**Parts Per Million (ppm)**

| Monitoring Sites | 3-Hour Average Maximum | 3-Hour Average 2nd Highest | 12-Month Average Maximum | Average Calendar Year |
|---|---|---|---|---|
| Ancora State Hospital | 0.026 | 0.025 | 0.003 | 0.003 |
| Bayonne | 0.046 | 0.031 | 0.006 | 0.006 |
| Burlington | 0.038 | 0.032 | 0.005 | 0.004 |
| Camden Lab | 0.061 | 0.044 | 0.007 | 0.007 |
| Chester | 0.052 | 0.033 | 0.004 | 0.004 |
| | | | | |
| Clarksboro | 0.041 | 0.031 | 0.005 | 0.005 |
| Elizabeth | 0.031 | 0.030 | 0.005 | 0.005 |
| Elizabeth Lab | 0.092 | 0.057 | 0.009 | 0.009 |
| Hackensack | 0.035 | 0.030 | 0.005 | 0.004 |
| Jersey City | 0.052 | 0.050 | 0.009 | 0.007 |
| | | | | |
| Millville | 0.035 | 0.030 | 0.004 | 0.004 |
| Nacote Creek Research Center | 0.022 | 0.021 | 0.003 | 0.003 |
| Newark Lab | 0.062 | 0.049 | 0.004 | 0.004 |
| Perth Amboy | 0.051 | 0.039 | 0.004 | 0.004 |
| Somers Point[d] | 0.063 | 0.031 | 0.003 | ---- |

[d] – Data not available after March 2002

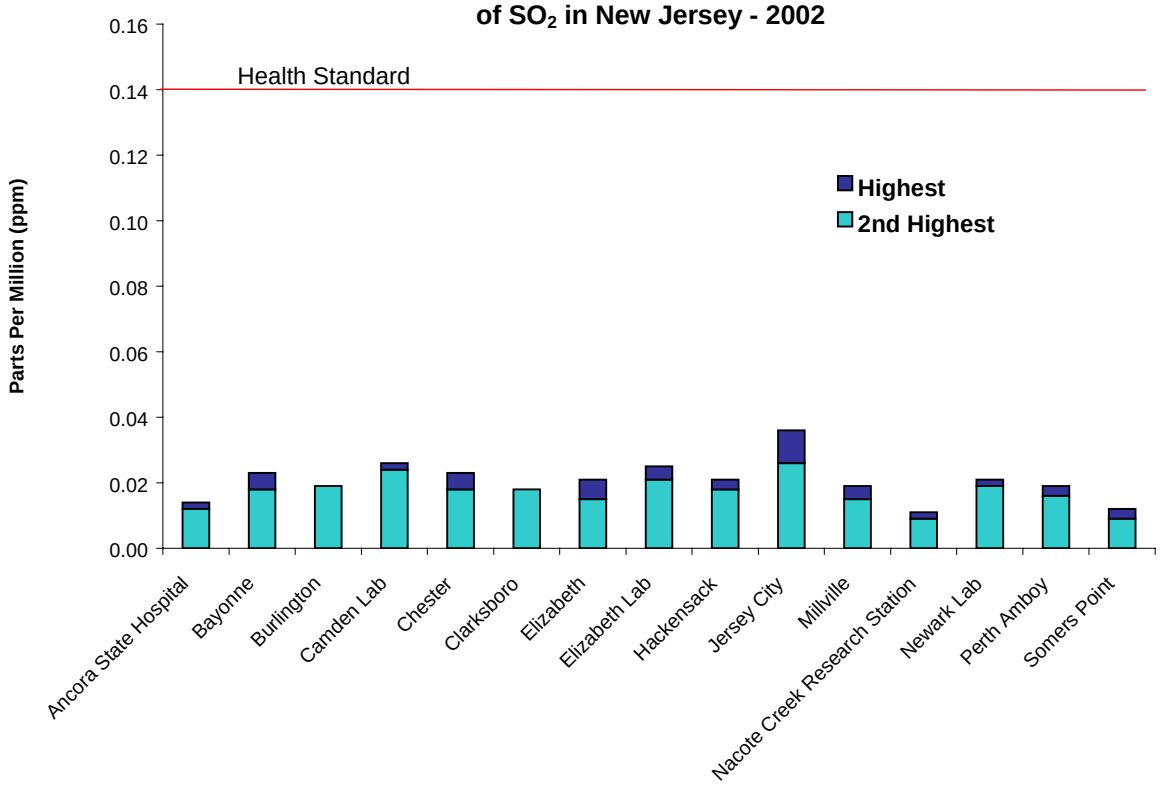
## Table 3
## Sulfur Dioxide Data – 2002
## 24-Hour and Daily Averages

**Parts Per Million (ppm)**

| Monitoring Sites | 24-Hour Average Maximum | 24-Hour Average 2nd Highest | Daily Average Maximum | Daily Average 2nd Highest |
|---|---|---|---|---|
| Ancora State Hospital | 0.020 | 0.014 | 0.014 | 0.012 |
| Bayonne | 0.023 | 0.018 | 0.023 | 0.018 |
| Burlington | 0.026 | 0.019 | 0.019 | 0.019 |
| Camden Lab | 0.030 | 0.028 | 0.026 | 0.024 |
| Chester | 0.024 | 0.022 | 0.023 | 0.018 |
| | | | | |
| Clarksboro | 0.028 | 0.015 | 0.018 | 0.018 |
| Elizabeth | 0.023 | 0.017 | 0.021 | 0.015 |
| Elizabeth Lab | 0.029 | 0.023 | 0.025 | 0.021 |
| Hackensack | 0.024 | 0.020 | 0.021 | 0.018 |
| Jersey City | 0.037 | 0.028 | 0.036 | 0.026 |
| | | | | |
| Millville | 0.024 | 0.016 | 0.019 | 0.015 |
| Nacote Creek Research Station | 0.012 | 0.011 | 0.011 | 0.009 |
| Newark Lab | 0.025 | 0.022 | 0.021 | 0.019 |
| Perth Amboy | 0.027 | 0.017 | 0.019 | 0.016 |
| Somers Point[d] | 0.013 | 0.010 | 0.012 | 0.009 |

[d] - Data not available after March 2002

## Figure 4
## Highest and 2nd Highest Daily Averages of $SO_2$ in New Jersey - 2002

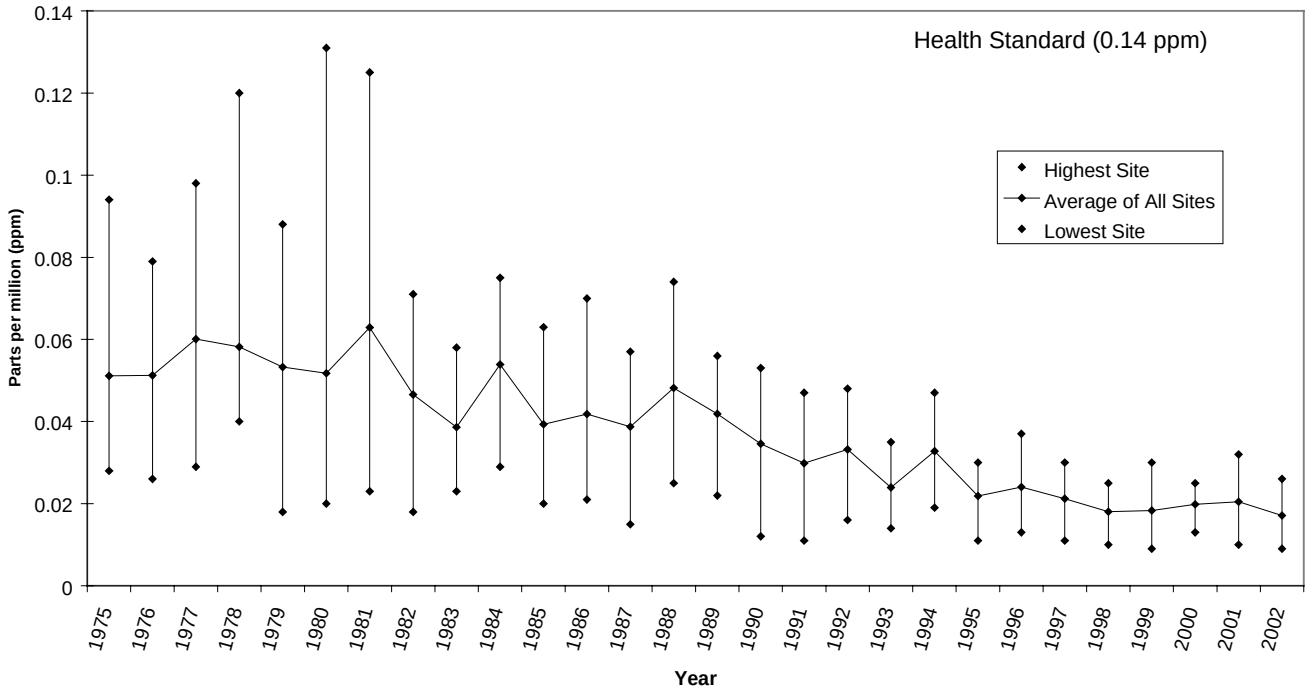


## TRENDS

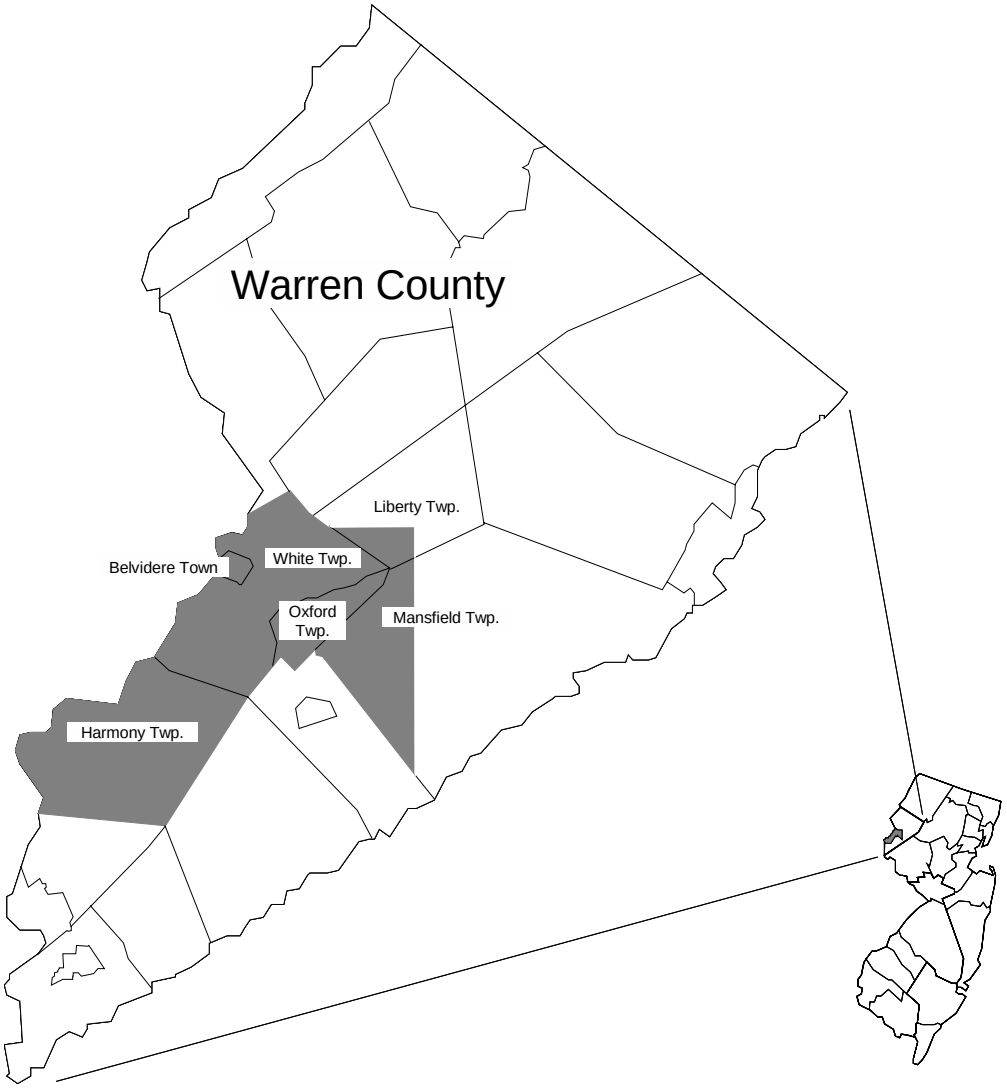
Since the implementation of regulations requiring the use of low sulfur fuels in New Jersey, $SO_2$ concentrations have improved significantly. The last time an exceedance of any of the National $SO_2$ standards was recorded in the state was in 1980. A trend graph of $SO_2$ levels showing the highest, lowest and average of the daily average concentrations recorded is presented in Figure 5. The graph uses the second highest daily value, 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 in the map in Figure 6 (page 6).

**Figure 5**
**Sulfur Dioxide Concentrations in New Jersey**
**1975-2002**
**Second Highest Daily Average**



# Figure 6
# 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

## Five Minute Average $SO_2$ Monitoring

A 1992 court decision compelled the USEPA to review, and if appropriate, revise the NAAQS for $SO_2$. After soliciting comments from the public and evaluating several options, the USEPA determined that high short-term $SO_2$ concentrations are a local problem rather than a widespread national concern. The USEPA Administrator decided in May 1996 not to revise the NAAQS for $SO_2$, but concluded that in some local areas, 5-minute $SO_2$ concentrations greater than 0.6 ppm pose a health threat to sensitive persons. In January 1997, the USEPA published proposed revisions to the regulations that would establish "concern and intervention levels (IL)." This IL would have a lower range of 0.6 ppm and an upper range of 2.0 ppm of $SO_2$. These levels are based on a 5-minute $SO_2$ concentration that is the highest of the 5-minute averages from the 12 possible non-overlapping periods during a clock hour. Under the proposed regulations, the USEPA would leave the responsibility of assessing the health risk and implementing corrective measures to the States. Also, the USEPA recommended that States evaluate the need to monitor 5-minute $SO_2$ averages around sources based on citizen complaints, the actual emissions of a source, the population in the vicinity of the source, and environmental justice issues.

The USEPA published a draft "Guideline Document for Ambient Monitoring of 5-Minute $SO_2$ Concentrations" on July 20, 2000. This guidance is intended to assist State and local agencies in determining whether 5-minute $SO_2$ monitoring should be established in their jurisdictions, and how to redesign an existing $SO_2$ network to fulfill these additional needs.

In October 2002, an air monitoring project was established in Warren County, New Jersey to evaluate the feasibility of monitoring 5-minute $SO_2$ concentrations in the vicinity of local point source. This is the first time since the publication of USEPA's draft "Guideline Document for Ambient Monitoring of 5-Minute $SO_2$ Concentrations" that $SO_2$ concentrations anywhere in New Jersey are being directly compared to the 5-minute $SO_2$ guideline IL. Warren County was selected for this study as the Belvidere area of the county is the only $SO_2$ non-attainment area in the state. The study had broad community involvement in its design and implementation. It is primarily being supported by a local industrial facility as part of a Supplemental Environmental Project (SEP). SEPs are sometimes part of settlement agreements between the DEP and a regulated facility. They are projects deemed to have an environmental benefit for the community, and are supported by a facility in lieu of, or in addition to, direct monetary penalties. The results of the monitoring study are available on the World Wide Web at www.airqap.com

# REFERENCES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