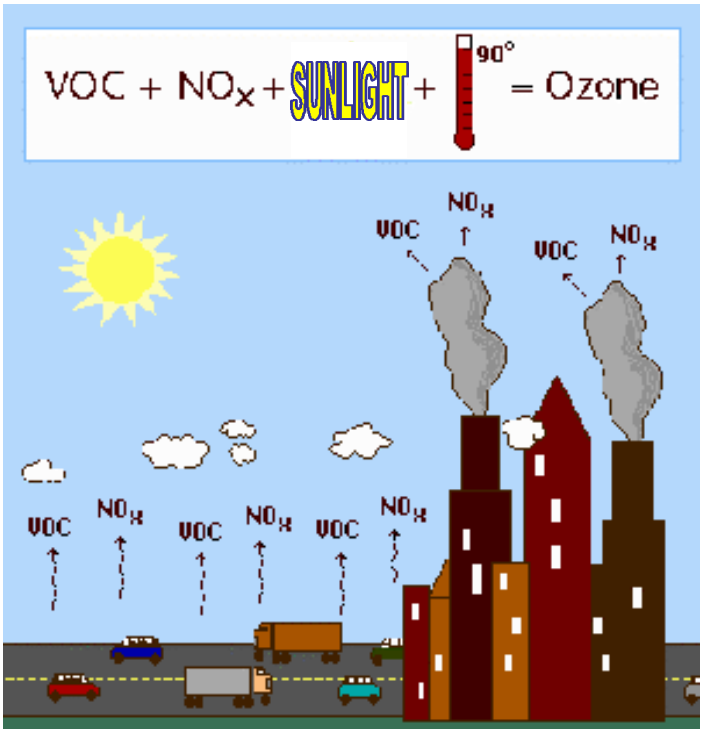
# 2001 Ozone Summary

New Jersey Department of Environmental Protection

## Nature and Sources

Ozone ($O_3$) is a gas consisting of three oxygen atoms. It occurs naturally in the upper atmosphere (stratospheric ozone) where it protects us from harmful ultraviolet rays. However, at ground-level (tropospheric ozone) it is considered an air pollutant and can have serious adverse health effects. Ground-level ozone is created when nitrogen oxides (NOx) and volatile organic compounds (VOC's) react in the presence of sunlight and heat. NOx is primarily emitted by motor vehicles, power plants, and other sources of combustion. VOC's are emitted from sources such as motor vehicles, chemical plants, factories, consumer and commercial products, and even natural sources such as trees. Ozone and the pollutants that form ozone (precursor pollutants) can also be transported into an area from sources hundreds of miles upwind.




Since ground-level ozone needs sunlight to form, it is mainly a daytime problem during the summer months. Weather patterns have a significant effect on ozone formation and hot, dry summers will result in more ozone than cool, wet ones. In New Jersey, the ozone season runs from April 1st to October 31st, although unhealthy conditions are rare before mid-May or after the first few weeks of September. For a more complete explanation of the difference between ozone in the upper and lower atmosphere, see the U.S. Environmental Protection Agency (EPA) publication "Ozone: Good Up High, Bad Nearby".[1]

## Environmental Effects

Ground-level ozone damages plant life and is responsible for 500 million dollars in reduced crop production in the United States each year. It interferes with the ability of plants to produce and store food, making them more susceptible to disease, insects, other pollutants, and harsh weather. "Bad" ozone damages the foliage of trees and other plants, sometimes marring the landscape of cities, national parks and forests, and recreation areas.[1]

## Health Effects

Repeated exposure to ozone pollution may cause permanent damage to the lungs. Even when ozone is present in low levels, inhaling it can trigger a variety of health problems including chest pains, coughing, nausea, throat irritation, and congestion. Ozone also can aggravate other health problems such as bronchitis, heart disease, emphysema, and asthma, and can reduce lung capacity. People with pre-existing respiratory ailments are especially prone to the effects of ozone. For example, asthmatics affected by ozone may have more frequent or severe attacks during periods when ozone levels are high. [2]

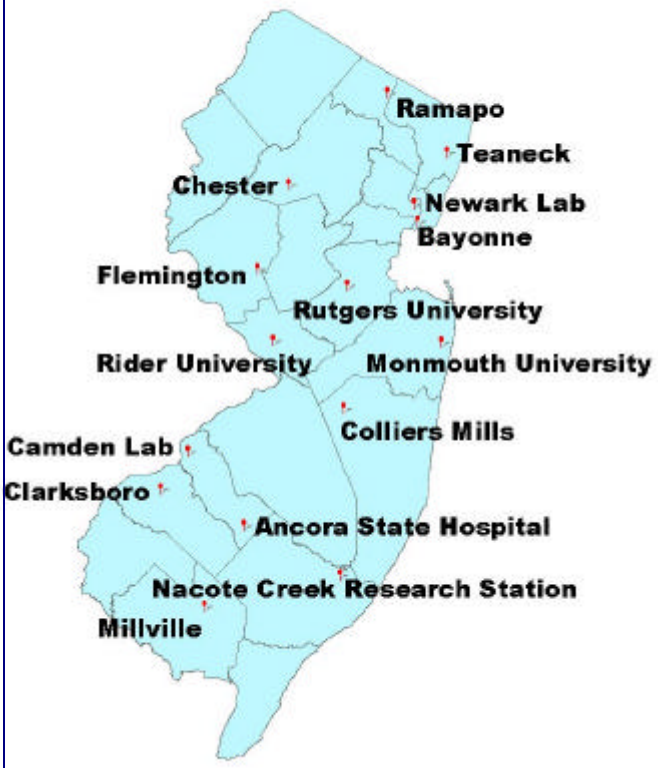
Children are also at risk for ozone related problems. Their respiratory systems are still developing and they breathe more air per pound of body weight than adults. They are also generally active outdoors during the summer when ozone levels are at their highest. Anyone who spends time outdoors in the summer can be affected, however, and studies have shown that even healthy adults can experience difficulty in breathing when exposed to ozone. Anyone engaged in strenuous outdoor activities such as jogging should limit activity to the early morning or late evening hours on days when ozone levels are expected to be high.

## Ozone Network

Ozone was monitored at 15 locations in New Jersey during 2001. Of those 15 sites, 12 operated year round and 3 operated only during the ozone season (April 1st through October 31st). The site in Newark had to be relocated and did not come on-line until August of 2001. Summary statistics for Newark are included in the tables, but this data should not be compared to the other sites, which operated throughout the ozone season.

**Figure 1**

**2001 Ozone Monitoring Network**




## Ambient Air Quality Standards for Ozone

National and state air quality standards have been established for ground level ozone. There are both primary standards, which are based on health effects, and secondary standards, which are based on welfare effects (e.g. damage to trees, crops and materials). For ground-level ozone, the primary and secondary National Ambient Air Quality Standards (NAAQS) are the same. The ozone NAAQS were revised in 1997 because EPA had determined that the old standard of 0.12 parts per million (ppm) maximum daily one-hour average was not sufficiently protective of public health. They set a revised standard of 0.08 ppm maximum daily eight-hour average. The standard changes were challenged in court but eventually upheld. As many people are accustomed to the old standards, summary information relative to that standard will be provided in this report along with summaries based on the new standard.

**Old Ambient Air Quality Standards for Ozone (Prior to July 18,1997)**

| Averaging Period | Type | New Jersey | National |
|---|---|---|---|
| 1-Hour | Primary | 0.12 ppm | 0.12 ppm |
| 1-Hour | Secondary | 0.08 ppm | 0.12 ppm |

**Current Ambient Air Quality Standards for Ozone (After July 18, 1997)**

| Averaging Period | Type | New Jersey | National |
|---|---|---|---|
| 8-Hour | Primary | ----- | 0.08 ppm |
| 8-Hour | Secondary | ----- | 0.08 ppm |

## Design Values

The NAAQS are set in such a way that determining whether they are being attained is not based on a single year. For example, an area was considered to be attaining the old 1-hour average standard if the average number of times the standard was exceeded over a three period was 1 or less (after correcting for missing data). Thus it was the fourth highest daily maximum 1-hour concentration that occurred over a three year period that determined if an area would be attainment. If the fourth highest value was above 0.12 ppm then the average number of exceedances would be greater than 1. The fourth highest value is also known as the design value.

Under the new standard, attainment is determined by taking the average of the 4th highest daily maximum 8-hour average concentration that is recorded each year for three years. This becomes the design value for an area under the new standard. When plans are developed for reducing ozone concentrations, an area must demonstrate that the ozone reduction achieved will be sufficient to ensure the design value will be below the NAAQS, as opposed to ensuring that the standards are never exceeded. This avoids having to develop plans based on extremely rare events.

## How the Changes to the Ozone Standards Affect Air Quality Ratings

In 2001 there were 11 days on which the old standard was exceeded in New Jersey and 35 days on which the new standard was exceeded. Significant progress was being made towards meeting the old standards (see Figure 2 below). There are fewer days on which that standard is exceeded, and when it is, fewer sites tend to be involved. Also, the maximum levels reached are not as high as they were in the past. The maximum one-hour average concentration recorded in 1988 was 0.218 ppm, compared to a maximum of 0.145 ppm in 2001.

It is apparent, however, that the new standard is significantly more stringent than the old one (compare Figure 2 to Figure 3 below). As a result, additional control measures to reduce ozone levels will be needed. These measures will have to be implemented over a wide area and will require the cooperative effort of many states and the federal government if they are to be successful.

**Figure 2**
**Days on Which the Old Standard (1-hour) was Exceeded in New Jersey 1988-2001**

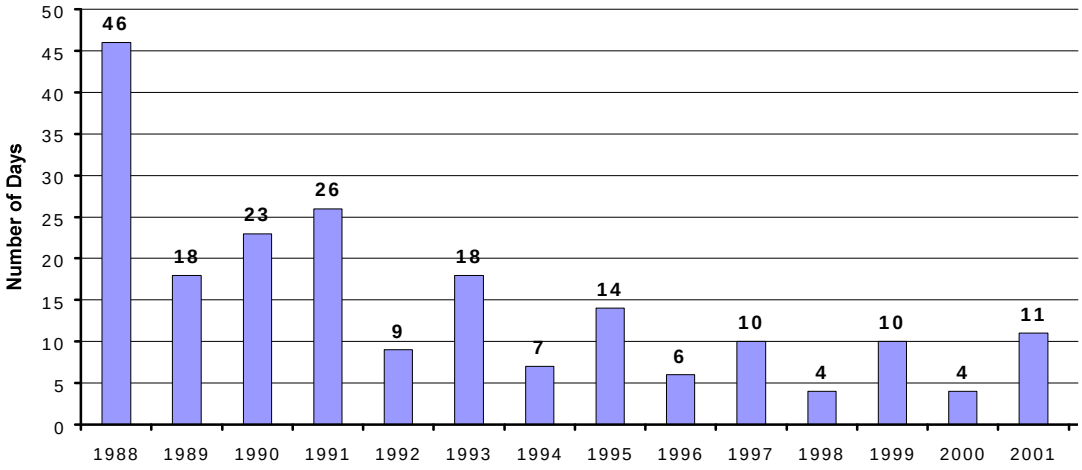
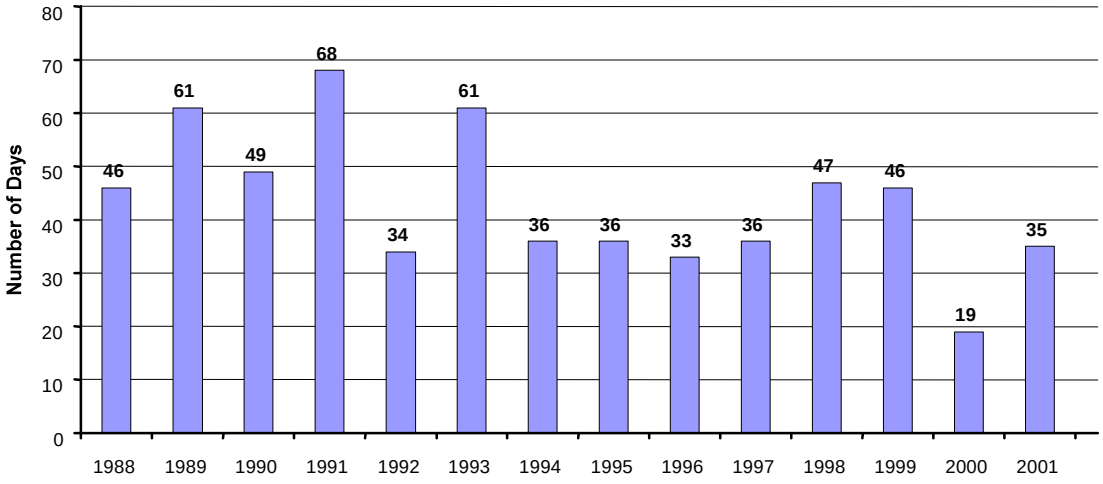



**Figure 3**
**Days on Which the Current Standard (8-hour) was Exceeded in New Jersey 1988-2001**



## RECAP - OZONE 2001

The summer of 2001 was characterized by warmer than normal temperatures (+2.0°F at Philadelphia International Airport) and abnormally dry conditions from July through September. The highest $O_3$ concentrations were low compared to recent years and seasonal average $O_3$ was also below normal. This was primarily due to cooler than normal July weather leading to very low $O_3$ concentrations throughout what is historically the height of the $O_3$ season.[3]

## MAJOR OZONE EPISODES

There were several major ozone episodes during the 2001 ozone season. One occurred during the first 10 days of August when exceedances of the 8-hour standard were recorded on all days except August 4th. On August 7th and 9th (see Figures 4 and 5) every ozone monitor in the network exceeded the 8-hour standard and the maximum 8-hour concentration of this season (0.121ppm) was recorded at Colliers Mills on August 7th.

The maximum 1-hour value of 0.145 ppm was recorded on August 9th at Rider University. It was the highest of 6 sites that exceeded the 1-hour standard that day (the most in a single day since July 15, 1997 when 9 sites exceeded the 1-hour standard).

A cold front swept across the region on August 11th bringing rain that provided relief from both the intense heat wave and the unhealthy ozone concentrations. This episode was the last significant event of the 2001 ozone season as only a few more scattered exceedances were recorded after August 10th.

Figure 4

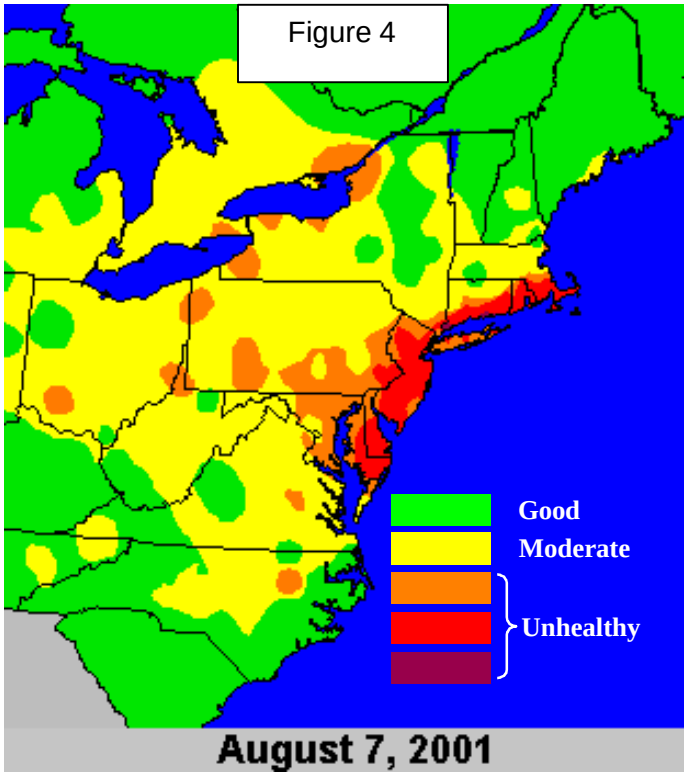
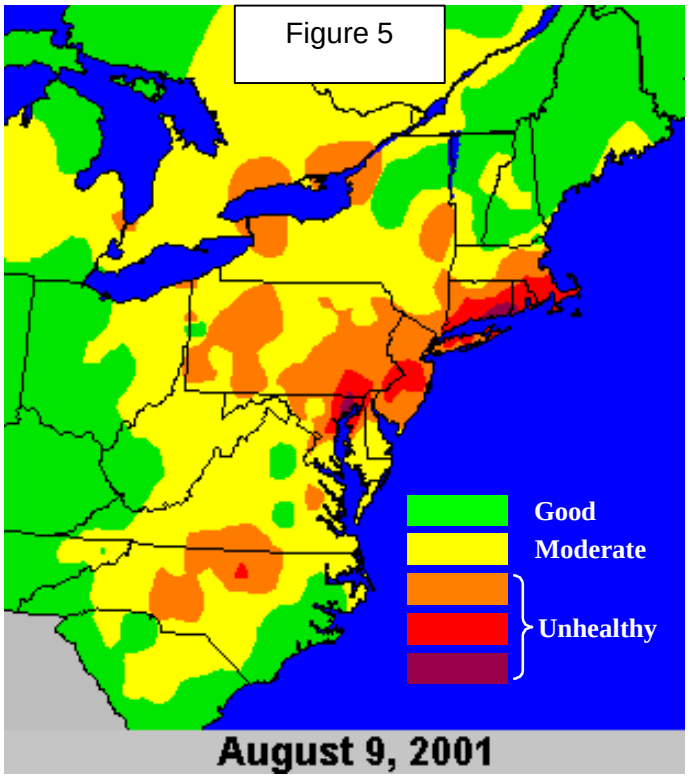



Figure 5




[4]2001 Ozone Map USEPA Archives

## SUMMARY OF 2001 Ozone Data Relative to the OLD 1-HOUR STANDARD

Of the 15 monitoring sites that were operated during the 2001 ozone season, 9 recorded levels above the old 1-hour standard of 0.12 ppm at least once during the year. Eight sites had at least two exceedances and Camden recorded the most exceedances with 5. The highest one-hour concentration was 0.145 ppm at the Rider University site on August 9, 2001. In the 2000 ozone season there were six sites that recorded levels above the standard and the maximum was 0.139 ppm, recorded at both the Clarksboro and Colliers Mills sites.

**Figure 6**
**Highest and Second Highest Daily 1-Hour Averages**

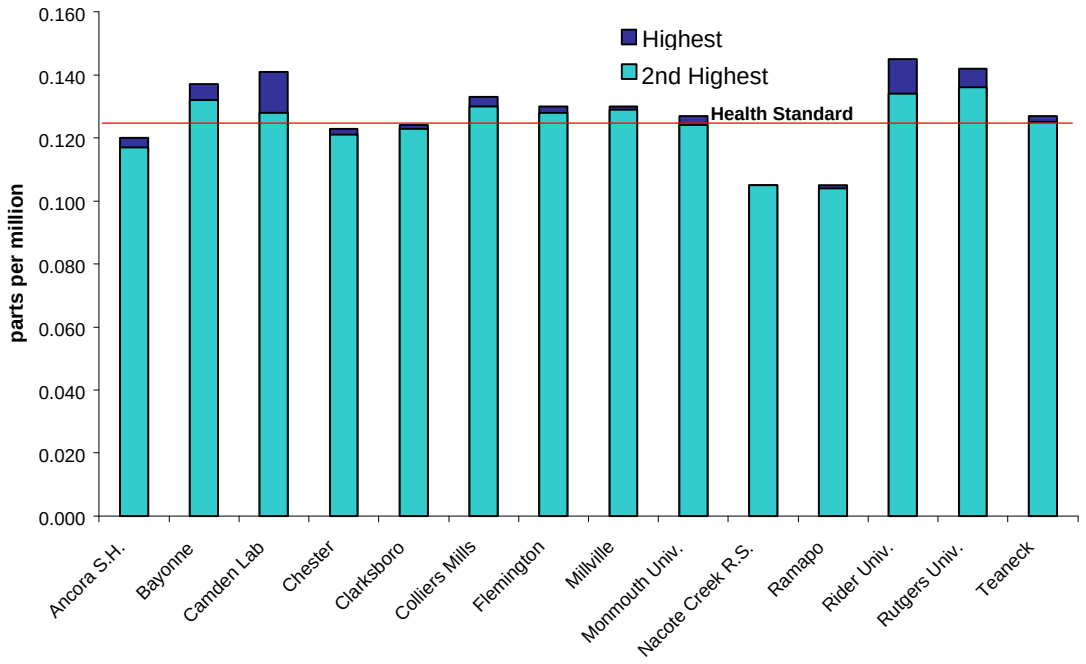



**Table 1**

| Monitoring Site | 1-hr Max | 2nd Highest 1-hr Max | 4th Highest 1-hour Average 1999-2001 | # of days with 1-hour Averages above 0.12ppm |
|---|---|---|---|---|
| Ancora S.H. | 0.120 | 0.117 | 0.127 | 0 |
| Bayonne | 0.137 | 0.132 | 0.137 | 3 |
| Camden Lab | 0.141 | 0.128 | 0.128 | 5 |
| Chester | 0.123 | 0.121 | 0.119 | 0 |
| Clarksboro | 0.124 | 0.123 | 0.124 | 0 |
| | | | | |
| Colliers Mills | 0.133 | 0.130 | 0.135 | 4 |
| Flemington | 0.130 | 0.128 | 0.128 | 3 |
| Millville | 0.130 | 0.129 | 0.122 | 2 |
| Monmouth Univ. | 0.127 | 0.124 | 0.124 | 1 |
| Nacote Creek R.S. | 0.105 | 0.105 | 0.112 | 0 |
| | | | | |
| Newark Lab* | 0.116 | 0.113 | --- | 0 |
| Ramapo | 0.105 | 0.104 | 0.112 | 0 |
| Rider University | 0.145 | 0.134 | 0.145 | 3 |
| Rutgers University | 0.142 | 0.136 | 0.142 | 3 |
| Teaneck | 0.127 | 0.125 | 0.120 | 2 |
| | | | | |
| Statewide | 0.145 | 0.137 | | 11 |

*Data not available prior to Aug. 6th

## SUMMARY OF 2001 OZONE DATA RELATIVE TO THE NEW 8-HOUR STANDARD

All of the 15 monitoring sites that were operated during the 2001 ozone season recorded levels above the new 8-hour standard of 0.08 ppm. Colliers Mills recorded the most exceedances with 21. The highest eight-hour concentration recorded was 0.121 ppm at the Colliers Mills site on August 7, 2001. All sites recorded levels above the 8-hour standard in 2000 as well, with a maximum concentration of 0.132 ppm, recorded at the Colliers Mills site. Design values for the 8-hour standard were also above the standard at all sites, indicating that the standard is being violated statewide.

**Figure 7**

**Ozone Design Values for 1999-2001**

3 Year Average of the 4th Highest 8-Hour Value

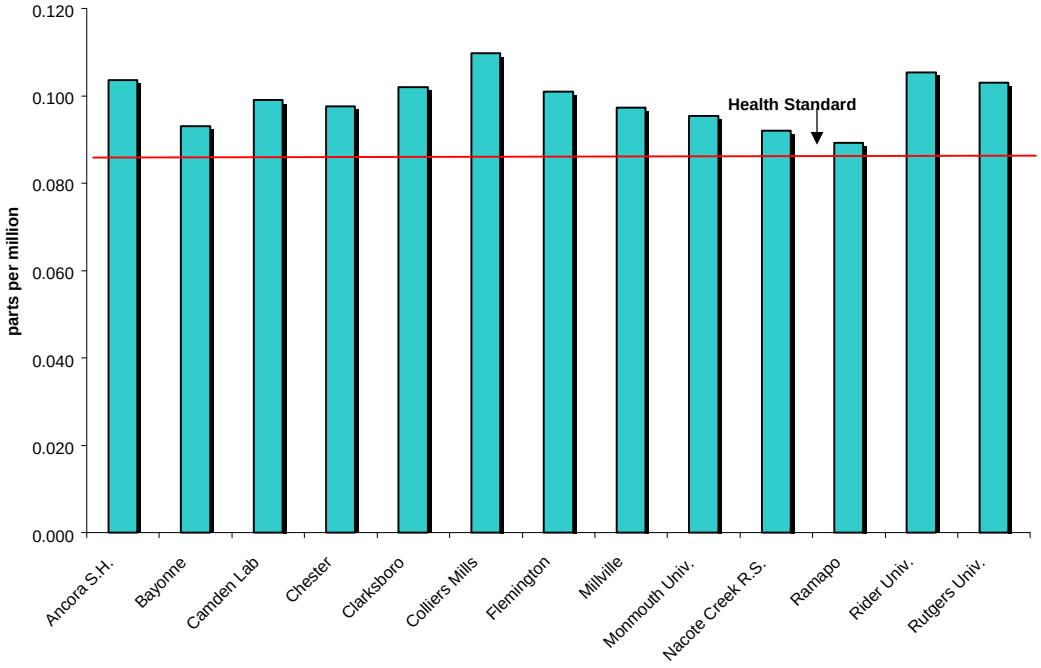



**Table 2**

| Monitoring Site | 1st Highest | 2nd Highest | 3rd Highest | 4th Highest | Avg. of 4th Highest 8-hour Averages 1999-2001 | # of days with 8-hour above 0.08ppm |
|---|---|---|---|---|---|---|
| Ancora S.H. | 0.112 | 0.111 | 0.107 | 0.104 | 0.104 | 17 |
| Bayonne | 0.117 | 0.108 | 0.103 | 0.091 | 0.093 | 6 |
| Camden Lab | 0.118 | 0.114 | 0.104 | 0.104 | 0.099 | 19 |
| Chester | 0.109 | 0.109 | 0.107 | 0.101 | 0.098 | 15 |
| Clarksboro | 0.108 | 0.108 | 0.098 | 0.097 | 0.102 | 17 |
| | | | | | | |
| Colliers Mills | 0.121 | 0.110 | 0.109 | 0.108 | 0.110 | 21 |
| Flemington | 0.113 | 0.103 | 0.103 | 0.101 | 0.101 | 12 |
| Millville | 0.110 | 0.109 | 0.104 | 0.102 | 0.097 | 14 |
| Monmouth Univ. | 0.115 | 0.112 | 0.098 | 0.091 | 0.095 | 8 |
| Nacote Creek R.S. | 0.101 | 0.097 | 0.096 | 0.096 | 0.092 | 9 |
| | | | | | | |
| Newark Lab* | 0.109 | 0.084 | 0.066 | 0.066 | --- | 1 |
| Ramapo | 0.092 | 0.092 | 0.088 | 0.088 | 0.089 | 9 |
| Rider University | 0.115 | 0.106 | 0.105 | 0.104 | 0.105 | 15 |
| Rutgers University | 0.120 | 0.109 | 0.107 | 0.106 | 0.103 | 17 |
| Teaneck** | 0.116 | 0.111 | 0.109 | 0.097 | --- | 10 |
| | | | | | | |
| Statewide | 0.121 | 0.120 | 0.118 | 0.115 | 0.117 | 35 |

*Data not available prior to Aug. 6th, 2001
**Data not available prior to 2000 season

# OZONE TRENDS

The primary focus of efforts to reduce concentrations of ground level ozone in New Jersey has been on reducing emissions of volatile organic compounds (VOCs). Studies have shown that such an approach should lower peak ozone concentrations, and it does appear to have been effective in achieving that goal. Maximum one-hour concentrations have not exceeded 0.20 ppm since 1988 and the last time levels above 0.18 ppm were recorded was in 1990. But improvements may have leveled off in recent years, especially with respect to maximum 8-hour average concentrations. Significant further improvements will require reductions in both VOCs and NOx. The NOx reductions will have to be achieved over a very large region of the country because levels in New Jersey are dependent on emissions from upwind sources.

**Figure 8**

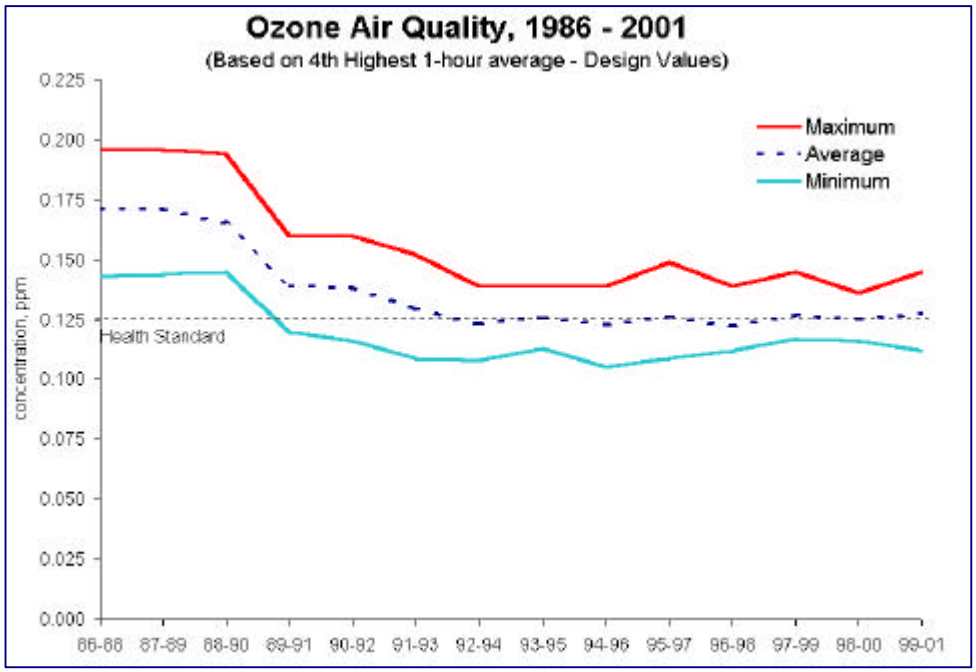



**Figure 9**

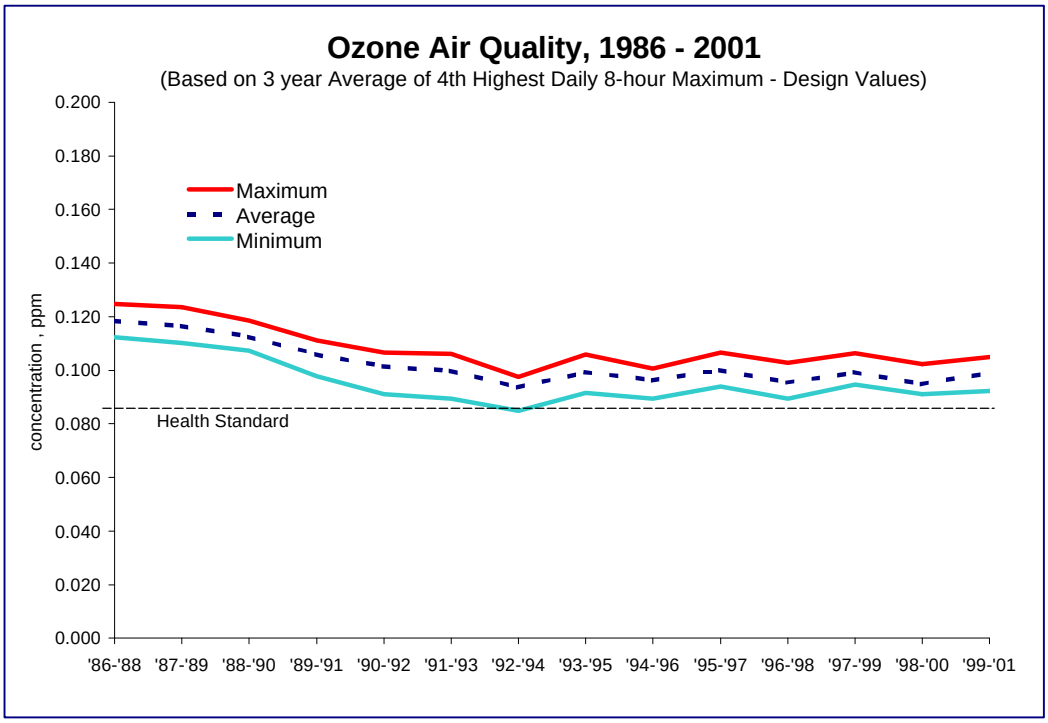
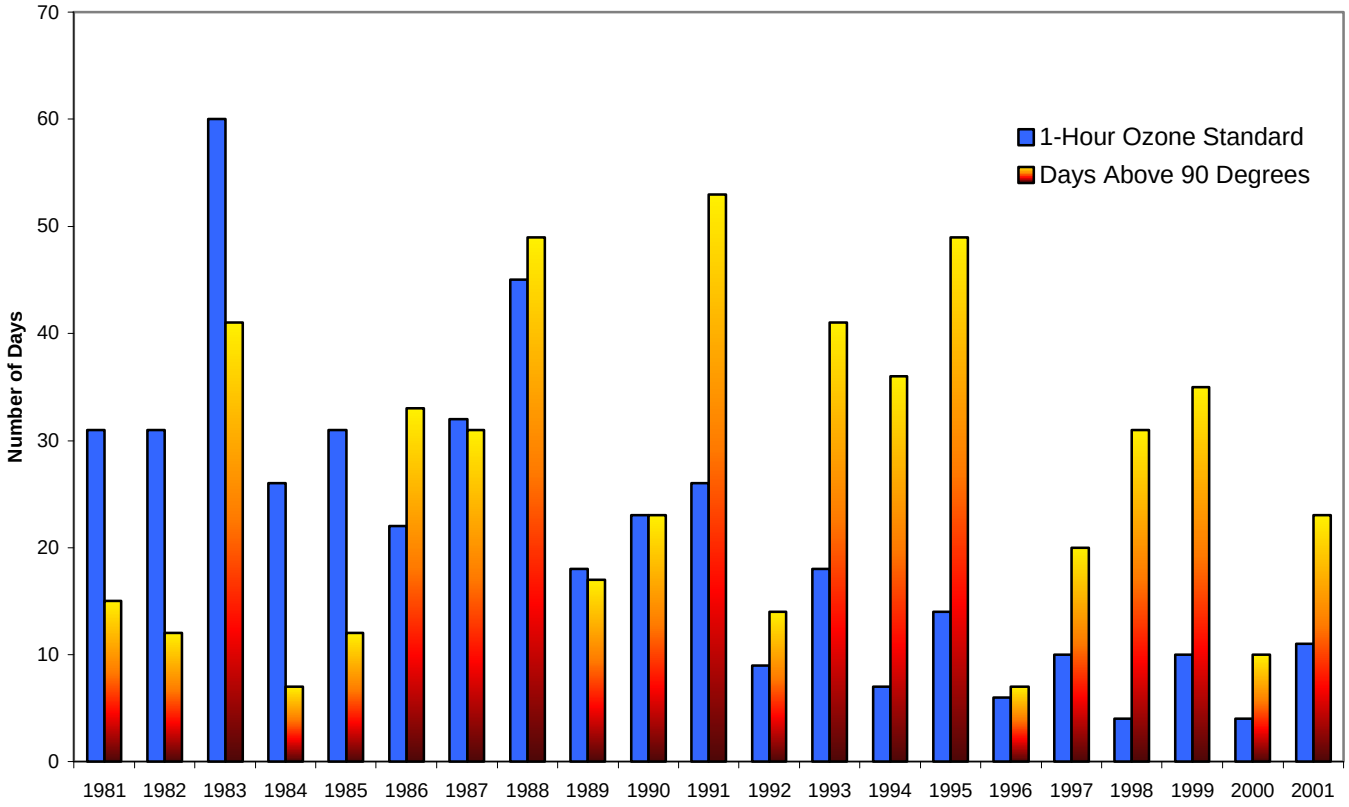


**Figure 10**

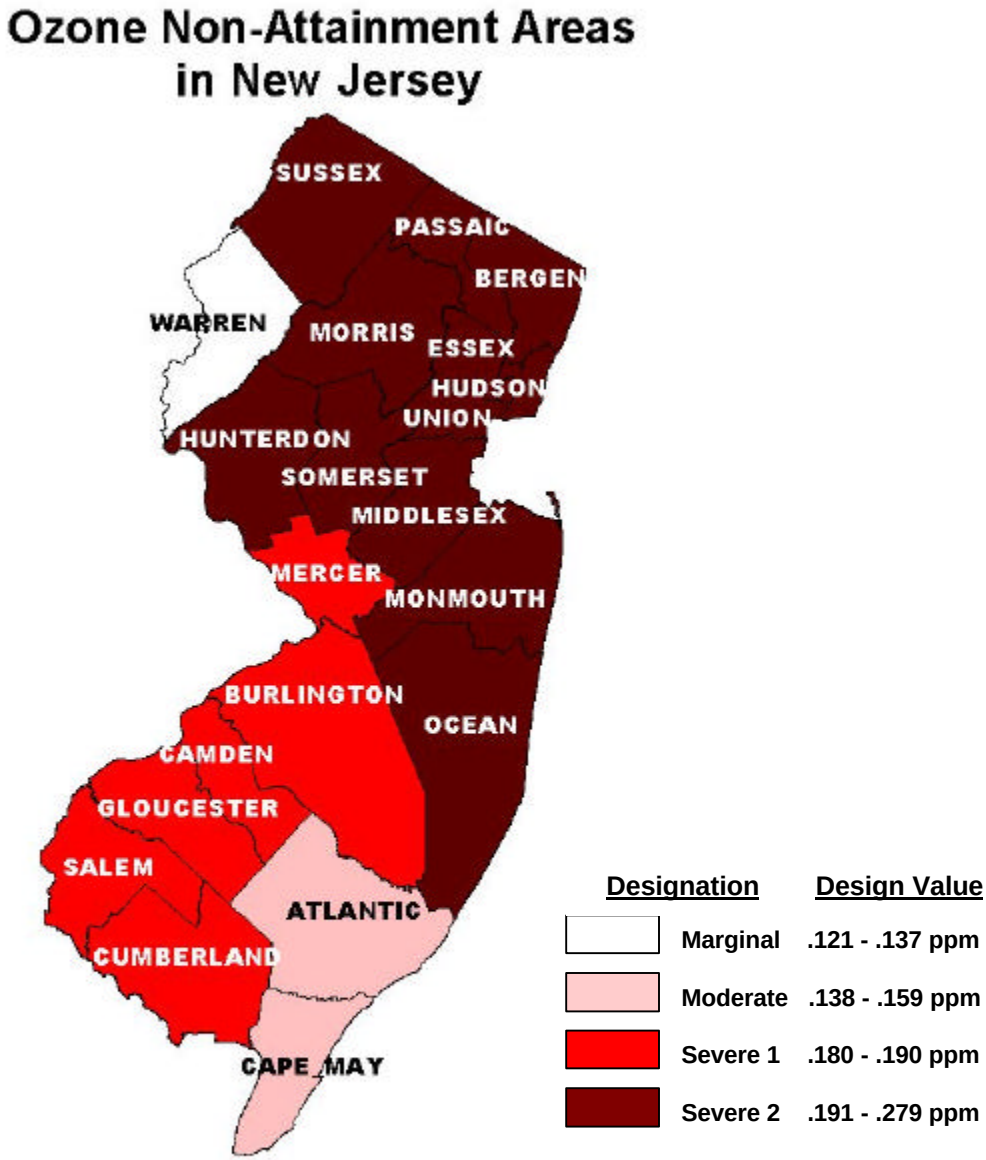
**Number of Days 1-Hour Ozone Standard Was Exceeded and Number of Days Above 90 Degrees New Jersey 1981 - 2001**




## ACCOUNTING FOR THE INFLUENCE OF WEATHER

Trends in ground level ozone are influenced by many factors including weather conditions, transport, growth, and the state of the economy, in addition to changes brought about by regulatory control measures. Of these factors, weather probably has the most profound effect on year to year variations in ozone levels. Several methods have been developed to try to account for the effect of weather on ozone levels so that the change due to emissions could be isolated. While none of these methods are completely successful they do show that over the long term, real reductions in ozone levels have been achieved. A simple way of showing the changing effect of weather on ozone is shown above. The number of days each year on which the ambient temperature was 90 degrees or greater is shown next to the number of days the ozone standard was exceeded. In the earliest years shown (1981-1985) there are significantly more days with high ozone than days above 90 degrees. But this pattern gradually changes and for the most recent years there are more "hot" days than "ozone" days. This in an indication that on the days when conditions are suitable for ozone formation, unhealthy levels are being reached less frequently.

## Figure 11




## Ozone Non-Attainment Areas in New Jersey

The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards. Areas can also be found to be "unclassifiable" under certain circumstances. The 1990 amendments to the act required that areas be further classified based on the severity of non-attainment. The classifications range from "marginal" to extreme" and are based on "design values". The design value is the value that actually determines whether an area meets the standard. For the 1-hour ozone standard for example, the design value is the fourth highest daily maximum 1-hour average concentration recorded over a three year period. Note that these classifications did not take into account the transport of ozone and its precursors and missed the concept of multi-state controls.

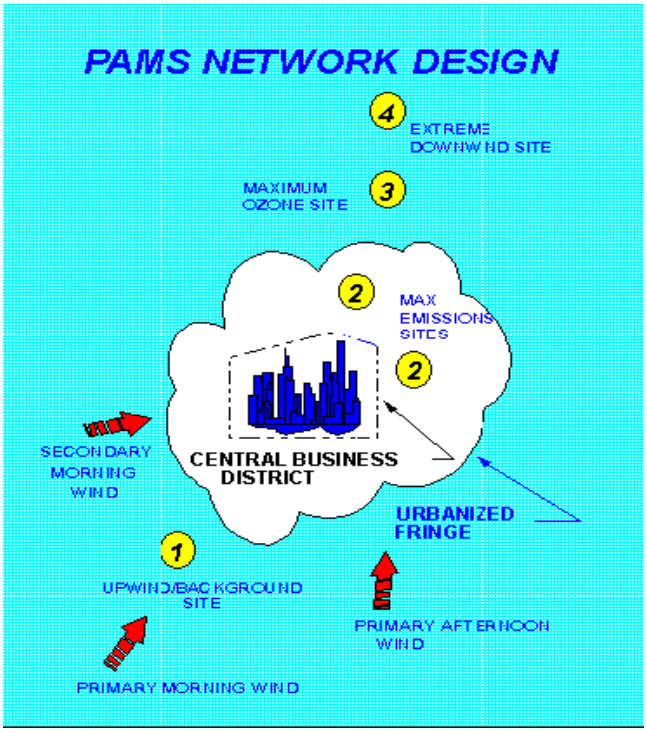
New Jersey is part of four planning areas, the New York, Philadelphia, Atlantic City and Allentown/Bethlehem areas. Their classification with respect to the old 1-hour standard is shown on the map. Now that the new 8-hour average standard for ozone has been upheld by the courts, new designations will have to be made.

## PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

Most ground level ozone is the result of oxides of nitrogen (NOx) and volatile organic compounds (VOCs) reacting in the presence of sunlight. As a result, it is necessary to measure these ozone forming pollutants, also known as precursor pollutants, to effectively evaluate strategies for reducing ozone levels. The Photochemical Assessment Monitoring Stations (PAMS) network was established for this purpose. Data from the PAMS network is used to better characterize the nature and extent of the $O_3$ problem, track VOC and NOx emission inventory reductions, assess air quality trends, and make attainment/nonattainment decisions. PAMS monitor both criteria and non-criteria pollutants including ozone ($O_3$), oxides of nitrogen (NOx), nitric oxide (NO), nitrogen dioxide (NO2), and specific VOCs, including several carbonyls, that are important in ozone formation. In addition, the measurement of specific weather parameters (e.g. Wind speed/direction, temperature) is required at all PAMS, and upper air weather measurements are required in certain areas. The VOC and carbonyl measurements are only taken during the peak part of the ozone season, from June 1st to August 31st each year.

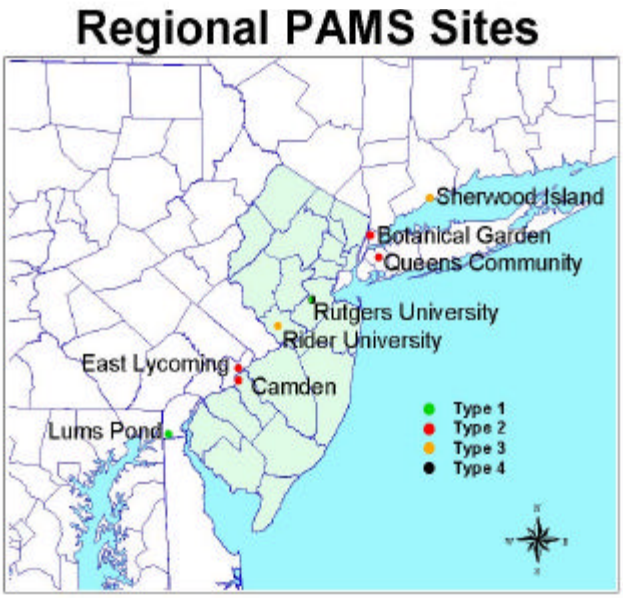
The PAMS network is designed around metropolitan areas where ozone is a significant problem, and each site in the network has a specific purpose as shown in the Figure 12 below. New Jersey is part of the Philadelphia and New York Metropolitan areas and has a total of three PAMS sites. A Type 3 maximum ozone site for the Philadelphia area is located at Rider University in Mercer County, a Type 2 maximum emissions site is located downwind of the Philadelphia Metropolitan urban area in Camden, and a site at Rutgers Universtiy in New Brunswick has been designated both a PAMS Type 1 upwind site for the New York urban area, as well as a Type 4 downwind site for the Philadelphia Metropolitan urban area. An upper air weather monitoring station is also located at the Rutgers University site. All of the PAMS sites for the Philadelphia and New York City areas are shown in Figure 13.

**Figure 12**




[5] USEPA , PAMS General Information

**Figure 13**

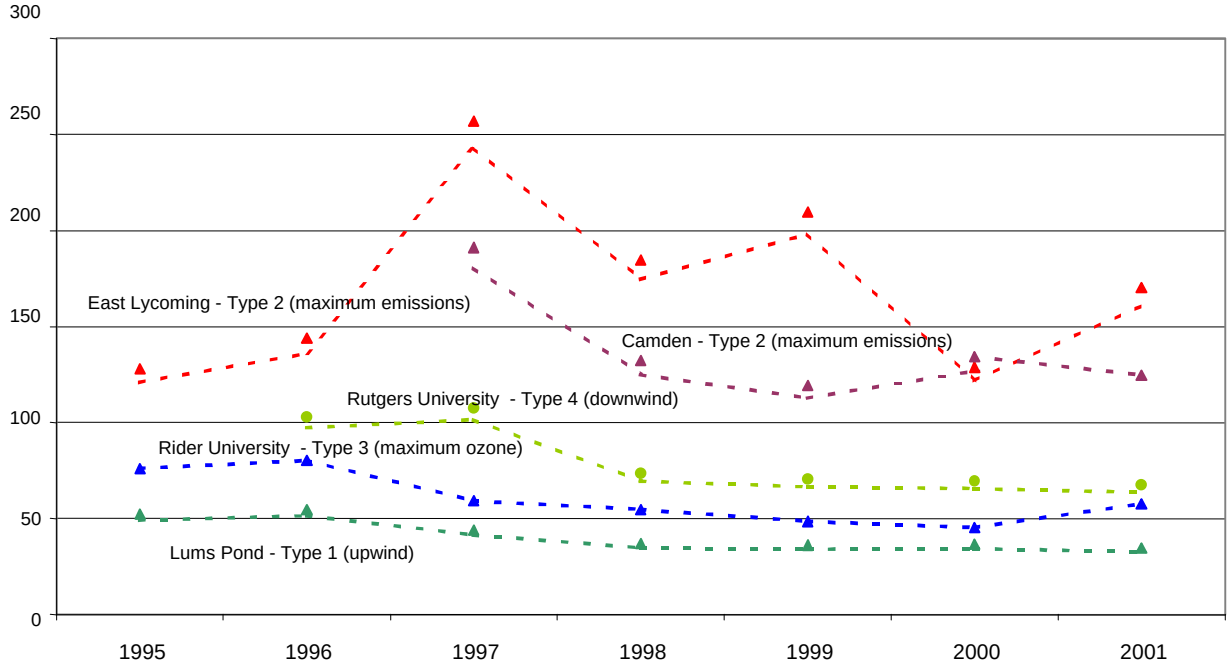



*Note:* Rutgers University PAMS site is both Type 1 for Philadelphia and Type 4 for New York City.

# PAMS (CONT.)

Figure 14 shows VOC trends for the PAMS sites in the Philadelphia area. In general, for Lums Pond (upwind - Type 1), Rider University (maximum ozone concentration - Type 3) and Rutgers University (downwind - Type 4), VOCs have declined over the measurement period. The improvements were initially more dramatic, with more level, though still declining concentrations, over the last several years. The maximum emissions -Type 2 sites (Camden and East Lycoming) for this area show a less clear trend, seemingly up and down, and for the East Lycoming site the 2001 levels are actually slightly higher than for the first year measurements were made (1995).

**Figure 14**
**Philadelphia Region**
**Total Non-methane Organic Compounds (TMNOC)**
**Seasonal Average 1995-2001**



# PAMS (cont.)

Figure 15 shows VOC trends for the PAMS sites in the New York City metropolitan area. In general, observations here are similar to those for the Philadelphia area. However, unlike the Type 2 site in the Philadelphia region, the Type 2 sites in the NY area (Queens Community College and the Bronx Botanical Gardens) also show a marked decline over the measurement period, though with more year to year variation than at the other sites.

In conclusion, with the exception of the East Lycoming site, VOC values measured at all PAMS sites in the Philadelphia and New York City areas declined during the time period these measurements were made. Changes in gasoline formulation over the period as well as the effect of newer, cleaner vehicles replacing older vehicles in the automotive fleet could account for the reductions. Type 2 sites, though impacted by vehicle emissions, are also affected by urban stationary sources whose emission trends over the measurement period are less clear. All sites are also impacted by naturally occurring isoprene, which is emitted by trees. All VOCs are not equal in their contribution to ozone formation and while isoprene levels are generally lower than many other VOCs, isoprene can account for a significant amount of the ozone forming potential, especially at the non-urban sites. Isoprene levels are thought to be influenced by factors that affect tree health and growth, such as rainfall and severe temperatures.

Summaries of results for all the VOCs and Carbonyls measured at the New Jersey PAMS sites are provided in Table 3 and Table 4.

**Figure 15**
**New York City Region**
**Total Non-methane Organic Compounds (TNMOC)**
**Seasonal Average 1995-2001**

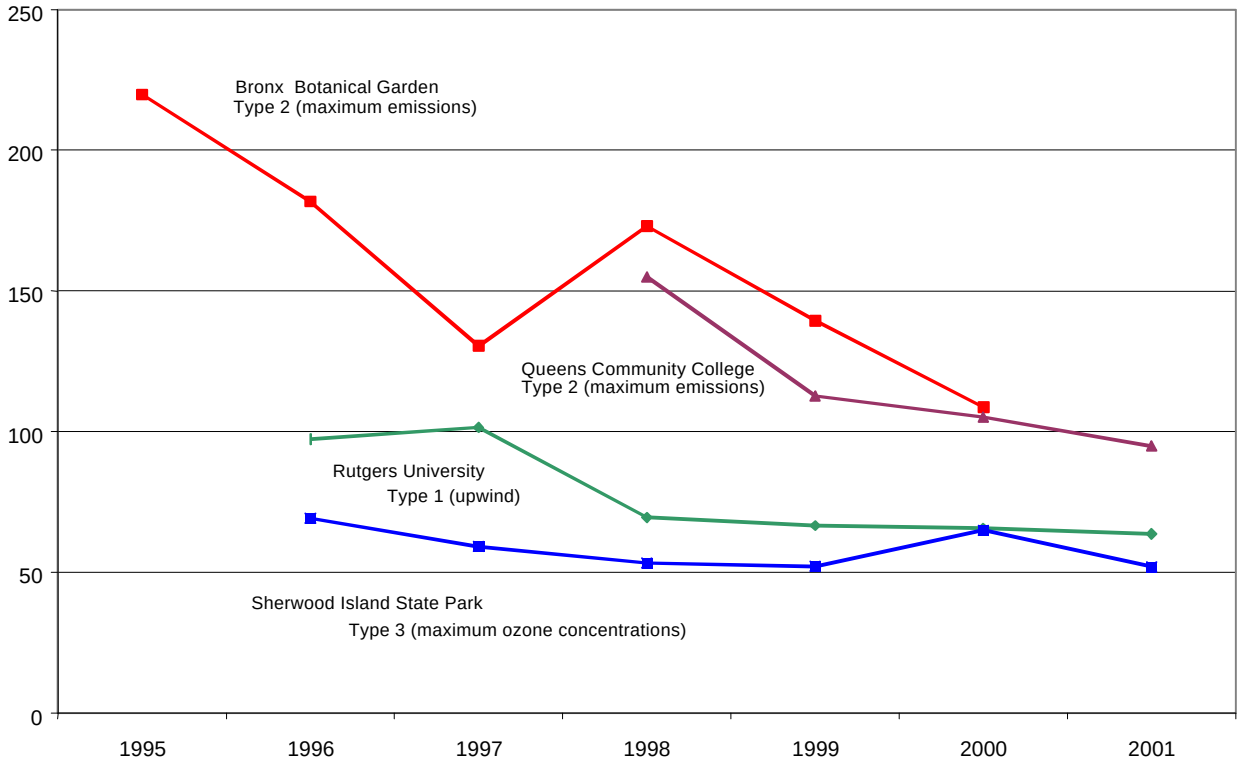


Table 3

Summary of Photochemical Assessment Monitoring (PAMS) Data

June, July, and August, 2001

Parts Per Billion (Volume) – ppbv
Parts Per Billion (Carbon) – ppbC
Max – Maximum Avg - Average

| | Camden Lab | | | | Rider University | | | | Rutgers University | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ppbv | | ppbC | | ppbv | | ppbC | | ppbv | | ppbC | |
| | Max | Avg | Max | Avg | Max | Avg | Max | Avg | Max | Avg | Max | Avg |
| Acetylene | 9.65 | 0.42 | 19.29 | 0.85 | 0.63 | 0.11 | 1.25 | 0.23 | 3.50 | 0.44 | 6.99 | 0.89 |
| Benzene | 5.54 | 0.32 | 33.25 | 1.93 | 0.80 | 0.14 | 4.77 | 0.86 | 0.70 | 0.15 | 4.18 | 0.91 |
| n-Butane | 22.45 | 1.57 | 89.80 | 6.29 | 6.38 | 0.42 | 25.52 | 1.70 | 8.75 | 0.53 | 35.00 | 2.10 |
| 1-Butene | 0.86 | 0.12 | 3.43 | 0.48 | 0.23 | 0.04 | 0.93 | 0.15 | 0.44 | 0.05 | 1.77 | 0.21 |
| cis-2-Butene | 0.88 | 0.07 | 3.51 | 0.27 | 0.21 | 0.02 | 0.83 | 0.08 | 1.15 | 0.04 | 4.59 | 0.14 |
| trans-2-Butene | 1.09 | 0.09 | 4.36 | 0.38 | 0.27 | 0.04 | 1.08 | 0.15 | 1.25 | 0.05 | 4.99 | 0.19 |
| Cyclohexane | 1.70 | 0.08 | 10.22 | 0.47 | 0.76 | 0.03 | 4.56 | 0.15 | 0.53 | 0.04 | 3.20 | 0.22 |
| Cyclopentane | 1.33 | 0.07 | 6.63 | 0.37 | 0.28 | 0.05 | 1.38 | 0.26 | 0.35 | 0.05 | 1.77 | 0.25 |
| n-Decane | 0.85 | 0.05 | 8.50 | 0.52 | 1.14 | 0.08 | 11.40 | 0.77 | 5.32 | 0.03 | 53.24 | 0.35 |
| m-Diethylbenzene | 0.10 | 0.01 | 1.03 | 0.08 | 0.11 | 0.01 | 1.13 | 0.09 | 0.23 | 0.01 | 2.27 | 0.09 |
| p-Diethylbenzene | 0.20 | 0.02 | 2.01 | 0.16 | 0.19 | 0.02 | 1.91 | 0.17 | 0.81 | 0.01 | 8.12 | 0.09 |
| 2,2-Dimethylbutane | 3.46 | 0.14 | 17.31 | 0.71 | 0.37 | 0.04 | 1.86 | 0.22 | 0.45 | 0.04 | 2.26 | 0.18 |
| 2,3-Dimethylbutane | 1.70 | 0.19 | 8.48 | 0.93 | 0.39 | 0.07 | 1.96 | 0.37 | 1.70 | 0.08 | 8.50 | 0.40 |
| 2,3-Dimethylpentane | 1.92 | 0.10 | 13.44 | 0.67 | 0.80 | 0.04 | 5.60 | 0.30 | 1.14 | 0.05 | 7.95 | 0.37 |
| 2,4-Dimethylpentane | 0.58 | 0.06 | 4.06 | 0.42 | 0.18 | 0.02 | 1.23 | 0.16 | 0.93 | 0.03 | 6.53 | 0.24 |
| Ethane | 19.51 | 3.76 | 39.01 | 7.53 | 7.48 | 2.04 | 14.95 | 4.09 | 16.37 | 2.98 | 32.73 | 5.96 |
| Ethylbenzene | 0.94 | 0.08 | 7.51 | 0.65 | 0.65 | 0.07 | 5.16 | 0.54 | 0.61 | 0.06 | 4.88 | 0.47 |
| Ethylene (Ethene) | 49.61 | 1.41 | 99.22 | 2.82 | 126.55 | 0.95 | 253.09 | 1.89 | 11.97 | 1.56 | 23.94 | 3.11 |
| m-Ethyltoluene | 0.94 | 0.07 | 8.44 | 0.60 | 0.47 | 0.02 | 4.25 | 0.22 | 1.10 | 0.06 | 9.94 | 0.54 |
| o-Ethyltoluene | 0.33 | 0.02 | 2.94 | 0.22 | 0.30 | 0.01 | 2.72 | 0.12 | 0.33 | 0.02 | 2.97 | 0.15 |
| p-Ethyltoluene | 0.34 | 0.02 | 3.03 | 0.17 | 1.06 | 0.01 | 9.54 | 0.10 | 0.35 | 0.02 | 3.12 | 0.16 |
| n-Heptane | 7.45 | 0.18 | 52.17 | 1.29 | 2.31 | 0.06 | 16.14 | 0.39 | 0.76 | 0.07 | 5.35 | 0.46 |
| Hexane | 4.79 | 0.32 | 28.76 | 1.90 | 1.12 | 0.15 | 6.72 | 0.88 | 1.68 | 0.15 | 10.06 | 0.88 |
| 1-Hexene | 0.45 | 0.03 | 2.69 | 0.15 | 0.61 | 0.02 | 3.67 | 0.12 | 0.16 | 0.01 | 0.95 | 0.06 |
| Isobutane | 24.27 | 1.06 | 97.09 | 4.25 | 3.51 | 0.30 | 14.05 | 1.20 | 7.58 | 0.43 | 30.33 | 1.73 |
| Isopentane | 22.37 | 1.63 | 111.84 | 8.13 | 4.14 | 0.60 | 20.72 | 2.99 | 15.15 | 0.76 | 75.77 | 3.80 |
| Isoprene | 1.75 | 0.25 | 8.76 | 1.27 | 6.25 | 0.32 | 31.27 | 1.62 | 3.74 | 0.53 | 18.68 | 2.63 |
| Isopropylbenzene | 1.36 | 0.06 | 12.26 | 0.50 | 0.20 | 0.02 | 1.83 | 0.17 | 0.50 | 0.01 | 4.48 | 0.13 |
| Methylcyclohexane | 1.82 | 0.12 | 12.76 | 0.81 | 0.38 | 0.05 | 2.64 | 0.32 | 0.40 | 0.05 | 2.80 | 0.35 |
| Methylcyclopentane | 2.87 | 0.18 | 17.21 | 1.06 | 0.39 | 0.06 | 2.36 | 0.38 | 0.90 | 0.08 | 5.41 | 0.48 |
| 2-Methylheptane | 0.49 | 0.04 | 3.89 | 0.34 | 0.16 | 0.02 | 1.30 | 0.14 | 0.25 | 0.02 | 2.00 | 0.17 |
| 3-Methylheptane | 0.45 | 0.05 | 3.56 | 0.37 | 0.13 | 0.02 | 1.03 | 0.14 | 0.20 | 0.02 | 1.56 | 0.20 |
| 2-Methylhexane | 4.38 | 0.15 | 30.63 | 1.07 | 1.94 | 0.06 | 13.55 | 0.40 | 0.51 | 0.06 | 3.59 | 0.44 |

Table 3 (Continued)
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July, and August, 2001

| | Camden Lab | | | | Rider University | | | | Rutgers University | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ppbv | | ppbC | | ppbv | | ppbC | | ppbv | | ppbC | |
| | Max | Avg | Max | Avg | Max | Avg | Max | Avg | Max | Avg | Max | Avg |
| 3-Methylhexane | 6.63 | 0.20 | 46.44 | 1.41 | 2.97 | 0.08 | 20.77 | 0.56 | 0.61 | 0.08 | 4.24 | 0.55 |
| 2-Methylpentane | 5.30 | 0.49 | 31.79 | 2.93 | 0.93 | 0.15 | 5.56 | 0.92 | 1.93 | 0.19 | 11.60 | 1.12 |
| 3-Methylpentane | 3.10 | 0.34 | 18.59 | 2.01 | 1.48 | 0.10 | 8.85 | 0.61 | 1.22 | 0.12 | 7.29 | 0.74 |
| n-Nonane | 0.76 | 0.05 | 6.81 | 0.48 | 1.72 | 0.06 | 15.50 | 0.55 | 4.08 | 0.03 | 36.72 | 0.30 |
| n-Octane | 0.94 | 0.08 | 7.48 | 0.62 | 0.27 | 0.03 | 2.16 | 0.25 | 0.44 | 0.04 | 3.52 | 0.29 |
| n-Pentane | 16.85 | 0.82 | 84.27 | 4.12 | 2.60 | 0.33 | 13.01 | 1.66 | 5.85 | 0.40 | 29.24 | 2.02 |
| 1-Pentene | 0.67 | 0.07 | 3.34 | 0.35 | 0.16 | 0.03 | 0.80 | 0.13 | 0.60 | 0.03 | 2.98 | 0.17 |
| cis-2-Pentene | 0.67 | 0.04 | 3.34 | 0.20 | 0.14 | 0.01 | 0.70 | 0.05 | 0.68 | 0.02 | 3.40 | 0.11 |
| trans-2-Pentene | 1.23 | 0.08 | 6.15 | 0.40 | 0.23 | 0.02 | 1.17 | 0.08 | 1.38 | 0.04 | 6.88 | 0.20 |
| Propane | 71.59 | 3.19 | 214.78 | 9.56 | 10.87 | 1.36 | 32.62 | 4.08 | 18.67 | 1.66 | 56.00 | 4.98 |
| n-Propylbenzene | 0.30 | 0.02 | 2.74 | 0.17 | 0.20 | 0.02 | 1.81 | 0.15 | 0.68 | 0.02 | 6.13 | 0.14 |
| Propylene (Propene) | 15.79 | 0.80 | 47.36 | 2.40 | 3.96 | 0.24 | 11.88 | 0.72 | 3.26 | 0.39 | 9.78 | 1.16 |
| Styrene | 0.34 | 0.02 | 2.73 | 0.14 | 0.43 | 0.06 | 3.44 | 0.52 | 0.93 | 0.02 | 7.46 | 0.13 |
| Toluene | 7.05 | 0.78 | 49.35 | 5.48 | 2.29 | 0.35 | 16.05 | 2.44 | 29.65 | 1.07 | 207.53 | 7.46 |
| 1,2,3-Trimethylbenzene | 0.67 | 0.06 | 6.04 | 0.50 | 14.82 | 0.11 | 133.42 | 1.01 | 1.29 | 0.05 | 11.61 | 0.48 |
| 1,2,4-Trimethylbenzene | 1.06 | 0.09 | 9.53 | 0.77 | 1.04 | 0.09 | 9.37 | 0.84 | 1.85 | 0.06 | 16.66 | 0.53 |
| 1,3,5-Trimethylbenzene | 0.59 | 0.03 | 5.35 | 0.30 | 0.38 | 0.03 | 3.44 | 0.25 | 1.14 | 0.02 | 10.22 | 0.22 |
| 2,2,4-Trimethylpentane | 2.58 | 0.27 | 20.63 | 2.16 | 0.58 | 0.10 | 4.66 | 0.83 | 4.21 | 0.15 | 33.68 | 1.23 |
| 2,3,4-Trimethylpentane | 0.78 | 0.07 | 6.24 | 0.55 | 0.71 | 0.03 | 1.57 | 0.24 | 1.07 | 0.05 | 8.56 | 0.39 |
| n-Undecane | 0.44 | 0.03 | 4.84 | 0.31 | 3.47 | 0.04 | 38.17 | 0.44 | 1.19 | 0.02 | 13.12 | 0.20 |
| m/p-Xylene | 2.95 | 0.26 | 23.63 | 2.05 | 1.52 | 0.12 | 12.17 | 0.93 | 1.89 | 0.17 | 15.10 | 1.34 |
| o-Xylene | 0.90 | 0.09 | 7.17 | 0.75 | 0.38 | 0.05 | 3.07 | 0.40 | 0.55 | 0.06 | 4.39 | 0.50 |

Table 4
Camden Lab
PAMS Carbonyls
June, July, and August, 2001
Parts Per Billion (Volume)
30 Sampling Dates (236 Observations)

| | # of Non-Detects* | Max | Avg | | # of Non-Detects | Max | Avg |
|---|---|---|---|---|---|---|---|
| Acetaldehyde | 2 | 4.35 | 1.33 | Formaldehyde | 0 | 9.57 | 3.61 |
| Acetone | 0 | 9.36 | 3.75 | Hexaldehyde | 50 | 1.36 | 0.17 |
| Benzaldehyde | 15 | 0.17 | 0.04 | Isovaleraldehyde | 235 | 0.01 | 0.00 |
| Butyr/Isobutyraldehyde | 52 | 1.62 | 0.10 | Propionaldehyde | 63 | 0.50 | 0.07 |
| Crotonaldehyde | 161 | 0.62 | 0.02 | Tolualdehyde | 58 | 1.56 | 0.06 |
| 2,5-Dimethybenzaldehyde | 222 | 0.12 | 0.00 | Valeraldehyde | 110 | 0.13 | 0.01 |

* The number of times, out of a possible 236, that the results were below the detection limits of the method.

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