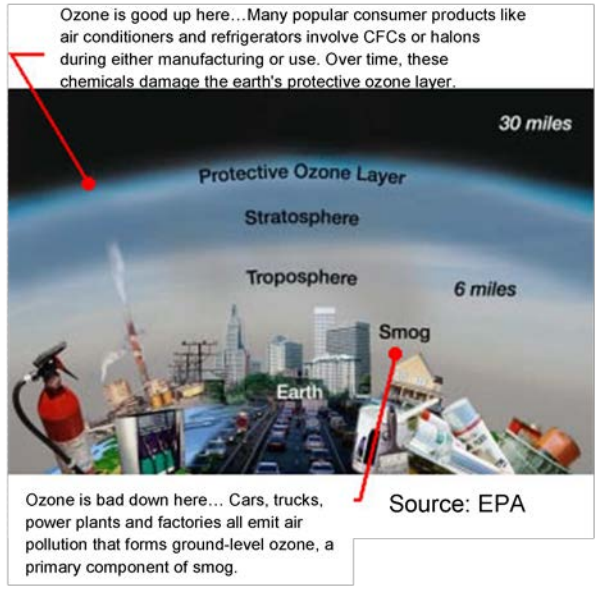
2011 Ozone Summary

New Jersey Department of Environmental Protection

NATURE AND SOURCES

Figure 1
Good and Bad Ozone



Ozone (O3) 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 (see Figure 1). 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 monitoring season runs from April 1st to October 31st. 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.

ENVIRONMENTAL EFFECTS

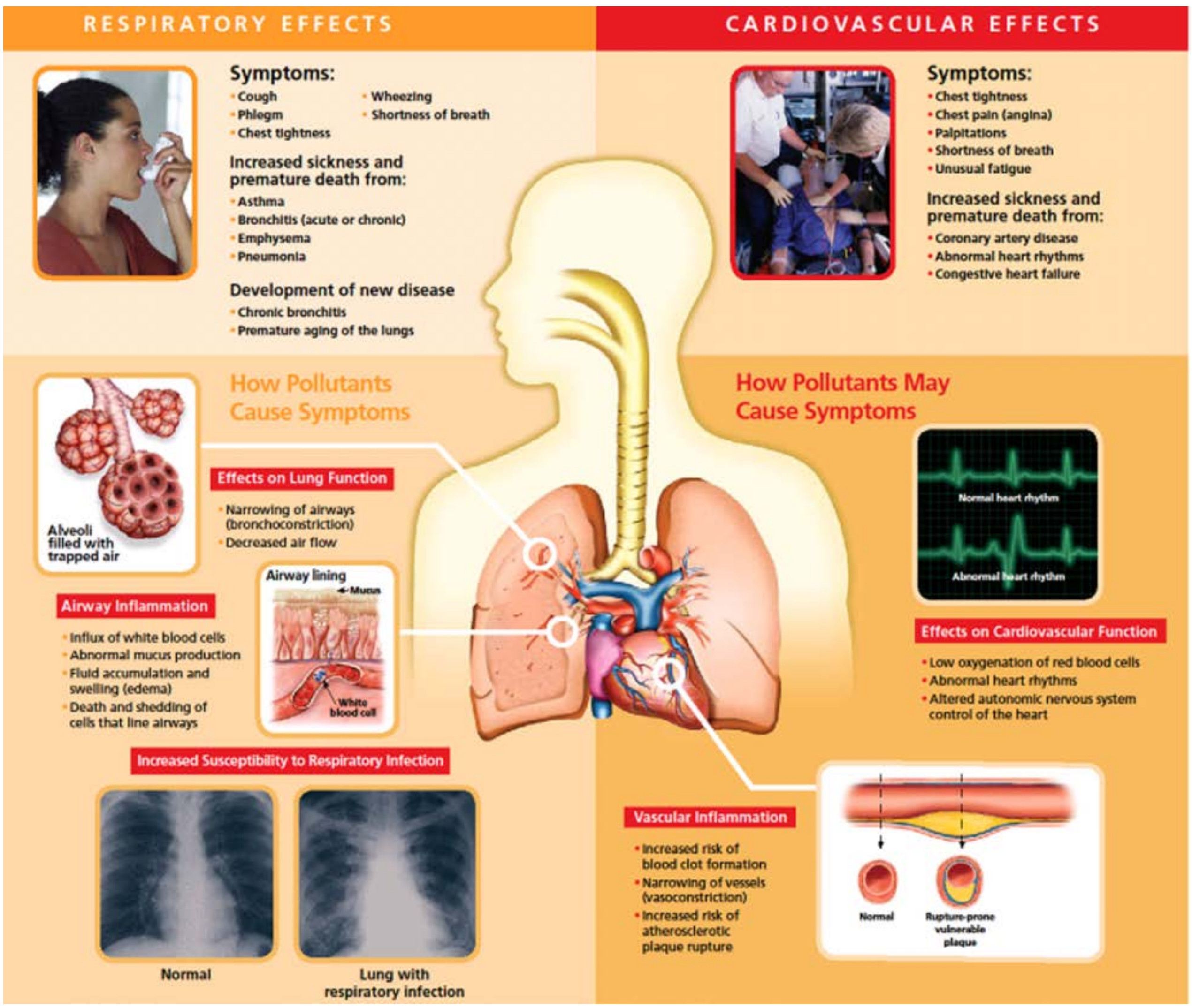
Ground-level ozone damages plant life and is responsible for 500 million dollars in reduced crop production in the United States each year. It interferes with the ability of plants to produce and store food, making them more susceptible to disease, insects, other pollutants, and harsh weather. "Bad" ozone damages the foliage of trees and other plants, sometimes marring the landscape of cities, national parks and forests, and recreation areas. The black areas on the leaves of the watermelon plant, shown in Figure 2, are damage caused by exposure to ground-level ozone.

(Figure 2 Photos by: Gerald Holmes, NCSU Dept. of Horticulture)

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. As shown in Figure 3 ozone can irritate the entire respiratory tract. 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 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.

Figure 3
Effects of Ozone & Common Air Pollutants



Source: www.airnow.gov

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 (see Table 1). The ozone NAAQS were revised in 2008 because EPA determined that the old standard of 0.08 parts per million (ppm) maximum daily eight-hour average was not sufficiently protective of public health. The revised standard of 0.075 ppm maximum daily 8-hour average went into effect on May 27, 2008. 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.

Table 1
National and New Jersey Ambient Air Quality Standards for Ozone
ppm = Parts per Million

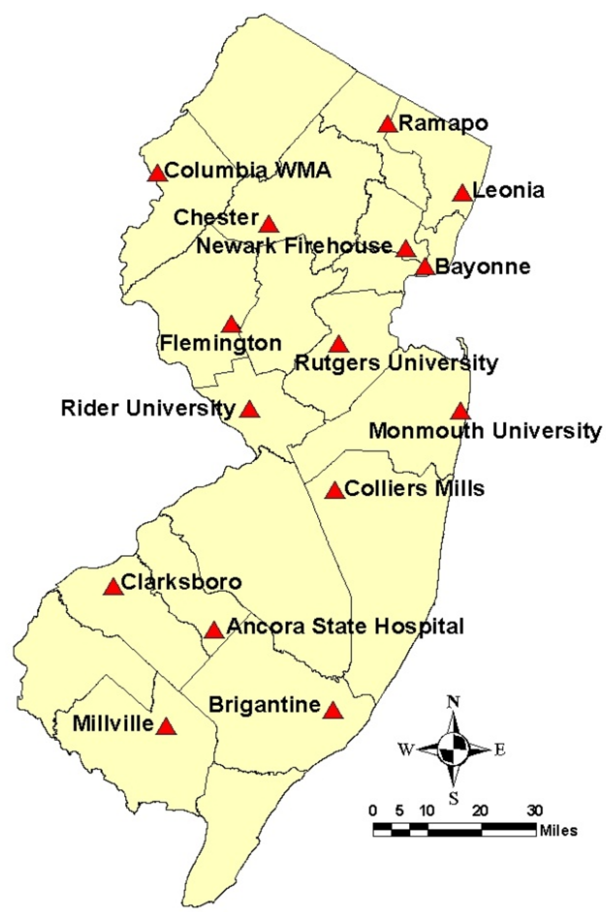
Averaging Period	Type	New Jersey	National
1-Hour	Primary	0.12 ppm	-----
1-Hour	Secondary	0.08 ppm	-----
8-Hour	Primary	-----	0.075 ppm
8-Hour	Secondary	-----	0.075 ppm

OZONE NETWORK

Ozone was monitored at 15 locations in New Jersey during 2011. Of those 15 sites, 12 operated year round and 3 operated only during the ozone season (April 1st through October 31st). Colliers Mills, Monmouth University, and Ramapo were only operated during the ozone season.

Site locations are shown in Figure 4.

FIGURE 4
2011 Ozone Monitoring Network



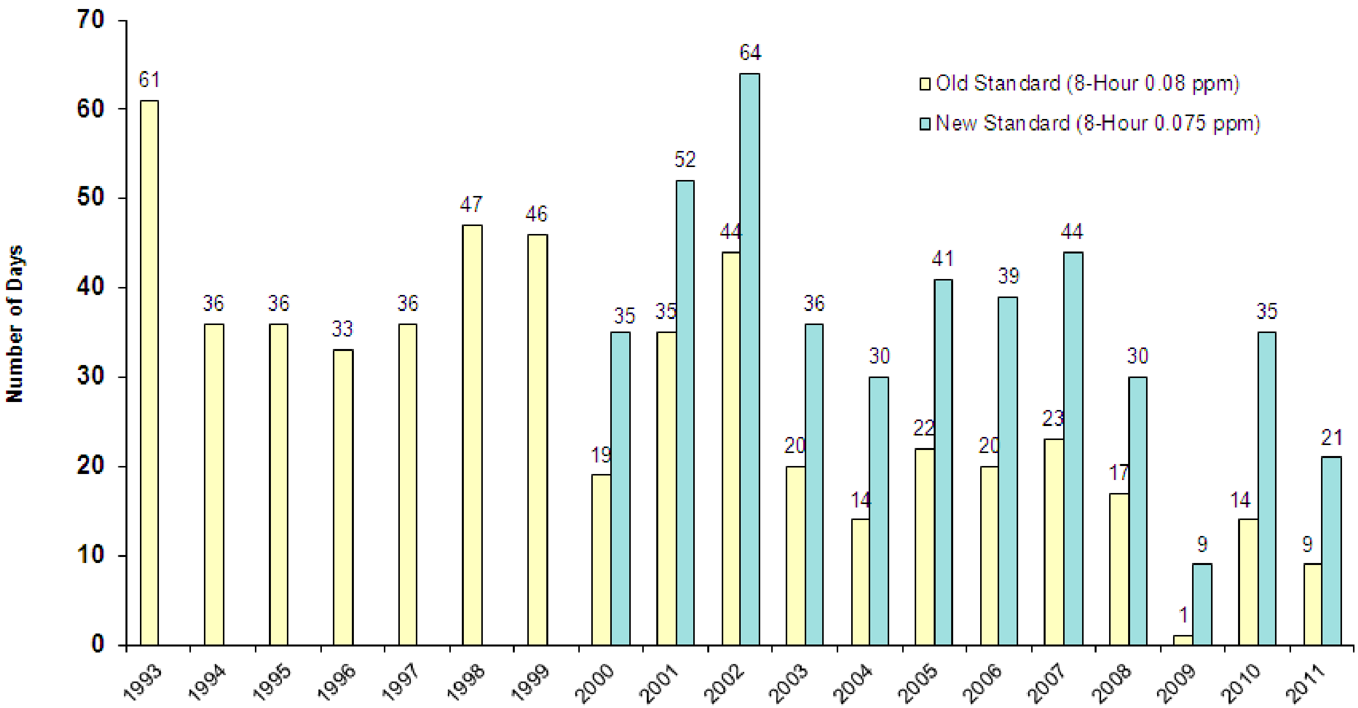
How the Changes to the Ozone Standards Affect Air Quality Ratings

Unlike 2010, 2011 was a much more typical summer in New Jersey for air pollution. 21 days exceeded the 0.075 ppm 8-hour standard and 9 days exceeded the old 0.08 ppm 8-hour standard. There are, however, fewer days on which those old standards are exceeded, and when they are, fewer sites tend to be involved. Also, the maximum levels reached are not as high as they were in the past. The maximum 1-hour average concentration recorded in 1993 was 0.162 ppm, compared to a maximum of 0.118 ppm in 2011.

It is apparent, however, that the current standard is significantly more stringent than the old (see Figure 5 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. In Figure 5 the new standard has been projected back through 2000 for comparison purposes. As mentioned previously, the current 8-hour standard of 0.075 ppm, was promulgated in May 2008.

FIGURE 5

Days on Which the Old and New Ozone Standards have been exceeded in New Jersey 1993-2011



DESIGN VALUE

The NAAQS for ozone 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-year 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 in 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 fourth 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 developing plans based on extremely rare events.

Table 3 and Table 4 on the following pages display the current design values for both the 1-hour standard and the 8-hour standard respectively.

SUMMARY OF 2011 OZONE DATA RELATIVE TO THE OLD 1-HOUR STANDARD

Of the 15 monitoring sites that were operated during the 2011 ozone season, none recorded levels above the old 1-hour standard of 0.12 ppm (Figure 7). The highest 1-hour concentration was 0.118 ppm recorded at Leonia on June 9th. As recently as 2002, New Jersey recorded 16 days above this old 1-hour standard.

Figure 7

Highest and Second Highest Daily 1-Hour Averages

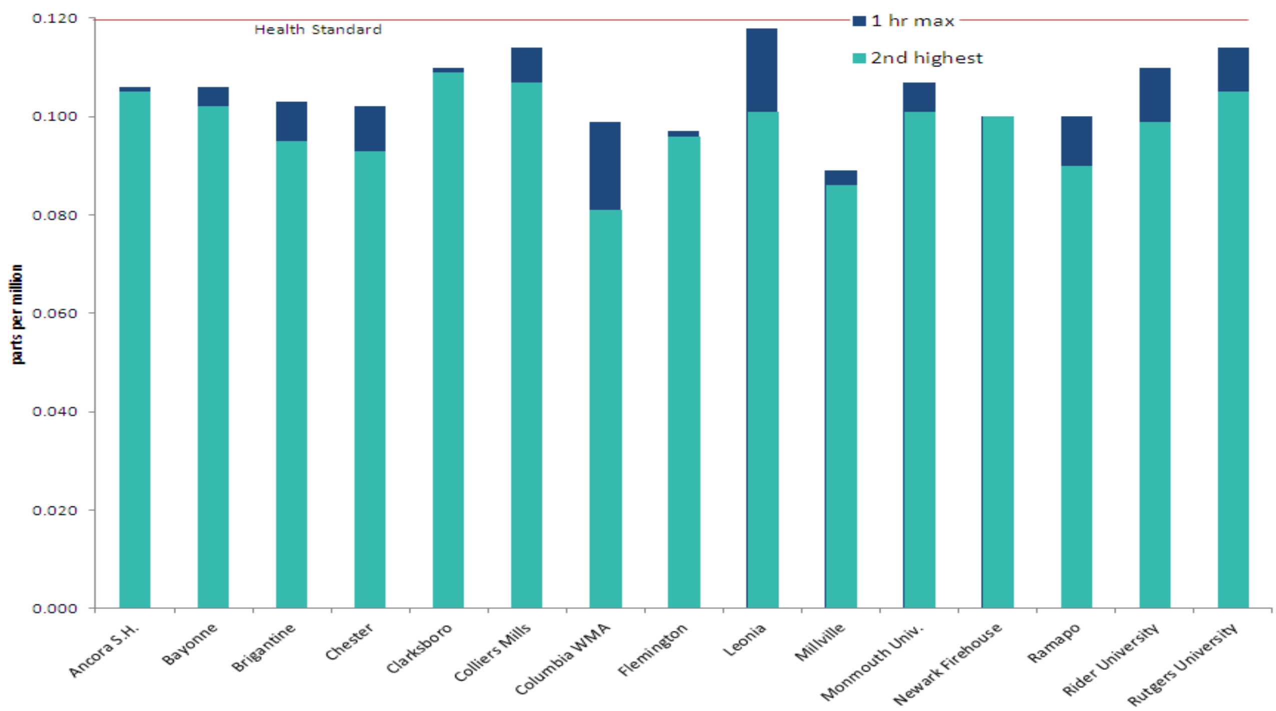


Table 3
Ozone Data – 2011
1-Hour Averages

Parts Per Million (ppm) — Old 1-hour standard is 0.12 ppm

Monitoring Site	1-hr Max	2nd Highest 1-hr Max	4th Highest 1-hour Average 2009-2011	# of days with 1-hour Averages above 0.12ppm
Ancora S.H.	.106	.105	.106	0
Bayonne	.106	.102	.103	0
Brigantine	.103	.095	.095	0
Chester	.102	.093	.094	0
Clarksboro	.110	.109	.107	0
Colliers Mills	.114	.107	.109	0
Columbia WMA*	.099*	.081*	.081*	0
Flemington	.097	.096	.096	0
Leonia	.118	.101	.105	0
Millville	.089	.086	.089	0
Monmouth Univ.	.107	.101	.106	0
Newark Firehouse	.100	.100	.100	0
Ramapo	.100	.090	.092	0
Rider University	.110	.099	.099	0
Rutgers University	.114	.105	.105	0

**Columbia WMA data based on 2011 data only. Uses 2^nd^ highest daily maximum 1-hour average.*

Summary of 2011 Ozone Data Relative to the 8-Hour Standard

All 15 monitoring sites that were operated during the 2011 ozone season recorded levels above the 8-hour standard of 0.075 ppm. The highest 8-hour concentration recorded was 0.102 ppm at Clarksboro on June 9th. Design values for the 8-hour standard (Figure 8) were above the standard at 10 of 14 sites, indicating that the ozone standard is being violated throughout almost all of New Jersey. Columbia began sampling in 2011 and therefore does not have a valid design value for this period.

Figure 8

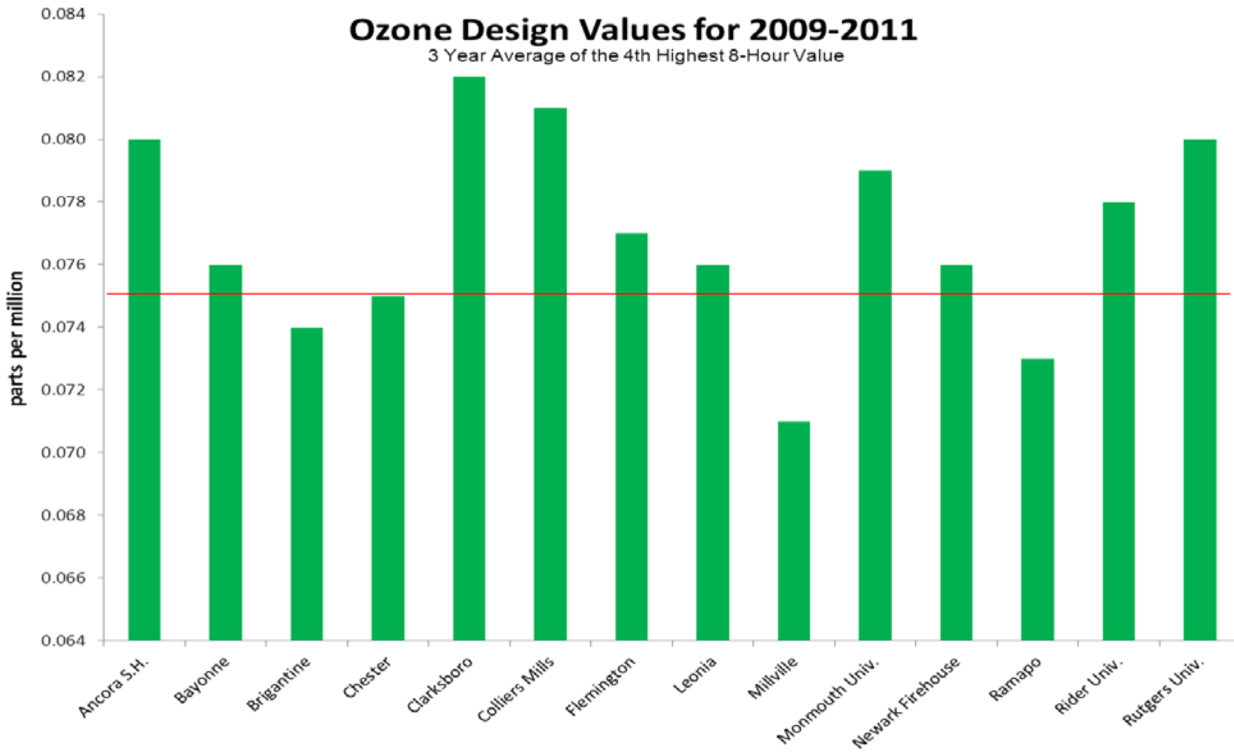
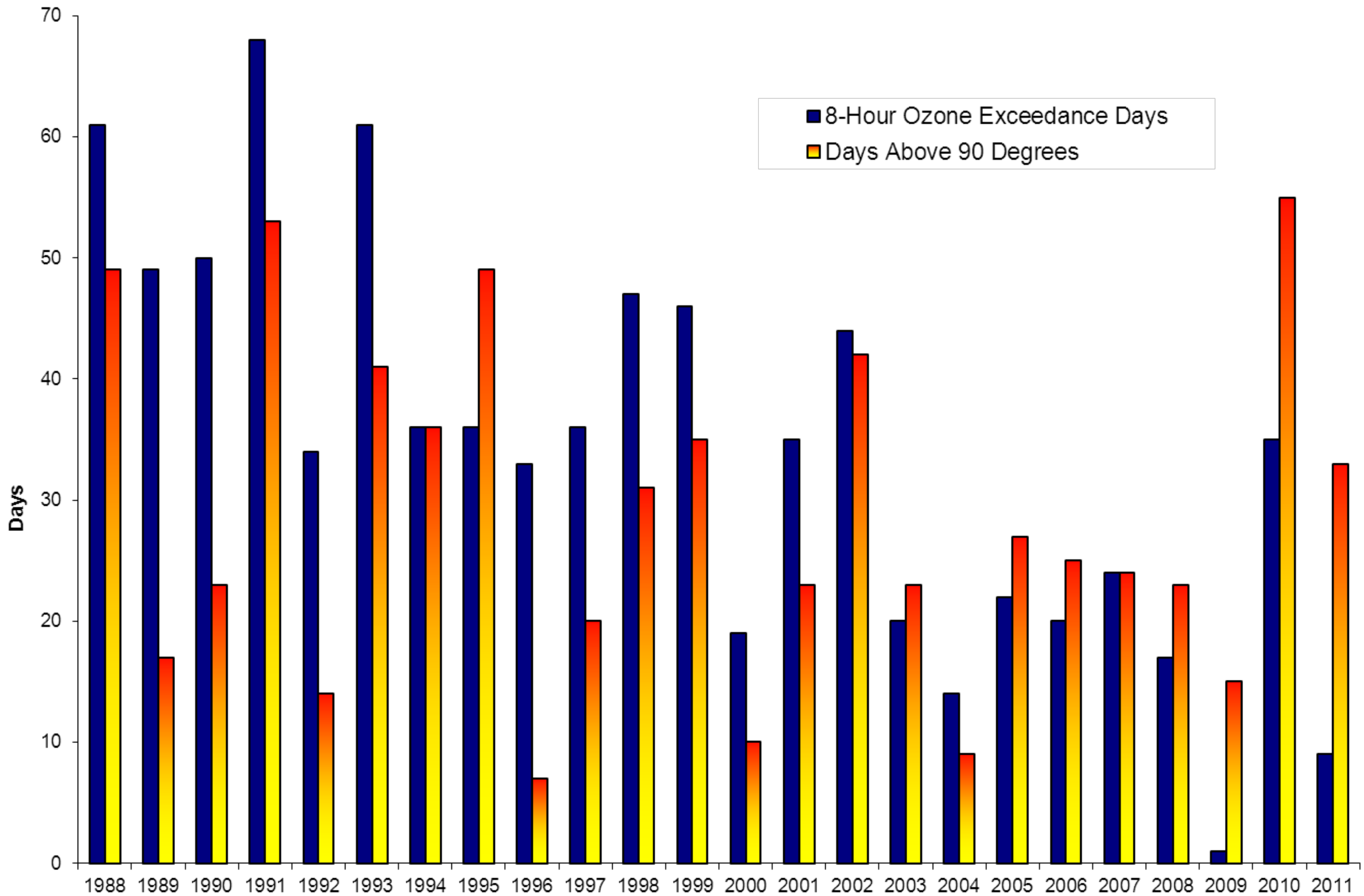


Table 4
Ozone Data – 2011
8-Hour Averages
Parts Per Million (ppm)

Monitoring Site	1st Highest	2nd Highest	3rd Highest	4th Highest	Avg. of 4th Highest 8-hour Averages 2009-2011	# of days with 8-hour Avg. above 0.075 ppm
Ancora S.H.	0.097	0.096	0.084	0.083	0.080	8
Bayonne	0.088	0.082	0.081	0.078	0.076	5
Brigantine	0.081	0.078	0.074	0.073	0.074	2
Chester	0.084	0.084	0.082	0.081	0.075	6
Clarksboro	0.102	0.095	0.093	0.092	0.082	11
Colliers Mills	0.101	0.094	0.089	0.085	0.081	11
Columbia WMA*	0.087	0.073	0.071	0.070	*	1
Flemington	0.088	0.086	0.085	0.081	0.077	7
Leonia	0.095	0.087	0.087	0.082	0.076	10
Millville	0.077	0.077	0.068	0.066	0.071	2
Monmouth Univ.	0.097	0.094	0.083	0.081	0.079	8
Newark Firehouse	0.091	0.091	0.084	0.081	0.076	8
Ramapo	0.081	0.079	0.076	0.075	0.073	3
Rider University	0.089	0.088	0.086	0.079	0.078	7
Rutgers University	0.092	0.092	0.090	0.087	0.080	11

**Columbia WMA data based on 2011 data only.*

Figure 9
Number of Days 8-Hour Ozone Standard was Exceeded and
Number of Days Above 90 Degrees in New Jersey 1988-2011
(Using 8-Hour 0.08 ppm standard (old) across entire time period)



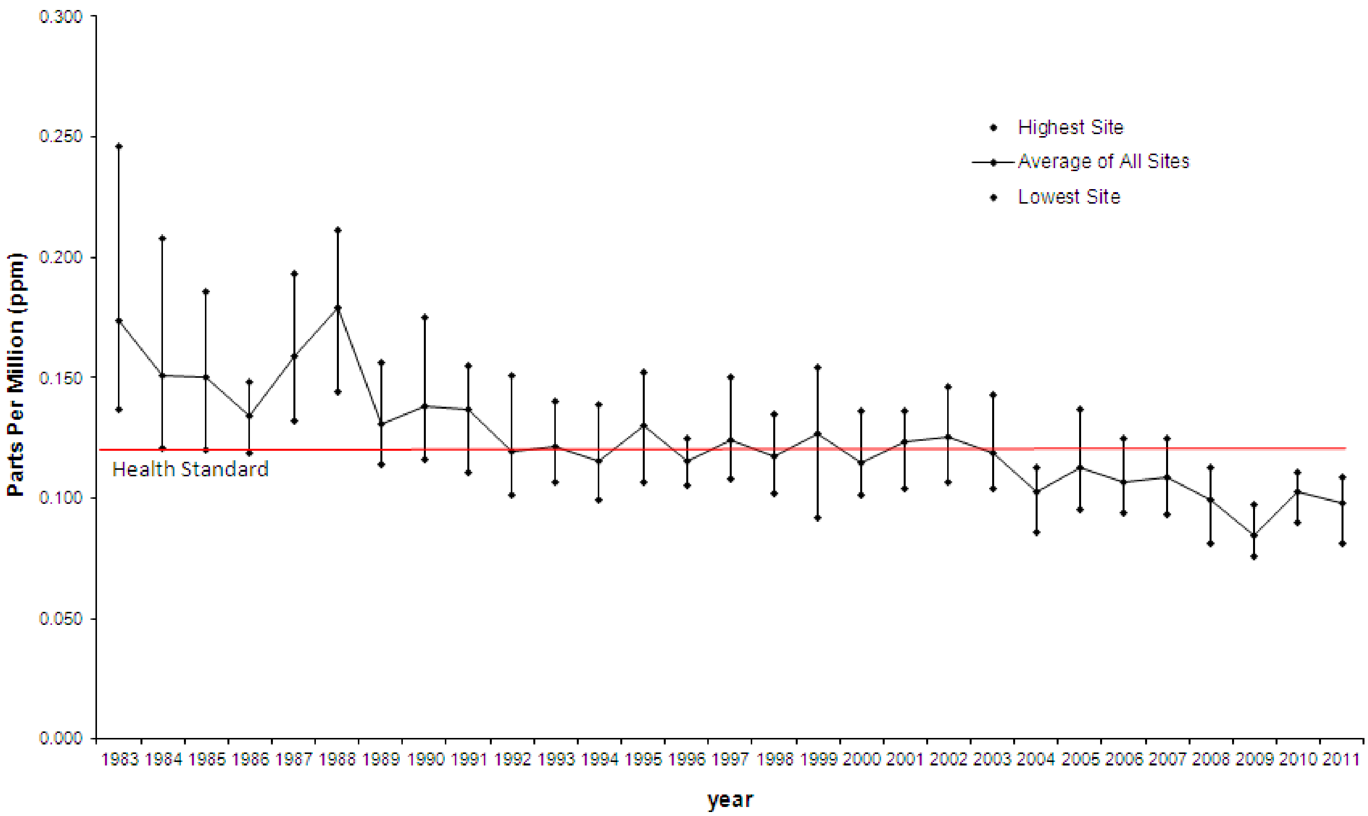
ACCOUNTING FOR THE INFLUENCE OF WEATHER

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 in Figure 9. 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 (1988-1993) 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 is an indication that on the days when conditions are suitable for ozone formation, unhealthy levels are being reached less frequently.

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 1-hour concentrations have not exceeded 0.200 ppm since 1988 and the last time levels above 0.180 ppm were recorded was in 1990 (Figure 10). Improvements 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 10
Ozone Concentrations in New Jersey
1983-2011
Second Highest 1-Hour Averages

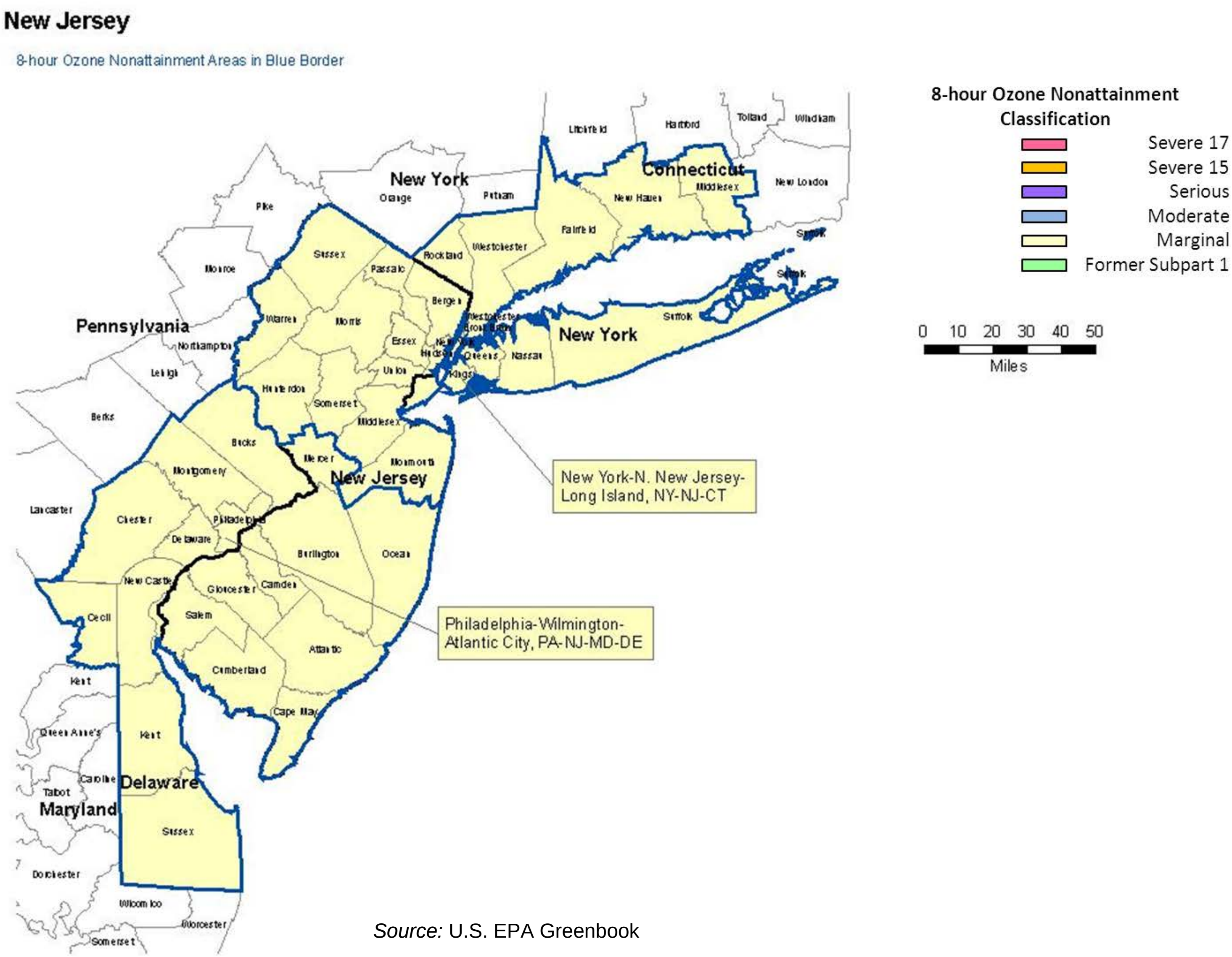


OZONE NON-ATTAINMENT AREAS IN NEW JERSEY

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 8-hour ozone standard for example, the design value is the average of the fourth highest daily maximum 8-hour average concentration recorded each year for three years.

Their classification with respect to the 8-hour standard is shown in Figure 11 below. The entire state of New Jersey is in non-attainment and is classified as being "Marginal." A "Marginal" classification is applied when an area has a design value of 0.085 ppm up to but not including 0.092 ppm.

Figure 11



Source: U.S. EPA Greenbook

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