AIR

For the purposes of this preliminary assessment report, air is defined as the part of the lower atmosphere (troposphere) located over the geographic area that constitutes the Piedmont Basin. *Ambient air* refers to the outdoor atmosphere and does not include indoor air. Ambient air constantly changes as it moves into and out of, as well as mixes vertically within, the Piedmont Basin.

The ambient air of the Piedmont Basin is best thought of as one small volume of an "ocean of air"; it is not separate from the air in nearby communities or states. With the lack of strong elevation features such as mountain ranges or deep valleys, the air moves relatively freely through and is generally well mixed across the Piedmont Basin. This means that ambient concentrations of most gaseous pollutants are fairly consistent throughout the area.

Characterization

Ambient Air

On a synoptic or regional scale, air flow is generally from west to east — which means that pollution sources to the west have a major influence on air quality in our region. In numerous instances, however, air moves into the Piedmont Basin from areas to the north or south of Delaware. In the summer, for example, the Piedmont Basin (and most of New Castle County) is often affected by air moving up from the Baltimore -Washington area. Generally speaking, the "airshed" affecting the Piedmont Basin is hundreds of square miles in size, is irregular in shape, and has a significant westerly component.

In considering the local influences on air quality in the Piedmont Basin, it is important to note that both a significant proportion of the state's population and many sources of air pollution are concentrated in this area. Some of the state's most heavily traveled traffic corridors (such as Interstate 95) are in this area, as well as a significant number of industrial facilities. Many small sources of pollution — such as dry cleaners and auto body shops — are found in areas with the greatest population density.

General Status

In general, air quality in the Piedmont Basin meets all federal regulatory pollutant standards, except ozone. Although there is no regulatory standard for acid precipitation, monitors outside the Piedmont Basin show an acidic precipitation, with an average annual pH of 4.2. There are also no ambient air standards for visibility or for the various chemicals generally referred to as "air toxics." In the follow-

Figure 18
1995 DAILY AIR-QUALITY INDEX FOR NEW CASTLE COUNTY

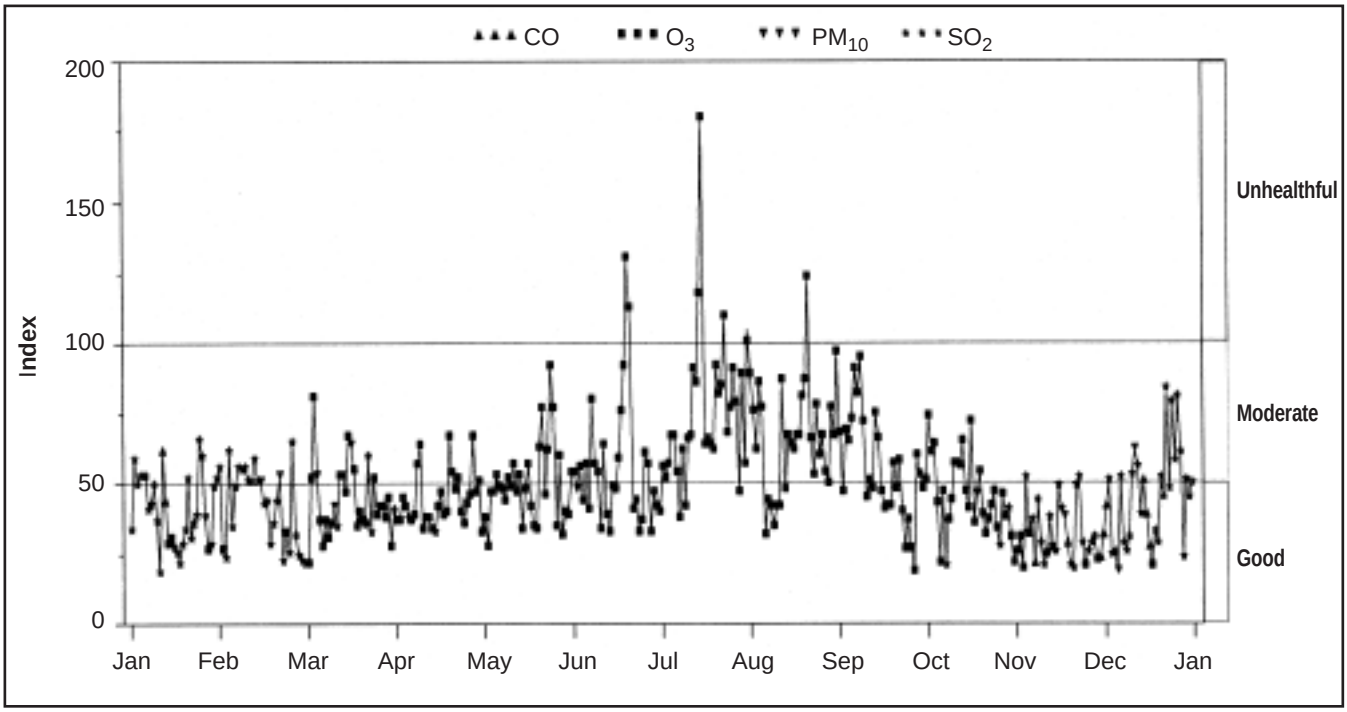


Table 42

PIEDMONT BASIN AIR-MONITORING SITES AND PARAMETERS

SITE	O_3	CO	SO_2	NO_2/NO_x	PM_{10}	ACID RAIN
Brandywine	X					
Bellefonte	X		X	X	X	
Wilmington		X	X		X	
*Lums Pond	X			X		X

Note: Sites active in 1995.
** Located outside the boundaries of the Piedmont Basin.*

Figure 19

PIEDMONT BASIN — 1995 AMBIENT AIR POLLUTANT CONCENTRATIONS

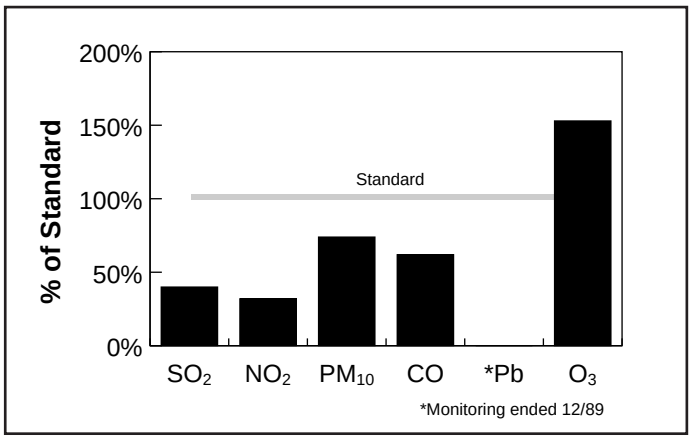


Table 43

OZONE — 1995 MAXIMUM CONCENTRATIONS AND NUMBER OF EXCEEDANCES OF NAAQS

1-HOUR AVERAGES (PPM)

SITE	#EXC.	1ST MAX.	2ND MAX.	3RD MAX.	4TH MAX.
Brandywine	3	0.144	0.130	0.126	0.116
Bellefonte	5	0.145	0.141	0.134	0.132
Lums Pond*	5	0.184	0.139	0.137	0.134

National Ambient Air Quality Standard (NAAQS):
Maximum 1-hour average = 0.12 ppm

**Although the monitoring site at Lums Pond is not located within the boundaries of the Piedmont Basin, the ambient air concentrations monitored here are considered representative of the southern portion of the basin and thus are included.*

ing discussion, "below the standard" means that the pollutant concentration in the air is lower than the National Ambient Air Quality Standard (NAAQS) set by the U.S. Environmental Protection Agency (EPA) to protect human health.

The EPA has established a system for measuring overall air quality. The concentrations of five ambient pollutants — ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, and particulate matter — are converted into a health-related numeric value called the "Pollutant Standards Index." Data for New Castle County — which are representative of the Piedmont Basin — indicate that during 1995 there were 210 days with good air quality, 149 days with moderate air quality, and 6 days with unhealthful air quality. All days with unhealthful air were determined to be so due to excessive ozone concentrations. Figure 18 shows the worst pollutant on each day during 1995.

Pollutants

Delaware has three air-monitoring stations in the Piedmont Basin. As shown on Map 23, they are located in Bellefonte (River Road Park), Brandywine Creek State Park, and Wilmington (12th and King Streets). The Bellefonte and Wilmington monitoring stations operate year-round, while the station at Brandywine Creek State Park operates only during the ozone season (April through October). Just outside the Piedmont Basin, a monitoring station at Lums Pond State Park records concentrations that are likely representative of the southern part of the Piedmont Basin and therefore are included in this discussion.

Table 42 describes those pollutants that are monitored at sites in or adjacent to the Piedmont Basin. Figure 19 is a graph of the current status of monitored pollutants relative to their associated ambient air-quality standard.

Pollutants with Air-Quality Standards

Ozone

Ozone is a highly reactive gas and is the main component of smog. While ozone in the upper atmosphere (the stratosphere) is beneficial because it absorbs ultraviolet light, in the lower atmosphere it is considered a pollutant. It is a strong respiratory irritant that affects healthy individuals as well as people with impaired respiratory systems. It can cause respiratory inflammation and reduced lung function. It also adversely affects trees, crops (soybeans are a particularly sensitive species), and other vegetation. Ozone is also implicated in white pine damage and reduced growth rates for red spruce at high elevations.

Note, however, that currently there is no quantitative data on damage to crops/vegetation in the Piedmont Basin caused by any form of air pollution. Vegetation or crop damage estimates are seldom measured directly because of the number of confounding factors (drought, insects, etc.)

Table 44

SULFUR DIOXIDE (SO_2) — 1995 ANNUAL AVERAGES AND MAXIMUMS (PPM)

SITE	ANNUAL ARITHMETIC MEAN	24-HOUR AVERAGES		3-HOUR AVERAGES	
		1ST MAX.	2ND MAX.	1ST MAX.	2ND MAX.
Bellefonte	0.008	0.031	0.029	0.065	0.059
Wilmington	0.012	0.044	0.044	0.097	0.091

National Ambient Air Quality Standard (NAAQS): Annual arithmetic mean = 0.03 ppm, 24-hour average = 0.14 ppm, 3-hour average = 0.5 ppm

that also cause damage. The EPA's estimates were generated by computer models that use data from smog chamber studies on individual plant species along with estimates of total crop acreage and average ozone levels.

In the Piedmont Basin, ozone is measured at Brandywine Creek State Park, at Bellefonte, and at Lums Pond, which is just outside the basin. Concentrations at these sites routinely exceed the acceptable standard several times each year, including six days during 1995 (see Table 43). The current standard for ozone (0.12 parts per million, or ppm) is based on a one-hour peak level that has been shown to adversely impact human health. The highest level measured during 1995 was 0.184 ppm at Lums Pond on July 15.

It has been recognized for some time that some of the vegetation damage from ozone is more clearly related to longer-term average levels of ozone than to one-hour peak concentrations. Recent human health studies have also implicated longer-term (eight-hour average) ozone concentrations. The EPA is reviewing the ozone standard and is expected to propose a change to a longer-term averaging interval as an ambient standard.

Sulfur Dioxide

Sulfur dioxide is a pungent, poisonous, yellow gas. It is an irritant that can interfere with normal breathing functions even at low levels. It aggravates respiratory diseases such as asthma, emphysema, and bronchitis. These effects can be magnified by high particulate levels. Sulfur dioxide can also cause plant chlorosis and stunted growth.

In the Piedmont Basin, sulfur dioxide is monitored at Bellefonte and Wilmington. Current ambient levels are well below the standard (see Table 44). Somewhat elevated levels (but still below the standard) occasionally occur at both monitoring sites when they are downwind of Delmarva Power's Edgemoor power plant. Sulfur dioxide levels also follow a seasonal pattern, with the highest levels recorded in the cold-weather months.

Nitrogen Dioxide

Nitrogen dioxide is a reddish-brown, toxic gas. It irritates the lungs and upper respiratory system and lowers resistance to respiratory infections. It is also known to damage vegetation by stunting growth and reducing seed production.

In the Piedmont Basin, nitrogen dioxide and other oxides of nitrogen are monitored at Bellefonte and at Lums Pond. Nitrogen dioxide levels in the Piedmont Basin are well below the acceptable standard (Table 45).

Carbon Monoxide

Carbon monoxide is a colorless, odorless, poisonous gas produced by the incomplete combustion of fossil fuels. It reduces the blood's ability to carry oxygen. Exposure to moderate concentrations can cause fatigue, headache, and impaired judgment and reflexes; at high levels, unconsciousness and death can result. People with heart disease, angina, emphysema, and other lung or cardiovascular diseases are most susceptible.

Carbon monoxide concentrations are highest along heavily traveled highways and decrease quickly with increasing distance from traffic. For this reason, carbon monoxide monitors are usually located close to roadways or in urban areas.

Table 45

NITROGEN DIOXIDE (NO_2) — 1995 ANNUAL AVERAGES (PPM)

SITE	ANNUAL AVERAGE
Bellefonte	0.017
*Lums Pond	0.016

National Ambient Air Quality Standard (NAAQS): Annual arithmetic mean = 0.053 ppm

**Although the monitoring site at Lums Pond is not located within the boundaries of the Piedmont Basin, the ambient air concentrations monitored here are considered representative of the southern portion of the basin and thus are included.*

Table 46
CARBON MONOXIDE — 1995 MAXIMUM CONCENTRATIONS (PPM)

SITE	1-HOUR AVERAGE		8-HOUR AVERAGE	
	1ST MAX.	2ND MAX.	1ST MAX.	2ND MAX.
Wilmington	11.4	10.0	5.6	4.6

National Ambient Air Quality Standard (NAAQS):
1-hour average = 35 ppm, not to be exceeded more than once per year.
8-hour average = 9 ppm, not to be exceeded more than once per year.

In the Piedmont Basin, carbon monoxide is monitored at the Wilmington site. Carbon monoxide concentrations are below the standard (Table 46). Levels at the Wilmington site, which would be expected to be the highest, show concentrations to be well below the standard.

Particulate Matter

Particulate matter (PM_{10}) is the portion of total suspended particulates that is less than 10 microns in diameter and thus small enough to be inhaled into the lungs. Particulate matter can include solid or liquid droplets that remain suspended in the air for various lengths of time. Particles small enough to be inhaled can carry other pollutants and toxic chemicals into the lungs. Major effects of particulate matter can include aggravation of existing respiratory and cardiovascular disease, alterations in immune responses in the lung, damage to lung tissue, and premature mortality. The most sensitive populations are those with chronic obstructive pulmonary or cardiovascular disease, asthmatics, the elderly, and children. Particulates are also a major cause of reduced visibility and can be involved in corrosion of metals (acidic dry deposition).

In the Piedmont Basin, particulate matter is measured at Bellefonte and at Wilmington. Levels are well below the standard, with the highest concentrations occurring at the urban Wilmington site (Table 47).

Recent studies have linked the smallest particulate matter particles (those with diameters of 2.5 microns or less) to human health effects. The EPA therefore currently is reviewing the air-quality standard and is expected to propose adding a new standard for these smaller particles in 1997.

Lead

Lead is a highly toxic metal that affects several physiological processes, including the renal (kidney), nervous, and blood-forming systems. It accumulates in both bone and soft tissues. Lead was monitored at Wilmington and Claymont from 1979 until sampling ended in 1989 because the majority of samples had concentrations below the analytical detection limit.

Pollutants without Air-Quality Standards

Air Toxics

This term is often used to refer to many chemicals that are toxic, or suspected of being toxic, in some way to humans. The complex chemical composition and the multitude of these compounds make comprehensive monitoring difficult. In the Piedmont Basin, Delaware has conducted limited monitoring for specific compounds in urban Wilmington and in some areas around large point sources. There are currently no accepted ambient air standards for these chemicals. Ambient monitoring in the Piedmont area has shown average concentrations of all chemicals monitored to be less than 1 part per billion (ppb) (see Table 48).

Heavy Metals

Heavy metals that harm human health — such as chromium, nickel, and cadmium — are not currently monitored in Delaware. From 1983 to 1987, ambient levels of 14 metals in total suspended particulates were monitored at two urban sites in Wilmington. Concentrations were similar to those reported for other urban areas (Table 49). There are no current ambient air standards for metals, except lead.

Table 47
PARTICULATE MATTER (PM_{10}) — 1995 MAXIMUM 24-HOUR AVERAGES AND ANNUAL AVERAGES ($\mu G/M^3$)

SITE	ANNUAL AVG.	1ST MAX. 24-HR AVG.	2ND MAX. 24-HR AVG.	3RD MAX. 24-HR AVG.	4TH MAX. 24-HR AVG.
Bellefonte	29.2	70	68	54	51
Wilmington	37.0	77	73	73	67

National Ambient Air Quality Standard (NAAQS): Annual arithmetic mean = 50 $\mu g/m^3$, 24-hour average = 150 $\mu g/m^3$

Pollutant Deposition: Wet and Dry Deposition

Chemicals are removed from the atmosphere and deposited on surfaces through a variety of mechanisms. Deposition can occur through both wet (rain, snowfall, fog) and dry processes. Both gases and particles can interact with water droplets as well as other chemical compounds to form contaminants that deposit on the Piedmont Basin. Again, atmospheric transport from varying distances plays an important role. Although the importance of atmospheric deposition in ecosystem health is becoming increasingly recognized, there is still a significant lack of knowledge concerning the physical and chemical processes.

Table 48

AIR TOXICS — 1995 SORBENT TUBE MONITORING ANNUAL AVERAGES (PPB)

COMPOUND	WILMINGTON-LIMITED NUMBER OF SAMPLES	*LUMS POND
Benzene	0.3	0.3
Toluene	0.7	0.4
m,p-Xylenes	0.3	0.2
o-Xylene	0.2	0.1
Ethyl benzene	0.1	0.1
1,1,1-Trichloroethane	0.1	0.1

** Located outside the boundaries of the Piedmont Basin.*

Table 49

HEAVY METALS — 1983 TO 1987 AVERAGE CONCENTRATIONS OF TOTAL SUSPENDED PARTICULATES MEASURED ($\mu G/M^3$)

METAL	ANNUAL CONC. $\mu G/M^3$
Arsenic	0.0020
Beryllium	0.0024
Barium	0.0000
Cadmium	0.0008
Chromium	0.0125
Cobalt	0.0009
Copper	0.1042
Iron	0.5460
Lead	0.0920
Manganese	0.0236
Molybdenum	0.0017
Nickel	0.0118
Vanadium	0.0158
Zinc	0.0547

Note: All monitoring occurred in Wilmington.

Acid Rain

Acid rain (more appropriately called *acid precipitation*) is rain, snow, or fog that contains sulfuric and/or nitric acids. The acids result from the reaction of water in the atmosphere with sulfur and nitrogen oxides released from various combustion processes. These chemical compounds can travel for many miles in the air before falling in acid rain.

Delaware collects weekly composite precipitation (wet only) samples at the Lums Pond site. Currently, the only measurements are for pH and conductivity. From 1983 to 1994, additional analyses were performed that identified various ion concentrations; these data have not yet been analyzed in detail. The annual average pH of the precipitation is 4.2 and is considered acidic ("clean" rain has a pH of around 5.6). This acidity is likely representative of precipitation throughout the Piedmont Basin.

Dry Deposition

Dry deposition consists of any type of particle that is deposited on a surface. This can include organic as well as inorganic compounds and trace metals. No monitoring of dry deposition has taken place in the Piedmont Basin.

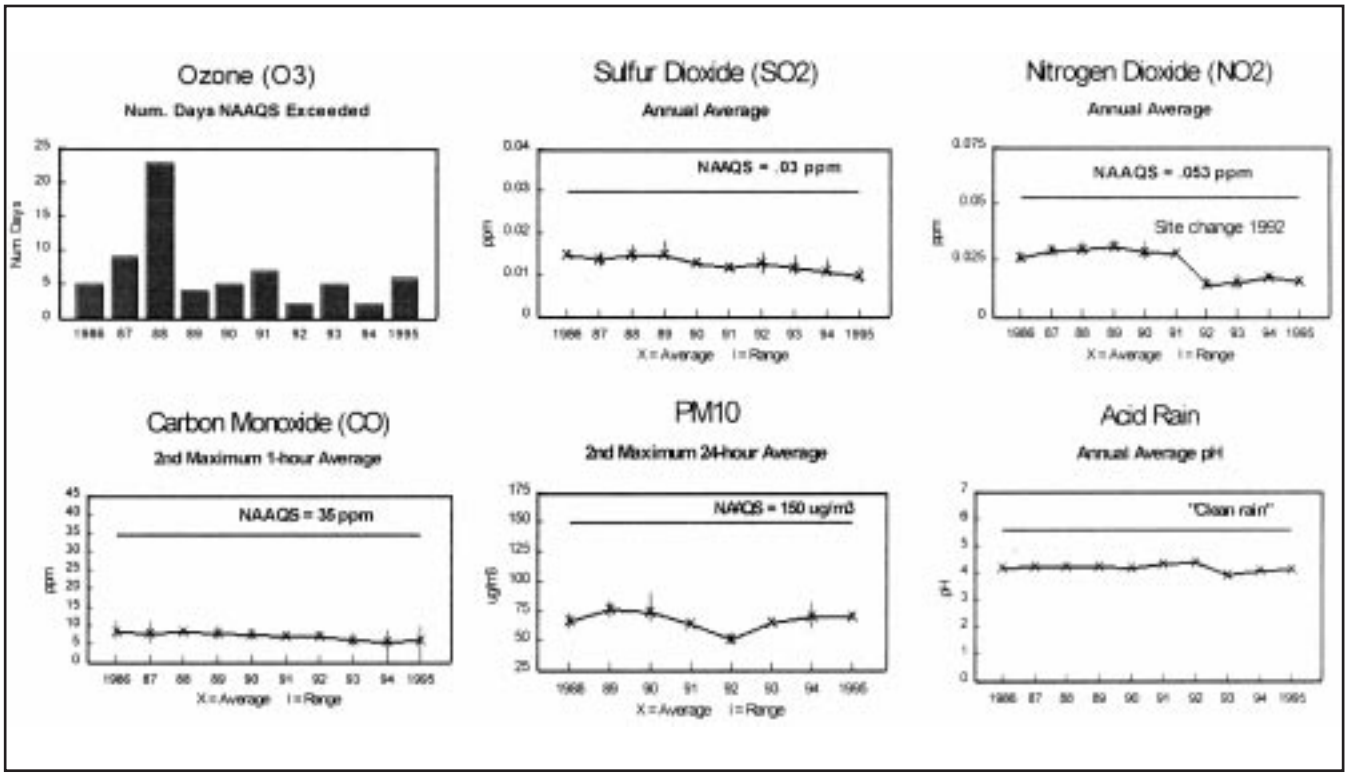
Sulfur Compounds

Sulfur dioxide can bind to dust particles and aerosols in the atmosphere, traveling long distances on the prevailing winds. It can also be oxidized to sulfur trioxide and combine with water vapor to form sulfuric acid and fall as acid rain. Sulfur compounds contribute to visibility degradation. The only current monitoring of sulfur compounds in the Piedmont Basin is for sulfur dioxide, as previously described.

Nitrogen Compounds

Reactions between nitrogen oxides and other compounds in the atmosphere can form nitric acid, which contributes to the acid rain problem. Other reactions can produce nitrate compounds that affect visibility. Atmospheric deposition of oxides of nitrogen can be a significant source of nitrogen to estuarine systems. The only current monitoring of nitrogen compounds in the Piedmont Basin is for nitrogen dioxide (along with nitrogen oxide and oxides of nitrogen), as previously described.

Figure 20
AMBIENT AIR POLLUTANT TRENDS IN THE PIEDMONT BASIN



Trends

Pollutants Measured in Ambient Air

See Figure 20 for trends graphs for ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter.

Ozone

Ozone trends are difficult to measure because of the influence of meteorology. In general, ozone concentrations during the 1990s are significantly lower and there are fewer exceedances of the standard than in meteorologically similar years during the 1980s. Improvements are attributed to pollution-reduction measures such as improved pollution controls on large industrial sources, vapor recovery on gasoline pumps, and lower volatility of gasoline and various solvents.

Sulfur Dioxide

Sulfur dioxide levels declined rapidly in the 1970s and appear to have remained relatively constant over the past 10 years. This improvement is largely due to the change to low or lower sulfur fuels in power plants as well as to improved control technologies.

Nitrogen Dioxide

Nitrogen dioxide levels have changed little since monitoring began and suggest no apparent upward or downward trend; this is also true of other oxides of nitrogen.

Carbon Monoxide

Its levels have decreased significantly since monitoring began in the 1970s, and recent data indicate that concentrations are remaining at low levels. Improvements are largely attributable to cleaner engines in cars and tighter automobile emissions standards.

Particulate Matter

Particulate matter (PM_{10}) concentrations have only been monitored since 1988, so there is limited data for estimating trends. However, it appears that particulate matter levels are relatively constant, currently suggesting no significant trend.

Deposition/Acid Rain

Measurements collected at Lums Pond since 1984 indicate no significant trend in precipitation pH, and precipitation continues to average around pH 4.2 annually. As stated

previously, no detailed analysis of ion concentrations has been performed.

Air Toxics

The Wilmington monitoring site is being used to establish trends for some toxic compounds; however, the monitoring methodology is still in development, and reliable data only exist since 1994. This is insufficient to establish trends at this time.

Heavy Metals

Monitoring was only done in the urban Wilmington area; samples were collected twice a month for four years. No trends were apparent.

Lead

Concentrations of lead in ambient air decreased 94% between 1978 and 1988. This dramatic improvement is attributed to the change from leaded to unleaded gasoline for automobiles. In 1989, the majority of samples collected were below the analytical detection limit, at which time the state ended its ambient air monitoring for lead.

Emissions

Pollutant emissions come from a wide variety of sources and are difficult to measure accurately. Sources are usually divided into several categories: *point* (large facilities with large amounts of emissions); *area* (small facilities such as dry cleaners and auto repair shops that are considered as a group); *mobile* (such as automobiles, trucks, farm equipment, airplanes); and *natural sources* (wind-blown dust, ash from forest fires) including those termed "biogenic," such as vegetation (e.g., pine trees are a significant source of isoprene, a flammable liquid hydrocarbon).

Methods of quantifying emissions from all categories of sources in order to track trends and evaluate efforts to improve air quality have improved significantly in recent years. While this means that emissions inventories developed since 1990 are more accurate, it also means they are not easily comparable to earlier inventories, and therefore there is very little data available to estimate trends.

Ozone Emissions

Emissions inventories of ozone precursors for the Piedmont Basin are complete for 1990 but only in draft form for 1993, so no trends are clear at this time. Pollutants included in these comprehensive inventories are volatile organic compounds, nitrogen oxides, and carbon monoxide. In addition, there are point source inventories that have been compiled for particulate matter (particulate matter$_{10}$ and/or total suspended particulates), sulfur oxides, and lead. (Please see the Appendix — Emission Estimation Methods for specific information on how the ozone precursor inventories are generated.)

Air Toxics Emissions

Specific information on emissions of air toxics is limited. The Toxics Release Inventory is one data base that can be used to examine emissions. More than 650 toxic chemicals are subject to release reporting by the manufacturing industry on an annual basis under this program. This information is presented in Tables 50 and 51. Air releases from reporting facilities covered by the inventory within the Piedmont Basin have declined by 55% since 1989 (see Figure 21).

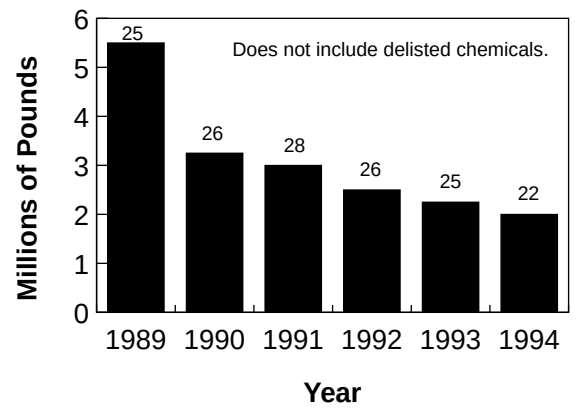
Sources of Impact

The determination of source-receptor relationships in air pollution is complex, and distinguishing between local and remote sources of pollution is extremely difficult. Observational data alone are usually insufficient to determine source-receptor relationships. Computer modeling is required, yet existing models have many limitations, and there are large degrees of uncertainty associated with the results. While it is possible to inventory the large air pollution emission sources located within the Piedmont Basin, the sources actually impacting the basin are not so easily determined. The following discussion is therefore limited in some areas to general statements and conclusions.

Maps 23 and 24 show the location of two types of emission sources — large point sources (facilities with large amounts of emissions of at least one of the following pollutants:

Figure 21

TOTAL TOXICS RELEASE INVENTORY AIR RELEASES IN PIEDMONT BASIN — 1989 TO 1994



The figure above each bar indicates the number of facilities within the basin reporting air releases.

Table 50

1994 TOXICS RELEASE INVENTORY EMISSIONS IN PIEDMONT BASIN

MAP NO.	FACILITY/ CHEMICAL	CAS NO.	AIR RELEASES
1	Allied Signal		
	Ammonia	7664-41-7	8,720
	1,3-Dichloropropylene	542-75-6	40
	Hydrochloric Acid	7647-01-0	10
	Toluene	108-88-3	1,020
	Facility Total		**9,790**
7	Alloy Surfaces		
	Nickel	7440-02-0	50
	1,1,1-Trichloroethane	71-55-6	300
	Facility Total		**350**
9	Ametek Haveg Division		
	Formaldehyde	50-00-0	11
	Hydrochloric Acid	7647-01-0	152
	Phenol	108-95-2	93
	Facility Total		**256**
18	Cabot Safety Corp.		
	Dichloromethane	75-09-2	42,975
	Methylenebis (Phenylisocyanate)	101-68-8	10
	Toluenediisocyanate (Mixed Isomers)	26471-62-5	10
	Facility Total		**42,995**
17	Chrysler		
	Benzene	71-43-2	562
	N-Butyl Alcohol	71-36-3	17,300
	Copper	7440-50-8	18
	Ethylbenzene	100-41-4	38,900
	Ethylene Glycol	107-21-1	43
	Glycol Ethers	N230	51,200
	Hydrochloric Acid	7647-01-0	93
	Methanol	67-56-1	18,700
	Methyl Ethyl Ketone	78-93-3	18,800
	Methyl Isobutyl Ketone	108-10-1	147,000
	Phosphoric Acid	7664-38-2	430
	Toluene	108-88-3	32,000
	1,2,4-Trimethylbenzene	95-63-6	21,100
	Xylene (Mixed Isomers)	1330-20-7	306,000
	Facility Total		**652,146**
14	CIBA-Geigy		
	Aniline	62-53-3	604
	Biphenyl	92-52-4	4,063
	Methanol	67-56-1	116,503
	Xylene (Mixed Isomers)	1330-20-7	525
	Facility Total		**121,695**
	CITISTEEL U.S.A.		
	Chromium Compounds	N090	274
	Copper Compounds	N100	447
	Lead Compounds	N420	3,230
	Manganese Compounds	N450	2,409
	Nickel Compounds	N495	85
	Zinc Compounds	N982	29,622
	Facility Total		**36,067**
6	DuPont Edge Moor		
	Carbonyl Sulfide	463-58-1	198,500
	Chlorine	7782-50-5	10,407
	Chlorodifluoromethane (HCFC-22)	75-45-6	520
	Hydrochloric Acid	7647-01-0	10,934
	Titanium Tetrachloride	7550-45-0	489
	Toluene	108-88-3	994
	Facility Total		**221,844**
22	DuPont Exp. Station		
	Acetonitrile	75-05-8	75
	Methanol	67-56-1	2,986
	Pyridine	110-86-1	3
	Xylene (Mixed Isomers)	1330-20-7	7
	Facility Total		**3,071**
15	DuPont Holly Run		
	Chromium Compounds	N090	823
	Sulfuric Acid (Aerosol)	7664-93-9	2
	Facility Total		**825**
16	FMC Newark		
	Hydrochloric Acid	7647-01-0	341
	Facility Total		**341**
2	General Chemical		
	Ammonia	7664-41-7	7,303
	Hydrogen Fluoride	7664-39-3	2,430
	Lead Compounds	N420	50
	Sulfuric Acid (Aerosol)	7664-93-9	19,020
	Facility Total		**28,803**
10	General Motors		
	Benzene	71-43-2	59
	N-Butyl Alcohol	71-36-3	92,778
	Ethylbenzene	100-41-1	69,414
	Ethylene Glycol	107-21-1	4,370
	Methanol	67-56-1	61,537
	Methyl Ethyl Ketone	78-93-3	66,344
	Methyl Isobutyl Ketone	108-10-1	195,908
	Toluene	108-88-3	42,853
	Xylene (Mixed Isomers)	1330-20-7	752,307
	Facility Total		**1,285,570**

Air releases are given in pounds.
Source: *DNREC Toxics Release Inventory Data Base, July 1996.*
CAS = Chemical Abstracts Service

Table 51

TOXICS RELEASE INVENTORY EMISSIONS — CONT'D.

MAP NO.	FACILITY/ CHEMICAL	CAS NO.	AIR RELEASES
21	Hercules Research		
	Toluene	108-88-3	1,584
	Facility Total		**1,584**
11	Insteel Wire Products		
	Hydrochloric Acid	7647-01-0	2,500
	Facility Total		**2,500**
13	Medal		
	Freon 113	76-13-1	8,400
	Methanol	67-56-1	14,000
	Facility Total		**22,400**
8	Noramco		
	1,3-Dichlorobenzene	541-73-1	423
	Dichloromethane	75-09-2	17,200
	Hydrochloric Acid	7647-01-0	343
	Methanol	67-56-1	6,000
	Methyl Isobutyl Ketone	108-10-1	2,980
	Toluene	108-88-3	2,320
	Facility Total		**29,266**
5	NVF Yorklyn		
	Hydrochloric Acid	7647-01-0	250
	Facility Total		**250**
19	Perma-Flex Rollers		
	Dichloromethane	75-09-02	37,800
	Facility Total		**37,800**
12	Rockland Technologies		
	Methanol	67-56-1	6,100
	Facility Total		**6,100**
20	Rodel		
	Methyl Ethyl Ketone	78-93-3	14,877
	Facility Total		**14,877**
3	Sun Refining & Mrkting.		
	Ethylene	74-85-1	111,000
	Ethylene Oxide	75-21-8	9,280
	Facility Total		**120,280**
	PIEDMONT BASIN TOTAL		**2,638,810**

Air releases are given in pounds.

Source: *DNREC Toxics Release Inventory Data Base, July 1996.*

CAS = Chemical Abstracts Service

carbon monoxide, sulfur oxides, nitrogen oxides, volatile organic compounds, particulate matter, or lead); and toxics release inventory sources. These maps were generated using data from the 1993 Point Source Emissions Inventory and the 1994 Toxics Release Inventory data base. The Point Source Emissions Inventory is limited to sources with significant emissions of pollutants involved in the formation of ozone.

Other kinds of pollution sources are mobile sources and small sources ("area sources"). Motor vehicles are significant sources of many pollutants; there is a high concentration of heavy traffic corridors in the Piedmont Basin, including the City of Wilmington. Map 25 shows the traffic network in the Piedmont Basin. The densities of housing and area sources in the Piedmont Basin are also significant factors in total emissions; Map 26 shows the population density in the Piedmont Basin.

Pollutant Sources Affecting the Piedmont Basin

Ozone

Ozone is not emitted directly by sources; it is formed in the atmosphere from precursors (mainly nitrogen oxides and volatile organic compounds) that react in the presence of sunlight and warm temperatures. Significant sources of nitrogen oxides include motor vehicles and power plants. Sources of volatile organic compounds include motor vehicles and a variety of commercial and industrial sources as well as natural biogenic emissions. Figure 22 shows the relative contribution of the various source categories in New Castle County. Since ozone formation is directly linked to warm temperatures and sunlight, elevated levels occur almost exclusively in the summer months.

In northern Delaware, including the Piedmont Basin, both local and distant upwind sources of nitrogen oxides and volatile organic compounds contribute to ozone formation. Since there is some time required to form ozone and there is usually some level of air flow across the Piedmont Basin, many local sources such as the Interstate 95 corridor and the City of Wilmington may contribute more to ozone in downwind areas than in the basin itself. The Baltimore-Washington area contributes significantly to Piedmont Basin ozone levels under many meteorological conditions. In other cases, Philadelphia or the Richmond area may be contributing. Recent studies indicate that even more remote sources in the Midwest or Southeast may be significant as well. On days with stagnant wind conditions, high temperatures, and little cloud cover, local sources become more important.

Due to the complex nature of ozone formation, computer modeling of different specific high-ozone episodes is necessary to evaluate the relative contribution of (and thus control strategies for) the various sources of volatile organic compounds and nitrogen oxides in a given area. This work

is presently under way for the areas in Delaware that are not in attainment of the ozone standard.

Sulfur Dioxide

Its main source is fossil fuel combustion, mostly by power plants and industrial boilers. In the Piedmont Basin, both local sources and those in neighboring states contribute to ambient concentrations.

Nitrogen Dioxide

The majority of nitrogen dioxide comes from a combination of mobile sources and point sources that burn fossil fuels. Both types of sources are present in the Piedmont Basin. Both local and remote sources contribute to the basin's ambient concentrations.

Carbon Monoxide

The major source of carbon monoxide in the Piedmont Basin is motor vehicles. As stated earlier, this means that the highest concentrations of carbon monoxide are in urban areas and along highways. Because carbon monoxide dissipates so quickly with distance from emission sources, ambient concentrations in the Piedmont Basin are mainly from nearby (within a few hundred yards) sources. Relative contributions of different source types are shown in Figure 22.

Particulate Matter

Both local and regional sources of particulate matter impact the Piedmont Basin. Sources include power plants, automobiles, various industrial facilities, unpaved roads, and agricultural activities. The smaller components of particulate matter such as particles smaller than 3 microns in diameter can travel very long distances and are considered to be a regional problem. The sources of these small particles are mainly anthropogenic activities, particularly fuel combustion.

Lead

In the past, lead concentrations in ambient air were due mainly to the use of leaded gasoline in automobiles. Currently, ambient concentrations are of concern only in areas affected by point sources, such as smelters and battery production facilities. The emissions inventories for the Piedmont Basin currently include no such sources.

Acid Rain

The relationship between the emission of sulfur oxide and nitrogen oxide gases and the formation of acid rain is complex. Emissions of acid-neutralizing compounds also play a role and can make contributions from various sources even harder to determine. In general, the sources of the sulfur and nitrogen compounds that contribute to acid rain are similar to those described above for sulfur

Figure 22

1993 PRELIMINARY PERIODIC OZONE INVENTORY EMISSIONS IN NEW CASTLE COUNTY

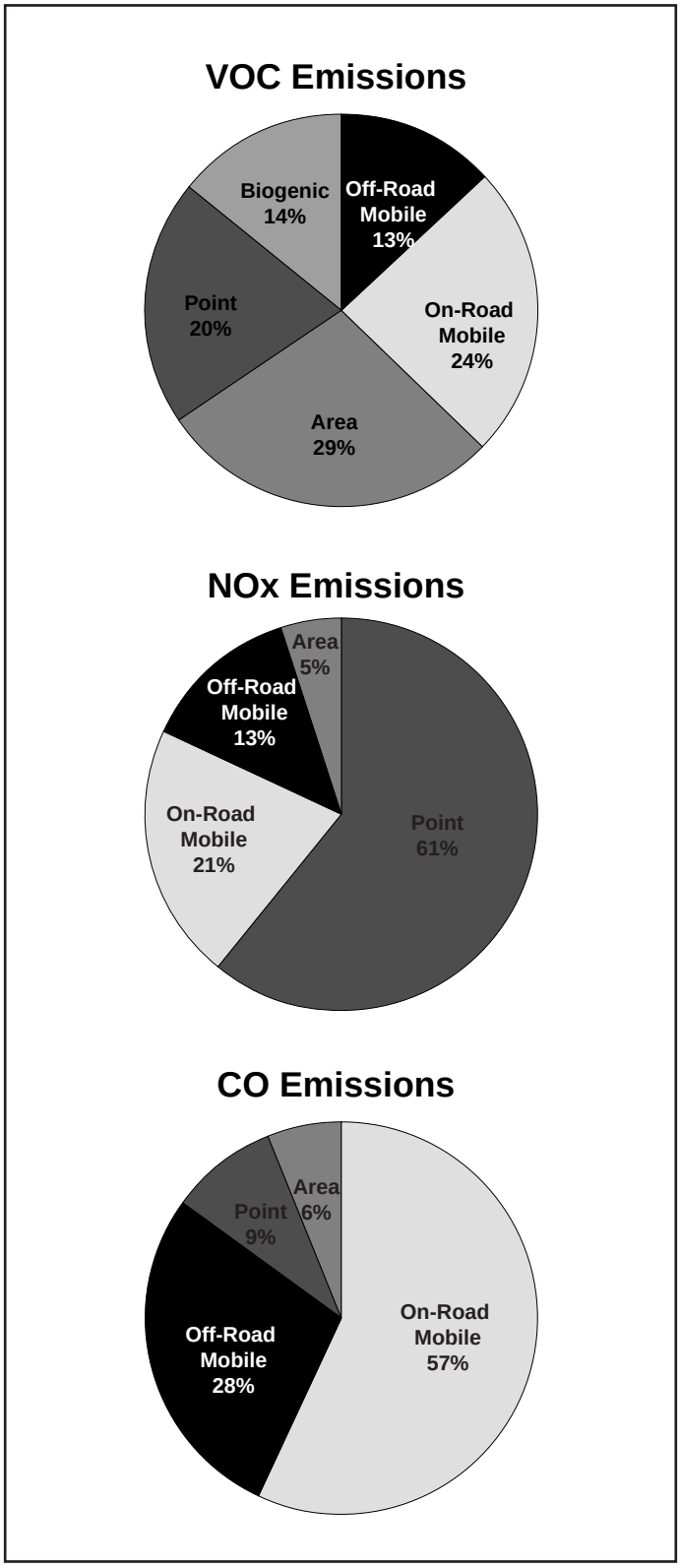


Table 52

LARGE POINT SOURCES INCLUDED IN OZONE PRECURSOR

MAP ID.	FACILITY NAME	TONS PER YEAR VOC	NO_X	CO	SO_X	PM_{10}
1	Allied Signal, Inc.	19.44	0.00	0.00	0.00	0.00
34	Atlantic Aviation	19.17	5.64	0.51	16.25	0.80
17	Blacktop Products - Commerce Street	0.00	0.00	0.00	0.00	0.00
36	Chrysler Motors	1167.65	91.77	15.04	83.62	7.27
28	Ciba - Geigy Corporation	460.66	46.74	10.00	19.11	7.03
5	Citisteel USA	64.25	76.04	2950.92	116.76	53.94
24	Clean Earth of New Castle	12.04	14.09	10.21	0.05	0.00
29	Crowell Corporation	12.25	5.60	15.22	3.75	7.08
19	DE Solid Waste Authority - Cherry Island	79.40	0.00	0.00	0.00	0.00
32	Delaware Air National Guard	9.96	0.88	0.20	1.03	0.03
15	Delmarva Power - Edgemoor	65.82	8095.36	474.93	17523.07	543.46
13	Delmarva Power - Hay Road	10.90	398.70	58.80	3.75	0.00
21	Diamond Materials, Inc.	2.40	2.60	1.26	1.90	0.04
11	DuPont - Chestnut Run	7.72	56.57	5.14	137.52	9.36
9	DuPont - Edgemoor	142.79	33.52	3913.96	129.29	107.26
6	DuPont Experimental Station	21.58	190.46	17.81	443.88	36.72
38	DuPont Stine - Haskell Laboratory	12.76	53.66	7.22	127.14	9.26
39	E-A-R Specialty Composites Corporation	10.39	0.00	0.00	0.00	0.15
25	Edgemoor Materials, Inc.	4.90	2.90	5.40	0.30	3.19
37	Free - Flow Packaging Corporation	109.11	0.55	0.11	0.00	0.01
2	General Chemical Corporation	0.56	64.18	8.08	709.42	39.89
20	General Motors	894.12	117.34	15.58	245.02	17.41
22	Georgia - Pacific	16.94	48.86	0.23	1.51	46.87
8	Hercules Incorporated Research	2.32	40.88	3.74	117.61	8.00
26	Medal L. P. - Willow Bank	22.18	2.03	0.51	0.00	0.04
10	Medical Center of Delaware	3.39	37.20	3.39	94.36	4.64
30	New Castle Hot Mix, Inc.	2.30	2.09	2.61	0.00	0.64
41	New London Textile, Inc.	12.40	0.05	0.01	0.00	0.00
16	NORAMCO of Delaware, Inc.	19.14	3.15	18.14	0.01	0.07
4	NVF Company Yorklyn	0.52	102.63	9.33	272.27	18.54
18	Rockland Technologies, Inc.	6.77	0.00	0.00	0.00	0.00
40	Rodel Inc.	15.28	1.33	0.00	0.00	0.00
3	Sun Refining & Marketing	180.44	1141.90	95.11	210.98	16.13
23	Tilcon - Terminal Avenue	6.38	3.75	7.00	0.00	0.83
35	University of Delaware	6.69	77.24	10.19	212.74	9.83
33	Westvaco Corporation	29.54	0.80	0.16	0.00	0.02
12	Wiley Cork Company	10.13	0.14	0.04	0.00	0.00
27	Wilmington Chemical Company	0.00	0.00	0.00	0.00	0.00
7	Wilmington Finishing Co.	20.92	13.58	3.25	2.67	0.45
14	Wilmington Waste Water Treatment Facility	272.55	10.33	0.12	1.47	0.02
31	Zeneca Specialties	1.20	0.00	0.00	0.00	0.00
	TOTALS	**3756.96**	**10742.6**	**7664.22**	**20475.5**	**948.98**

dioxide and nitrogen dioxide. Because many of the sulfur and nitrogen compounds can travel long distances, remote sources such as coal-burning power plants in the Ohio River valley impact the Piedmont area. Some computer modeling work, combined with extensive monitoring in the state of Maryland, indicates that 70% or more of the sources contributing to the acid precipitation in Maryland are located outside the state (Maryland Critical Loads Study, 1995); this is probably representative of the situation in the Piedmont Basin as well.

Air Toxics

The emissions data base most directly involved with air toxics is the Toxics Release Inventory. As recorded by this data base, sources of air toxics include many types of large and small industrial facilities. In 1994, the most recent year available, the number of reporting facilities located within the Piedmont Basin was 28, which represents 39% of all the inventoried facilities in Delaware. Twenty-two of the 28 facilities indicated having air releases of one or more Toxics Release Inventory chemicals and are shown on Map 24.

There are several caveats that must be considered in evaluating Toxics Release Inventory data. Most data are derived from engineering estimates as opposed to actual measurements. In addition, only certain types of facilities and only certain chemicals are covered. Sources of air toxics that are not covered include on- and off-road mobile sources and non-manufacturing facilities. Finally, exposure estimates cannot be made from the annual amounts re-ported and it is therefore difficult to assess the effects of the releases on humans or the environment. Please see the *Annual Toxics Release Inventory Report,* available from the Air Quality Management Section, for more information.

Positive Initiatives

Many of the programs initiated to control pollutants in ambient air have the added benefit of reducing deposition to land and water surfaces as well. Since the sources impacting the Piedmont Basin are not limited to Delaware, this discussion covers regional and national as well as state initiatives. The following is a brief listing of actions currently under way that will affect the air quality in the Piedmont Basin.

The Clean Air Act Amendments of 1990 represent a comprehensive nationwide attempt to address ambient air pollution, and many sections impact the Piedmont Basin's ambient air. Included are requirements to:

- Reduce nitrogen oxide emissions to improve ozone. The Ozone Transport Commission agreement calls for nitrogen oxide emission reductions from large boilers (> 250 mm btu/hour rating) from 1990 levels of 65% by 1999 and 75% by 2003; Delaware will therefore reduce nitrogen oxide emissions by 24 tons per day by 1999. This will also result in significant improvements in nitrogen deposition as well.
- Reduce sulfur dioxide emissions nationally to reduce acid deposition; the goal is a reduction of 10 million tons per year from 1980 levels. This represents a reduction of approximately 40%. There is also a national cap on major point-source emissions.
- Expand Maximum Available Control Technology standards to sources of toxic emissions not previously covered. Standards nearing completion will result in reduced emissions of benzene from wastewater treatment plants by 95%, emissions of chrome from cooling towers by nearly 100%, and significantly reduced emissions of tetrachloroethylene (perchloroethylene) from dry cleaning and chrome electroplating.
- Reduce volatile organic compounds emissions to attain the ozone standard. The Clean Air Act Amendments require Delaware to reduce peak ozone-season daily emissions in New Castle and Kent counties by 15% from 1990 to 1996 with further reductions of at least an additional 3% per year to reach attainment of the ozone standard by 2005. (Please see Appendix for more detailed information.)
- Reduce Toxics Release Inventory emissions from current (1994 inventory) levels by a further 30% by 2000.
- Implement Title V of the Clean Air Act Amendments by establishing a new operating permit program for all major stationary sources of air pollutant emissions. This program will ensure that both industry and the public are knowledgeable as to the rules and regulations that all major stationary sources are required to meet.

Many of these actions will have added benefits as control technologies implemented for one type of pollutant can also reduce emissions of other types of pollutants. For example, since many volatile organic compounds are also considered air toxics, overall reductions aimed at improving ozone will result in lower ambient concentrations of air toxics as well.