



2.4 AIR QUALITY

2.4.1 INTRODUCTION

In 1970, Congress amended the Clean Air Act of 1963 and authorized the EPA to establish National Ambient Air Quality Standards (NAAQS) for pollutants shown to threaten human health and welfare. Primary standards were set according to criteria designed to protect public health, including an adequate margin of safety to protect sensitive populations (e.g., children, asthmatics, and the elderly). Secondary standards were set according to criteria designed to protect public welfare (decreased visibility, damage to crops, vegetation, buildings, etc.).

Six principal pollutants currently have NAAQS: ozone (O₃), carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), particulate matter (PM₁₀), and lead (Pb). These are commonly referred to as the *criteria* pollutants. When air quality does not meet NAAQS, the affected area is said to be in non-attainment with NAAQS. Currently, there are no standards for acid rain, nitrogen deposition, or air toxics.

Delaware's land surface is relatively flat, and because of this condition, outdoor or ambient air moves fairly smoothly through and is generally well mixed across the entire state. The predominant airflow is from west to east. In the summer, southwesterly winds prevail while in the winter northwesterly winds are dominant.

2.4.1.1 Status

Pollutant levels

Air quality in the Chesapeake Basin meets all NAAQS except for ozone, with PM_{2.5} status yet to be determined. New Castle and Kent counties are classified as serious non-attainment areas for ozone while Sussex County meets the one-hour standard, but not the new eight-hour standard. Acid rain monitors outside the Chesapeake Basin show precipitation to average around pH 4.2 to 4.3 (acidic).

Delaware has one air monitoring station located within the Chesapeake Basin. This station is located at the Shipley State Service Center in Seaford. Pollutants monitored include ozone (April through October), sulfur dioxide, and particulate matter. Descriptions of these pollutants, as well as their health effects, are summarized as follows.

Ozone (O₃)

Ozone is a highly reactive gas that is the main component of smog. While ozone in the upper atmosphere (stratosphere) is beneficial because it absorbs ultraviolet light, it is considered a pollutant in the lower atmosphere (troposphere). It is a strong respiratory irritant that affects

CONTENTS

AIR QUALITY

2.4.1 Introduction	57
2.4.1.1 Status	57
2.4.2 Central Issues	60
2.4.2.1 Ozone	60
2.4.2.2 Pollutant Deposition	61
2.4.2.3 Air Toxics.	62
2.4.2.4 Changing National Ambient Air Quality Standards	63
2.4.3 Positive Initiatives	64
2.4.3.1 Brief Discussion of the Clean Air Act of 1990 and Requirements	64
2.4.4 Data Gaps and Recommendations	64
2.4.5 References	64
2.4.6 Addendum #1 – Emission Estimation Approach .65	
2.4.6.1 Point Sources	65
2.4.6.2 Stationary Area Sources	65
2.4.6.3 On-Road Mobile Source Emissions	65
2.4.6.4 Off-road Mobile Sources	65
2.4.7 Addendum # 2 – Progress Toward Attainment of the NAAQS for Ozone	66

Figures:

Figure 2.4-1 Sulfur Dioxide Trend at Seaford Monitoring Station	58
Figure 2.4-2 PM ₁₀ Trend at Seaford Monitoring Station	58
Figure 2.4-3 Distribution of Peak Ozone Season Daily VOC Emissions	59
Figure 2.4-4 Distribution of Peak Ozone Season Daily NO _x Emissions	59
Figure 2.4-5 Distribution of Peak Ozone Season Daily CO Emissions	59
Figure 2.4-6 Number of Days Exceeding Ozone Standard	61

Tables:

Table 2.4-1 Exceedances of 1-hour Ozone Standard (ppm).	60
Table 2.4-2 Seaford Site Envirochem Sorbent Tube Results (ppb)	63

See Map section at end of document:

Map 2.4-1 Air Sources

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 elevation sites.

Ozone is not emitted directly by a pollution source but is formed in the atmosphere by the reaction of nitrogen oxides and volatile organic compounds in the presence of sunlight and warm temperatures. Therefore, ozone is basically a problem only in the summer months. In Delaware, the season for ozone monitoring runs from April through October.

Ozone trends are difficult to measure because of the complex nature of weather. In general, ozone concentrations in recent years (1990s) have been significantly lower, with fewer exceedances of the standard, than during similar weather patterns in the 1980s. Improvement is due to corrective 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 (SO₂)

Sulfur dioxide is a pungent, poisonous, colorless gas. It is an irritant that can interfere with normal breathing functions, even at low concentrations. It aggravates respiratory diseases such as asthma, emphysema, and bronchitis. The severity of these condition can be magnified as particulate levels increase. Sulfur dioxide can also cause plant chlorosis and stunted growth.

Sulfur dioxide levels declined rapidly in the 1970s and have remained fairly steady over the last 10 years. *Figure 2.4-1* depicts the trend at the Seaford monitoring station. The improvement is largely due to the change to low or lower sulfur fuels in power plants as well as to improved emission control technologies.

Particulate Matter (PM₁₀)

PM₁₀ 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. PM₁₀ 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 PM₁₀ 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).

Figure 2.4-1
SULFUR DIOXIDE TREND AT SEAFORD MONITORING STATION

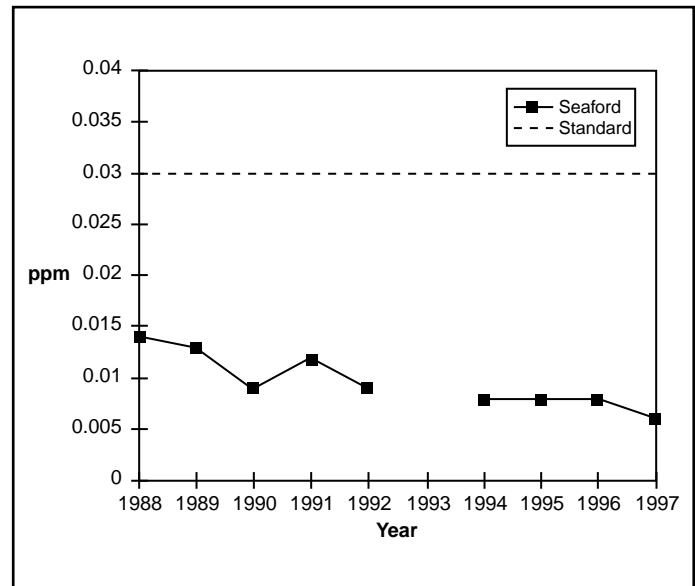
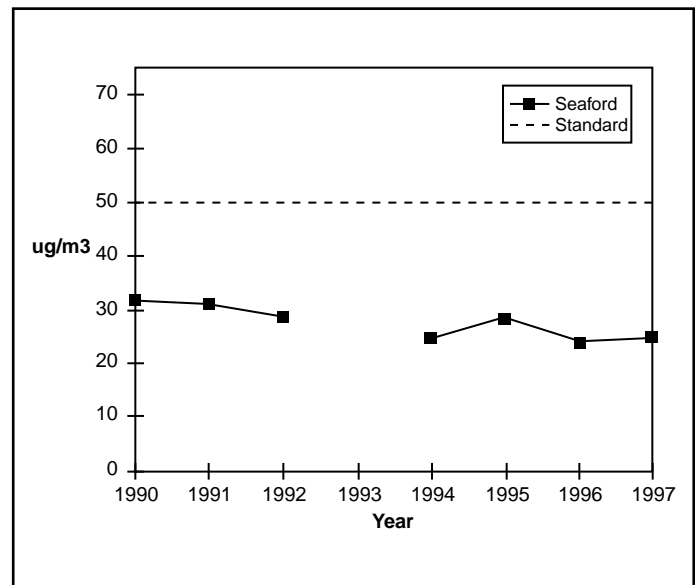


Figure 2.4-2
PM₁₀ TREND AT SEAFORD MONITORING STATION



There are other pollutants with NAAQS that presently are not monitored in the Chesapeake Basin, but are monitored elsewhere in Delaware. These pollutants include nitrogen dioxide, carbon monoxide, and lead.

Sources

The federal Clean Air Act Amendments of 1990 (CAAA) required Delaware to inventory baseline air emissions

Figure 2.4-3
DISTRIBUTION OF PEAK OZONE SEASON DAILY VOC EMISSIONS

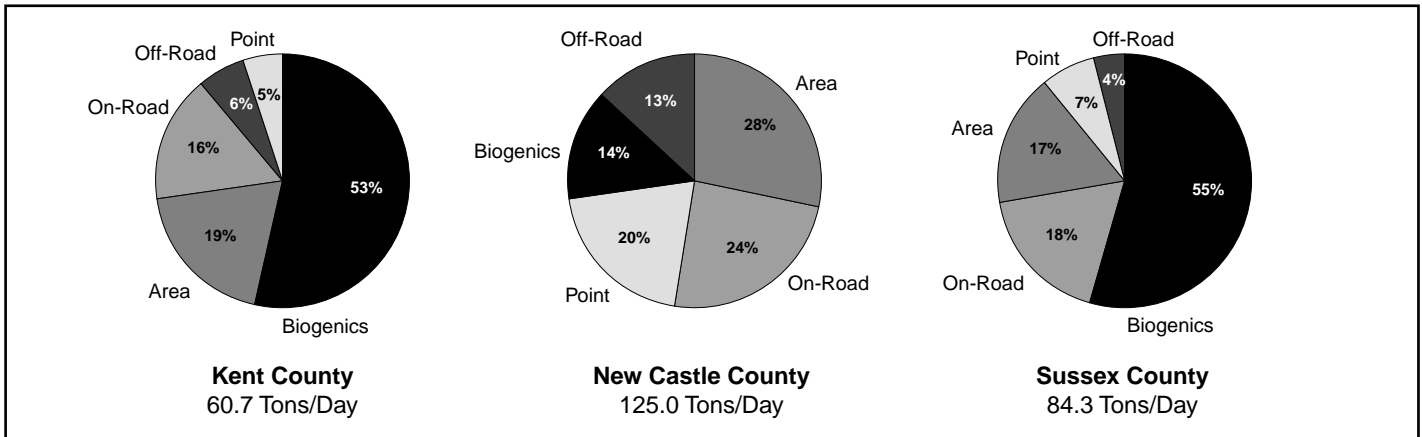


Figure 2.4-4
DISTRIBUTION OF PEAK OZONE SEASON DAILY NO_x EMISSIONS

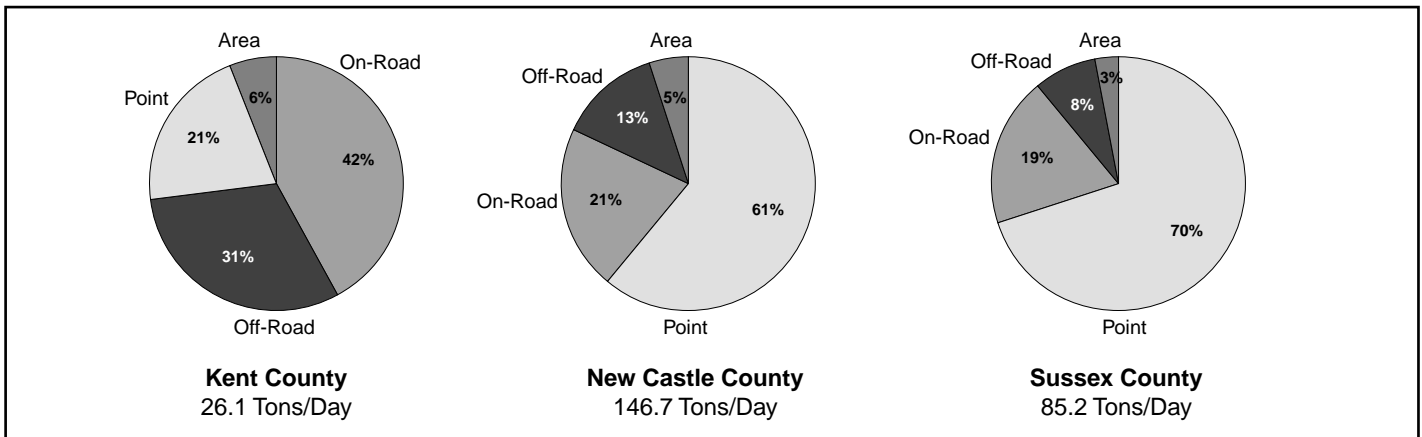
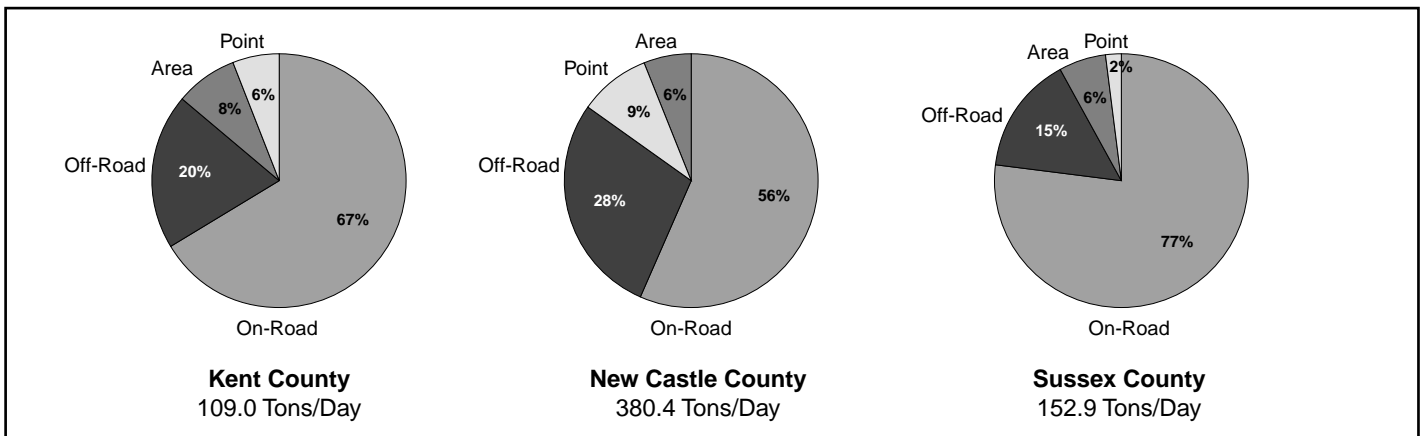


Figure 2.4-5
DISTRIBUTION OF PEAK OZONE SEASON DAILY CO EMISSIONS



beginning in 1990. Delaware must subsequently inventory air emissions every three years in order to show reasonable progress toward attainment of the NAAQS (see Addenda 1 and 2). These inventories are prepared on a countywide basis. Sources of air emissions are classified by the nature of the emissions and the physical characteristics of the emitter. Source categories of air emissions within the Chesapeake Basin for which data are collected include stationary point sources, stationary area sources, mobile sources, and biogenic sources. *Figures 2.4-3 through 2.4-5* illustrate VOC, NO_x, and CO emissions by county and source category.

The five source categories are defined as follows:

Stationary Point Sources

A stationary point source is defined as a facility that emits 10 tons per year (TPY) or more of volatile organic compounds (VOCs) or 100 TPY or more of oxides of nitrogen (NO_x) or carbon monoxide (CO). (see *Map 2.4-1 Air Sources*)

Stationary Area Sources

Stationary area sources represent a collection of many small, unidentified points of air pollution emissions within a specified geographical area, all emitting less than the level attributed to stationary point sources. Since these sources are too small and/or too numerous to be characterized individually, all area sources must be identified and emissions from these activities collectively estimated. Area sources can be grouped into four types of general activity categories:

1. Fuel combustion sources;
2. Solid waste incineration and open burning sources;
3. Fugitive dust sources; and
4. Volatile organic compound sources.

Mobile Sources

Mobile sources of air emissions are divided into on-road and off-road categories of activity. On-road emissions are those attributed to all vehicular traffic active on the state's highway network. Quantities of emissions are indirectly calculated through the use of both a travel demand model and a mobile emissions simulation model. The off-road emissions category includes a diverse set of source types. The movement of sources in this category occurs on surfaces other than the public highway system and includes the following sources: aircraft, locomotives, marine vessels, and other off-highway vehicles and equipment. These emissions are estimated through a series of complex simulation equations. Pollutant emissions estimated for these two categories during the statewide inventory process are VOCs, NO_x, and CO.

Biogenic Sources

Biogenic air emissions are those which originate from naturally occurring sources, with vegetation being the primary contributor. Air pollutant emissions from these sources are estimated through a computer simulation model. As NO_x and CO emissions from natural sources are negligible, only VOC emissions were estimated for this category during the statewide inventory process.

Air Toxics Sources

As required by the federal government, more than 650 toxic chemicals are subject to release reporting by industrial and manufacturing facilities on an annual basis. Sources of air toxics include many types of large and small industrial facilities, as well as mobile sources. The Toxic Release Inventory, prepared by the Department, contains annual data from specific larger industrial facilities that manufacture, process, and/or use toxic materials.

2.4.2 CENTRAL ISSUES

2.4.2.1 Ozone

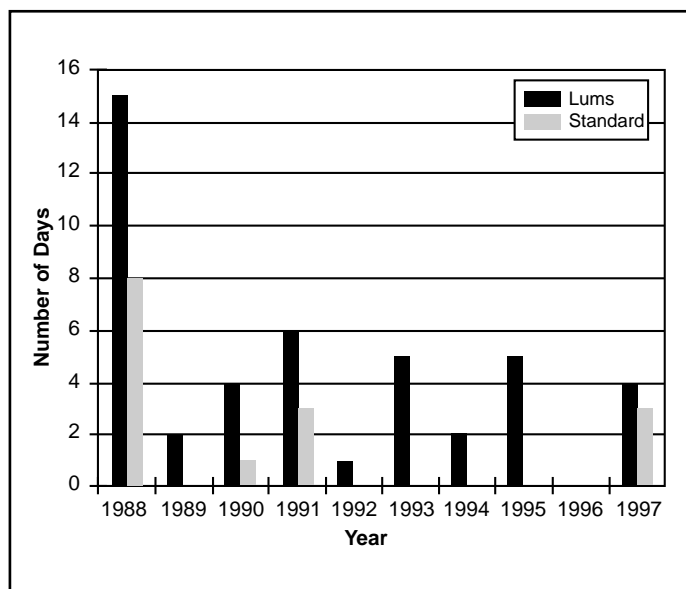
Ambient Concentrations

In the Chesapeake Basin, maximum ozone levels usually occur in the afternoon or early evening on hot, sunny days. During most high ozone days, the concentrations of ozone are greater in the northern part of the Basin and are often associated with light southwesterly winds. The highest ozone levels in the southern part of the Basin usually occur with a westerly wind that places towns in this area directly downwind of Washington, D.C.

In 1997, there were three days when ozone levels in the Town of Seaford (in the southern part of the Chesapeake Basin) exceeded the one-hour ozone NAAQS. The maximum ozone concentration was 0.132 ppm. The monitor located at Lums Pond evaluates the northern

Table 2.4-1
EXCEEDANCES OF 1-HOUR OZONE STANDARD (ppm)

DATE	LUMS POND	SEAFORD
20 June	0.127	
24 June	0.146	
25 June		0.132
14 July	0.140	
16 July		0.127
17 July	0.125	
28 July		0.125

Figure 2.4-6**NUMBER OF DAYS EXCEEDING OZONE STANDARD**

part of the Basin. This monitor recorded four days with exceedances, and a maximum one-hour concentration of 0.146 ppm. It should be noted that the exceedance days in the northern and southern portions of the Basin occurred on different dates (*see Table 2.4-1*), reflecting the difference in prevailing wind direction on those days.

Regional Transport Versus Local Sources

The regional transport of ground-level ozone and ozone precursors over long distances is a recognized scientific fact and a serious regional problem in the eastern United States. For example, even if all emissions sources within the Basin were controlled, upwind sources such as Washington, DC, and Baltimore, MD, would still produce episodes of unhealthy air quality and exceedances of the NAAQS within the Basin. Consequently, the states involved are working together to address the problem.

Two organizations — the Ozone Transport Assessment Group (OTAG) and the Ozone Transport Commission (OTC) — were formed under the authority of the federal Clean Air Act to examine the mechanisms and likely controls of ozone transport within the United States. The OTAG, made up of representatives from the 38 states east of the Rocky Mountains, prepared a report outlining specific recommendations to the EPA for the control of the transport of ozone and ozone precursors. OTAG disbanded in June 1997. The OTC addresses ozone and ozone precursor formation and transport within the Ozone Transport Region (OTR), which extends along the Atlantic coast from Virginia to Maine. This commission currently maintains a full-time staff and is comprised of governmental

leaders and environmental officials from all the member states, the District of Columbia, and the EPA.

Effects on Agriculture/Ecosystem

Ozone interferes with the ability of plants to produce and store food. Ozone weakens the plant and makes it more susceptible to injury from pests and other environmental stresses. Some species of plants are more sensitive to ozone than others. Susceptibility can also vary among individual plants within a species. Factors affecting the response of plants to ozone include environmental conditions (drought, soil conditions, etc.), presence of pathogens, and interactions with other plants, as well as the timing and duration of exposure to ozone. In general, studies of various crop species have shown that ambient ozone concentrations above the NAAQS cause decreases in crop yields.

Ozone also causes foliar (leaf) damage to plants. Trees that have been reported to show injury due to ozone include white pine, red spruce, and black cherry. Milkweed is another native plant species that is sensitive to ozone and has been used as an indicator of elevated ozone levels. Milkweed is also a good example of how ozone can impact an ecosystem. As milkweed is the only food source for the larva of the monarch butterfly, ozone damage to milkweed could indirectly affect the monarch butterfly population.

Vegetation damage from ozone is more strongly related to longer-term average levels of ozone than to one-hour peak concentrations. The new eight-hour primary standard for ozone is estimated to represent a level that would also be equally protective of plants. Therefore the secondary standard for ozone has been set equal to the primary standard.

2.4.2.2 Pollutant Deposition

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

Dry Deposition — Dry deposition consists of any type of particle that is deposited on a surface. Organic as well as inorganic compounds and trace metals can be a part of this deposition. Delaware has yet to monitor dry deposition in the Chesapeake Basin.

Sulfur Compounds — Sulfur dioxide can bind to dust particles and aerosols in the atmosphere, traveling long distances on the prevailing winds. It can be oxidized to a sulfate ion (SO₃) and combine with water vapor to form sulfuric acid and fall as acid rain. Sulfur compounds also contribute to visibility degradation. The only current monitoring of sulfur compounds in the Chesapeake Basin is for SO₂ (as described previously).

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. There is no current monitoring of nitrogen compounds in the ambient air of the Chesapeake Basin.

“Acid Rain”

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

The National Atmospheric Deposition Program (NADP) reported an improvement in the acidity of precipitation in 1995, particularly in the Mid-Atlantic and New England regions. Although there is no current monitoring of acid rain in the Chesapeake Basin, the NADP data indicate widespread improvements that include the area of the Chesapeake Basin.

Nitrogen

Nitrogen compounds deposited as either acid rain or dry deposition contribute to the total nutrient loading in a watershed. Studies conducted in the Chesapeake Bay Program indicate that 21 to 27 percent of the total nitrogen loading to the Chesapeake Bay is a result of atmospheric deposition. Computer modeling studies have defined the Chesapeake Bay Airshed (the region that contributes 80 percent of the deposition falling into the bay watershed) as approximately five times larger than the watershed. Recent studies also have indicated that industrial sources such as power plants contribute the largest portion of nitrogen deposition in the western part of the Chesapeake Bay watershed, while mobile sources contribute the largest portion of nitrogen in the eastern part, which includes the Delaware Chesapeake Basin (EPA, 1997).

Although Delaware does not monitor for nitrogen deposition in the Chesapeake Basin, data from the NADP monitors can be used to estimate deposition rates. Data from the latest annual NADP report show wet deposition rates of 6.8 kg/ha in the area of the Delmarva Peninsula (NADP, 1998).

2.4.2.3 Air Toxics

Air toxics is a term often used to refer to chemicals that are toxic or suspected of producing a toxic response through human exposure. The complex chemical composition of these compounds, as well as the great number of them, makes comprehensive monitoring difficult. In northern Delaware, the Department has conducted limited monitoring for specific compounds in the City of Wilmington and in some areas near large point sources.

Ambient Concentrations

There are currently no national ambient air standards for air toxics. Ambient monitoring in the Seaford area is conducted by using sorbent tubes and analysis by GC/MS. Samples are collected for 24 hours every sixth day. Sampling began in January 1997 and ran through the end of 1998. Average concentrations of all chemicals monitored have been less than one part per billion (ppb). Results (through October 16) are shown in *Table 2.4-2*.

Sources/Controls

Three programs currently possess data and information regarding toxic air emissions from point sources within the Chesapeake Basin. Mobile sources of toxic air emissions other than VOCs, NO_x, and CO are not quantified at this time.

Annual Point Source Inventory – This inventory is compiled annually. It covers emissions of VOCs, NO_x, CO, SO₂, PM₁₀, TSP, and Pb from facilities that are major emitters or potential major emitters of at least one of these pollutants. This inventory has been generated since 1990 and covers 14 facilities within the Chesapeake Basin (refer to Site Index Database). Currently, 1990, 1992, and 1993 are completed; 1994 is in draft form. There are currently no written reports of these inventories, but emissions summary printouts can be generated from the computer database, *I-STEPS*.

Toxic Release Inventory – The Toxics Release Inventory (TRI) contains annual data from large industrial facilities that manufacture, process, or otherwise use toxic chemicals. Fourteen facilities located within the Chesapeake Basin (all within the Nanticoke Watershed) have reported to the TRI program since 1988. Twelve of these facilities have reported for 1998, the most current reporting year. Of these twelve, seven reported the release of toxic chemicals to the air. Refer to the Site Index Database's facility list as well as 1996 air-release data from facilities.

The Permitting & Compliance Group of the Air Quality Management Section maintains air permits for various processes that emit air toxics. While these permits do not provide actual emissions data, they do provide information regarding the potential to emit and the controls that exist to reduce that emission. Specific toxic chemicals, called Hazardous Air Pollutants (HAPs), are regulated under these permits.

Table 2.4-2
SEAFORD SITE ENVIROCHEM SORBENT TUBE RESULTS (ppb)

COMPOUND	1997 ANNUAL AVERAGE	MAXIMUM 24-HR AVERAGE	RANGE OF 1997 ANNUAL AVERAGES IN DE
1,1,1-Trichloroethane	0.11	0.37	0.07 – 0.13
Benzene	0.20	0.65	0.14 – 0.45
Methyl Isobutyl Ketone (MIK)	0.00	0.02	0.00 – 0.12
Toluene	0.27	0.98	0.27 – 1.10
Tetrachloroethene	0.05	0.20	0.03 – 0.35
Chlorobenzene	0.00	0.02	0.00 – 0.05
Ethyl benzene	0.05	0.18	0.05 – 0.23
m,p-Xylenes	0.13	0.49	0.13 – 0.62
Styrene	0.01	0.04	0.01 – 0.07
o-Xylene	0.06	0.25	0.06 – 0.33
m-Dichlorobenzene	0.00	0.02	0.00 – 0.01
p-Dichlorobenzene	0.02	0.07	0.02 – 0.15

2.4.2.4 Changing National Ambient Air-Quality Standards

Attainment vs. Non-Attainment

The EPA defines reasonable progress towards attainment of the ozone standard as a 3 percent annual reduction in volatile organic compounds and/or NO_x from 1990 levels (see Addendum 2). In 1994, the Department submitted a 15 percent Volatile Organic Compound Reduction Plan to the EPA. The plan targeted sources such as heavy industry, gasoline stations, and motor vehicles. As an example of reduction, companies were required to reduce volatile emissions from paints and solvents, and control leaks of volatile production materials and gases in manufacturing processes. Also, gasoline stations were required to capture emissions from refueling. Finally, the Department issued a summertime ban on all open burning. The plan also included a reduction in VOCs from the use of reformulated gasoline, a new type of fuel mandated by the federal government for use in ozone non-attainment areas.

Delaware must demonstrate, through complex atmospheric computer modeling, that it will attain the ozone standard by 2005. Many new strategies to control VOCs and NO_x emissions will need to be implemented before the year 2005 to produce the necessary improvements in air quality. If Delaware fails to meet the mandated reductions in air pollutants, it will lose federal highway funding as well as face stricter emission controls prescribed by the EPA.

To meet the 2005 target, the Department estimates that both VOCs and NO_x may have to be reduced by as much

as 75 percent from 1990 levels. Alternative reduction strategies range from additional controls on dry cleaners and other small businesses to adoption of a far more comprehensive motor vehicle emission inspection and maintenance program and required sale of ultra-low polluting and electric cars. More emphasis also may have to be placed on controlling pollution from household and recreational sources such as lawn mowers, motor boats, and barbecue grills.

In response to new research on the effects of ozone on human health, the EPA revised both the form and the level of the ozone standard in July 1997. The new standard is an eight-hour average of 0.08 ppm. An area will attain this standard when the three-year average of the annual fourth highest daily maximum eight-hour concentration is less than or equal to 0.08 ppm. This standard will apply to all areas after they have met the one-hour standard as described above and have three complete years of monitoring data indicating attainment. Areas will not be officially designated as meeting or failing to meet the eight-hour standard until 2005 at the earliest. Current monitoring data indicate that the entire state of Delaware, including the Chesapeake Basin, will not meet this new standard.

Fine Particulates

In 1996, the EPA completed its review of the PM₁₀ NAAQS. The result was a change in form of the PM₁₀ standards and the addition of new annual and 24-hour PM_{2.5} standards. These new standards are based on recent studies showing human health impacts from fine particulates, or PM_{2.5}, at

levels lower than the existing PM₁₀ standards. The new standards are designed to emphasize monitoring and evaluation of community-wide levels of fine particulates.

Fine particles are generated mainly by combustion processes. Sources include large point sources such as fossil-fuel burning power plants as well as mobile sources (both on- and off-road). Fine particles can be emitted directly from a source (primary pollution) or form in the atmosphere from combinations of compounds (secondary pollution). They can travel long distances due to their extremely small size and behave almost like a gas. This means that long-distance transport is more important for fine particles than coarse particles and regional and/or national control strategies will be needed to address air-quality problems.

There are limited data on ambient levels of PM_{2.5}, and no monitoring has been conducted yet in Delaware. Existing PM₁₀ data indicate that Delaware will not meet the new fine particulate standard and that concentrations will probably be higher in the northern urbanized areas of the state.

2.4.3 POSITIVE INITIATIVES

2.4.3.1 Brief Discussion of the Clean Air Act of 1990 and Requirements

Although the 1990 Clean Air Act is a federal law covering the entire country, the states do much of the work required to carry out the specific provisions within the Act. These provisions include the development of State Implementation Plans which define what steps each state will take in order to comply with the NAAQS and progress toward the required ozone reductions by the year 2005 (see addendum).

Under this law, the EPA sets limits on how much of a pollutant can be in the air anywhere in the United States. This ensures that all Americans have the same basic health and environmental protections. The law allows individual states to have stronger pollution controls, but states are not allowed to have weaker pollution controls than those set for the rest of the country.

2.4.4 DATA GAPS AND RECOMMENDATIONS

1. Adequate information currently exists to evaluate status and trends for the criteria pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead. Data collection and evaluation should continue unchanged.
2. The regional nature of the ozone problem makes it essential that state, regional, and federal agencies share data. Delaware currently works with other states, regional agencies, and the EPA to provide ozone data among the various states and agencies. The Department should continue these efforts.
3. Adequate information currently exists to evaluate the status and trends for PM₁₀. New particulate matter stan-

dards for PM_{2.5} have been enacted by the EPA and require the development of baseline data from which future reductions may be calculated.

4. The periodic ozone precursor emission inventories for VOCs, NO_x, and CO are compiled every three years. The inventories are comprehensive and cover all emission source categories. Emission inventories for SO₂, PM₁₀, TSP, lead, and toxics are performed annually but only for large point sources. More comprehensive inventories of these pollutants with the addition of PM_{2.5} are recommended in order to gain additional information on impacts to the Chesapeake and other basins. Impacts of emissions on the Chesapeake and other basins could also be improved by developing methods to enable aerial, mobile, and biogenic emissions to be illustrated in graphical form, such as on a Geographic Information System (GIS) map.
 - a. Explore options for acquiring the needed resources to produce comprehensive periodic inventories of SO₂, PM₁₀, TSP, lead, and toxics.
 - b. Develop a method to allocate aerial, mobile, and biogenic emissions to geographic basins, and graphically portray those emissions.
5. Atmospheric deposition is proving to be a major contributor to acidification, nitrogen loading, and toxification of waterways. There is currently little or no specific information on the impact of atmospheric deposition to the Chesapeake and other Delaware basins. It is recommended that options be explored for acquiring the necessary resources to conduct computer modeling and other research to quantify the impact of atmospheric deposition on the Chesapeake and other basins.
6. National studies have shown that high ozone levels cause crop damage and reduce yield, thus adversely impacting our food supply and causing millions of dollars in losses to the agricultural community. Little or no information is available on the level of crop damage and associated impacts on the Chesapeake and other Delaware basins. It is recommended that options be explored for acquiring the necessary resources to study and quantify the level of crop damage and associated impacts on the Chesapeake basins.

2.4.5 REFERENCES

- NADP. 1998. *National Atmospheric Deposition Program (NRSP-3)/National Trends Network*. NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820
- EPA. 1997. U.S. EPA. *Deposition of Air Pollutants to the Great Waters: Second Report to Congress*. Office of Air Quality Planning and Standards. EPA-453/R-97-011, June.

2.4.6 ADDENDUM #1 – EMISSION ESTIMATION APPROACH

2.4.6.1 Point Sources

A *point source* is defined as a stationary source facility that emits at least 10 tons per year (TPY) of volatile organic compounds (VOCs) or 100 TPY or more of NO_x, CO, SO₂, PM₁₀, total suspended particulates (TSP), or lead. The point source inventory represents estimated emissions from these facilities.

In general, one of three estimation methods is used. In order of preference, the estimation methods are (1) stack testing or continuous emissions monitoring; (2) material balance calculations; and (3) emission factor calculations based on units of throughput or activity. All data necessary to make the emissions estimations are collected by means of annual reporting by the facility. All point source data are entered into a computer database called *I-STEPS*.

2.4.6.2 Stationary Area Sources

Area source emissions are compiled once every three years for the Ozone State Implementation Plan (SIP) Inventory. The pollutants covered are VOCs, NO_x, and CO. Area source emissions are estimated by multiplying an emission factor by a known indicator of collective activity for each source category within the inventory area. An indicator is any parameter associated with the activity level of a source, such as production, employment, or population, that can be correlated with the air pollutant emission from that source.

In general, one of four factor-based emission estimation approaches is used to calculate area source emissions:

- ◆ Per-capita emission factors;
- ◆ Employment-related emission factors;
- ◆ Commodity consumption-related emission factors; or
- ◆ Level-of-activity-based emission factors.

A major portion of the work that goes into creating an area source inventory involves collecting information that defines the collective activity for the source category. Several methods are available for estimating area source activity levels and emissions:

- ◆ Treating area sources as point sources;
- ◆ Surveying local activity levels;
- ◆ Apportioning national or statewide activity totals to local inventory areas;
- ◆ Using per capita emission factors; or
- ◆ Using emissions-per-employee factors.

Source activity may fluctuate significantly on a seasonal basis. As area emissions are generally a direct function of source activity, seasonal changes in activity levels are examined closely. Emissions are calculated on a TPY basis and seasonally adjusted for peak ozone season daily emissions.

2.4.6.3 On-Road Mobile Source Emissions

On-road mobile source emissions are compiled once every three years for the Ozone SIP Emissions Inventory. Pollutants covered are VOCs, NO_x, and CO emitted by vehicles traveling on the Delaware highway system. The mobile source emissions inventory provides estimates of statewide emissions through the application of a network-based travel demand model. Two models of Delaware's highway system are available: one represents New Castle County, and the other, Kent and Sussex counties. These travel demand models are updated to 1993. They are adaptable to estimating vehicle miles traveled (VMT) for various temporal and seasonal conditions, and they have an extensive capability for forecasting future year VMT based on changes in land use and in the transportation system. The model networks include federal highway functional classes and local collector roads.

The New Castle County (NCC) travel model estimates for 1993 were derived from the traditional four-step trip generation, trip distribution, modal split, and trip assignment process. The Kent and Sussex counties (KSC) model is similar to NCC except for the modal split component. The NCC and KSC models generate 24-hour volumes representative of average annual daily traffic (AADT). The models were modified to also produce morning and evening peak-period traffic data with travel speeds representative of these periods. Subtracting the total peak-period data from the 24-hour data generated the off-peak hour data (20 hours). Further adjustments were made to represent the typical ozone day. The traffic data were adjusted to August for New Castle and Kent counties and to July for Sussex County.

The emission factors were developed by the Department using MOBILE5A, which is the EPA's most recent version of the computer model used to calculate VOCs, CO, and NO_x vehicle emission factors. These emission factors take into account numerous parameters that affect vehicle emissions. Parameters include county-specific vehicle registration, age distribution, an inspection and maintenance program, ambient temperatures appropriate for the ozone season, gasoline Reid Vapor Pressure; operating mode, and vehicle speeds.

2.4.6.4 Off-Road Mobile Sources

Off-road mobile source inventories are compiled once every three years for the Ozone SIP Emissions Inventory. Pollutants covered are VOC, NO_x, and CO. Off-road mobile sources are not calculated with the same methods as on-road mobile source emissions. The off-road mobile source categories are aircraft, marine vessels, railroad locomotives, race cars, and other off-road sources. The other off-road sources category encompasses miscellaneous equipment such as construction equipment, farm equipment, industrial equipment, lawn and garden equipment, motorcycles, and recreational vehicles. All emissions are estimated on an annual basis (TPY) and on a peak ozone season daily basis (TPD).

2.4.7 ADDENDUM #2 – PROGRESS TOWARD ATTAINMENT OF THE NAAQS FOR OZONE

The 1990 Clean Air Act Amendments (CAAA) contain provisions for the attainment and maintenance of the National Ambient Air Quality Standards (NAAQS). Control plans must be developed in designated non-attainment areas. Plan requirements vary depending on the severity of the individual area's air pollution problem.

One key requirement of the CAAA for moderate and above ozone non-attainment areas involves achievement of Reasonable Further Progress (RFP) toward the attainment of the NAAQS. States must demonstrate RFP by achieving at least a 15 percent reduction of peak ozone season daily volatile organic compounds (VOC) emissions from 1990 levels by 1996. In addition, states must offset any net growth projected from 1990 to 1996. A nine percent reduction of VOC or NO_x is required for every three years between 1997 and 2005. 2005 is the year in which, through the use of computer modeling, severe non-attainment areas must demonstrate attainment. Modeling results may indicate that reductions greater than the RFP reductions are required to achieve attainment of the ozone NAAQS.

Progress toward attainment of the NAAQS in the year 2005 is measured by periodic emission inventories conducted every three years, beginning in 1993. Actual air emission data are inventoried for reactive VOCs, oxides of nitrogen (NO_x), and carbon monoxide (CO) from point, area, and mobile sources.

Point sources, as defined for the 1990 base year and successive inventories, are those facilities/plants/activities

that have actual emissions greater than or equal to at least one of the following: 10 tons per year VOC, 100 tons per year NO_x, or 100 tons per year CO. Detailed plant, point, and process data are maintained by each point source. Area sources represent collections of many small air pollutant emitters existing within a specified geographical area. Because area sources are too small and/or too numerous to be surveyed and characterized individually, area source emissions must be estimated collectively. Mobile sources are represented by all forms of transportation (commercial, recreational, and private), as well as portable machinery and tools powered by internal combustion engines. Emissions for mobile sources are estimated through primary data, computer modeling, and collective estimates.

In 1994, the Department submitted a 15 percent VOC reduction plan for 1996 to the EPA. The plan targeted reductions through multiple-control strategies, including gasoline vapor collection, low-volatility coatings and solvents, and controlling leaks in manufacturing processes. Additionally, a summertime ban on open burning is in effect, and further reductions in VOCs will be achieved by requiring the use of reformulated gasoline.

Delaware must produce three more rate-of-progress plans for target years 1999, 2002 and 2005 that ensure an additional 9 percent reduction in VOCs. In addition, a Year 2005 model attainment demonstration must be completed. Many new emission control strategies must be developed and implemented to attain the ozone standard by 2005.