# Part 1: Environmental Contaminants

This section describes selected environmental contaminants in children's indoor and outdoor environments, including air, drinking water, and contaminants in soil and food.

## 1.1 Outdoor Air Pollutants

Outdoor air pollution is a complex mixture of gases and small particles of both natural and human origin. Its composition can vary significantly from one time or place to another. For regulatory purposes, there are two main categories of air pollutants: criteria air pollutants and air toxics.

### Criteria Air Pollutants

Criteria air pollutants are those regulated under EPA's Clean Air Act: ozone, lead, carbon monoxide, sulfur dioxide, oxides of nitrogen, and both fine and coarse particulate matter (PM). The standards for these pollutants are updated every few years by the EPA under the Clean Air Act, and are set at levels designed to protect public health with an adequate margin of safety.

- ***Ozone.*** Ground-level ozone, the major component of smog, is formed when emissions of volatile organic compounds (VOCs) and nitrogen oxides ($NO_X$) combine in the presence of heat and sunlight. The VOCs and $NO_X$ are emitted from many sources, including motor vehicle exhaust, industrial emissions, gasoline vapors, chemical solvents, and naturally occurring sources. Sunlight and hot weather work together to accelerate the chemical reactions and form harmful levels in the air, making ozone in Maryland primarily a summertime pollutant.

  Children, older adults, and people with lung disease can be affected by lower levels of ozone than healthy adults. Ground-level ozone can trigger symptoms, including chest pain, coughing, throat irritation, and congestion, and worsen bronchitis, emphysema, and asthma. Studies suggest that exposure over a long period of time can reduce lung function, cause additional cases of asthma in children who exercise outdoors, and increase asthma symptoms overall (AAP, 2004).

- ***Particulate Matter.*** Particulate matter consists of very small solids and liquid droplets suspended in the air. Particles that have a diameter of 10 micrometers or less are referred to as $PM_{10}$ or "coarse" particles. Particles with a diameter of 2.5 micrometers or less are called $PM_{2.5}$ or "fine" particles. Fine particles are small particles or liquid droplets that usually consist of acids, organic chemicals, or metals from combustion sources such as cars, trucks, and other engines, coal-fired power plants, and wood smoke. A significant portion can also form from chemical reactions in the air. Coarse particles tend to consist of larger, wind-blown soil or dust particles and allergens, such as fragments of pollen or mold spores.

  Particle pollution, especially fine particles, can get deep into the lungs. Studies have linked them to a variety of problems, including irritation of the airways, decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease. People with heart or lung diseases, children and older adults are the most likely to be affected. However, even healthy individuals may experience temporary symptoms if the levels are high enough.

The Maryland Department of the Environment maintains approximately twenty fixed monitors for criteria air pollutants, with the majority in the central, more heavily populated part of the state. This represents one of the more dense monitoring networks in the eastern

U.S. due to the cluster of large metropolitan areas in the state, despite Maryland's relatively small size (MDE, 2007). Results must be estimated for areas outside the reach of the monitoring network. Ozone behaves as a regional pollutant, meaning that county-wide estimates are generally accurate. Levels of PM are more strongly influenced by local conditions, meaning there is more uncertainty in county-wide estimates.

### Air Toxics

In addition to criteria air pollutants, there is another, larger group of 188 chemicals called air toxics (also called hazardous air pollutants) that are regulated under the Clean Air Act. Examples include benzene, trichloroethylene, mercury, and chromium. Air toxics have many sources in the environment. Their potential health effects are also diverse, ranging from cancer to asthma and respiratory problems, neurological problems such as learning disabilities, and other effects.

Specific numerical air quality standards do not exist for these compounds, but they are nonetheless regulated to achieve reductions in exposures with the goal of improved public health. The major regulated sources of air toxics include:

- ***Major point sources.*** Large industrial facilities such as chemical manufacturing plants, refineries, and waste incinerators.
- ***Area sources.*** Small stationary facilities such as dry cleaners and gas stations. Although emissions from individual area sources are relatively small, collectively their emissions can be of concern.
- ***Mobile sources.*** Cars, trucks, buses, farm and construction equipment, lawn and garden equipment, marine engines, aircraft, and trains.

### Indicator E1: Trends in Average Daily Peak Ozone Concentrations

Several measures indicate that ozone pollution in Maryland has decreased in recent years. There are fewer days with high ozone, lower maximum concentrations, shorter ozone episodes, smaller areas where ozone is above the standard, and a change in the state's designation from "severe non-attainment" to "moderate non-attainment" for ozone. Since 2002, an average of 2.5 weeks per year have experienced eight-hour ozone concentrations greater than or equal to 85 parts per billion (ppb) in contrast to the two months worth of exceedance days which existed in the 1980s (MDE, 2007). The sources of ozone are under better control through rules controlling the use and handling of volatile chemicals (40 percent reduction since 1990) and through controls and inspections on cars and other vehicles (50 percent reduction in vehicle emissions since 1990). Controls on the regional emissions of $NO_X$ since 2003 have had a notable impact on ozone levels.

Additional reductions in ozone will continue as new rules scheduled for power plants take effect in Maryland and upwind states. In 2008, EPA tightened the ozone standard to 75 ppb to better protect public health as recommended by newer health studies. This change is expected to trigger additional controls.

Figure 1 shows how ozone levels have changed in Maryland since the early 1990s. The curves represent an average of all eight-hour peak ozone values in Maryland grouped by four-year periods.

- Peak summertime ozone concentrations are declining in Maryland. The greatest drop occurred in the most recent period, from 2003 to 2006.
- Similar trends have occurred throughout the Mid-Atlantic states (not shown).

***Healthy People 2010:*** Objective 8-01 of Healthy People 2010 aims to reduce the proportion of persons exposed to air that exceeds the levels of U.S. EPA's health-based standards for harmful air pollutants.

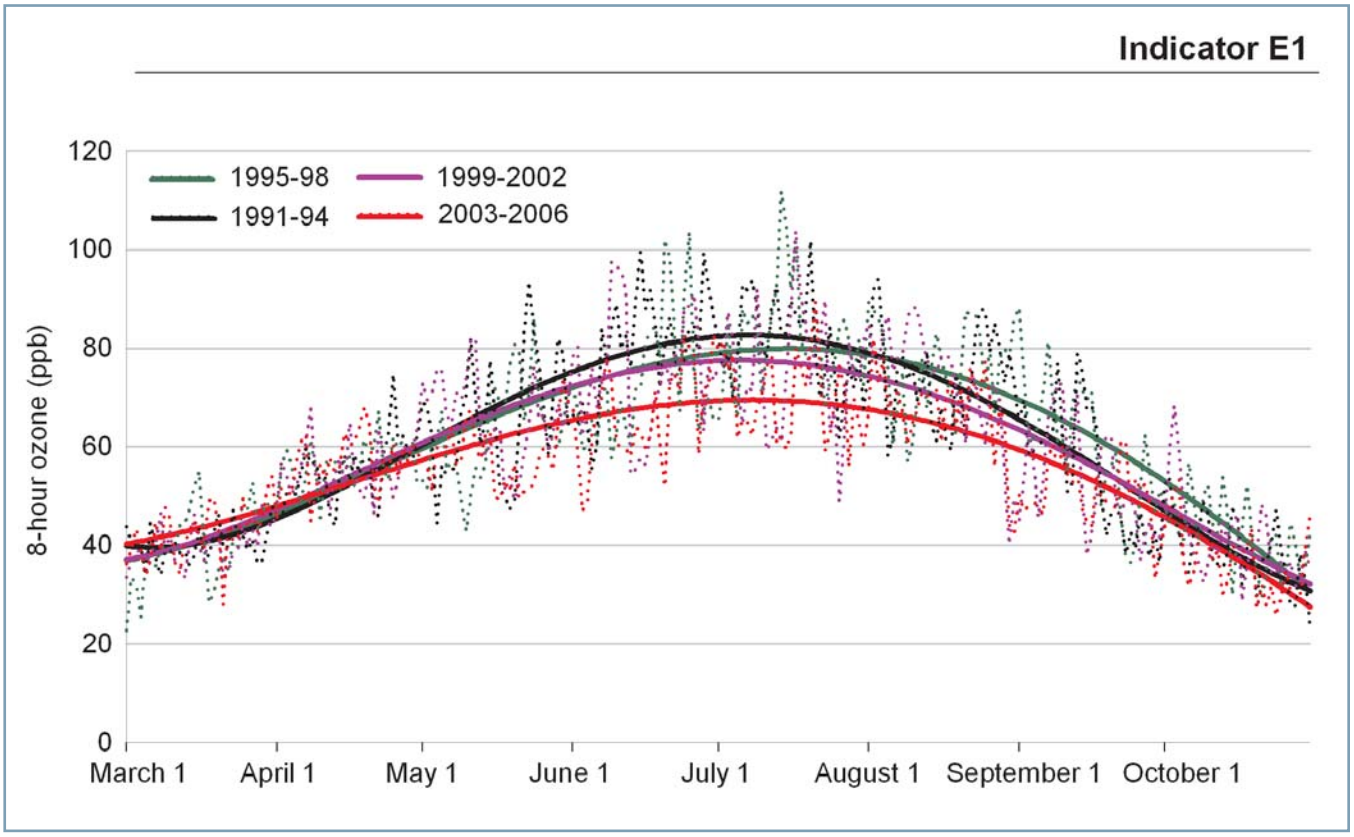


**Figure 1. Average Ozone Concentration in Maryland**
Source: Maryland Department of the Enrivonment

## Indicator E2: Distribution of Annual Ozone Concentrations

Harmful levels of ozone occur in both urban and rural areas from a combination of local sources and winds that can carry pollution hundreds of miles. Maryland has significant problems with pollution transported from other states. On the worst ozone days, over 50 percent of the air pollution in Maryland originates in other states, primarily from emissions generated by power plants in the Midwest (MDE, 2004; MDE, 2005). As a result of control measures, there has been a sustained decline in ozone precursor levels (particularly nitrogen oxides) throughout the eastern U.S. The maps in Figure 2 show where ozone levels were above the national standard over the past decade. While short-term ozone peaks are not represented, the maps do indicate where short-term peaks are most likely to have occurred. As with all interpolation techniques, there are inevitably areas of over or under estimation.

- Areas of ozone above the national standard (85 ppb) are smaller than a decade ago.
- Ozone levels are highest in suburban and rural areas as a result of upwind sources, heat and other weather conditions, the daily timing of ozone formation in the atmosphere, and the influence of other chemicals that scavenge ozone from the air.

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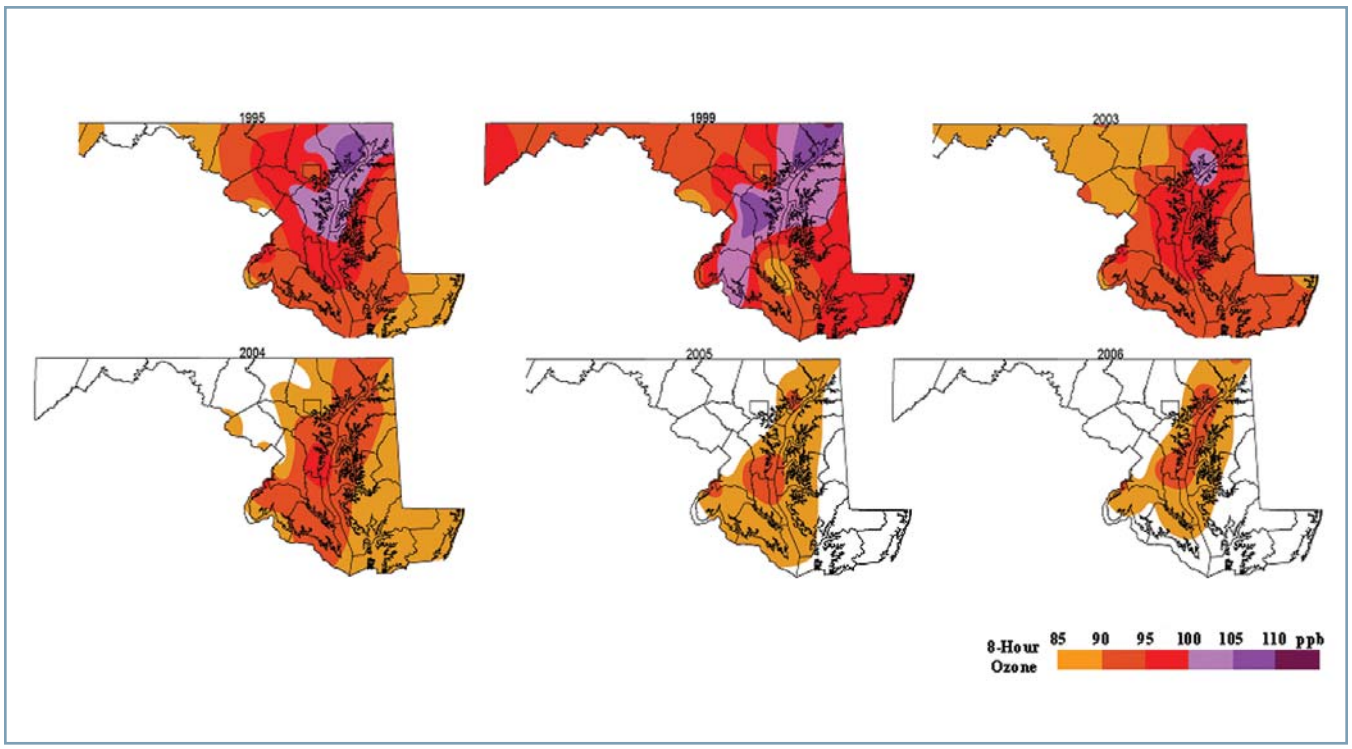


**Figure 2. Distribution of Ozone Concentration >85 ppb in Maryland, 1995 – 2006.**
Source: Maryland Department of the Enrivonment

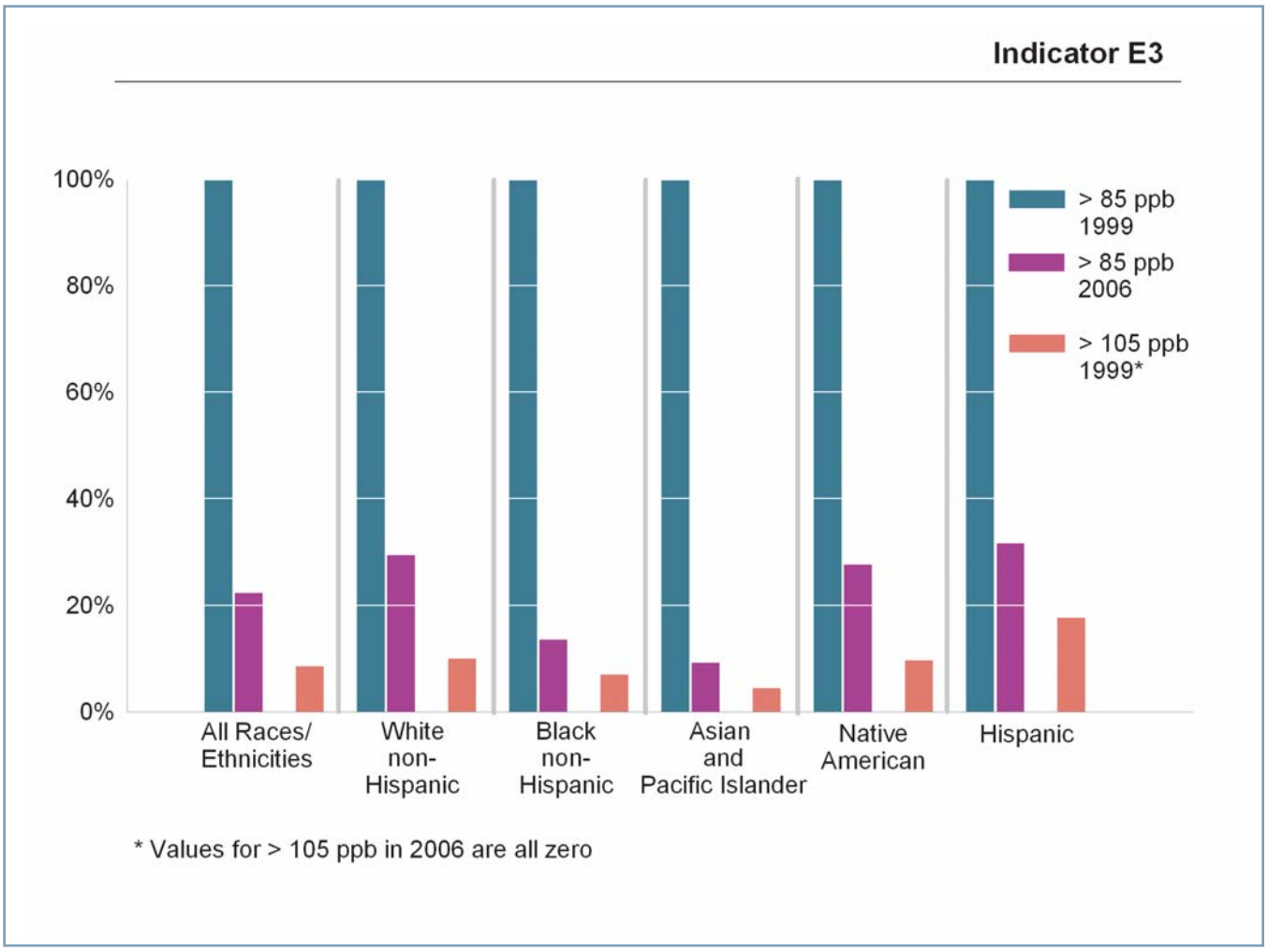


**Figure 3. Percentage of Children Exposed to Ozone Above the National Standard (85 ppb), 1999 – 2006**
Source: Maryland Department of the Enrivonment

## Indicator E3: Percent of Children Exposed to Annual Ozone Concentrations Above the National Standard by Race

In order to examine the distribution of exposures, the ozone maps in Figure 2 have been merged with census data to estimate ozone exposures among children by race. See Figure 3.

- The percentage of children exposed to elevated long-term ozone levels decreased in the period from 1999 to 2006.
- This decrease was seen in children of all ethnic groups.

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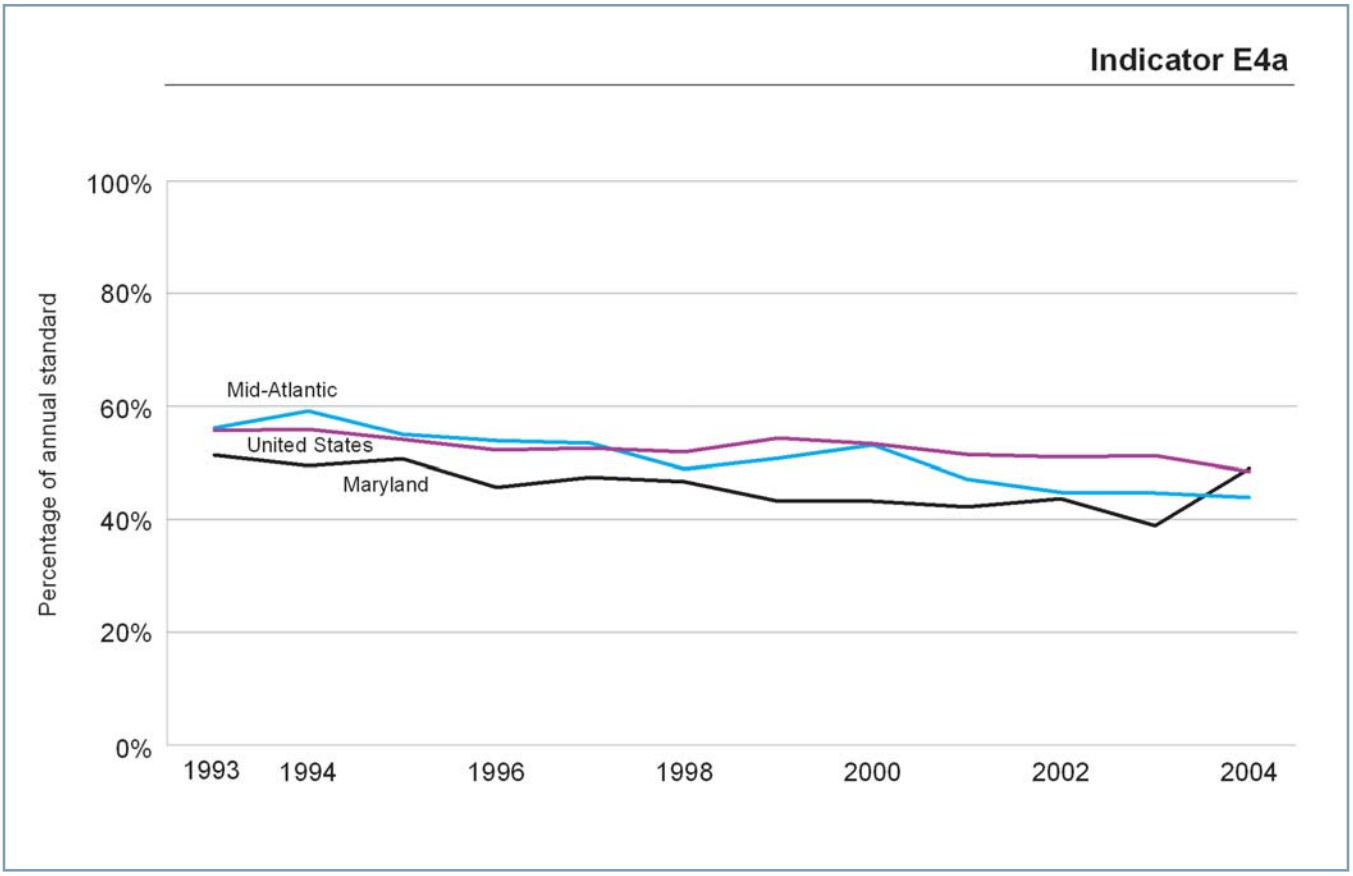


**Figure 4. Average Annual Concentrations of Particulate Matter, 1993 – 2004**
Source: US Environmental Protection Agency, Office of Air and Radiation, Aerometric Information Retrieval System

## Indicator E4: Trends in Annual Average $PM_{10}$ and $PM_{2.5}$ Concentrations

Figures 4 and 5 show statewide annual average $PM_{2.5}$ and $PM_{10}$ concentrations at stationary monitors and how they have changed relative to national standards. These average values have been adjusted to give more weight to counties with large numbers of children (see Appendix B).

- Since reliable $PM_{2.5}$ monitoring results became available in 2000, the statewide annual averages have remained near the national standard. The trend line suggests some improvement.

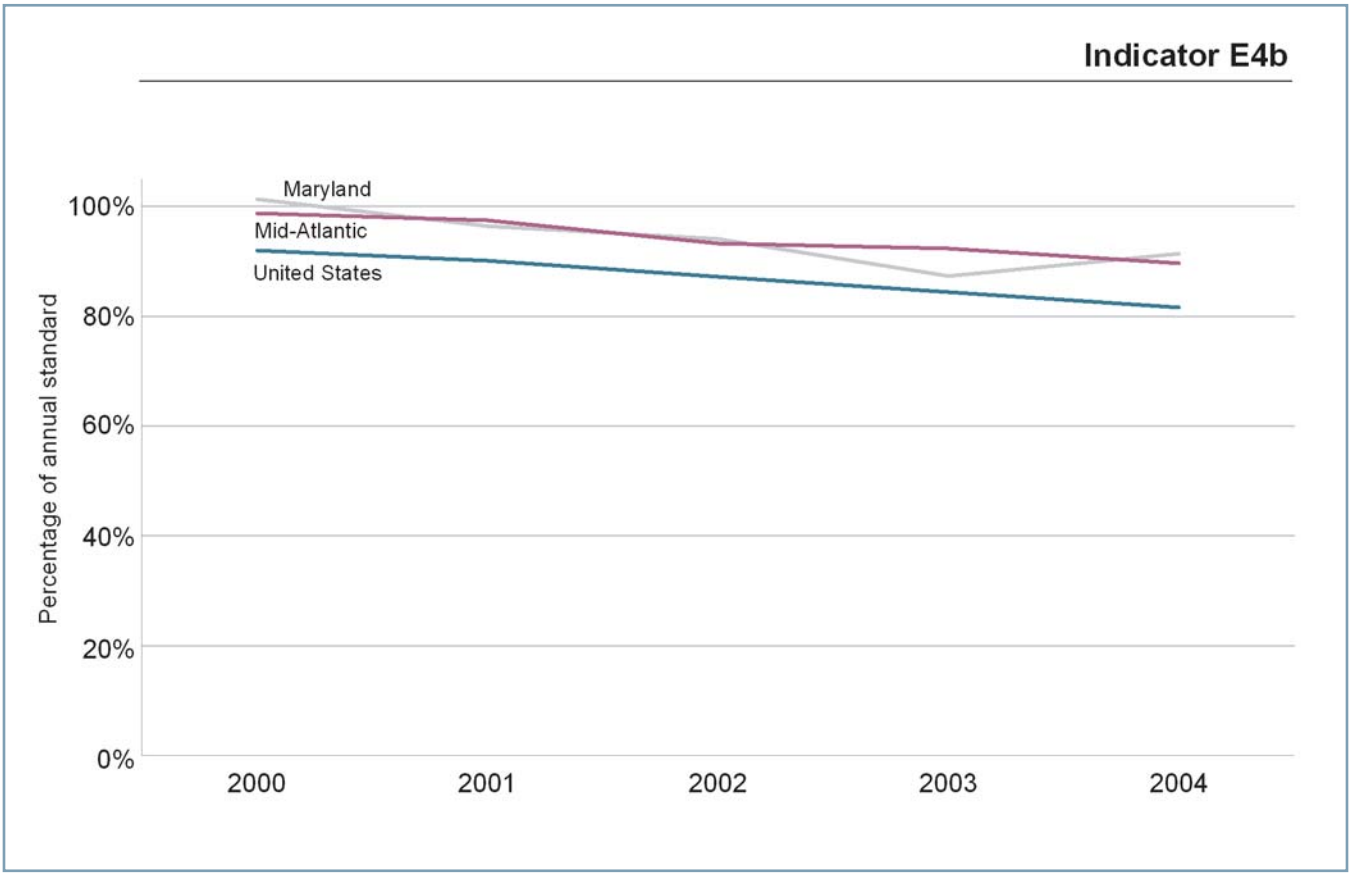


**Figure 5. Estimated Exposure of Children to $PM_{2.5}$, 2000 – 2004**

Source: US Environmental Protection Agency, Office of Air and Radiation, Aerometric Information Retrieval System

- $PM_{10}$ averages have remained at approximately one-half of the national standard since 1993.

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### Indicator E5: Percentage of Children Living in Counties Where Estimated Hazardous Air Pollutant Concentrations Were Greater Than Health Benchmarks

This indicator shows the extent to which outdoor air toxics in Maryland in 1999 created increased risks of cancer and other health effects (see Figure 6). A 1-in-100,000 cancer benchmark means that one additional case of cancer is expected to occur in a population of 100,000 people exposed for a lifetime to the air toxics levels similar to those existing in 1999. The 1-in-100,000 and 1-in-10,000 benchmarks are commonly used goals in the control of air pollution. The third benchmark deals with health effects other than cancer; it corresponds to a daily exposure to a combined level of air toxics having essentially no risk of deleterious non-cancer effects (Appendix A).

All sources of pollution (point, area, and mobile sources) and nearly all of the 188 air toxics are combined in these analyses. The exposures are assumed to be continuous over a lifetime. The analyses do not predict the risks of disease living close to specific sources or the risks associated with indoor air pollution.

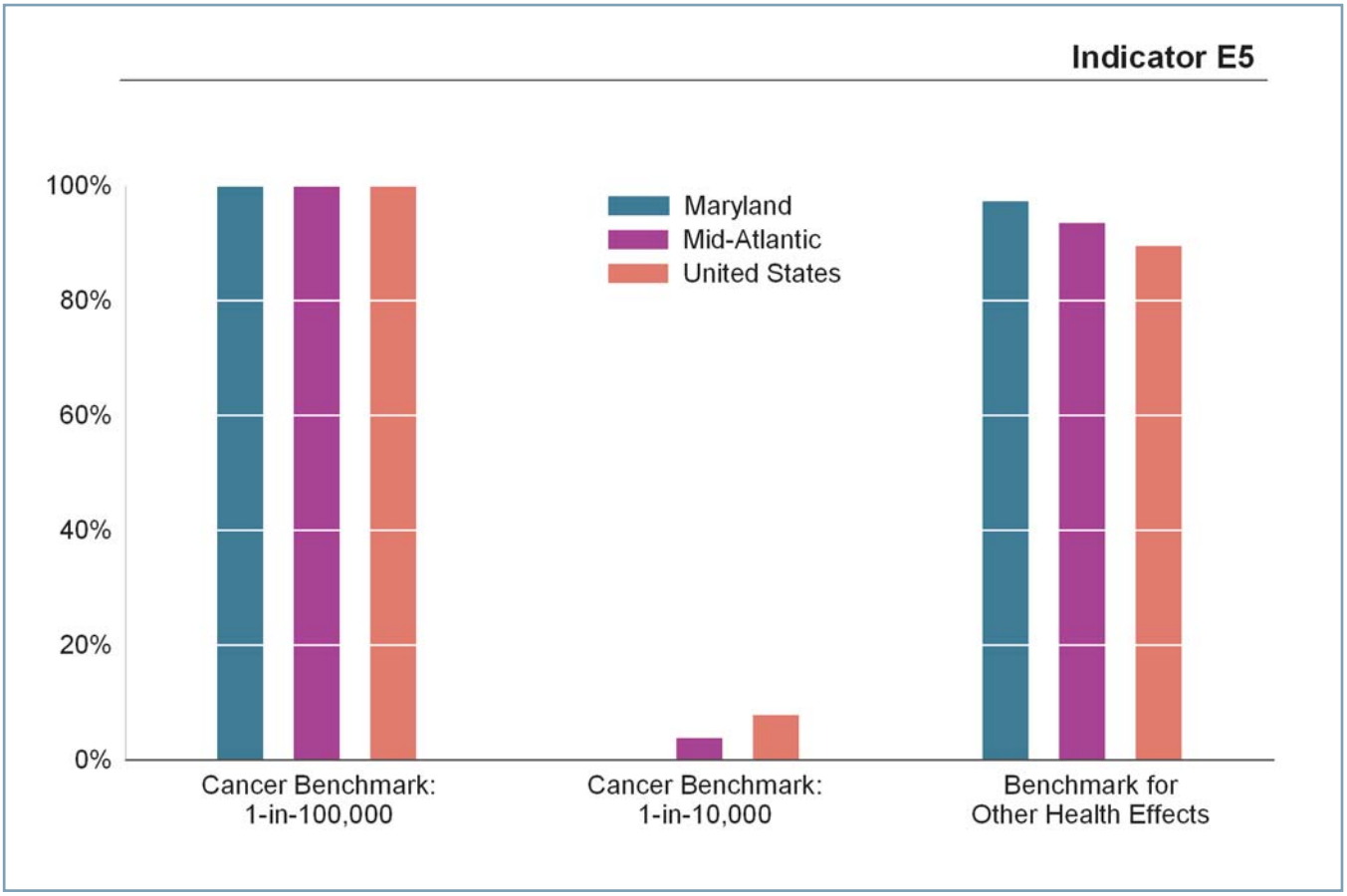


**Figure 6. Percentage of Children in Counties where Hazardous Air Pollutants Exceeded Benchmarks in 1999**
Source: US Environmental Protection Agency, National Air Toxics Assessment

- In 1999, all U.S. and Maryland children lived in counties where the combined concentrations of outdoor air toxics exceeded the 1-in-100,000 cancer risk benchmark. About 8 percent of U.S. children lived at concentrations above the 1-in-10,000 cancer risk benchmark; the percentage of Maryland children in this risk category was essentially zero.
- Benzene, 1,3-butadiene, and chromium compounds were at the top of the list of known carcinogens contributing to overall risk. The majority of benzene and 1,3-butadiene comes from mobile sources.
- In 1999, most children lived in counties where at least one outdoor toxic air pollutant exceeded the benchmark for non-cancer health effects: 97 percent in Maryland and 89 percent in the U.S. In most places, acrolein, a respiratory irritant, was the primary cause of elevated risk. The majority of acrolein comes from mobile sources.

***Healthy People 2010:*** Objective 8-04 of Healthy People 2010 focuses on reducing emissions of hazardous air pollutants.