Dirty, Detrimental, And Deadly

Cincinnati Diesel Hot Spots

O·H·I·O ENVIRONMENTAL COUNCIL

KEEP WATCH, TAKE ACTION, MAKE CHANGE

Prepared by the Ohio Environmental Council
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The Ohio Environmental Council (OEC) has been behind the scenes and on the front lines of some of Ohio's most critical environmental battles. For 30 years, citizens across the state have counted on the Ohio Environmental Council to be their voice in the Statehouse—fighting to protect Ohio's environment and vanishing open space.

The mission of the Ohio Environmental Council is to inform, unite, and empower Ohio citizens to protect the environment and conserve natural resources. We rely on the support of foundations, community organizations and individuals to carry on our work. The Ohio Environmental Council is a 501(c)3 charitable organization that neither promotes nor opposes any candidate for public office.

With its over 2400 individual members, 124 Eco-Network Members and 132 community supporters, the OEC continues to unite Ohio's conservation and environmental community to *keep watch* of Ohio's air and water quality, *take action* to better environmental policies, and *make change* for a greener tomorrow.

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Executive Summary

This report, *Diesel Hot Spots–Dirty, Detrimental and Deadly,* was undertaken by the Ohio Environmental Council (OEC) to address the serious health threats and air quality non-attainment issues that relate to emissions from dirty diesel engines. The OEC compiled and analyzed traffic counts, diesel emissions, and census data to identify areas in Cincinnati with elevated diesel emissions, referred to as "hot spots." The goal of this report is two-fold. First, we want to make people aware of this serious and deadly threat that is affecting the health of our families, agricultural crops, forests, waters, wildlife, and climate. Second, we hope that, with recognition of these dangers and the requirement of meeting federal air quality standards, regulations and programs will be adopted both locally and at the state level by school districts, transit fleets, government supported operations, private industry, and legislators to utilize available technology and establish regulations to clean up Ohio's air.

Emissions from dirty diesels affect both public health and the environment. Diesel exhaust emissions have been linked to eye irritation, asthma attacks, respiratory and neurological ailments, lung cancer, and premature death. According to research conducted by Joel Schwartz of the Harvard School of Public Health, particulate matter pollution "kills about 70,000 Americans each year. That's more people than die from breast and prostate cancers combined. Air pollution is a huge public health problem."[1] Diesel emissions contribute significantly to the failure of National Ambient Air Quality Standards (NAAQS) for ozone and the pending failure for fine particulate matter by Cincinnati and all major Ohio cities. Finally, our crops, forests, waterways, wildlife, and cityscapes (skyline views) are also being adversely impacted by toxic diesel emissions.

There are solutions. For example, the combination of pollution control retrofits and use of ultralow sulfur diesel can reduce diesel particulate matter (soot) by over 90%. This technology is readily available and currently used by many bus and truck fleets. It is unmistakably cost effective to work at eliminating toxic diesel exhaust rather than dealing with the resulting health impacts and the consequences of failing to meet air quality standards. It is up to communities and local and state governments to take the necessary steps to require cleaner practices leading to healthier air and people and a healthier environment.

CincinnatiñFailing Air Quality Standards

The ambient air quality in Cincinnati is considered unhealthy according to the U.S. Environmental Protection Agency (EPA). The U.S. EPA updated the national air quality standards for ozone and particulate matter in 1997 after research showed health effects at concentrations below the then-established standard. Cincinnati, and every major city in Ohio, officially will be declared in non-compliance with these standards in 2004 and required to meet them by 2010. One-quarter of all ozone and particulate matter (PM) forming nitrogen oxide emissions in the United States come from diesel emissions. Diesel tailpipes contribute 72% of the particulate pollution from on-road mobile sources and 57% of the particulate pollution from non-road mobile sources.

Hot Spots

Hot spots are areas that experience levels of diesel exhaust emissions that pose health risks beyond those from normal background levels. In this report, we define hot spots as areas that are within one-quarter mile of a roadway with PM emission levels of at least 675 grams per mile per day (g/mi/day). According to several recent studies, populations living in an area such as this are considered to have a significantly elevated exposure to air toxics and be at an elevated risk for childhood cancer and leukemia, development of asthma, asthma hospitalizations, and premature death (see appendix A).

An estimated 460,382 people in the Cincinnati area live in a diesel hot spot—23% of the area's total population. Approximately 36,320 of those living in Cincinnati hot spots suffer from asthma.

The Dirty Dozen

The top twelve Cincinnati communities with the most people living in diesel hot spots are:

Diesel Hot Spots–Table 1			
Municipality	Population living in a hot spot	County	State
Cincinnati Area	149,111	Hamilton	Ohio
Hamilton	17,669	Butler	Ohio
Covington	14,414	Kenton	Kentucky
Middletown	11,907	Butler	Ohio
Florence	9,944	Boone	Kentucky
Fairfield	8,588	Butler	Ohio
Finneytown	6,667	Hamilton	Ohio
Erlanger	6,444	Kenton	Kentucky
Norwood	5,966	Hamilton	Ohio
Springdale	5,607	Hamilton	Ohio
Kenwood	5,369	Hamilton	Ohio
Forestville	5,219	Hamilton	Ohio

The top twelve communities with the highest percentage of their population living in diesel hot spots are:

diesel hot spots–table 2			
Municipality	Percent of population living in a hot spot	County	State
Arlington Heights	98.8%	Hamilton	Ohio
Butlerville	72.9%	Warren	Ohio
Kenwood	72.3%	Hamilton	Ohio
Walton	65.8%	Boone	Kentucky
Crestview Hills	65.3%	Kenton	Kentucky
Lakeside Park	64.6%	Kenton	Kentucky
Ross	56.1%	Butler	Ohio
Olde West Chester	56.1%	Butler	Ohio
Mariemont	55.4%	Hamilton	Ohio
Park Hills	54.5%	Kenton	Kentucky
Cheviot	53.9%	Hamilton	Ohio
Springdale	53.1%	Hamilton	Ohio

Additional areas with potentially significant levels of diesel emissions are train yards, airports, truck stops, construction sites, and loading docks. Due to insufficient availability of traffic counts in these areas, they were not included in our hot spot analysis but should be recognized as likely "hot spot" areas.

Where Do We Go From Here?

In 2001, U.S. EPA established rules for on-road diesels which will reduce emissions from newly manufactured diesel engines beginning in 2007. In May of 2004, U.S. EPA finalized rules for non-road diesel engines, extending pollution control and ultra low sulfur fuel requirements to construction and agricultural equipment, trains, and marine vessels. The on- and non-road diesel rules will apply *only* to newly manufactured engines, starting in 2007 and 2008, respectively. Because diesel engines have inherently long lifetimes and are commonly rebuilt rather than retired, pre-2007 engines will continue to pollute the air until the end of their life, often decades down the road. Consequently, according to U.S. EPA, air quality benefits from cleaner diesels will not be fully realized for an estimated 30 years.

Recommendations

In order to reduce or eliminate diesel hot spots and meet federal air quality standards in the Cincinnati area, it is imperative that existing diesel engines reduce their pollution. Initiative and incentives are needed both at the local and state level to make existing diesel engine cleanup a reality (Appendix E summarizes some existing programs in Cincinnati, the State of Ohio, and across the nation).

The OEC recommends the following local, state, and federal efforts to reduce Ohio's pollution burden from dirty diesels:

Local Efforts

- School and local transportation fleets should retrofit with pollution control and idling reduction technologies and switch to cleaner fuels (ultralow sulfur diesel, biodiesel, or alternative fuels) by utilizing federal retrofit assistance and grant programs.
- All fleets owned or contracted by local governments (garbage trucks, city services, government construction, etc.) should be required to use cleaner fuels, to retrofit by installing pollution control technology, and to purchase new, cleaner diesel engines or alternative fuel engines when replacing fleets.
- Local governments should encourage the adjustment of contracts to require the use of cleaner fuels and pollution control devices now, without waiting for federal mandates to require such actions.
- Anti-idling policies and/or ordinances should be established to limit emissions from vehicles waiting to load and unload people or cargo.

State Efforts

- Ohio should establish a more comprehensive air quality monitoring program to address issues of passenger exposure to emissions and the effects on indoor air quality.
- State-level vehicle inspection and monitoring programs should be implemented to promote routine maintenance of diesel vehicles.
- Ohio should develop a retrofit assistance program via a dedicated funding source (i.e., title transfer fees, vehicle registration fees, settlement money) to provide financial assistance to school boards and local governments for cleaning up their fleets and purchasing alternative-fuel vehicles.
- Ohio should require existing vehicles to retrofit with pollution controls and convert to using ultralow sulfur diesel fuel prior to 2007. This requirement should be part of Ohio's state implementation plan to meet federally established air quality standards.

Federal Efforts

- Congressional lawmakers should develop a comprehensive national diesel retrofit program to further encourage and promote diesel cleanup initiatives.
- The Administration and Congressional lawmakers should expand the funding programs currently in existence (Clean School Bus USA and the Voluntary Diesel Retrofit Program) by authorizing larger appropriation budgets to meet the high demand for assistance.

Source: Bruce Hill, Clean Air Task Force

Hot Spots

"Hot spots" are areas that chronically experience levels of diesel exhaust emissions that likely result in increased risks for health impacts including cancer, asthma hospitalizations, and premature death. This is a pilot analysis designed to identify Cincinnati area diesel hot spots based on distance from the roadway and estimated diesel emissions based on truck and bus traffic levels. There are other significant sources of diesel emissions that almost certainly qualify as hot spots, but are not included in the analysis due to lack of data. These include non-road sources such as locomotives and airport service equipment and temporary sources of large diesel emissions, such as large highway construction projects. Finally, the analysis does not include "micro hot spots," areas that may experience elevated diesel emissions in a small but intense area–such as on board school and transit buses, shipping docks, truck stops, and large bus terminals.

For the purposes of this report, we define hot spots as areas that are within one-quarter mile of a roadway with PM emission levels of at least 675 g/mi/day (equivalent to the PM emissions from an average major urban arterial roadway). According to recent studies, populations living in these areas are considered to have significantly elevated exposure to air toxics and to be at greater risk for childhood cancer and leukemia, asthma development, and asthma hospitalizations. The following health studies were used to define a hot spot:

- A study in Denver identified that children living within 250 yards of urban roadways with heavy truck traffic were six times more likely to develop cancer and eight times more likely to develop leukemia.[2]
- A study in Erie County, New York identified that children living within 200 meters of roadways with heavy truck traffic had a significant increase in risk of asthma hospitalization.[3]
- A British study determined that living near major roads was associated with the risk of hospital admission for asthma in children.[4]
- A study in London identified that children living within 90 meters of a major roadway had a significant increase in risk for the development of asthma.[5]

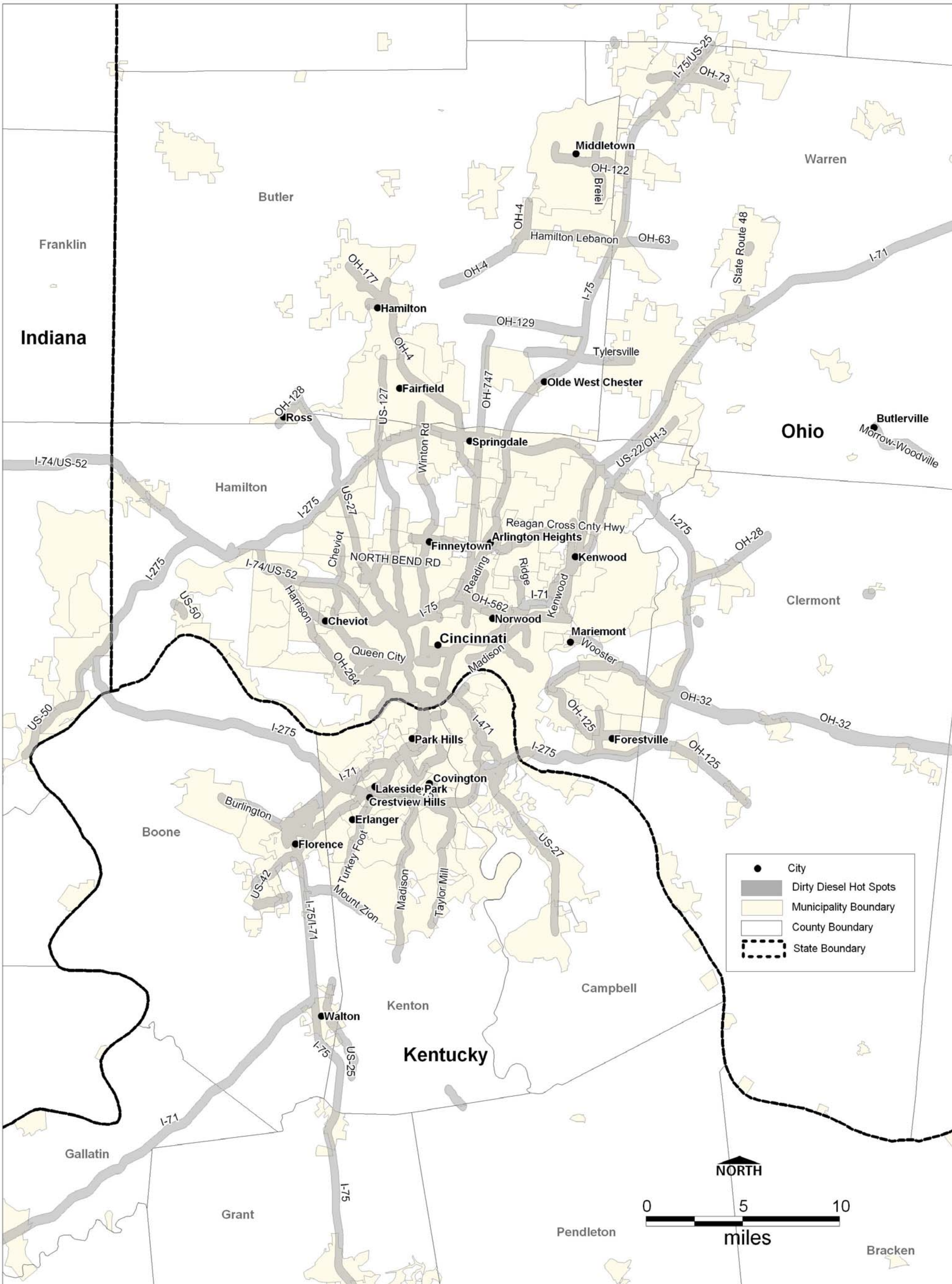
For a more detailed list of health studies and explanation of how they were used to define a hot spot, please see Appendix A.

An estimated 460,382 Cincinnati area residents live within a diesel hot spot. An estimated 36,320 of these residents suffer from asthma. The map on the facing page identifies the hot spot communities in the Cincinnati area.

For more complete information on community hot spot rankings see Appendix B, which includes a:

- listing of Cincinnati area communities in alphabetical order (Table 3).
- ranking by number of people living in hot spots (Table 4).
- ranking by percent of population living in hot spots (Table 5).
- ranking by number of people with asthma living in hot spots (Table 6).

Dirty Diesel Hot Spots in the Cincinnati Metropolitan Area



Diesel Exhaust-A Pervasive, Uncontained Problem

Diesel exhaust is a far-reaching problem. It is not simply a pollutant affecting outdoor environments. An astounding two-thirds of diesel particulate matter penetrates indoor environments.[6] This pollution problem is aggravated by the collection of diesel exhaust in urban canyons and streets, where it can penetrate adjacent buildings. A prime example is the idling of school buses outside of schools. Exhaust is able to accumulate and penetrate the school via the ventilation system, impacting children in their classrooms. Indoor air quality is largely unregulated with the exception of occupational chemicals, pesticides, and some tobacco smoke regulations.

Source: Bruce Hill, Clean Air Task Force

Measurements show that exhaust from idling trucks and buses not only affects those outside the vehicle, but also affects those inside when exhaust seeps into the vehicle through windows and doors, unsealed engine compartments, backdoors on school buses, leaking exhaust systems, and unfiltered air and heating vents.[7] Emission concentrations can be hazardous for an individual riding a bus or driving a truck. A study examining children's exposure to diesel exhaust on school buses in Connecticut determined children were exposed to airborne PM (PM_{10} and $PM_{2.5}$) concentrations as much as 5-15 times higher than background levels of fine PM.[8] Contrary to what some may believe, closing windows actually results in a higher level of diesel exhaust trapped inside the bus while opening windows facilitates rapid ventilation.

ìChildrenís exposure to diesel exhaust particulate pollution on school buses is as much as 5-15 times higher than background levels.î

Source: Environment and Human Health, Inc. (EHHI), Children's Exposure to Diesel Exhaust on School Buses

Furthermore, studies have shown that the most harmful diesel emissions are those released at ground level. A California study measuring concentrations of black carbon inside vehicles during transit found the following: 5 micrograms per cubic meter (ug/cu m) for vehicles following no other vehicles, 15 ug/cu m for vehicles following a diesel truck with a high exhaust stack, 50 ug/cu m for vehicles following a diesel truck with a ground-level tailpipe, and 130 ug/cu m for vehicles traveling behind an urban transit bus making numerous stops.[9] A review by the International Center for Technology Assessment of 20 reports on internal vehicular air contamination determined that pollution levels inside vehicles were regularly significantly higher than levels along roadsides. The message is that commuters are exposed to some of the highest levels of diesel emissions simply by traveling the same roads as diesel vehicles.

Source: Union of Concerned Scientists, Clean Vehicles Campaign

Diesel Pollution: Components and Consequences

Introduction

Diesel engines are efficient and long-lived pieces of machinery. Their low maintenance and efficient generation of power and electricity has led to their desirable use in heavy duty buses, trucks, trains, marine vessels, and non-road equipment such as construction, agricultural, and airport equipment. Diesel engines utilize two-thirds the fuel and emit less carbon dioxide (CO_2) compared to similar ignition-based gasoline engines. Yet, these workhorses of industry have a downside. Exposure to diesel emissions has been linked to serious health effects including a compromised immune system, aggravated asthma and allergy symptoms, heart and lung disease, and cancer. Diesel emissions are the number one air toxics cancer risk in the United States.[10,11] The federal government regulates the standards for newly manufactured diesel engines, but it is the responsibility of the individual states to clean up existing diesel systems.

The diesel engines creating the most concern are heavy duty diesel engines (HDDE) with gross vehicle weight ratings over 8,500 pounds. These are the primary source of diesel emissions, contributing 95% of on-road diesel emissions and 85 to 90% of all diesel particulate matter.[12] On-road diesels include transport trucks and refuse trucks as well as municipal and commercial buses. Non-road diesels include construction equipment (bulldozers and excavators), agricultural equipment (tractors), recreational vehicles, airport service equipment, locomotives, and marine vessels (river boats, barges and oceangoing vessels).

Diesel ExhaustñWhatís In It?

The health impacts of diesel emissions are of grave concern. Emissions from diesels have been cited as the leading air toxics cancer risk in the United States. Emissions contain harmful constituents in both gaseous and solid form such as particulate matter (PM), nitrogen oxides (NOx), volatile organic compounds (VOCs), hydrocarbons (HC), and sulfur oxides (SOx). Diesel exhaust includes 40 hazardous air pollutants defined under the Clean Air Act, with 15 being known or probable carcinogens such as benzene, formaldehyde, acetaldehyde, dioxins, and polycyclic aromatic hydrocarbons (PAHs). PAHs[13] are some of the most potent known carcinogens.[14] All of these elements make diesel exhaust a serious health concern for our communities. Air pollution from diesel exhaust contributes to health problems such as increased asthma attacks, aggravation of chronic bronchitis, painful breathing, decreased lung function, heart and lung disease, cancer, and premature death.

A component of diesel emissions generating substantial alarm is particulate matter, commonly known as soot. Diesel exhaust contributes the largest source of particulate matter from motor vehicles. Coarse PM (PM_{10}) are particulates less than 10 microns but larger than 2.5 microns in size. Coarse PM sources include windblown dust, materials handling, and crushing operations. This type of matter can settle in the windpipe and is what you would blow into a tissue, but is considered less harmful to people than fine PM. Fine PM, or $PM_{2.5}$, is particulate matter smaller than 2.5 microns (millionths of a meter). These particles are so small that several thousand could fit on the tip of a pin. Fine PM sources include fuel combustion, motor vehicles, industrial facilities, and forest fires. It can penetrate deeply into the lungs, collecting in tiny air sacs where oxygen enters the bloodstream affecting both the heart and lungs.

Common Items and their respective particle sizes	
Tobacco Smoke	0.01 to 1 micron
Oil Smoke	0.03 to 1 micron
Typical Atmospheric Dust	0.001 to 30 microns
Mold Spores	10 to 30 microns
Human Hair	40 to 300 microns
Pollens	10 to 1000 microns
Beach Sand	100 to 2000 microns
Eye of a Needle	1,230 microns
Postage Stamp, 1 inch high	25,400 microns

The origin of particulate pollution in the atmosphere is still under analysis. Primary particulate pollution is an estimate of the emissions coming directly from a tailpipe or smokestack. U.S. EPA's 1999 emissions data attributes 72% of the particle pollution from on-road mobile sources and 57% of the particle pollution from off-road mobile sources to diesel engines. Further analysis is needed to determine the origin of secondary particulate formation, the PM generated in the atmosphere from various chemical reactions of pollutants (gas-to-particle conversions). For example, the nitrogen oxide emissions coming out of a tailpipe can contribute to both ozone and particulate formation in the atmosphere.

Particulate matter does not act alone in adversely affecting the environment and health; nitrogen oxides are another serious problem. A colorless and odorless gas, NOx contributes to smog (ground-level ozone) formation by reacting with hydrocarbons and sunlight. In 1999, the Midwest produced the second highest NOx emissions in the country–4.98 million tons–with highway vehicles, electrical utilities and off-highway vehicles being the top three contributors.[15] Nitrogen oxides combine with other atmospheric constituents to form fine particulate matter. One-quarter of all ozone and PM-forming nitrogen oxide emissions in the United States come from diesel emissions.[16]

Source: American Lung Association-"Asthma is the most common long-term childhood disease, affecting over 6.3 million children."

Health Impacts

The health impacts of diesel emissions have been heavily studied in recent decades. It is estimated that 70% of the total air toxics cancer risk is attributable to diesel exhaust.[17,18] In May 2002, the U.S. EPA's *Health Assessment Document for Diesel Exhaust* stated that the hazards of diesel included "acute exposure-related symptoms, chronic-exposure related noncancer respiratory effects, and chronic carcinogenic effects" saying diesel is "likely" a human carcinogen.[19] Dozens of epidemiological studies have linked diesel exhaust to lung cancer as well as bladder cancer. An American Cancer Society study in 2002 equated the risk of breathing in particulate matter in our most polluted cities as comparable to the risk of secondhand smoke.[20] Pollutants inflame the lungs, damaging tissue and causing the formation of scar tissue which makes the lungs rigid and less efficient. Additionally, inflammation causes stress on the heart by reducing the amount of oxygen carried by the blood. Exposure to air pollution can thicken the blood, increasing the tendency for clotting, which damages arteries, and leading to a buildup of fatty deposits along vessel walls. Railroad workers with long-term exposure to emissions were shown to have serious and permanent impairment of the central nervous system.[21] Animal studies suggest it is likely that diesel emissions impact the immune system.[22,23] Diesel exhaust adversely affects fetuses and newborn children, resulting in birth defects, growth retardation and Sudden Infant Death Syndrome.[24,25,26,27,28] The U.S. EPA's *Health Assessment Document for Diesel Exhaust* also stated "other supporting evidence includes the demonstrated mutagenic and chromosomal effect of diesel exhaust and its organic constituents, and the suggestive evidence for bioavailability of the diesel particulate matter organics in humans and animals," further suggesting emissions are carcinogenic.[29]

ìAir pollution kills about 70,000 Americans each year. Thatís more people than die from breast and prostate cancers combined. Air pollution is a huge public health problem.î

Source: Joel Schwartz, Associate Professor of Public Health at the Harvard School of Public Health

Almost half of the nation's population is breathing unhealthy air. With over 70,000 premature deaths per year attributed to air pollution, air quality should certainly be a national concern. Sensitive populations include the elderly, those with pre-existing heart and/or lung disease, children, asthmatics, and occupationally exposed workers. Tens of thousands of elderly die prematurely every year from exposure

to ambient levels of fine particulate matter.[30] People with heart and lung disease suffer aggravation of symptoms from exposure to air pollutants.

Children are extremely susceptible to potential health threats from exposure to diesel emissions because their respiratory systems are still developing. They breathe 50% more air per pound of body weight than an adult.[31] Exposure to fine PM has been associated with increased frequency of childhood illness resulting in acute and chronic complications. Coughing, difficulty breathing, and other respiratory ailments may require limiting of activity and absences from school. Asthmatics are another group vulnerable to pollutants in our air. Nearly half of all asthma cases occur in children. Deaths resulting from asthma have increased three times since two decades ago, with 14 Americans dying every day.[32] Breathing in particulate matter, along with other pollutants, leads to an increase in the need for medical treatment. An average of $500 a year is spent on asthma-related health care per child afflicted.[33]

Numerous studies show Ohio needs to work on cleaning up air pollution. The American Lung Association's *State of the Air: 2004*, an annual report assessing the toll of ozone and newly included this year, particulate pollution, on the nation's ability to breathe, gave a failing grade to all ozone-monitoring counties and several failing grades to particulate-monitoring counties . A report commissioned by State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officers (STAPPA/ALAPCO) estimated that when the U.S. EPA begins to regulate non-road mobile sources, Ohio would avoid 341 premature deaths and 7,229 asthma attacks per year. The state would see a monetary benefit of $2.7 billion annually, through the prevention of lost work days, hospitalizations, and other health care costs, simply by regulating diesel emissions through improved technology and ultralow sulfur diesel fuels. A 1999 study by Abt Associates, a consulting firm for the U.S. EPA, estimated that 2,800 Ohioans were admitted to the hospital and 8,200 visited the emergency room due to smog levels in 1997, a relatively low smog season. A Natural Resources Defense Council study from 1996 estimated that nearly 4,000 Ohioans have their lives cut short each year due to the level of particulate air pollution in the state. These numbers are cause for concern and much needed change in Ohio's air quality policy.

ìOhio would avoid 341 premature deaths and 7,229 asthma attacks a year, with a monetary benefit of $2.7 billion annually, if EPA regulated non-road mobile sources.î

Source: STAPPA/ALAPCO report

Cincinnati Air QualityñFailing the Standard

Every major metropolitan area in Ohio–including Cincinnati–has failed to meet the new standards for ozone and are expected to fail the standard for fine particulate matter. The Clean Air Act, established in 1970, created provisions for air quality standards and monitoring. The act requires the federal government to establish National Ambient Air Quality Standards (NAAQS) and requires states to develop state implementation plans (SIPs) to meet these standards. Failure to meet the NAAQS requirements results in an area being designated a nonattainment area. Areas designated nonattainment may lose federal highway dollars, suffer fines, and be subject to a federally mandated implementation plan rather than a state established plan.

In 1997, U.S. EPA updated the exposure limits of ozone and particulate matter based on decades of research concluding that the standards were too lax. On April 15, 2004, U.S. EPA designated all or part of 474 counties in nonattainment for the 8-hour ozone standard, accounting for 158 million people living in an area failing the standard. U.S. EPA's June recommendations to states on PM nonattainment areas includes 243 counties, with over 99 million people living with air quality levels that exceed the standards. Diesel vehicles contribute 72% of $PM_{2.5}$ and 42% of NOx emissions from all on-road mobile sources and 67% of $PM_{2.5}$ and 49% of NOx emissions for all non-road sources (see Appendix C). Consequently, it is vital that both on-road and non-road mobile sources be targeted to facilitate improvement in air quality and attainment of the standards.

State implementation plans must be finalized by 2007 for ozone and 2008 for particulate matter, with plans to meet standards by 2010 (2015 at the latest). U.S. EPA studies have shown that some areas will need to significantly reduce the pollution from motor vehicles *in addition* to meeting all other aspects of Clean Air Act requirements in order to reach attainment levels. Ohio can begin efforts today to meet attainment by regulating diesel emissions. This will require the implementation of programs to clean up existing diesels rather than waiting three decades for the effects of the on- and off-road rules to be realized. (See Appendix D for a more comprehensive look at the Clean Air Act.)

Other Impacts

Ecosystem and agricultural

Air pollution is not only a threat to the humans breathing the air, but also to the environment and the life it supports. Diesel smoke is composed of organic compounds and heavy metals that persist in the environment and food chain. The chemistry of soils and waters are being changed by pollution to the extent they cannot adequately sustain aquatic and terrestrial life. Nitrogen deposition from diesel NOx emissions contributes to eutrophication of waterways, resulting in harmful algae blooms and increased fish mortality. Soot soils buildings and affects cloud cover, contributing to atmospheric warming. Diesel emissions contribute to other environmental damage such as acid rain, crop and forest damage, and erosion on buildings and car paint. Emissions have also been linked to haze in our cities and global warming.

Cincinnati skies under ideal conditions (above) and on a hazy day (below). Source: Midwest Hazecam

Haze

Our cityscapes are being defiled by these pollutants. Together, particulate matter and NOx contribute to haze. Although individual particles cannot be seen, collectively they are viewed as soot, dust clouds and gray hazes. Useful tools for appreciating the effects of haze are Hazecam sites on the internet. The Midwest Hazecam site (www.mwhazecam.net/cincinnati.html) allows you to view current haze conditions in Cincinnati as well as other Midwestern cities and scenic areas. These sites show current cityscapes' haze conditions with a reference picture for a clear day. There is usually a rating for PM and ozone levels included with the picture. Visibility impairment from diesel engine pollution has resulted in areas of the United States having lost 70% of the natural condition visibility range. Fine particles can travel great distances, with one-third of the haze in the Grand Canyon attributed to pollution from Southern California.[34] In 1977, Clean Air Act Amendments

began to address the issue of haze in our national parks and wilderness areas. Despite the realization 25 years ago that air pollution is not restricted to our cities and areas of emissions discharge, we are still trying to address the issue of haze in scenic areas.

Climate Change

Particulate matter and nitrogen oxide emissions from diesel engines are major global warming agents. Reduction in these emissions will not just benefit public health and the environment, but will also create real reductions in significant greenhouse pollutants–in spite of the fact there is no national policy on climate change. Diesels are Ohio's largest source of black carbon emissions and second largest source of ozone-forming nitrogen oxides. By some estimates, black carbon has about 75% of the warming impact of CO_2 and ground-level ozone has about 50% of the warming impact of CO_2.[35] Black carbon and ozone have short residence times in the atmosphere (a few days to weeks, respectively) which means reductions would immediately provide a climate benefit as compared to carbon dioxide which has a very long residence time in the atmosphere (a few years to 100 years). Reducing these emissions can help bypass political opposition to action on climate change by practically demonstrating that reductions are achievable.

Technology

Source: Manufacturers of Emissions Controls Association shows a truck retrofitted with a diesel particulate filter.

Modern emission control technologies and cleaner fuels could allow exisiting diesel engines to rival emissions from gasoline and natural gas engines, emitting one-quarter less CO_2 while achieving better fuel economy.[36] In addition, replacement of older diesel vehicles with less polluting and cost-effective alternative fuel vehicles (which utilize liquified natural gas, compressed natural gas, propane, biodiesel, or hybrid electric technology) will help reduce emissions and achieve better air quality. Current technology provides the ability to significantly reduce emissions by retrofitting exisiting engines with PM and NOx control devices as well as using lower sulfur fuels.

Particulate matter reduction technology has been around for decades and is quite effective. In simple terms, a muffler on a diesel engine is replaced with a PM control that traps the soot preventing it from blowing out the tailpipe. One retrofit technology for PM is the catalyzed diesel particulate filter (DPF), also known as a trap. The catalysts are poisoned by large concentrations of sulfur, so for the practical use of a trap, the sulfur content in diesel fuel must be reduced to 15 parts per million (ppm), known as ultralow sulfur diesel fuel (ULSD). A combination of catalyzed DPF and ULSD can lead to a 90% reduction of PM emissions and a significant air toxics reduction benefit.[37] A 2002 Washington, D.C. Metro bus DPF retrofit study showed PM reduction of over 90%, CO reduction of 95%, and complete elimination of HC. Another emission control product for particulate matter reduction is a diesel oxidation catalyst (DOC). Less costly than DPFs, DOCs are easy to install; unfortunately, they are also less effective, reducing PM by only 20% to 50%. The Big Dig construction project in Boston requires the use of DOCs on equipment to meet the guidelines of its voluntary retrofit program. DOCs oxidize diesel pollutants by converting them to less harmful emissions such as water and carbon dioxide.

There are several solutions for reducing NOx concentrations in diesel exhaust that are commercially available today or likely to be so in the next two to three years. First, there is the NOx adsorber catalyst which removes NOx by chemically binding the pollutant to the surface of the catalyst. This control requires the use of ULSD. Testing on new cars and trucks has shown a 70% to 90% reduction in NOx emissions. A second control is diesel-water emulsion, a diesel and water fuel blend additive that reduces NOx by cooling combustion temperatures. It is commercially available and has been shown to reduce NOx by 16% to 41% and PM by 24% to 69%. Another NOx control is selective catalytic reduction (SCR) which reduces NOx by 75% to 90%, HC by 80%, and PM by 20%. It injects a chemical agent to convert oxides of nitrogen to gaseous nitrogen and water vapor. SCR technology requires additional fueling infrastructure and on-board storage for the chemical agent, making widespread implementation of this technology in the U.S. questionable. An additional option is exhaust gas recirculation (EGR) which returns exhaust gas to the engine, reducing NOx by 29% to 56%.[38] Installation of NOx retrofit controls on heavy duty diesel engines will help facilitate ozone attainment.

Some additional technologies to further reduce diesel emissions include engine block heaters and crank-case filters. Unnecessary idling generates a significant portion of diesel emissions, and it is time to break this outdated habit as most modern engines can warm up in 3-5 minutes. Engine block

heaters are capable of warming up the engine by heating the coolant or oil, and some can warm the cab as well, serving as an auxiliary source of power when the bus engine is turned off. The heaters help the engine achieve peak operating temperature quickly, shaving off tens of minutes involved in morning warm-ups thereby reducing emissions inside and outside the vehicle (16-53%) and reducing human exposure. Closed crank-case filters help significantly reduce diesel emissions by eliminating the 25% of diesel fumes entering the vehicle directly from a draft tube in the engine. The filter seals this emissions source, routing the oil back into the engine and eliminating the direct blow into the vehicle.

Cleaner burning fuels play a crucial role in reducing diesel emissions. The reduction of sulfur content occurring in ultra low sulfur diesel fuel can reduce particulate emissions by 5-10%. Any diesel engine can utilize ULSD without modifications to the engine. The greatest emission reduction benefit occurs when ULSD fuel is used in conjunction with a particulate control. Some of the pollution control devices previously mentioned utilize catalysts that are poisioned by large concentrations of sulfur making the reduction of sulfur in diesel fuel from 500 ppm to 15 ppm vital to pollution reduction. Ultralow sulfur diesel fuel is currently being used in Cleveland and is available for distribution by BP throughout Ohio. Biodiesel is another cleaner fuel option. It is a blend of conventional diesel with a renewable biomass (usually soybean or vegetable oils) commonly at an 80-20 ratio, known as B20. Biodiesel can reduce hydrocarbons, carbon monoxide, and particulate matter by 12-20%, with a minimal increase in nitrogen oxides of 2%.

Clearly, the technology is available to substantially decrease diesel exhaust emissions for both on-road and non-road mobile sources. This technology should be applied to existing engines as well as newly manufactured diesel engines. A combination of PM and NOx pollution control technologies with cleaner fuel will have the most significant impact on cleaning up diesel emissions.

New Federal Rulesña positive, but incomplete step

In 2001, the U.S. EPA updated its emission regulations for on-road diesel engines. Known as the HDE 2007 Rule, it will cut PM emissions from new on-road diesels by 90% beginning in the year 2007. The rule requires that new engines must incorporate up-to-date pollution control technologies. The sulfur content of highway diesel fuel will be reduced from 500 ppm to 15 ppm, the standard for ultralow sulfur diesel fuel, by 2006–a step that is necessary in order for pollution control devices to function properly. While these new regulations mean the diesel engines coming off production lines in 2007 will be the cleanest we have seen, they do not account for the existing diesel engines which will continue to pollute our skies for the next 20 to 30 years. The U.S. EPA estimates that the emission reduction benefits from the on-road rule will not be fully realized until 2036, when theoretically all the vehicles on the road will have the newer technology.

Non-road diesels have escaped the depth of the regulations that on-road diesels have been subjected to over the years. Consequently, the technology used in these engines is generally older and likely emits higher levels of pollution, making it all the more imperative to bring these archaic generators of emissions up to current on-road standards. Fontunately, in May 2004, U.S. EPA finalized rules for non-road diesels similar to the rules for on-road diesels. Implementation of the non-road diesel rule will reduce PM and NOx emissions by more than 95% and 90%, respectively, starting in 2008. Emission reductions would extend to hydrocarbons, carbon monoxide, sulfur oxides, and air toxics (air pollutants of concern for which a NAAQS does not exist). By 2030, U.S. EPA estimates the program will reduce annual NOx emissions by 738,000 tons and PM by 129,000 tons. Such a reduction will prevent an estimated 12,000 premature deaths, over

Source: City of San Francisco using compressed natural gas.

8,900 hospitalizations, and one million lost workdays each year. U.S. EPA estimates the quantifiable benefits will be approximately $80 billion annually by 2030. This savings far outweighs the $2 billion annual cost of the necessary engine and fuel requirements,[39] a cost-benefit ratio of 40 to 1.

The shortfall of current regulations is that they only apply to the production of new engines. The long life of diesel engines means the majority of those in existence today will be operating for another two to three decades, polluting the environment. Essentially, the bus a child rides to kindergarten could still be transporting students when that child graduates from high school. The federal government is unlikely to extend regulations into this realm, so it is up to state governments to implement regulations for retrofit programs on existing engines. Retrofitting engines with pollution controls, in conjunction with reduced sulfur content in fuel, will decrease the amount of detrimental emissions affecting the public and environment. As U.S. EPA suggested, many states will absolutely need to clean up emissions from diesel exhaust as well as fulfill the other requirements of the Clean Air Act in order to reach attainment for NAAQS. The fastest way for states to meet the standards is to clean up the emission problems within their authority, and it is within a state's power to implement diesel cleanup regulations and incentives to assist in meeting NAAQS.

Where Do We Go From Here?

According to the U.S. EPA's recently released *Toxic Release Inventory for 2002*, Ohio ranked number one in the nation for air discharges, releasing over 123 million pounds of toxic pollutants into the atmosphere.[40] As a highly industrial state with coal burning power plants, steel production, and gas and oil refineries, it is not surprising our emission levels are abundant. Diesels are the second largest source of fine particle (soot) and ozone (smog) forming emissions in Ohio, after power plants. This makes it all the more important to utilize current technology to reduce emissions and improve Ohio's air quality. Certainly the dubious honor of top state for air discharges is not one we wish to gloat about. Rather, a proactive state-wide program to reduce emissions and clean the air through self-imposed regulations and deadlines would provide a more distinguishable honor.

The majority of Ohio's population is spread throughout six urban areas. Consequently, reducing emissions from mobile sources in these areas will most effectively reduce mortality and facilitate attaining NAAQS. Action can be taken at the community, local, state, and federal government levels.

Community and Local Government Solutions

Locally, school and transit fleets should take up the challenge of implementing clean technology by utilizing cleaner fuels, installing pollution control and idling reduction retrofits and purchasing cleaner diesel or alternative fuel vehicles when replacing older buses in fleets. Accordingly, the cleanest buses should be used on the longest routes to limit widespread contamination from emissions and minimize population exposure. Anti-idling regulations should be established and enforced to prevent unnecessary exhaust affecting people both inside and outdoors. School buses should be required to shut down their engines while waiting at schools to load or unload passengers. Such action would greatly benefit communities socially and economically by decreasing the health-related effects of air pollution and subsequent health care costs.

All fleets owned or contracted by local government (garbage trucks, city services, local government construction, etc.) should be required to use cleaner fuels (ULSD and/or biodiesel), install retrofit technology, use idling reduction equipment, and purchase new, cleaner diesel or alternative-fuel engines when replacing fleets. Local government should encourage the adjustment of contracts to require the use of cleaner fuels and retrofits now, without waiting for federal mandates to require such actions. Construction contracts should be contingent upon the diesel engines involved utilizing emission reducing technologies, cleaner fuels, and idling reduction practices.

Local initiative is not uncommon and has been successful in many metropolitan areas. Ann Arbor, Michigan has used grants to facilitate the purchase of alternative fuel vehicles and is currently using biodiesel fuel in its fleet.[41] The Ann Arbor Transportation Authority operates its bus fleet on ULSD and uses diesel particulate filters to further reduce emissions. The University of Michigan runs its diesel powered

Anti-idling ordinance sign at the Big Dig in Boston, Mass. *Source: www.bigdig.com*

equipment on ultralow sulfur biodiesel fuel and has retrofitted some of its buses, reducing emissions by over 85%. The University of Michigan also purchased ethanol-powered vehicles and electric trucks as part of its transportation department's movement to alternative-fuel vehicles. Automotive Fleet magazine's August 2001 issue rated the University of Michigan first among universities in its use of alternative fuels.[42]

Initiatives by schools and transit authorities are also taking place here in Ohio. The Ohio State University has begun using biodiesel in a portion of its fleet and should be encouraged to retrofit with pollution controls as well. The Greater Cleveland Regional Transit Authority (RTA) began utilizing alternative fuels in 1990. They currently have 166 buses running on compressed natural gas (CNG) with two garages fitted for CNG fueling.[43] A total of 225 new buses arrived in mid-2003 and are using ULSD fuel, allowing RTA to retire older, polluting buses. The RTA could further reduce emissions by implementing the use of after-treatment technologies in their fleet. The Cleveland Municipal School District has received U.S. EPA grants to install particulate filters on its fleet. A total of 59 buses have been retrofitted with diesel particulate filters and are running on ULSD fuel. The district has adopted an anti-idling policy aimed at reducing idling by 50%. Public officials should help facilitate these retrofit projects through assistance programs and incentives. Cash-strapped school districts need support to adopt diesel cleanup initiatives allowing children to ride to school on cleaner, healthier buses.

Statewide Solutions

At the state level, programs focusing on maintainance, inspection and monitoring, and grant assistance should be developed. Ohio EPA has proposed an inspection and maintenance program for urban buses and should proceed with finalizing these rules and extending them to all diesels. Routine maintenance of vehicles will help ensure they are running properly and reduce unnecessary excess emissions from improperly tuned engines. A standard, mandatory testing of diesel tailpipe emissions should also be required to further persuade companies to implement clean air technologies and to eliminate the gross emitters by encouraging regular engine maintenance. Ohio should develop a retrofit assistance program which would provide financial assistance to school boards and local governments for cleaning up their fleets. These could be modeled after state programs like the Carl Moyer Program in California, the Texas Emissions Reduction Program (TERP) in Texas or the Washington Clean School Bus program, each of which have a dedicated funding source (ie. title transfer fees, vehicle registration fees).

Legislatively, the state can have profound impacts on diesel cleanup and remove the tarnish of being a pollution forerunner by taking the initiative in reducing diesel emissions. First, as mentioned above, Ohio EPA should finalize rules for an inspection and monitoring program for all diesels. Second, the state should require an earlier transition to ULSD by fleets than that currently set by the U.S. EPA, which would result in an immediate reduction in emissions and aid the state in meeting attainment requirements. Third, state regulations should be adopted to include existing diesels in the retrofit process and establish a retrofit assistance program to foster this project. Fourth, the state should establish a more comprehensive air monitoring program to address the issues of passenger exposure to emissions and indoor air quality. Finally, state law should restrict idling of diesel engines for the safety of passengers, drivers and populations located near idling areas. A combination of these approaches will dramatically reduce the amount of NOx and PM entering our air.

Federal Solutions

At the federal levels, efforts need to be focused on expanding existing diesel cleanup funding programs. The Administration and Congressional lawmakers should expand the two current funding assistance programs, the Clean School Bus USA and the Voluntary Diesel Retrofit Programs, by authorizing larger appropriation budgets to meet the high demand for assistance. In 2003, the Clean School Bus USA program received over 120 proposals requesting nearly $60 million in funding assistance, yet only 17 projects were funded at a total of $5 million. The Administration's recent Budget proposal asked for an increase of $60 million in annual funding to the program, but the House Committee only preauthorized $10 million. The Senate Appropriations Committee should support the Administration and recommend fully funding the program at $65 million/year. Larger funding appropriations are needed for these highly competitive programs.

In order to further assist state and local efforts to retrofit diesel engines, Congressional lawmakers should develop a comprehensive national diesel retrofit program to serve as both a model and large-scale funding source for diesel cleanup projects. Such a national program could target non-attainment areas in order to demonstrate how diesel cleanup efforts can be incorporated into state implementation plans. A plethora of projects could be developed to demonstrate innovative efforts to reduce emissions by incorporating all types of diesel engines (transit, construction, and generators) and pollution control options into a concentrated area effort to address diesel emissions. Federal leadership has lead to the on- and non-road rules that will affect newly manufactured engines beginning in 2007, now leadership must also be directed towards efforts to clean up existing fleets.

CONCLUSION

More than thirty years ago, the Clean Air Act provided the guidelines necessary for transforming the United States into a country with healthier air, yet not all the regulations have been applied to make these goals a reality. Both newly manufactured and existing diesels should be required to utilize emission control technologies and cleaner fuels to minimize pollution. Continued efforts to purchase alternative fuel vehicles should be encouraged and assisted by government grants. As the U.S. EPA has stated, the cost of implementing clean technology regulations is largely outweighed by the cost of health complications from diesel emission exposure. Likewise, many states, including Ohio, will need to address diesel emissions as a direct approach to achieving attainment for NAAQS.

By 2030, U.S. EPA estimates implementation of the non-road diesel rule alone could prevent 12,000 premature deaths and 19,000 nonfatal heart attacks per year. The combined benefits of both the non-road and the on-road diesel rules are estimated at 20,300 avoided deaths per year in 2030. Imagine the benefits if all the dirty diesels on the road were cleaned up today. Children could actually ride buses to school without the threat of developing asthma from the poisonous exhaust. Our environment would reap the benefits as well with healthier crops, forests, waterways, and wildlife. Cityscapes would regain some of their natural visibility and reductions in harmful atmospheric warming agents would be immediate and beneficial across the globe.

It is time for Ohio to rise to the challenge of reducing emissions from diesel engines by retrofitting existing fleets, using cleaner fuels, and encouraging purchase of alternative-fuel vehicles, as well as establishing an inspection and monitoring program, anti-idling ordinances, and a retrofit assistance program. These are important steps which will help protect the health of our communities. People living along heavy diesel traffic routes, children riding their only mode of transportation to and from school, people sitting in their places of work and residence, individuals outside enjoying "fresh" air, and workers doing their job transporting people and goods deserve to be safe without this often unseen health hazard taking years off their lives.

The health risks are real. The technology and know-how to clean up exists. The economic benefits are significant. The need for action is as stark as the exhaust belching from a diesel tailpipe. It is time for Ohioans to demand that we restore our air quality through comprehensive diesel cleanup programs. Maybe then, we can all breathe easier.

Appendix A: Methodology

The analysis for determining the hot spot areas and affected population was based on traffic data, particulate matter emission estimates, and census data. The definition of a hot spot was based on recent studies identifying the risk associated with distance from and traffic intensity of roadways.

Defining a Hot Spot

A hot spot is meant to describe an area in which the risk of health impacts from exposure to HDDE emissions is likely to be significantly increased. We defined a hot spot as an area within one-quarter mile of a roadway with PM emission levels of at least 675 g/mi/day. The maximum one-quarter mile distance was chosen based on several recent studies indicating that within this distance there is an increased risk for cancer and leukemia in children (250 yards), development of asthma in children (90 meters), hospitalizations due to asthma for children (500 and 200 meters), and premature death (50 to 100 meters). The minimum 675 g/mi/day PM level was chosen based on our estimates of the PM level from a major urban arterial roadway with an annual average daily traffic level (AADT) of 20,000 or a congested urban area highway with an AADT of 32,000. There are three recent studies that identify traffic counts as a risk threshold for health impacts. With the two American studies, the Denver 2000 study identified a 20,000 AADT risk threshold for nearby busy roadways, and the Erie County, NY study identified a 4,000 vehicle miles traveled (VMT) threshold, equivalent to 32,000 AADT for state highways. Neither study identified the relative number of roadways that were urban arterials and highways. We assumed the Denver study was more likely to be urban arterial and the Erie County study was more likely to be highway. In both cases, the PM emission levels are similar.

Studies that were used in developing this definition include:

Truck Traffic Linked to Childhood Asthma Hospitalizations

A study in Erie County, New York (excluding the city of Buffalo) found that children living in neighborhoods with heavy truck traffic within 200 meters of their homes had increased risks of asthma hospitalization. The study examined hospital admissions for asthma among children ages 0 to 14 and residential proximity to roads with heavy traffic.

Lin, Munsie, Hwang, Fitzgerald, and Cayo. (2002). Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic. Environmental Research*, Section A, Vol. 88, pp. 73-81.*

Children Living Near Busy Roads More Likely to Develop Cancer

A 2000 Denver study showed that children living within 250 yards of streets or highways with 20,000 vehicles per day are six times more likely to develop all types of cancer and eight times more likely to get leukemia. The study looked at associations between traffic density, power lines, and all childhood cancers from measurements obtained in 1979 and 1990. It found a weak association from power lines, but a strong association with highways. It suggested, without epidemiological evidence, that benzene pollution might be the cancer promoter causing the problem. However, the paper was published prior to a study by a the California Air Recources Board (CARB) identifying diesel emissions as a significant human carcinogen. An additional CARB study found HDDE emissions to be responsible for 70% of all ambient air toxics (from traffic and other sources) in the Los Angeles Basin.

Pearson et al. (2000). Distance-weighted traffic density in proximity to a home is a risk factor for leukemia and other childhood cancers. Journal of Air and Waste Management Association, *50:175-180.*

Air Pollution from Nearby Roads Linked to Shorter Life Spans for Residents

Dutch researchers looked at the effects of long-term exposure to traffic-related air pollutants on 5,000 adults. They found that people who lived near a main road were almost twice as likely to die from heart or lung disease and 1.4 times as likely to die from any cause compared with those who lived in less-trafficked areas. Researchers say these results are similar to those seen in previous United States studies on the effects of long-term exposure to traffic-related air pollution. The authors say traffic emissions contain many pollutants that might be responsible for the health risks, such as ultrafine particles, diesel soot, and nitrogen oxides, which have been linked to cardiovascular and respiratory problems.

Hoek, Brunekreef, Goldbohn, Fischer, van den Brandt. (2002). Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. Lancet*, 360 (9341): 1203-9.*

Cancer Risk from Outdoor Air 1 in 750 near Urban Highway due to Truck Traffic

A 2002 study modeled the ambient level of air toxics near the convergence of three major highways near Los Angeles, California. The cancer risk was estimated based on the analysis of how diesel particulate emissions dispersed in the area. The peak risk, closest to the highway, was identified to be a 1,500 cancer risk per 1 million (1 in 750), with the risk lowered to 200 in 1 million (1 in 5000) 1 kilometer away from the peak. The air dispersion model also indicated that, while prevailing winds did contribute to higher risk zones in downwind areas, the risk from emission exposure included all directions emanating from the highway convergence.

Balentine, et. al (2003) Risk Assessment for Diesel Particulate Matter from Motor Vehicles Using the ISCST3 Model, Air and Waste Management Association Annual Meeting*, June 2003.*

Asthma More Common for Children Living Near Freeways

A study of nearly 10,000 children in England found that wheezing illnesses, including asthma, were more likely with increasing proximity of a child's home to main roads. The risk was greatest for children living within 90 meters of the road.

Venn et al. (2001). Living Near A Main Road and the Risk of Wheezing Illness in Children. American Journal of Respiratory and Critical Care Medicine*. Vol. 164, pp 2177-2180.*

Cancer Risk Higher Near Major Sources of Air Pollution, Including Highways

A 1997 English study found a cancer corridor within three miles of highways, airports, power plants, and other major polluters. The study examined children who died of leukemia or other cancers from 1953 to 1980, where they were born, and where they died. It found that the greatest danger lies a few hundred yards from the highway or pollution facility and decreases as you get away from the facility.

Knox and Gilman. (1997). Hazard proximities of childhood cancers in Great Britain from 1953-1980. Journal of Epidemiology and Community Health. *51: 151-159.*

Proximity of a Child's Residence to Major Roads Linked to Hospital Admissions for Asthma

A study in Birmingham, United Kingdom, determined that living near major roads was associated with the risk of hospital admission for asthma in children younger than 5 years of age. The area of residence and traffic flow patterns were compared for children admitted to the hospital for asthma, children admitted for non-respiratory reasons, and a random sample of children from the community. Children admitted with an asthma diagnosis were significantly more likely to live in an area with high traffic flow (greater than 24,000 vehicles per 24 hours) located along the nearest segment of main road than were children admitted for non-respiratory reasons or children from the community.

Edwards, J., S. Walters, et al. (1994). Hospital admissions for asthma in preschool children: relationship to major roads in Birmingham, United Kingdom. Archives of Environmental Health. *49(4): 223-7.*

People Who Live Near Freeways Exposed to 25 Times More Particle Pollution

Studies conducted in the vicinity of Interstates 405 and 710 in southern California found that the number of ultrafine particles in the air was approximately 25 times more concentrated near the freeways and that pollution levels gradually decrease back to normal (background) levels around 300 meters, or 984 feet, downwind from the freeway. The researchers note that motor vehicles are the most significant source of ultrafine particles, which have been linked to increases in mortality and morbidity. Recent research concludes that ultrafine particles are more toxic than larger particles with the same chemical composition. Moreover, the researchers found considerably higher concentrations of carbon monoxide pollution near the freeways.

Zhu, Hinds, Kim, Sioutas. Concentration and size distribution of ultrafine particles near a major highway. Journal of the Air and Waste Management Association. *September 2002.*

Zhu, Hinds, Kim, Shen, Sioutas. Study of ultrafine particles near a major highway with heavy-duty diesel traffic. Atmospheric Environment. *36(2002), 4323-4335.*

Estimating PM Emissions

Emissions from on-road HDDE were determined by combining traffic data with emission factors derived by the

U.S. EPA's mobile vehicle emissions model, Mobile6.[44]

Traffic data

Annual Average Daily Traffic data on state roads was obtained from the Ohio Department of Transportation (ODOT) and AADT local road data was obtained from the Ohio-Kentucky-Indiana Regional Council of Governments (OKI). The state road data was pre-selected for Federal Highway Administration (FHWA) vehicle class types 4 through 13 (trucks and buses). It was assumed that all these vehicles used diesel engines. The local road data included FHWA vehicle class types 1 through 13. In order to determine the portion of vehicles from local roads that fell in categories 4 through 13, an estimate of the distribution for vehicles had to be applied. We used a statistical distribution developed by ODOT that provided an estimated breakdown for every vehicle category for each type of roadway in Ohio.[45]

Emissions data

The analysis applied an emission factor to the AADT data from each roadway. The emission factor was weighted for the distribution of each FHWA vehicle class for that particular road type, based on the ODOT analysis mentioned above.

Road types were divided into three speed categories: uncongested freeway (FHWA class rural interstate) at 55 mph, congested freeways (FHWA classes urban interstate, urban other freeways, and expressways) at 35 mph, and local roads (all remaining FHWA classes) at 20 mph.

An emission factor for each vehicle road class type was developed by taking the HDDE emissions and correction factors from U.S. EPA's Mobile 6 model and applying them to the appropriate FHWA vehicle classification types.[46] The emission factors (EFs) were initially based on the U.S. EPA's emission standards for HDDEs (HDDE categories 2B, 3, 4, 5, 6, 7, 8a, 8b, School Buses, and Transit Buses[47]) and age of engine (1994 through 2003, 1991 through 1993, 1990 and older). The EFs were weighted by the distribution of vehicles by age and converted from g/bhp-hr to g/mi. Speed correction factors were based on CO speed correction factors.[48]

Asthma Estimates

Asthma estimates were based on the American Lung Association's 2003 publication, *Estimated Prevalence and Incidence of Lung Disease by Lung Association Territory*. The seven Ohio counties (Brown, Butler, Clermont, Clinton, Hamilton, Montgomery and Warren) experienced an average asthma rate of 7.67% (adult and child rates combined). Dearborn County in Indiana experienced an asthma rate of 7.91% (adult and child rates combined). The seven Kentucky counties (Boone, Campbell, Carroll, Gallatin, Grant, Kenton, and Pendleton) experienced and average asthma rate of 8.38% (adult and child rates combined). These rates were applied to U.S. Census population data for those particular county groupings to obtain the study's specific asthma estimates. For example, 149,111 residents in Cincinnati live in a diesel hot spot. Multiplying that figure by 0.0767 produces 11,437, the estimated number of Cincinnati residents with asthma living in a diesel hot spot.

Cincinnati Area Communities in Alphabetical Order–Table 3							
Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Alexandria	Campbell	Kentucky	City	1,751	8,286	21.1%	147
Amberley	Hamilton	Ohio	Village	668	3,425	19.5%	51
Amelia	Clermont	Ohio	Village	983	2,752	35.7%	75
Arlington Heights	Hamilton	Ohio	Village	888	899	98.8%	68
Aurora	Dearborn	Indiana	City	801	3,965	20.2%	63
Batavia	Clermont	Ohio	Village	208	1,617	12.8%	16
Beckett Ridge	Butler	Ohio	CDP	1,180	8,663	13.6%	91
Bellevue	Campbell	Kentucky	City	3,286	6,480	50.7%	275
Blue Ash	Hamilton	Ohio	City	4,717	12,513	37.7%	362
Bridgetown North	Hamilton	Ohio	CDP	4,057	12,569	32.3%	311
Burlington	Boone	Kentucky	CDP	1,595	10,779	14.8%	134
Butlerville	Warren	Ohio	Village	168	231	72.9%	13
Carlisle	Warren	Ohio	Village	181	5,121	3.5%	14
Cherry Grove	Hamilton	Ohio	CDP	718	4,555	15.8%	55
Cheviot	Hamilton	Ohio	City	4,863	9,015	53.9%	373
Cincinnati	Hamilton	Ohio	City	149,111	331,285	45.0%	11,437
Claryville	Campbell	Kentucky	CDP	307	2,588	11.9%	26
Cleves	Hamilton	Ohio	Village	573	2,790	20.5%	44
Cold Spring	Campbell	Kentucky	City	1,076	3,806	28.3%	90
Covedale	Hamilton	Ohio	CDP	122	6,360	1.9%	9
Covington	Kenton	Kentucky	City	14,414	43,370	33.2%	1,208
Crescent Springs	Kenton	Kentucky	City	187	3,931	4.8%	16
Crestview Hills	Kenton	Kentucky	City	1,886	2,889	65.3%	158
Crittenden	Grant	Kentucky	City	652	2,401	27.1%	55
Dayton	Campbell	Kentucky	City	785	5,966	13.2%	66
Dent	Hamilton	Ohio	CDP	2,905	7,612	38.2%	223
Dillonvale	Hamilton	Ohio	CDP	838	3,716	22.6%	64
Dry Ridge	Grant	Kentucky	City	287	1,995	14.4%	24
Dry Run	Hamilton	Ohio	CDP	217	6,553	3.3%	17
Edgewood	Kenton	Kentucky	City	1,167	9,400	12.4%	98
Elmwood Place	Hamilton	Ohio	Village	1,143	2,681	42.7%	88
Elsmere	Kenton	Kentucky	City	1,518	8,139	18.6%	127
Erlanger	Kenton	Kentucky	City	6,444	16,676	38.6%	540
Evendale	Hamilton	Ohio	Village	3	3,090	0.1%	0
Fairfield	Butler	Ohio	City	8,588	42,097	20.4%	659
Fairview	Kenton	Kentucky	City	4	156	2.4%	0
Finneytown	Hamilton	Ohio	CDP	6,667	13,492	49.4%	511
Florence	Boone	Kentucky	City	9,944	23,551	42.2%	833
Forest Park	Hamilton	Ohio	City	4,802	19,463	24.7%	368
Forestville	Hamilton	Ohio	CDP	5,219	10,978	47.5%	400
Fort Mitchell	Kenton	Kentucky	City	4,063	8,089	50.2%	340
Fort Thomas	Campbell	Kentucky	City	3,227	16,495	19.6%	270
Fort Wright	Kenton	Kentucky	City	2,961	5,681	52.1%	248

Cincinnati Area Communities in Alphabetical Order (continued)–Table 3

Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Franklin	Warren	Ohio	City	3,567	11,396	31.3%	274
Fruit Hill	Hamilton	Ohio	CDP	1,255	3,945	31.8%	96
Glendale	Hamilton	Ohio	Village	631	2,188	28.8%	48
Grandview	Hamilton	Ohio	CDP	36	1,391	2.6%	3
Greendale	Dearborn	Indiana	City	197	4,296	4.6%	16
Greenhills	Hamilton	Ohio	Village	1,419	4,103	34.6%	109
Groesbeck	Hamilton	Ohio	CDP	1,126	7,202	15.6%	86
Hamilton	Butler	Ohio	City	17,669	60,690	29.1%	1,355
Harrison	Hamilton	Ohio	City	682	7,487	9.1%	52
Highland Heights	Campbell	Kentucky	City	3,035	6,554	46.3%	254
Independence	Kenton	Kentucky	City	3,955	14,982	26.4%	331
Kenton Vale	Kenton	Kentucky	City	77	156	49.0%	6
Kenwood	Hamilton	Ohio	CDP	5,369	7,423	72.3%	412
Lakeside Park	Kenton	Kentucky	City	1,852	2,869	64.6%	155
Landen	Warren	Ohio	CDP	2,943	12,766	23.1%	226
Latonia Lakes	Kenton	Kentucky	City	132	325	40.6%	11
Lawrenceburg	Dearborn	Indiana	City	1,125	4,685	24.0%	89
Lebanon	Warren	Ohio	City	1,064	16,962	6.3%	82
Lincoln Heights	Hamilton	Ohio	Village	986	4,113	24.0%	76
Lockland	Hamilton	Ohio	Village	1,958	3,707	52.8%	150
Loveland	Hamilton	Ohio	City	609	11,677	5.2%	47
Madeira	Hamilton	Ohio	City	1,775	8,923	19.9%	136
Mariemont	Hamilton	Ohio	Village	1,888	3,408	55.4%	145
Mason	Warren	Ohio	City	1,837	22,016	8.3%	141
Middletown	Butler	Ohio	City	11,907	51,605	23.1%	913
Milford	Clermont	Ohio	City	608	6,284	9.7%	47
Monfort Heights East	Hamilton	Ohio	CDP	1,208	3,880	31.1%	93
Monfort Heights South	Hamilton	Ohio	CDP	1,851	4,466	41.4%	142
Monroe	Butler	Ohio	City	2,088	7,133	29.3%	160
Montgomery	Hamilton	Ohio	City	4,283	10,163	42.1%	328
Mount Carmel	Hamilton	Ohio	CDP	1,867	4,308	43.3%	143
Mount Healthy	Hamilton	Ohio	City	1,997	7,149	27.9%	153
Mount Healthy Heights	Hamilton	Ohio	CDP	625	3,450	18.1%	48
Mount Repose	Clermont	Ohio	CDP	530	4,102	12.9%	41
Mulberry	Clermont	Ohio	CDP	1,257	3,139	40.0%	96
Newport	Campbell	Kentucky	City	4,260	17,048	25.0%	357
Newtonsville	Clermont	Ohio	Village	190	492	38.7%	15
Newtown	Hamilton	Ohio	Village	1,196	2,420	49.4%	92
North College Hill	Hamilton	Ohio	City	2,945	10,082	29.2%	226
Northbrook	Hamilton	Ohio	CDP	811	11,076	7.3%	62
Northgate	Hamilton	Ohio	CDP	2,484	8,016	31.0%	190
Norwood	Hamilton	Ohio	City	5,966	21,675	27.5%	458

Cincinnati Area Communities in Alphabetical Order (continued)–Table 3

Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Oakbrook	Boone	Kentucky	CDP	718	7,726	9.3%	60
Olde West Chester	Place	Ohio	CDP	130	232	56.1%	10
Park Hills	Kenton	Kentucky	City	1,622	2,977	54.5%	136
Pleasant Run	Hamilton	Ohio	CDP	1,105	5,267	21.0%	85
Pleasant Run Farm	Hamilton	Ohio	CDP	765	4,731	16.2%	59
Reading	Hamilton	Ohio	City	3,286	11,292	29.1%	252
Ross	Butler	Ohio	CDP	1,106	1,971	56.1%	85
Sharonville	Hamilton	Ohio	City	2,647	13,804	19.2%	203
Sherwood	Hamilton	Ohio	CDP	832	3,907	21.3%	64
Silverton	Hamilton	Ohio	City	346	5,178	6.7%	27
South Lebanon	Warren	Ohio	Village	4	2,538	0.1%	0
Southgate	Campbell	Kentucky	City	866	3,472	24.9%	73
Sparta	Gallatin	Kentucky	City	16	230	6.8%	1
Springboro	Warren	Ohio	City	1,961	12,380	15.8%	150
Springdale	Hamilton	Ohio	City	5,607	10,563	53.1%	430
St. Bernard	Hamilton	Ohio	City	1,159	4,924	23.5%	89
St. Leon	Dearborn	Indiana	Town	108	387	27.9%	9
Summerside	Clermont	Ohio	CDP	1,579	5,523	28.6%	121
Taylor Mill	Kenton	Kentucky	City	3,160	6,913	45.7%	265
The Village of Indian Hill	Hamilton	Ohio	City	63	5,907	1.1%	5
Turpin Hills	Hamilton	Ohio	CDP	625	4,960	12.6%	48
Union	Boone	Kentucky	City	1,206	2,893	41.7%	101
Walton	Boone	Kentucky	City	1,611	2,450	65.8%	135
Wetherington	Butler	Ohio	CDP	124	1,010	12.3%	10
White Oak	Hamilton	Ohio	CDP	3,349	13,277	25.2%	257
White Oak East	Hamilton	Ohio	CDP	1,268	3,508	36.1%	97
White Oak West	Hamilton	Ohio	CDP	697	2,932	23.8%	53
Wilder	Campbell	Kentucky	City	502	2,624	19.1%	42
Williamsburg	Clermont	Ohio	Village	3	2,358	0.1%	0
Williamstown	Grant	Kentucky	City	4	3,227	0.1%	0
Withamsville	Clermont	Ohio	CDP	1,480	3,145	47.1%	114
Woodlawn	Campbell	Kentucky	City	139	268	51.8%	12
Woodlawn	Hamilton	Ohio	Village	441	2,816	15.6%	34
Wyoming	Hamilton	Ohio	City	2,758	8,261	33.4%	212

Cincinnati Area Communities Ranked by Number of People Living in Hot Spots–Table 4

Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Cincinnati	Hamilton	Ohio	City	149,111	331,285	45.0%	11,437
Hamilton	Butler	Ohio	City	17,669	60,690	29.1%	1,355
Covington	Kenton	Kentucky	City	14,414	43,370	33.2%	1,208
Middletown	Butler	Ohio	City	11,907	51,605	23.1%	913
Florence	Boone	Kentucky	City	9,944	23,551	42.2%	833
Fairfield	Butler	Ohio	City	8,588	42,097	20.4%	659
Finneytown	Hamilton	Ohio	CDP	6,667	13,492	49.4%	511
Erlanger	Kenton	Kentucky	City	6,444	16,676	38.6%	540
Norwood	Hamilton	Ohio	City	5,966	21,675	27.5%	458
Springdale	Hamilton	Ohio	City	5,607	10,563	53.1%	430
Kenwood	Hamilton	Ohio	CDP	5,369	7,423	72.3%	412
Forestville	Hamilton	Ohio	CDP	5,219	10,978	47.5%	400
Cheviot	Hamilton	Ohio	City	4,863	9,015	53.9%	373
Forest Park	Hamilton	Ohio	City	4,802	19,463	24.7%	368
Blue Ash	Hamilton	Ohio	City	4,717	12,513	37.7%	362
Montgomery	Hamilton	Ohio	City	4,283	10,163	42.1%	328
Newport	Campbell	Kentucky	City	4,260	17,048	25.0%	357
Fort Mitchell	Kenton	Kentucky	City	4,063	8,089	50.2%	340
Bridgetown North	Hamilton	Ohio	CDP	4,057	12,569	32.3%	311
Independence	Kenton	Kentucky	City	3,955	14,982	26.4%	331
Franklin	Warren	Ohio	City	3,567	11,396	31.3%	274
White Oak	Hamilton	Ohio	CDP	3,349	13,277	25.2%	257
Bellevue	Campbell	Kentucky	City	3,286	6,480	50.7%	275
Reading	Hamilton	Ohio	City	3,286	11,292	29.1%	252
Fort Thomas	Campbell	Kentucky	City	3,227	16,495	19.6%	270
Taylor Mill	Kenton	Kentucky	City	3,160	6,913	45.7%	265
Highland Heights	Campbell	Kentucky	City	3,035	6,554	46.3%	254
Fort Wright	Kenton	Kentucky	City	2,961	5,681	52.1%	248
North College Hill	Hamilton	Ohio	City	2,945	10,082	29.2%	226
Landen	Warren	Ohio	CDP	2,943	12,766	23.1%	226
Dent	Hamilton	Ohio	CDP	2,905	7,612	38.2%	223
Wyoming	Hamilton	Ohio	City	2,758	8,261	33.4%	212
Sharonville	Hamilton	Ohio	City	2,647	13,804	19.2%	203
Northgate	Hamilton	Ohio	CDP	2,484	8,016	31.0%	190
Monroe	Butler	Ohio	City	2,088	7,133	29.3%	160
Mount Healthy	Hamilton	Ohio	City	1,997	7,149	27.9%	153
Springboro	Warren	Ohio	City	1,961	12,380	15.8%	150
Lockland	Hamilton	Ohio	Village	1,958	3,707	52.8%	150
Mariemont	Hamilton	Ohio	Village	1,888	3,408	55.4%	145
Crestview Hills	Kenton	Kentucky	City	1,886	2,889	65.3%	158
Mount Carmel	Hamilton	Ohio	CDP	1,867	4,308	43.3%	143
Lakeside Park	Kenton	Kentucky	City	1,852	2,869	64.6%	155
Monfort Heights South	Hamilton	Ohio	CDP	1,851	4,466	41.4%	142

Cincinnati Area Communities Ranked by Number of People Living in Hot Spots (continued)–Table 4							
Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Mason	Warren	Ohio	City	1,837	22,016	8.3%	141
Madeira	Hamilton	Ohio	City	1,775	8,923	19.9%	136
Alexandria	Campbell	Kentucky	City	1,751	8,286	21.1%	147
Park Hills	Kenton	Kentucky	City	1,622	2,977	54.5%	136
Walton	Boone	Kentucky	City	1,611	2,450	65.8%	135
Burlington	Boone	Kentucky	CDP	1,595	10,779	14.8%	134
Summerside	Clermont	Ohio	CDP	1,579	5,523	28.6%	121
Elsmere	Kenton	Kentucky	City	1,518	8,139	18.6%	127
Withamsville	Clermont	Ohio	CDP	1,480	3,145	47.1%	114
Greenhills	Hamilton	Ohio	Village	1,419	4,103	34.6%	109
White Oak East	Hamilton	Ohio	CDP	1,268	3,508	36.1%	97
Mulberry	Clermont	Ohio	CDP	1,257	3,139	40.0%	96
Fruit Hill	Hamilton	Ohio	CDP	1,255	3,945	31.8%	96
Monfort Heights East	Hamilton	Ohio	CDP	1,208	3,880	31.1%	93
Union	Boone	Kentucky	city	1,206	2,893	41.7%	101
Newtown	Hamilton	Ohio	Village	1,196	2,420	49.4%	92
Beckett Ridge	Butler	Ohio	CDP	1,180	8,663	13.6%	91
Edgewood	Kenton	Kentucky	City	1,167	9,400	12.4%	98
St. Bernard	Hamilton	Ohio	City	1,159	4,924	23.5%	89
Elmwood Place	Hamilton	Ohio	Village	1,143	2,681	42.7%	88
Groesbeck	Hamilton	Ohio	CDP	1,126	7,202	15.6%	86
Lawrenceburg	Dearborn	Indiana	City	1,125	4,685	24.0%	89
Ross	Butler	Ohio	CDP	1,106	1,971	56.1%	85
Pleasant Run	Hamilton	Ohio	CDP	1,105	5,267	21.0%	85
Cold Spring	Campbell	Kentucky	City	1,076	3,806	28.3%	90
Lebanon	Warren	Ohio	City	1,064	16,962	6.3%	82
Lincoln Heights	Hamilton	Ohio	Village	986	4,113	24.0%	76
Amelia	Clermont	Ohio	Village	983	2,752	35.7%	75
Arlington Heights	Hamilton	Ohio	Village	888	899	98.8%	68
Southgate	Campbell	Kentucky	City	866	3,472	24.9%	73
Dillonvale	Hamilton	Ohio	CDP	838	3,716	22.6%	64
Sherwood	Hamilton	Ohio	CDP	832	3,907	21.3%	64
Northbrook	Hamilton	Ohio	CDP	811	11,076	7.3%	62
Aurora	Dearborn	Indiana	City	801	3,965	20.2%	63
Dayton	Campbell	Kentucky	City	785	5,966	13.2%	66
Pleasant Run Farm	Hamilton	Ohio	CDP	765	4,731	16.2%	59
Oakbrook	Boone	Kentucky	CDP	718	7,726	9.3%	60
Cherry Grove	Hamilton	Ohio	CDP	718	4,555	15.8%	55
White Oak West	Hamilton	Ohio	CDP	697	2,932	23.8%	53
Harrison	Hamilton	Ohio	City	682	7,487	9.1%	52
Amberley	Hamilton	Ohio	Village	668	3,425	19.5%	51
Crittenden	Grant	Kentucky	City	652	2,401	27.1%	55
Glendale	Hamilton	Ohio	Village	631	2,188	28.8%	48

Cincinnati Area Communities Ranked by Number of People Living in Hot Spots (continued)–Table 4

Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Mount Healthy Heights	Hamilton	Ohio	CDP	625	3,450	18.1%	48
Turpin Hills	Hamilton	Ohio	CDP	625	4,960	12.6%	48
Loveland	Hamilton	Ohio	City	609	11,677	5.2%	47
Milford	Clermont	Ohio	City	608	6,284	9.7%	47
Cleves	Hamilton	Ohio	Village	573	2,790	20.5%	44
Mount Repose	Clermont	Ohio	CDP	530	4,102	12.9%	41
Wilder	Campbell	Kentucky	City	502	2,624	19.1%	42
Woodlawn	Hamilton	Ohio	Village	441	2,816	15.6%	34
Silverton	Hamilton	Ohio	City	346	5,178	6.7%	27
Claryville	Campbell	Kentucky	CDP	307	2,588	11.9%	26
Dry Ridge	Grant	Kentucky	City	287	1,995	14.4%	24
Dry Run	Hamilton	Ohio	CDP	217	6,553	3.3%	17
Batavia	Clermont	Ohio	Village	208	1,617	12.8%	16
Greendale	Dearborn	Indiana	City	197	4,296	4.6%	16
Newtonsville	Clermont	Ohio	Village	190	492	38.7%	15
Crescent Springs	Kenton	Kentucky	City	187	3,931	4.8%	16
Carlisle	Warren	Ohio	Village	181	5,121	3.5%	14
Butlerville	Warren	Ohio	Village	168	231	72.9%	13
Woodlawn	Campbell	Kentucky	City	139	268	51.8%	12
Latonia Lakes	Kenton	Kentucky	City	132	325	40.6%	11
Olde West Chester	Place	Ohio	CDP	130	232	56.1%	10
Wetherington	Butler	Ohio	CDP	124	1,010	12.3%	10
Covedale	Hamilton	Ohio	CDP	122	6,360	1.9%	9
St. Leon	Dearborn	Indiana	Town	108	387	27.9%	9
Kenton Vale	Kenton	Kentucky	City	77	156	49.0%	6
The Village of Indian Hill	Hamilton	Ohio	City	63	5,907	1.1%	5
Grandview	Hamilton	Ohio	CDP	36	1,391	2.6%	3
Sparta	Gallatin	Kentucky	City	16	230	6.8%	1
Williamstown	Grant	Kentucky	City	4	3,227	0.1%	0
Fairview	Kenton	Kentucky	City	4	156	2.4%	0
South Lebanon	Warren	Ohio	Village	4	2,538	0.1%	0
Williamsburg	Clermont	Ohio	Village	3	2,358	0.1%	0
Evendale	Hamilton	Ohio	Village	3	3,090	0.1%	0

Cincinnati Area Communities Ranked by percent of population Living in Hot Spots–Table 5							
Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Arlington Heights	Hamilton	Ohio	Village	888	899	98.8%	68
Butlerville	Warren	Ohio	Village	168	231	72.9%	13
Kenwood	Hamilton	Ohio	CDP	5,369	7,423	72.3%	412
Walton	Boone	Kentucky	City	1,611	2,450	65.8%	135
Crestview Hills	Kenton	Kentucky	City	1,886	2,889	65.3%	158
Lakeside Park	Kenton	Kentucky	City	1,852	2,869	64.6%	155
Ross	Butler	Ohio	CDP	1,106	1,971	56.1%	85
Olde West Chester	Place	Ohio	CDP	130	232	56.1%	10
Mariemont	Hamilton	Ohio	Village	1,888	3,408	55.4%	145
Park Hills	Kenton	Kentucky	City	1,622	2,977	54.5%	136
Cheviot	Hamilton	Ohio	City	4,863	9,015	53.9%	373
Springdale	Hamilton	Ohio	City	5,607	10,563	53.1%	430
Lockland	Hamilton	Ohio	Village	1,958	3,707	52.8%	150
Fort Wright	Kenton	Kentucky	City	2,961	5,681	52.1%	248
Woodlawn	Campbell	Kentucky	City	139	268	51.8%	12
Bellevue	Campbell	Kentucky	City	3,286	6,480	50.7%	275
Fort Mitchell	Kenton	Kentucky	City	4,063	8,089	50.2%	340
Newtown	Hamilton	Ohio	Village	1,196	2,420	49.4%	92
Finneytown	Hamilton	Ohio	CDP	6,667	13,492	49.4%	511
Kenton Vale	Kenton	Kentucky	City	77	156	49.0%	6
Forestville	Hamilton	Ohio	CDP	5,219	10,978	47.5%	400
Withamsville	Clermont	Ohio	CDP	1,480	3,145	47.1%	114
Highland Heights	Campbell	Kentucky	City	3,035	6,554	46.3%	254
Taylor Mill	Kenton	Kentucky	City	3,160	6,913	45.7%	265
Cincinnati	Hamilton	Ohio	City	149,111	331,285	45.0%	11,437
Mount Carmel	Hamilton	Ohio	CDP	1,867	4,308	43.3%	143
Elmwood Place	Hamilton	Ohio	Village	1,143	2,681	42.7%	88
Florence	Boone	Kentucky	City	9,944	23,551	42.2%	833
Montgomery	Hamilton	Ohio	City	4,283	10,163	42.1%	328
Union	Boone	Kentucky	city	1,206	2,893	41.7%	101
Monfort Heights South	Hamilton	Ohio	CDP	1,851	4,466	41.4%	142
Latonia Lakes	Kenton	Kentucky	City	132	325	40.6%	11
Mulberry	Clermont	Ohio	CDP	1,257	3,139	40.0%	96
Newtonsville	Clermont	Ohio	Village	190	492	38.7%	15
Erlanger	Kenton	Kentucky	City	6,444	16,676	38.6%	540
Dent	Hamilton	Ohio	CDP	2,905	7,612	38.2%	223
Blue Ash	Hamilton	Ohio	City	4,717	12,513	37.7%	362
White Oak East	Hamilton	Ohio	CDP	1,268	3,508	36.1%	97
Amelia	Clermont	Ohio	Village	983	2,752	35.7%	75
Greenhills	Hamilton	Ohio	Village	1,419	4,103	34.6%	109
Wyoming	Hamilton	Ohio	City	2,758	8,261	33.4%	212
Covington	Kenton	Kentucky	City	14,414	43,370	33.2%	1,208
Bridgetown North	Hamilton	Ohio	CDP	4,057	12,569	32.3%	311

Cincinnati Area Communities Ranked by percent of population Living in Hot Spots (continued)–Table 5

Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Fruit Hill	Hamilton	Ohio	CDP	1,255	3,945	31.8%	96
Franklin	Warren	Ohio	City	3,567	11,396	31.3%	274
Monfort Heights East	Hamilton	Ohio	CDP	1,208	3,880	31.1%	93
Northgate	Hamilton	Ohio	CDP	2,484	8,016	31.0%	190
Monroe	Butler	Ohio	City	2,088	7,133	29.3%	160
North College Hill	Hamilton	Ohio	City	2,945	10,082	29.2%	226
Hamilton	Butler	Ohio	City	17,669	60,690	29.1%	1,355
Reading	Hamilton	Ohio	City	3,286	11,292	29.1%	252
Glendale	Hamilton	Ohio	Village	631	2,188	28.8%	48
Summerside	Clermont	Ohio	CDP	1,579	5,523	28.6%	121
Cold Spring	Campbell	Kentucky	City	1,076	3,806	28.3%	90
Mount Healthy	Hamilton	Ohio	City	1,997	7,149	27.9%	153
St. Leon	Dearborn	Indiana	Town	108	387	27.9%	9
Norwood	Hamilton	Ohio	City	5,966	21,675	27.5%	458
Crittenden	Grant	Kentucky	City	652	2,401	27.1%	55
Independence	Kenton	Kentucky	City	3,955	14,982	26.4%	331
White Oak	Hamilton	Ohio	CDP	3,349	13,277	25.2%	257
Newport	Campbell	Kentucky	City	4,260	17,048	25.0%	357
Southgate	Campbell	Kentucky	City	866	3,472	24.9%	73
Forest Park	Hamilton	Ohio	City	4,802	19,463	24.7%	368
Lawrenceburg	Dearborn	Indiana	City	1,125	4,685	24.0%	89
Lincoln Heights	Hamilton	Ohio	Village	986	4,113	24.0%	76
White Oak West	Hamilton	Ohio	CDP	697	2,932	23.8%	53
St. Bernard	Hamilton	Ohio	City	1,159	4,924	23.5%	89
Middletown	Butler	Ohio	City	11,907	51,605	23.1%	913
Landen	Warren	Ohio	CDP	2,943	12,766	23.1%	226
Dillonvale	Hamilton	Ohio	CDP	838	3,716	22.6%	64
Sherwood	Hamilton	Ohio	CDP	832	3,907	21.3%	64
Alexandria	Campbell	Kentucky	City	1,751	8,286	21.1%	147
Pleasant Run	Hamilton	Ohio	CDP	1,105	5,267	21.0%	85
Cleves	Hamilton	Ohio	Village	573	2,790	20.5%	44
Fairfield	Butler	Ohio	City	8,588	42,097	20.4%	659
Aurora	Dearborn	Indiana	City	801	3,965	20.2%	63
Madeira	Hamilton	Ohio	City	1,775	8,923	19.9%	136
Fort Thomas	Campbell	Kentucky	City	3,227	16,495	19.6%	270
Amberley	Hamilton	Ohio	Village	668	3,425	19.5%	51
Sharonville	Hamilton	Ohio	City	2,647	13,804	19.2%	203
Wilder	Campbell	Kentucky	City	502	2,624	19.1%	42
Elsmere	Kenton	Kentucky	City	1,518	8,139	18.6%	127
Mount Healthy Heights	Hamilton	Ohio	CDP	625	3,450	18.1%	48
Pleasant Run Farm	Hamilton	Ohio	CDP	765	4,731	16.2%	59
Springboro	Warren	Ohio	City	1,961	12,380	15.8%	150
Cherry Grove	Hamilton	Ohio	CDP	718	4,555	15.8%	55

Cincinnati Area Communities Ranked by percent of population Living in Hot Spots (continued)–Table 5							
Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Woodlawn	Hamilton	Ohio	Village	441	2,816	15.6%	34
Groesbeck	Hamilton	Ohio	CDP	1,126	7,202	15.6%	86
Burlington	Boone	Kentucky	CDP	1,595	10,779	14.8%	134
Dry Ridge	Grant	Kentucky	City	287	1,995	14.4%	24
Beckett Ridge	Butler	Ohio	CDP	1,180	8,663	13.6%	91
Dayton	Campbell	Kentucky	City	785	5,966	13.2%	66
Mount Repose	Clermont	Ohio	CDP	530	4,102	12.9%	41
Batavia	Clermont	Ohio	Village	208	1,617	12.8%	16
Turpin Hills	Hamilton	Ohio	CDP	625	4,960	12.6%	48
Edgewood	Kenton	Kentucky	City	1,167	9,400	12.4%	98
Wetherington	Butler	Ohio	CDP	124	1,010	12.3%	10
Claryville	Campbell	Kentucky	CDP	307	2,588	11.9%	26
Milford	Clermont	Ohio	City	608	6,284	9.7%	47
Oakbrook	Boone	Kentucky	CDP	718	7,726	9.3%	60
Harrison	Hamilton	Ohio	City	682	7,487	9.1%	52
Mason	Warren	Ohio	City	1,837	22,016	8.3%	141
Northbrook	Hamilton	Ohio	CDP	811	11,076	7.3%	62
Sparta	Gallatin	Kentucky	City	16	230	6.8%	1
Silverton	Hamilton	Ohio	City	346	5,178	6.7%	27
Lebanon	Warren	Ohio	City	1,064	16,962	6.3%	82
Loveland	Hamilton	Ohio	City	609	11,677	5.2%	47
Crescent Springs	Kenton	Kentucky	City	187	3,931	4.8%	16
Greendale	Dearborn	Indiana	City	197	4,296	4.6%	16
Carlisle	Warren	Ohio	Village	181	5,121	3.5%	14
Dry Run	Hamilton	Ohio	CDP	217	6,553	3.3%	17
Grandview	Hamilton	Ohio	CDP	36	1,391	2.6%	3
Fairview	Kenton	Kentucky	City	4	156	2.4%	0
Covedale	Hamilton	Ohio	CDP	122	6,360	1.9%	9
The Village of Indian Hill	Hamilton	Ohio	City	63	5,907	1.1%	5
Williamsburg	Clermont	Ohio	Village	3	2,358	0.1%	0
South Lebanon	Warren	Ohio	Village	4	2,538	0.1%	0
Williamstown	Grant	Kentucky	City	4	3,227	0.1%	0
Evendale	Hamilton	Ohio	Village	3	3,090	0.1%	0

Cincinnati Area Communities Ranked by number of people with asthma Living in Hot Spots–Table 6

Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Cincinnati	Hamilton	Ohio	City	149,111	331,285	45.0%	11,437
Hamilton	Butler	Ohio	City	17,669	60,690	29.1%	1,355
Covington	Kenton	Kentucky	City	14,414	43,370	33.2%	1,208
Middletown	Butler	Ohio	City	11,907	51,605	23.1%	913
Florence	Boone	Kentucky	City	9,944	23,551	42.2%	833
Fairfield	Butler	Ohio	City	8,588	42,097	20.4%	659
Erlanger	Kenton	Kentucky	City	6,444	16,676	38.6%	540
Finneytown	Hamilton	Ohio	CDP	6,667	13,492	49.4%	511
Norwood	Hamilton	Ohio	City	5,966	21,675	27.5%	458
Springdale	Hamilton	Ohio	City	5,607	10,563	53.1%	430
Kenwood	Hamilton	Ohio	CDP	5,369	7,423	72.3%	412
Forestville	Hamilton	Ohio	CDP	5,219	10,978	47.5%	400
Cheviot	Hamilton	Ohio	City	4,863	9,015	53.9%	373
Forest Park	Hamilton	Ohio	City	4,802	19,463	24.7%	368
Blue Ash	Hamilton	Ohio	City	4,717	12,513	37.7%	362
Newport	Campbell	Kentucky	City	4,260	17,048	25.0%	357
Fort Mitchell	Kenton	Kentucky	City	4,063	8,089	50.2%	340
Independence	Kenton	Kentucky	City	3,955	14,982	26.4%	331
Montgomery	Hamilton	Ohio	City	4,283	10,163	42.1%	328
Bridgetown North	Hamilton	Ohio	CDP	4,057	12,569	32.3%	311
Bellevue	Campbell	Kentucky	City	3,286	6,480	50.7%	275
Franklin	Warren	Ohio	City	3,567	11,396	31.3%	274
Fort Thomas	Campbell	Kentucky	City	3,227	16,495	19.6%	270
Taylor Mill	Kenton	Kentucky	City	3,160	6,913	45.7%	265
White Oak	Hamilton	Ohio	CDP	3,349	13,277	25.2%	257
Highland Heights	Campbell	Kentucky	City	3,035	6,554	46.3%	254
Reading	Hamilton	Ohio	City	3,286	11,292	29.1%	252
Fort Wright	Kenton	Kentucky	City	2,961	5,681	52.1%	248
North College Hill	Hamilton	Ohio	City	2,945	10,082	29.2%	226
Landen	Warren	Ohio	CDP	2,943	12,766	23.1%	226
Dent	Hamilton	Ohio	CDP	2,905	7,612	38.2%	223
Wyoming	Hamilton	Ohio	City	2,758	8,261	33.4%	212
Sharonville	Hamilton	Ohio	City	2,647	13,804	19.2%	203
Northgate	Hamilton	Ohio	CDP	2,484	8,016	31.0%	190
Monroe	Butler	Ohio	City	2,088	7,133	29.3%	160
Crestview Hills	Kenton	Kentucky	City	1,886	2,889	65.3%	158
Lakeside Park	Kenton	Kentucky	City	1,852	2,869	64.6%	155
Mount Healthy	Hamilton	Ohio	City	1,997	7,149	27.9%	153
Springboro	Warren	Ohio	City	1,961	12,380	15.8%	150
Lockland	Hamilton	Ohio	Village	1,958	3,707	52.8%	150
Alexandria	Campbell	Kentucky	City	1,751	8,286	21.1%	147
Mariemont	Hamilton	Ohio	Village	1,888	3,408	55.4%	145
Mount Carmel	Hamilton	Ohio	CDP	1,867	4,308	43.3%	143

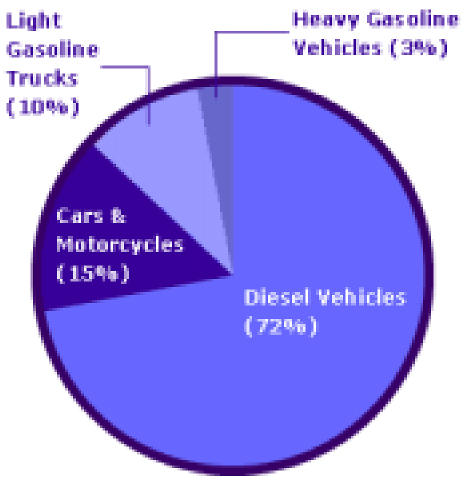
Cincinnati Area Communities Ranked by number of people with asthma Living in Hot Spots (continued)–Table 6							
Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Monfort Heights South	Hamilton	Ohio	CDP	1,851	4,466	41.4%	142
Mason	Warren	Ohio	City	1,837	22,016	8.3%	141
Madeira	Hamilton	Ohio	City	1,775	8,923	19.9%	136
Park Hills	Kenton	Kentucky	City	1,622	2,977	54.5%	136
Walton	Boone	Kentucky	City	1,611	2,450	65.8%	135
Burlington	Boone	Kentucky	CDP	1,595	10,779	14.8%	134
Elsmere	Kenton	Kentucky	City	1,518	8,139	18.6%	127
Summerside	Clermont	Ohio	CDP	1,579	5,523	28.6%	121
Withamsville	Clermont	Ohio	CDP	1,480	3,145	47.1%	114
Greenhills	Hamilton	Ohio	Village	1,419	4,103	34.6%	109
Union	Boone	Kentucky	city	1,206	2,893	41.7%	101
Edgewood	Kenton	Kentucky	City	1,167	9,400	12.4%	98
White Oak East	Hamilton	Ohio	CDP	1,268	3,508	36.1%	97
Mulberry	Clermont	Ohio	CDP	1,257	3,139	40.0%	96
Fruit Hill	Hamilton	Ohio	CDP	1,255	3,945	31.8%	96
Monfort Heights East	Hamilton	Ohio	CDP	1,208	3,880	31.1%	93
Newtown	Hamilton	Ohio	Village	1,196	2,420	49.4%	92
Beckett Ridge	Butler	Ohio	CDP	1,180	8,663	13.6%	91
Cold Spring	Campbell	Kentucky	City	1,076	3,806	28.3%	90
Lawrenceburg	Dearborn	Indiana	City	1,125	4,685	24.0%	89
St. Bernard	Hamilton	Ohio	City	1,159	4,924	23.5%	89
Elmwood Place	Hamilton	Ohio	Village	1,143	2,681	42.7%	88
Groesbeck	Hamilton	Ohio	CDP	1,126	7,202	15.6%	86
Ross	Butler	Ohio	CDP	1,106	1,971	56.1%	85
Pleasant Run	Hamilton	Ohio	CDP	1,105	5,267	21.0%	85
Lebanon	Warren	Ohio	City	1,064	16,962	6.3%	82
Lincoln Heights	Hamilton	Ohio	Village	986	4,113	24.0%	76
Amelia	Clermont	Ohio	Village	983	2,752	35.7%	75
Southgate	Campbell	Kentucky	City	866	3,472	24.9%	73
Arlington Heights	Hamilton	Ohio	Village	888	899	98.8%	68
Dayton	Campbell	Kentucky	City	785	5,966	13.2%	66
Dillonvale	Hamilton	Ohio	CDP	838	3,716	22.6%	64
Sherwood	Hamilton	Ohio	CDP	832	3,907	21.3%	64
Aurora	Dearborn	Indiana	City	801	3,965	20.2%	63
Northbrook	Hamilton	Ohio	CDP	811	11,076	7.3%	62
Oakbrook	Boone	Kentucky	CDP	718	7,726	9.3%	60
Pleasant Run Farm	Hamilton	Ohio	CDP	765	4,731	16.2%	59
Cherry Grove	Hamilton	Ohio	CDP	718	4,555	15.8%	55
Crittenden	Grant	Kentucky	City	652	2,401	27.1%	55
White Oak West	Hamilton	Ohio	CDP	697	2,932	23.8%	53
Harrison	Hamilton	Ohio	City	682	7,487	9.1%	52
Amberley	Hamilton	Ohio	Village	668	3,425	19.5%	51
Glendale	Hamilton	Ohio	Village	631	2,188	28.8%	48

Cincinnati Area Communities Ranked by number of people with asthma Living in Hot Spots (continued)–Table 6

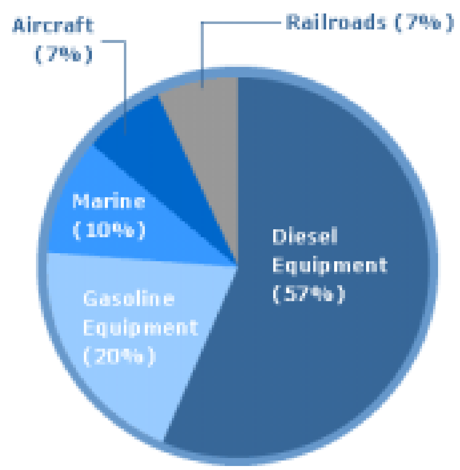
Municipality	County	State	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Mount Healthy Heights	Hamilton	Ohio	CDP	625	3,450	18.1%	48
Turpin Hills	Hamilton	Ohio	CDP	625	4,960	12.6%	48
Loveland	Hamilton	Ohio	City	609	11,677	5.2%	47
Milford	Clermont	Ohio	City	608	6,284	9.7%	47
Cleves	Hamilton	Ohio	Village	573	2,790	20.5%	44
Wilder	Campbell	Kentucky	City	502	2,624	19.1%	42
Mount Repose	Clermont	Ohio	CDP	530	4,102	12.9%	41
Woodlawn	Hamilton	Ohio	Village	441	2,816	15.6%	34
Silverton	Hamilton	Ohio	City	346	5,178	6.7%	27
Claryville	Campbell	Kentucky	CDP	307	2,588	11.9%	26
Dry Ridge	Grant	Kentucky	City	287	1,995	14.4%	24
Dry Run	Hamilton	Ohio	CDP	217	6,553	3.3%	17
Batavia	Clermont	Ohio	Village	208	1,617	12.8%	16
Crescent Springs	Kenton	Kentucky	City	187	3,931	4.8%	16
Greendale	Dearborn	Indiana	City	197	4,296	4.6%	16
Newtonsville	Clermont	Ohio	Village	190	492	38.7%	15
Carlisle	Warren	Ohio	Village	181	5,121	3.5%	14
Butlerville	Warren	Ohio	Village	168	231	72.9%	13
Woodlawn	Campbell	Kentucky	City	139	268	51.8%	12
Latonia Lakes	Kenton	Kentucky	City	132	325	40.6%	11
Olde West Chester	Place	Ohio	CDP	130	232	56.1%	10
Wetherington	Butler	Ohio	CDP	124	1,010	12.3%	10
Covedale	Hamilton	Ohio	CDP	122	6,360	1.9%	9
St. Leon	Dearborn	Indiana	Town	108	387	27.9%	9
Kenton Vale	Kenton	Kentucky	City	77	156	49.0%	6
The Village of Indian Hill	Hamilton	Ohio	City	63	5,907	1.1%	5
Grandview	Hamilton	Ohio	CDP	36	1,391	2.6%	3
Sparta	Gallatin	Kentucky	City	16	230	6.8%	1
Williamstown	Grant	Kentucky	City	4	3,227	0.1%	0
Fairview	Kenton	Kentucky	City	4	156	2.4%	0
South Lebanon	Warren	Ohio	Village	4	2,538	0.1%	0
Williamsburg	Clermont	Ohio	Village	3	2,358	0.1%	0
Evendale	Hamilton	Ohio	Village	3	3,090	0.1%	0

Appendix C: EPA DATA on 1999 Emissions

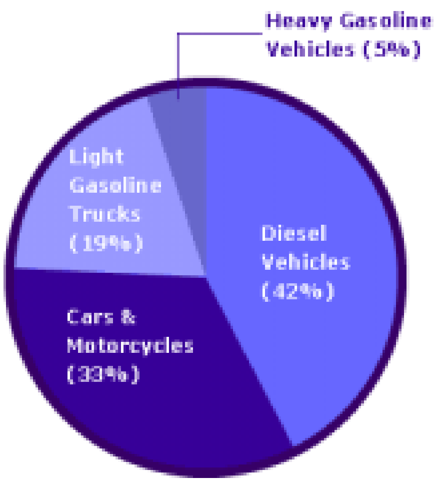
1999 National Emissions by Source:
Particulate Matter ($PM_{2.5}$)
On-road Mobile Sources



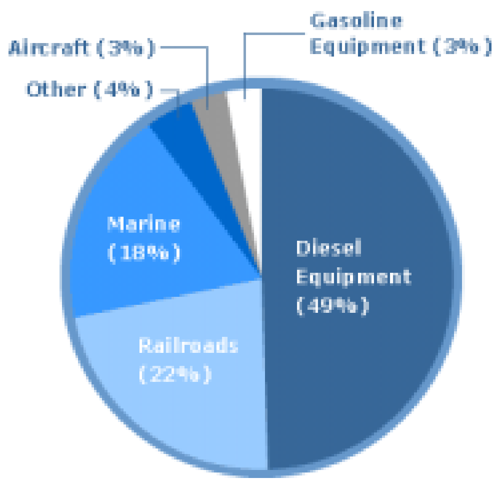
1999 National Emissions by Source:
Particulate Matter ($PM_{2.5}$)
Non-road Mobile Sources



1999 National Emissions by Source:
Nitrogen Oxides
On-road Mobile Sources



1999 National Emissions by Source:
Nitrogen Oxides
Non-road Mobile Sources



Appendix D: The Clean Air Act and Ohio

The Clean Air Act was officially established in 1970 with amendments made over the years, the most significant occurring in 1990. The act started by requiring the federal government to establish National Ambient Air Quality Standards (NAAQS), states to develop implementation plans, new sources to meet more stringent standards than existing sources, and by setting emission limits for passenger cars. The NAAQS cover six pollutants, called criteria pollutants: carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), ozone (O_3), lead (Pb) and nitrogen oxides (NOx). Over the subsequent decades the Act was amended and the deadlines for meeting attainment for NAAQS were repeatedly moved back. The 1990 Amendments extended the deadlines into the 21st century, established a new permit program for major stationary sources, created new programs dealing with acid rain and stratospheric ozone-depleting substances, tightened motor vehicles emission standards, and revised requirements for state implementation plans. Air quality laws also regulate hazardous air pollutants (HAPs), 189 chemicals which cause serious health and environmental hazards. U.S. EPA's role is to identify the primary sources of pollution and issue regulations such as the use of Maximum Achievable Control Technology (MACT) to reduce pollutants.

When U.S. EPA sets a standard or adopts a rule related to attaining NAAQS, they require the states to develop a State Implementation Plan (SIP). Primary enforcement lies with the state governments, which can create stronger regulations but may not have lower standards than the national guidelines. Basically, U.S. EPA is required to tell the states what goals they must meet, but does not tell them how to achieve those goals. A SIP contains the regulations the state will use to clean up polluted areas in accordance with the Clean Air Act. Examples would be control measures for setting limits on emissions from stationary sources (factories), area sources (residential fireplaces), and motor vehicles. States identify the levels of control to be utilized in the facility-specific permits. The public must be allowed involvement through hearings and comment periods during the creation of a SIP. The SIP must then be approved by the U.S. EPA. If it is found unacceptable, the U.S. EPA can either take over the state's role of enforcing the Clean Air Act by creating a federal implementation plan (FIP) or withhold federal highway dollars from the state. In addition, U.S. EPA has the ability to veto permits issued by the state.

Ohio has some of the worst air quality in the country. U.S. EPA data suggests that diesel engines and power plants are the primary sources of particulate matter in urban areas. The majority of Ohio's population is spread throughout six urban areas; reducing emissions from these areas will most effectively reduce mortality and facilitate attaining NAAQS. In April 2004, thirty-three Ohio counties were declared in nonattainment by U.S. EPA for the 8-hour ozone standard. It is expected that thirty-three counties will be declared in nonattainment for fine particles in November 2004. SIPs must be adopted by 2007 for ozone and 2008 for particulate matter with provisions to meet the standards by 2010. Failure to meet attainment results in prohibition of new facilities releasing emissions unless the overall emissions for the area can be lowered through other means. Consequently, if a new or modified source is proposed for the non-attainment area Ohio EPA must demonstrate that the total emissions in the area will decrease (Lowest Achievable Emissions Rate or LAER). U.S. EPA studies have shown that some areas in Ohio will need to significantly reduce the pollution from mobile sources in addition to meeting all the other aspects of Clean Air Act requirements in order to reach attainment levels. A real and immediate way for states to quickly push towards reaching attainment is to regulate for diesel emissions. This requires programs to clean up existing diesels instead of waiting three decades for the benefits of the on- and non-road diesel rules to be realized.

Appendix E: Programs across the country

The following program list contains examples of some existing diesel cleanup efforts and should not be considered a comprehensive list as many additional programs not mentioned here are currently occurring around the country.

U.S. EPA

The goal of **Clean School Bus USA** is to reduce both children's exposure to diesel exhaust and the amount of air pollution created by diesel school buses by encouraging policies and practices to eliminate unnecessary public school bus idling, upgrading ("retrofitting") buses that will remain in the fleet with better emission control technologies and/or fueling them with cleaner fuels, and replacing the oldest buses in the fleet with new, less polluting buses.

EPA has developed the **Voluntary Diesel Retrofit Program** to help make a difference in the immediate future prior to implementation of the on- and non-road diesel rules. The program will address pollution from diesel construction equipment and heavy-duty vehicles that are on the road today. This web site is designed to help fleet operators, air quality planners in state/local government, and retrofit manufacturers understand this program and obtain the information they need to create effective retrofit projects.

Texas

The Texas Emissions Reduction Plan (TERP) was established by the 77th Texas Legislature in 2001. The TERP includes a number of voluntary financial incentive programs, as well as other assistance programs, to help improve the air quality in Texas. The goals of the TERP are to: assure that the air in the state is safe to breathe and meets minimum federal standards established under the Federal Clean Air Act; develop multi-pollutant approaches to solving the state's environmental problems; and adequately fund research and development that will make the state a leader in new technologies that can solve the state's environmental problems while creating new business and industry.

California

The Carl Moyer Memorial Air Quality Standards Attainment Program provides funds on an incentive-basis for the incremental cost of cleaner than required engines and equipment. Eligible projects include cleaner on-road, off-road, marine, locomotive, and stationary agricultural pump engines, as well as forklifts, airport ground support equipment, and auxiliary power units. The program achieves near-term reductions in NOx emissions, which are necessary for California to meet its clean air commitments under the State Implementation Plan. In addition, local air districts use these NOx emission reductions to meet commitments in their conformity plans, thus preventing the loss of federal funding for local areas throughout California. The program also reduces particulate matter, a component of diesel exhaust the Air Resources Board recently identified as a toxic air contaminant.

Washington State

Washington State Ferries (WSF)/Washington State Department of Transportation (WSDOT) have developed a program to shift the entire ferry fleet to low sulfur diesel fuel, test ultra low sulfur diesel fuel, and test biodiesel fuel—all steps that will improve air quality by reducing the amount of harmful substances in the ferries' diesel fuel exhaust. The Department is undertaking this effort to work in partnership with diesel users to make clean diesel vehicles more of a reality. The goals are to protect the environment, improve public health, enhance public relations and potentially avoid the need for a regulatory program.

Governor Gary Locke signed SB 6072 to provide up to $5 million annually to be used for school bus retrofits in Washington State. The bill uses an existing title transfer fee for vehicles to create a $5 million annual appropriation. At least 85% of the money must be spent on school bus retrofits and the remainder can be spent on other mobile source, air toxics and air quality programs. The bill was initiated by the Puget Sound Clean Air Agency which currently has commitments to retrofit over 2,000 diesel vehicles and a list of up to 8,000 retrofit candidates.

The City of Seattle has committed to retrofitting 500 vehicles. The Port of Seattle is fueling construction vehicles working on a new runway with ULSD. Cruise ships in Seattle Harbor are using ULSD while in port.

Ann Arbor, MI A member of the Clean Cities Program, grants have facilitated the purchase of four CNG buses, two bi-fuel propane vehicles and a heavy-duty CNG refuse hauler. Further, the city is currently using biodiesel and is considering implementing the use of ULSD.

The Ann Arbor Transportation Authority is currently using ULSD and diesel particulate filters for its fleet.

University of Michigan operates its diesel engines with ultralow sulfur biodiesel fuel, has ethanol powered vehicles and electric trucks as part of its transportation department's movement to alternative fuel vehicles.

Boston, MA Several hundred pieces of heavy-duty off-road diesel equipment are being used in construction of the Central Artery/Tunnel Project (Big Dig). The Massachusetts Turnpike Authority (MTA) in collaboration with the Massachusetts Department of Environmental Protection (DEP) and the Northeast States for Coordinated Air Use Management (NESCAUM) implemented a voluntary diesel retrofit program. The use of oxidation catalysts was so successful that what began as a voluntary program was shifted to a requirement for all vehicles used through the end of the dig.

Boston Massachusetts Bay Transit Authority has committed to using ULSD fuel prior to the federal requirement in 2006 and to the phased-in purchase of compressed natural gas buses. Initiatives also include rebuilding engines and installing diesel particulate filters on existing buses and working to relocate maintenance facilities from urban neighborhoods to industrial locations where feasible.

Cincinnati, OH The Hamilton County Department of Environmental Services received a U.S. EPA Voluntary Diesel Retrofit grant to assist area school districts in retrofitting 34 buses with diesel oxidation catalysts and provide a 10-month supply of biodiesel to fuel 74 buses.

Cleveland, OH The Greater Cleveland Regional Transit Authority (RTA) began utilizing alternative fuels in 1990. They currently have 166 buses running on compressed natural gas, with two garages fitted for CNG fueling. RTA recently purchased 225 clean air buses, which they plan to run on ultralow sulfur fuel.

The Cleveland Municipal School District (CMSD) received funding for a retrofit project from the U.S. EPA as part of the Cleveland Air Toxics Project. The district had to delay installing the particulate filters on 23 buses until they received an additional grant to offset the cost of purchasing the ULSD fuel. CMSD has since received a Clean School Bus USA grant from U.S.EPA to retrofit an additional 36 buses with particulate filters and purchase more ULSD. The school district has also adopted an anti-idling policy aimed at reducing idling time by 50%.

Columbus, OH The Franklin County Board of Mental Retardation and Developmental Disabilities became the first school district in the state to use biodiesel fuel in its fleet starting in May 2004.

Dayton, OH The Regional Air Pollution Control Agency received a Clean School Bus USA grant to assist the Montgomery County Board of Mental Retardation and Developmental Disabilities school district with retrofitting 33 school buses with diesel oxidation catalysts.

New York, NY All New York City transit buses (part of the Metropolitan Transit Authority) have been retrofitted and are running on ULSD. New York State has $11 million dollars in funding for projects, with $6 million from the New York Power Authority and $5 million from bonds. The $6 million will focus on school bus retrofits. The $5 million bond package originally was written for purchasing alternative-fuel vehicles. After realizing school districts found this too costly, the language was rewritten to include retrofits. Grants will cover 100% of the retrofit technology, but school districts will need to cover the increase in fuel costs.

Endnotes

1. Schwartz, J., “Harvesting and Long Term Exposure Effects in the Relation between Air Pollution and Mortality,” *American Journal of Epidemiology*, Vol. 151, No. 5, 2000, pp. 440-448.

2. Pearson et al., “Distance-weighted traffic density in proximity to a home is a risk factor for leukemia and other childhood cancers,.” *Journal of Air and Waste Management Association*, Vol. 50, 2000, pp. 175-180.

3. Lin et al., “Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic,” *Environmental Research*, Section A, Vol. 88, 2002, pp. 73-81.

4. Edwards et al., “Hospital admissions for asthma in preschool children: relationship to major roads in Birmingham, United Kingdom,” *Archives of Environmental Health*, Vol. 49, No. 4, 1994, pp. 223-227.

5. Venn et al., “Living Near A Main Road and the Risk of Wheezing Illness in Children,” *American Journal of Respiratory and Critical Care Medicine*, Vol. 164, 2001, pp. 2177-2180.

6. Clean Air Task Force, “Diesel Engines: Emissions and Human Exposure,” *Diesel Fact Sheets*, http://www.catf.us/publications/fact_sheets/diesel/Diesel_Emissions_and_Exposures.pdf.

7. Environment and Human Health, Inc., *Children’s Exposure to Diesel Exhaust on School Buses*, 2002, p. 43.

8. Environment and Human Health, Inc., *Children’s Exposure to Diesel Exhaust on School Buses*, 2002, p. 43.

9. Fruin et al., “Fine Particle and Black Carbon Concentrations Inside Vehicles.” *10th Annual Conference of the International Society of Exposure Analysis*, 2000.

10. Diesel exhaust risk relative to risk of all air toxics via inhalation exposure.

11. U.S. PIRG, “Dangers of Diesel. How diesel soot and other air toxics increase Americans’ risk of cancer,” 2002, http://uspirg.org/reports/dangersofdiesel2002/dangersofdieselreport2002.pdf.

12. Heavy duty engines emit 95% of the pollution from all on-road diesel engines. From: the Projection of Mobile Source Air Toxics from 1996 to 2007: Emissions and Concentrations, 2001.

13. Clean Air Task Force, “Diesel Engines: Emissions and Human Exposure,” *Diesel Fact Sheets*, http://www.catf.us/publications/fact_sheets/diesel/Diesel_Emissions_and_Exposures.pdf.

14. Environment and Human Health, Inc., *Children’s Exposure to Diesel Exhaust on School Buses*, 2002, p. 23.

15. American Lung Association, *The American Lung Association State of the Air: 2003*, http://lungaction.org/reports/sota03_full.html.

16. Clean Air Task Force, “Diesel Engines: Emissions and Human Exposure,” *Diesel Fact Sheets*, http://www.catf.us/publications/fact_sheets/diesel/Diesel_Emissions_and_Exposures.pdf.

17. California Environmental Protection Agency Air Resources Board, *Risk Reduction Plan toReduce Particulate Matter Emissions from Diesel-fueled Engines and Vehicles*, 2000, p. 1-Executive Summary.

18. Diesel exhaust poses 70 percent of the air toxics risk (by inhalation only) in Southern California according to the South Coast Air Quality Management District’s Multiple Air Toxics (MATES-II) study.

19. EPA, *Health Assessment Document for Diesel Exhaust: Office of Research and Development*, EPA/600/8-90/057F, 2002.

20. New York University, “Most Definitive Study Yet Shows Tiny Particles in Air Are Linked to Lung Cancer.” *NYU Press Release*, March 5, 2002.

21. Kilburn, K.H. “Effects of Diesel Exhaust on Neurobehavioral and Pulmonary Functions,” *Archives of Environmental Health*, Vol. 55, No. 1, 2000, p. 11-17.

22. Yin, X. et al., "Alteration of Pulmonary Immunity to Listeria Monocytogenes by Diesel Exhaust Particles (DEPs). I. Effects of DEPs on Early Pulmonary Responses," *Environmental Health Perspectives*, Vol. 110, No. 11, 2002.

23. Diesel exposure in pregnant rats caused changes to the thymus gland in newborns, a key organ of the immune system. It has been hypothesized that the rising prevalence of allergic disease in infants could be linked to diesel effects on the development of the thymus gland during pregnancy and resulting immune system impacts. See Watanabe, N et al., "The Masculinization of the Fetus During Pregnancy Due to Inhalation of Diesel Exhaust," *Environmental Health Perspectives*, Vol. 109, No. 2, 2001.

24. Avol, E.L et al., "Respiratory Effects of Relocating to Areas of Differing Air Pollution Levels." *American Journal of Respiratory and Critical Care Medicine*, Vol. 164, 2001, p. 2067-2072.

25. Ritz, B. et al., "Ambient Air Pollution and Risk of Birth Defects in Southern California," *American Journal of Epidemiology*, Vol. 155, No. 1, 2002.

26. Woodruff, T. et al., "The Relationship Between Selected Causes of Post-neonatal Infant Mortality and Particulate Air Pollution in the United States," *Environmental Health Perspectives*, Vol. 105, 1997, p. 608-612.

27. Plopper, C.G. et al., "Air Pollution Effects in a Primate Model of Asthma," *Abstract and presentation, HEI Annual Conference*, Washington DC, 2001.

28. McConnell, R. et al., "Asthma in Exercising Children Exposed to Ozone: A Cohort Study," *The Lancet*, Vol. 359, 2002, p. 386-391.

29. EPA, *Health Assessment Document for Diesel Exhaust: Office of Research and Development*, EPA/600/8-90/057F, 2002, p. 1-5.

30. EPA, *Health and Environmental Effects of Particulate Matter Fact Sheet*, 1997, http://www.epa.gov/ttn/oarpg/naaqsfin/pmhealth.html.

31. NRC, "Pesticides in the diets of infants and children," *NAS Press*, 1993. See also: Dietert et al., "Workshop to Identify Critical Windows of Exposure for Children's Health: Immune and Respiratory Systems Work Group." *Environmental Health Perspective*, Vol. 108, Supp. 3, 2000.

32. EPA, *Health and Environmental Effects of Particulate Matter Fact Sheet*, 1997, http://www.epa.gov/ttn/oarpg/naaqsfin/pmhealth.html.

33. Environment and Human Health, Inc., *Children's Exposure to Diesel Exhaust on School Buses*, 2002, p. 10.

34. EPA, *Health and Environmental Effects of Particulate Matter Fact Sheet,* 1997, http://www.epa.gov/ttn/oarpg/naaqsfin/pmhealth.html.

35. Hansen, J., et.al., "Trends of Measured Climate Forcing Agents", *PNAS*, Vol. 98, No. 26, 2001, p. 14778-14783.

36. Clean Air Task Force, "Diesel Engines: Emissions Controls and Retrofits," *Diesel Fact Sheets*, http://www.catf.us/publications/fact_sheets/diesel/Diesel_Controls_and_Retrofits.pdf.

37. Range of control efficiencies is 85-97 percent according to California Air Resources Board. CARB, *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-fueled Engines and Vehicles*, 2000, p. 19.

38. Clean Air Task Force, "Diesel Engines: Emissions Controls and Retrofits," *Diesel Fact Sheets*, http://www.catf.us/publications/fact_sheets/diesel/Diesel_Controls_and_Retrofits.pdf.

39. EPA, 40 CFR Parts 9, 69, et al, "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule," *Federal Register,* Vol. 69, No. 124, June 29, 2004, http://www.epa.gov/otaq/url-fr/fr29jn04.pdf.

40. EPA, *Toxic Release Inventory for 2002*, 2004, http://www.epa.gov/tri/tridata/tri02/index.html.

41. Michigan Clean Cities Program, http://www.michigan.gov/cis/0%2C1607%2C7-154-10573_17393_17408-42667--%2C00.html.

42. University of Michigan, "Environmental Initiatives," *Transportation and Parking Services*, http://www.parking.umich.edu/transport/Environmental_Initiatives.html.

43. Clean Cities, *Alternative Fuel Success Stories: Greater Cleveland Regional Transit Authority (GCRTA)*, http://www.ccities.doe.gov/success/gcrta.shtml.

44. Emission factors were based on factors identified in *Update of Heavy-Duty Emission Levels (Model Years 1988-2004+) for use in MOBILE6*; U.S. EPA, April 1999; Conversion factors for calculating emissions in grams per mile from grams per brake-horse-power per hour were taken from *Update Heavy-Duty Engine Conversion Factors for MOBILE6*; U.S. EPA, January 2002; Estimates for the distribution of heavy engine fleets by age were taken from *Fleet Characterization Data for MOBILE6*; U.S. EPA, September, 2001.

45. Source: Ohio Department of Transportation

46. Matching the EPA's weight-based classification system with the FHWA vehicle classification system was undertaken using an analysis from ODOT identifying average weight of FHWA vehicle classes and matching that to the HDDE emission factors identified by weight taken from EPA's (cite rport). Buses were self-identified in both classification systems.

47. The Transit bus emissions factor was used as a conservative default for FHWA class 4 (buses), because a distribution of school, transit and inter-city buses was not available, and the transit bus EF was the lowest EF in that category.

48. EPA has not yet developed a speed correction factor based on Mobile 6. The CO speed correction factor was used as a default, based on a study indicating that CO and PM emissions respond in similar ways to engine performance, *Paul Andrei, West Virginia University, 2001.*

Glossary of acronyms

AADT	annual average daily traffic
CARB	California Air Resources Board
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
DEP	(Massachusetts) Department of Environmental Protection
DOC	diesel oxidation catalyst
DPF	diesel particulate filter
EF	emission factors
EGR	exhaust gas recirculation
EHHI	Environment and Human Health, Inc.
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FIP	federal implementation plan
g/mi/day	grams per mile per day
HC	hydrocarbons
HDDE	heavy duty diesel engines
LAER	lowest achievable emissons rate
MACT	maximum achievable control technology
MORPC	Mid Ohio Regional Planning Commission
mph	miles per hour
MTA	Massachusetts Turnpike Authority
NAAQS	National Ambient Air Quality Standards
NESCAUM	Northeast States for Coordinated Air Use Management
NOx	nitrogen oxides
O_3	ozone
ODOT	Ohio Department of Transportation
OEC	Ohio Environmental Council
PAHs	polycyclic aromatic hydrocarbons
Pb	lead
PM	particulate matter
PM_{10}	coarse particulate matter
$PM_{2.5}$	fine particulate matter
ppm	parts per million
RTA	(The Greater Cleveland) Regional Transit Authority
SCR	selective catalytic reduction
SIP	state implementation plan
SO_2	sulfur dioxide
SOx	sulfur oxides
STAPPA/ALAPCO	State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officers
ug/cu m	micrograms per cubic meter
ULSD	ultralow sulfur diesel
VMT	vehicle miles traveled
VOCs	volatile organic compounds

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