

We must adjust to changing times and still hold to unchanging principles.

Jimmy Carter
Nobel lecture, 10 December 2002

CHILDREN'S HEALTH

School Siting Poses Particulate Problem

Numerous studies dating back 18 years indicate that children who live close to major roadways tend to have more respiratory ailments as a result of exposure to nitrogen dioxide, carbon monoxide, ultra-fine diesel exhaust particles, and other traffic pollutants. Children spend about 8 hours each weekday in school—and this part of their day may bring no relief from exposure. A new study finds that about one-third of U.S. public schools are located within 400 meters of a major roadway, and about one-tenth are within 100 meters. “School attendance may result in a large dose of inhaled traffic pollutants that have been completely overlooked,” says study leader Sergey Grinshpun, director of the Center for Health-Related Aerosol Studies at the University of Cincinnati in Ohio.

Grinshpun’s team mapped inner-city, suburban, and rural schools located in the Atlanta, Boston, Philadelphia, Cincinnati, Memphis, Denver, Los Angeles, Minneapolis, and San Antonio metropolitan regions. A total of 8,803 public schools attended by 6 million students were included. The

distance to the nearest interstate or state highway was estimated using geographic information system software. The team counted how many schools were sited within 400 and 100 meters of a roadway, parameters selected on the basis of previous studies that linked these distances with exposure to traffic pollutants and with chronic respiratory symptoms.

Thirty-three percent of the schools were within 400 meters of a roadway, and 12% were within 100 meters. Schools in the East tended to be closer to roadways than those in the West. Boston, for example, had twice as many schools within 400 meters as Los Angeles (44% versus 20%) and six times more schools within 100 meters (18% versus 3%). Schools in the suburbs were more likely to be closer to busy roadways than inner-city schools, especially in the East. In Boston, Philadelphia, Atlanta, and Cincinnati, more than half the schools located within 400 meters were in the suburbs. The study, the first known national survey of school proximity to roadways and health risks, was reported in the September 2008 issue of the *Journal of Environmental Planning and Management*.

Grinshpun recommends that schools situated near highways be retrofitted with air filtration systems to clean up traffic pollutants, adding that most schools are

already equipped with central HVAC systems that can be improved by adding special filters to trap ultrafine diesel exhaust particles. He suggests that outdoor activities such as recess and sports be scheduled to avoid peak rush hour times when traffic pollution levels are highest.

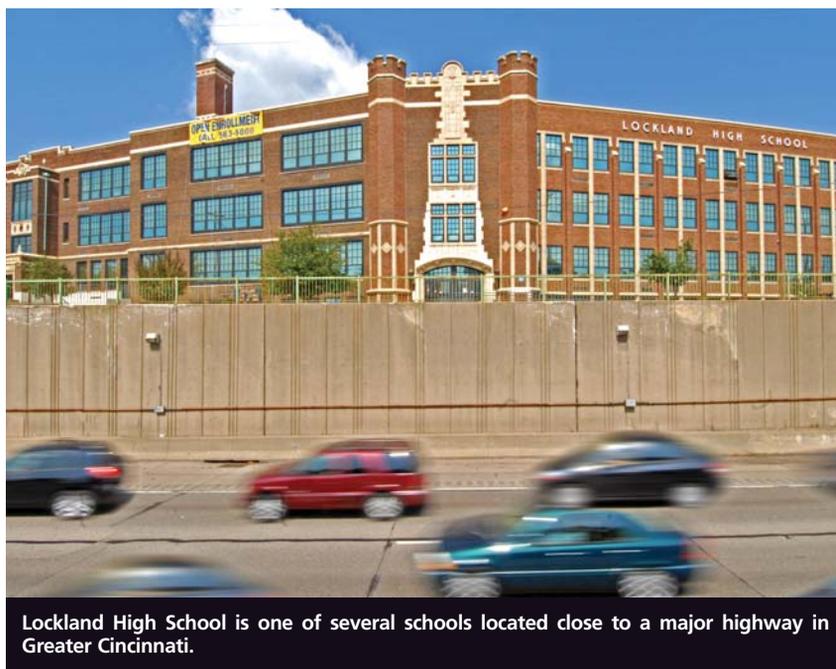
However, George Allen, an environmental engineer at NESCAUM, a non-profit air management think tank in Boston, points out the need to balance particulate and ozone exposures: “Particulate matter is highest in the morning rush hour and sometimes evening rush hour, [but] ozone peaks at early afternoon in most areas. Both are issues with regard to children’s exposure to air pollution, especially when exercising.”

Grinshpun further recommends that new schools be built at least 400 meters from major roadways. This may not always be feasible, he says, yet policy makers should strive to strike a balance between the economics of urban planning and health concerns when building new schools. In California, a state law already dictates that schools cannot be built within 500 feet (168 meters) of a freeway or other busy traffic corridor. “This is not far enough if you are concerned about traffic air pollution,” Grinshpun says.

Allen sees the 400-meter limit as “difficult to implement,” given that the study defined “major roads” to include small roads, which he points out are often small two-lane roads. “Los Angeles is having trouble siting schools that comply with the law,” he says—the problem is finding land that lies far enough from highways. Conceivably, Allen says, schools may end up being built farther out of town, which could require more students to ride buses (instead of walking or biking) and create more traffic pollution and exposure for children.

“School districts generally are limited to obtaining property that developers don’t want,” points out Michael Hall, marketing director at Fanning/Howe Associates, specialists in educational architecture and engineering, and poor locations often come with poor air quality. But new design approaches can help control exposure to exterior pollutants. For example, displacement ventilation systems push air contaminants toward the ceiling, where they are vented from the room. “These issues are at the forefront of school design,” Hall says.

—Carol Potera



Lockland High School is one of several schools located close to a major highway in Greater Cincinnati.

AIR POLLUTION

Ship Sulfate an Unexpected Heavyweight

A technique that can identify the source of sulfate (SO_4) produced during combustion—or primary SO_4 —has shown ships may be responsible for a large proportion of this pollutant in the fine particulate matter suspended in Southern California's coastal air. This is a much higher percentage than regulators thought likely and—given that fine particles are harmful to human health—much more than anyone would like.

Ships commonly burn sulfur-rich “bunker oil,” but until now, it has been difficult to tease out the contributions to air pollution of this and other transport fuels or to distinguish anthropogenic components of sulfate pollution from the natural sulfate aerosols in the tropospheric background. This new research suggests that ships burning bunker oil are responsible for a significant fraction of sulfate particles in coastal areas.

“Our technique works on the principle of oxygen isotope ‘fingerprinting,’” explains research leader Mark Thiemens, dean of the Division of Physical Sciences at the University of California, San Diego (UCSD). “By knowing these fingerprints, we can work out how much primary sulfate comes from each source in air samples.” The research appears in the 2 September 2008 issue of the *Proceedings of the National Academy of Sciences*.

The researchers collected samples of smoke from the stack of a ship burning bunker oil, from the end of the Scripps Pier in La Jolla, California, and from an unpolluted coastal area off Northern California. They chemically isolated the samples' SO_4 content as silver sulfate. This was then combusted to release its oxygen, which was analyzed with a mass spectrometer to determine its ratio of $\delta^{18}\text{O}$, $\delta^{17}\text{O}$, and $\Delta^{17}\text{O}$ isotopes—thus providing an isotopic fingerprint of the SO_4 .

Brad Collins, a chemist with the National Toxicology Program, explains that $\delta^{17}\text{O}$ refers to the ratio of the ^{16}O to ^{17}O isotopes in a sample, whereas $\delta^{18}\text{O}$ refers to the ratio of ^{16}O to ^{18}O isotopes. The $\Delta^{17}\text{O}$ value refers to how much the $\delta^{17}\text{O}$ values deviate from what would be expected on the basis of mass-dependent fractionation of the isotopes. “For example,” Collins says, “ ^{16}O water molecules vaporize more easily than ^{17}O water molecules because they are lighter. So based on the

mass alone, you would expect rain [being condensed water vapor] to be deficient in ^{17}O water molecules by a certain amount. The deviation from what you expect and what you actually find is $\Delta^{17}\text{O}$. You can use these ratios to look for anthropogenic sources of oxygen-containing substances.”

“By comparing the isotope fingerprints of sulfate in pristine coastal air, the stack smoke sulfate . . . and [pier] air samples, we showed that the ship smoke was making a large contribution to the fine particle sulfate in [those pier air samples],” says first author Gerardo Dominguez, a postdoctoral fellow in the UCSD Department of Chemistry and Biochemistry. In fact, on some days this contribution reached 44%.

To date, however, SO_4 has been largely ignored in environmental impact assessments of ship smoke. “This may have to change,” says Dominguez, who explains that these fine particles build up over time and can travel long distances. If the contributions observed in this study are typical, he says, primary SO_4 from ships could account for 4–25% of the $15\text{-}\mu\text{g}/\text{m}^3$ annual maximum fine particle exposure limit set by the U.S. Environmental Protection Agency.

“Epidemiological studies have associated particulate matter with increased risk of respiratory illness and cardiopulmonary mortality,” says Spyros Pandis, a research professor of chemical engineering at Carnegie Mellon University. “To the best of our knowledge sulfate particle effects are similar to those of [nonsulfate] particles. This is the reason that regulations in both the United States and Europe target particulate mass and not the mass of, say, organic particles or sulfate.”

“The fingerprinting technique is excellent and allows better discrimination of the



SO_4 in ship smoke has largely flown under the radar—until now.

ehpnet | by Erin E. Dooley

Stop TB Partnership

<http://www.stoptb.org/>

In 2000 international agencies, government ministers, and donor groups formed the Stop TB Partnership with the mission of eliminating tuberculosis (TB). The partnership's Global Plan to Stop TB 2006–2015, one of its central efforts, is a comprehensive survey of the steps and resources the Stop TB partners believe will be needed to make the greatest impact on the global TB burden. The Plan section of the Stop TB website features updates on progress toward meeting the plan's goals and bridging a \$30.8 billion funding gap.

The site also highlights the Global Drug Facility (GDF), established as a mechanism to expand implementation of “daily observed treatment, short course” programs by facilitating consistent access to high-quality TB drugs. In 2007, the GDF funded treatment for more than a million people in 44 countries.

The Working Groups section of the site describes the activities of seven groups coordinating various aspects of TB control. Among other areas, these groups address multidrug-resistant TB as well as new vaccines, treatments, and diagnostics. The Stop TB Resource Centre links to additional tools, including fact sheets, reports, guides, a TB glossary, and video and photo libraries.

natural and anthropogenic sources of the various aerosols in the marine atmosphere,” adds Geoff Millward, a professor of marine chemistry at Plymouth University, United Kingdom. “The technique might have some application in the policing of emissions.”

Indeed, lawmakers are requiring vessels to switch from bunker oil to lower-sulfur marine distillate fuel on the basis of evidence such as findings published by James J. Corbett and colleagues in the 15 December 2007 issue of *Environmental Science & Technology*, which suggest that total smokestack emissions from ships may be responsible for 60,000 cardiopulmonary and lung cancer deaths annually worldwide. By 2012, oceangoing vessels calling on California ports must switch to marine distillate fuel with a sulfur content of 0.1% within 24 nautical miles of the California coastline, says Michael Robinson-Dorn, director of the Kathy and Steve Berman Environmental Law Clinic at the University of Washington (currently the sulfur content in bunker fuel used in California averages about 2.4%). Similarly, European Union Directive 2005/33/EC mandates that inland waterway vessels and docked ships must use 0.1% sulfur marine distillate fuel by 2010. —Adrian Burton

TRANSPORTATION

De-icers Add Sweet to Salt

With the onset of winter, towns are laying in a supply of road salt in preparation for icy weather. According to the U.S. Geological Survey's *Mineral Commodity Summaries 2008*, the United States used nearly 50 million metric tons of salt in 2007, with 37% of that going toward road de-icing. Road salt—primarily sodium chloride, the cheapest option—is a lifesaver on slick roads, but it is also a growing cause of environmental contamination. So some companies are exploring ways to reduce how much de-icer it takes to keep roads clear.

A study by Eric V. Novotny and colleagues, slated for the 15 November 2008 issue of *Science of the Total Environment*, showed that seasonal and long-term changes in salinity in Minneapolis-area lakes closely followed the amount of road salt purchased by the state of Minnesota. In two of the lakes studied, a saline layer formed at the lake bottom and prevented oxygen transfer to the lake bed for months at a time, posing a potential threat to aquatic life. An earlier study, published by Domenico Sanzo and Stephen J. Hecna in volume 140, issue 2 (2006) of *Environmental Pollution*, found low survival, reduced weight, and abnormalities in frog larvae exposed to water that the authors said contained “environmentally realistic concentrations” of sodium chloride.

The U.S. Environmental Protection Agency (EPA) does not regulate road salt but acknowledges that special consideration and best management practices are needed to protect reservoirs and other drinking water supplies near treated highways and salt storage sites from contamination with road salt runoff, says spokesperson Dale Kemery.

Besides its environmental effects, road salt also has functional drawbacks: it easily washes away and must be reapplied, and sodium chloride can melt snow and ice in temperatures only down to about 16°F. But when sugar is mixed with salt, the combination can address

both drawbacks, making the salt stick better and allowing it to work at lower temperatures, thus reducing the total need for salt.

One such product, Ice B'Gone, is made by Sears Ecological Applications Company of Rome, New York, and combines magnesium chloride (a salt) with “distillers condensed solubles” (a sugar by-product obtained from molasses factories). Sears sells its additive to salt companies, which blend it with rock salt. Company president David Wood says the treated salt can be spread by highway agencies using existing equipment.

Ice B'Gone drops the minimum melting temperature to -45°F , Wood says, and although the treatment does raise the price of a ton of salt, it enables each ton to go further, netting a 25–40% reduction in road salt usage. In addition, he says, the Ice B'Gone formula reduces the corrosivity of the salt by as much as 70% over regular road salt. In 2008, that potential for reducing salt usage and associated corrosion earned Sears Ecological Applications the right to carry the EPA's Design for the Environment label.

Sugar derived from sugar beets is the basis for another road salt additive called GeoMelt, made by SNI Solutions of Geneseo, Illinois. Mixed with rock salt, GeoMelt lowers the melting temperature to -30°F . The Ohio Department of Transportation tested GeoMelt in 11 counties last winter. The department's deputy director, Scott Varner, says GeoMelt helped salt adhere better to the pavement and reduced the melting temperatures, and the state plans to continue evaluating the costs and benefits.

The 50% increase in price Ohio is paying for salt over the past year may tilt the tables in favor of additives, Varner says, because that raises the value of each ton saved by the additive. “If there are ways for us to use less salt, and it's cheaper for our budgets,” he says, “ultimately that is good for the environment as well.” —David Tenenbaum

The Beat | by Erin E. Dooley

Green Energy Credit Renewed

The renewable energy industry held its breath as Congress decided whether to renew tax credits for residential and commercial use of alternatives such as wind, solar, and tidal power [see “Solar Tax Credit Loses Energy,” *EHP* 116:A380 (2008)]. Now the decision has been made: the \$18 billion plan was signed into law 3 October 2008 as part of the Emergency Economic Stabilization Act of 2008. Under the plan, credits for solar energy are extended for 8 years, those for wind energy for 1 year, and those for other renewable energy sources including wave and tidal energy for 2 years. The bill also eliminates a \$2,000 cap on residential solar systems and includes an allowance for utilities to use the commercial credit. In addition, the legislation allows \$800 million in bonds to finance renewable energy facilities and provides \$1.5 billion in tax credits for carbon capture-and-storage projects.



France Scraps “Picnic Tax”

On 15 September 2008 French environment minister Jean-Louis Borloo announced the country would institute a “picnic tax” on disposable paper and plastic plates, cups, and cutlery as part of a package of measures aimed at reducing waste and energy use. Just 3 days later, prime minister François Fillon threw out the tax in the face of overwhelming negative response from the public and political

opposition, who called the measure an unfair burden on ordinary citizens enjoying a popular French pastime. Similar taxes said to be still under consideration apply to other high-volume consumer products such as batteries, televisions, and appliances, with consumers purchasing environmentally friendly versions of these products seeing tax breaks.

Nitrate Sampled in U.S. Wells

Since the mid-20th century, use of nitrate fertilizer has steadily increased in the United States. One of the first nationwide studies of nitrates in groundwater over time, published in a September 2008 supplement to the *Journal of Environmental Quality*, has found that nitrate concentrations increased significantly between 1988 and 2004 in almost a third of well networks sampled. In three networks, median concentrations exceeded the EPA maximum contaminant level of 10 ppm, reaching 11.68 ppm in the Delmarva Peninsula. Nitrate, a common groundwater contaminant, has been linked in infants to methemoglobinemia, caused by reduced ability of blood to carry oxygen.

AGRICULTURE

Green Screen for Poultry Farms

The Delmarva Peninsula, comprising Delaware and parts of Maryland and Virginia, is home to one of the country's highest concentrations of poultry farms, some 2,000 outfits that can house upward of 75,000 birds at any one time. All those birds can mean a lot of dust, odor, and ammonia. At the August 2008 annual meeting of the American Chemical Society, researchers from the University of Delaware reported they have found a cost-effective way to help control these emissions.

Dust and odor are linked with respiratory effects in poultry workers, but little is known about the effects caused by these agents—beyond quality of life issues—among people who live near farms, conclude Dick Heederik and colleagues in the February 2007 issue of *EHP*. Of perhaps more immediate concern is the ammonia from poultry excrement. Numerous studies have linked atmospheric ammonia emissions to excessive algal growth in waters including the Chesapeake Bay. Ammonia can also combine with oxides of nitrogen and sulfur to form fine particulates small enough to lodge deep in human lungs.

In warm weather, poultry houses use “tunnel ventilation,” in which large fans pull air in one end and exhaust it—along with dust, feathers, and odors—out the other. In 2002, extension poultry specialist George Malone and his team planted a 30-foot-wide, three-row plot of trees as a so-called vegetative environmental buffer (VEB) opposite poultry house tunnel fans. The first row of trees was deciduous bald cypress, which caught the brunt of the dust and feathers. The second and third rows consisted of thickly needled Leyland cypress and Eastern red cedar, evergreens that acted as additional filters.

“We didn't use evergreens in the first row, as the dust and feathers had a tendency to mat up on the leaves and could kill the tree,” Malone says. “With a deciduous tree, you get a fresh leaf screen every spring.” In measurements collected over six summers by sensors on

each side of the VEB, the buffer reduced dust by 56%, ammonia by 53%, and odor by 18%.

Besides controlling emissions, VEBs also provide visual and auditory screens for farms as well as aid in energy efficiency by providing shade in summer and acting as windbreaks during the winter, says Malone. Moreover, their root systems absorb nutrients around the perimeter of the poultry houses, helping to reduce nitrogen runoff into surface and groundwater.

Penn State poultry scientist Paul H. Patterson and colleagues have studied a number of trees for use in VEBs. In an article in the January 2008 issue of the *Journal of Environmental Science and Health, Part B*, they reported that Spike hybrid poplar, ‘Streamco’ purpleosier willow, and hybrid willow were effective at removing ammonia emissions from the air around poultry farms, while Norway spruce and hybrid willow were the best at trapping dust and associated odors.

To date, about one-third of the Delmarva poultry farms have established VEBs. Up to 75% of the cost of VEBs may be covered under programs such as the Environmental Quality Incentives Program of the Natural Resources Conservation Service.

Bill Rohrer, a program administrator for Delaware's Nutrient Management Commission, says, “The VEB concept that Malone has developed is an excellent step in emissions reduction. We've seen that fifty percent of all ammonia that comes out of the building is deposited within a few hundred yards of the farm, so if you build the vegetative screen where Malone's research has put it, you can do an excellent job of cutting back on atmospheric ammonia and dust.”

“This isn't a silver bullet,” Malone says. “But it's a green, cost-effective technology for an industry that makes its living on being cost-effective.” —Lance Frazer

Triple Washed, Twice Shy?

Consumers often look to convenient forms of produce to put more vegetables in their diet. An expert on foodborne pathogens speaking at the Food Micro 2008 conference in September suggested consumers should wash prepacked produce even though labels claim bagged vegetables are “ready to eat.” Gad Frankel of Imperial College London pointed out that pathogens such as *Salmonella* and *E. coli* can



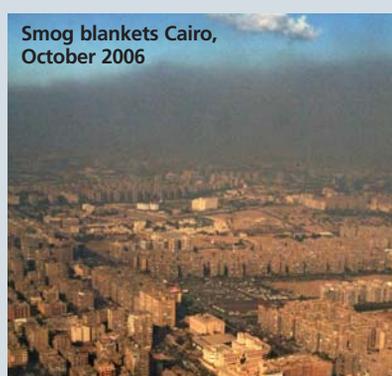
still bind to vegetable leaves. In research published 2 October 2008 ahead of print in *The ISME Journal*, Frankel described how *S. enterica* uses its flagella to cling to basil leaves, a finding that may offer clues for enhancing food safety.

Bacterium Is Arsenic Watchdog

A newly discovered “extremophile,” a bacterium that thrives at ultracold temperatures, not only remediates arsenic-contaminated sites but may also serve as a living sensor to warn of arsenic escaping from mines and chemical facilities and to test well water. Discovered in northern Canada's Giant Mine, the bacterium lives in communities of biofilms where it converts arsenite, an intractable form of arsenic, into arsenate, which is relatively easy to remove. Thomas Osborne and colleagues from University College London announced their finding at the Autumn 2008 meeting of the Society for General Microbiology.

Arab Cities Get Green Standards

Ahead of the first Eco-Cities of the Mediterranean Forum, an October 2008 meeting on



Smog blankets Cairo, October 2006

urban sustainability, Jordanian environment minister Khaled Irani announced a new initiative to set standards for renewable energy, carbon emission reductions, and environmental policy in Mediterranean cities. Jordanian officials organized the forum, which they hope will become a biennial event, to encourage partnerships and to learn from the experience of more than 200 global experts and policy makers in addressing the environmental challenges and opportunities facing the region.