Puget Sound
Clean Air Agency
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Working Together For Clean Air

Indoor Air Quality

Indoor air is the air that we breathe in our homes, schools and workplaces. The quality of indoor air is important because we typically spend more than 80 percent of our time inside.

Several studies show that air pollutant concentrations are often much higher indoors than outdoors.[1,2] This is because many pollutants have indoor sources in addition to ambient air pollution that penetrates indoors, and pollutants remain undiluted in an indoor environment. Higher concentrations combined with greater exposure time make health risks from indoor air pollutants significant.[3,4]

A recent US Environmental Protection Agency (EPA) report ranked environmental health risk from indoor air pollution at a level consistent with outdoor pollution from vehicles.[5]

Improving indoor air quality is necessary to meaningfully reduce total exposures and health risks from air pollution, yet there's no existing comprehensive program that integrates it. Addressing *both* outdoor and indoor air pollution sources would likely result in lower exposures and potential health risks from air pollutants for Puget Sound region residents.

Indoor Air Quality Scope

Indoor air quality typically refers to reducing exposures to a range of criteria air pollutants and air toxics, and also includes biological agents and environmental tobacco smoke. Biological agents include fungi (mold), animal dander, and cockroaches that can trigger asthma and allergic reactions. Environmental tobacco smoke, also known as secondhand smoke, is a mixture of the smoke given off by the burning end of tobacco products (sidestream smoke) and the smoke exhaled by smokers (mainstream smoke).[6]

This overview will not include biological agents or environmental tobacco smoke, as they're not listed as air pollutants in Washington State and the Agency has limited familiarity with them. Instead, we will focus on indoor air toxics and indoor criteria air pollutants.

Background

The Agency devotes its energy to reducing ambient (outdoor) air pollution, targeting the pollutants that present greatest health risk. Actions that improve ambient air quality also affect indoor air quality because outdoor air penetrates indoor environments (with varying degrees of infiltration, depending on the building).

Additionally, some of our programs affect indoor environments more directly:

- Our asbestos permitting program reduces asbestos exposures by ensuring proper protective measures are taken during abatement
- Our wood stove change-out programs reduce fine particulate and air toxics exposures in participating homes (in addition to improving the ambient air quality)
- Our extensive Diesel Solutions retrofit program reduces the exposures of children on school buses, another type of "indoor" environment

Beyond these programs, the Agency is not directly involved with indoor air quality. Nationally, local air agencies are not typically involved with indoor air quality. An exception is the Northwest Clean Air Agency (in Mount Vernon, Washington) that maintains an active indoor air quality program. The Northwest Clean Air Agency program includes performing school walk-throughs to improve the indoor air quality in local schools, providing training for people interested in indoor air quality, and providing support for people who call in with indoor air quality concerns.

No comprehensive state or federal indoor air quality program exists, due largely to lack of legal authority or mandate. In the Puget Sound area and the rest of the country, local and state health departments implement indoor air quality programs with partners where funding permits. Limited funding relies heavily on EPA grants.

Top Indoor Air Pollutants of Concern, Sources, and Health Effects

Many ambient air pollutants also have indoor sources. The potential health effects of these pollutants are broad, and include cancer and respiratory, cardiovascular, neurological, reproductive and immunological systems effects.

Asthma is an especially important respiratory condition to note, as it is often linked to indoor air triggers and its incidence is increasing most in small children.[7] Asthma prevalence is higher in Washington than the national average.[8]

The most sensitive populations – young children, the elderly, and the sick – spend most of their time indoors.

Indoor air pollutants include both the criteria air pollutants and air toxics, which both affect health but are regulated differently. EPA has established six criteria air pollutants that have national ambient air quality standards. The Washington State Department of Ecology (WA Ecology) and the Agency list about 400 air toxics, which includes the 188 federal hazardous air pollutants as a subset.[9]

The table below summarizes some of the top indoor air pollutants of concern, their indoor sources and their potential health effects.[10]

Pollutant	**Indoor Sources**	**Potential Health Effects**
Formaldehyde and aldehydes†	Plywood, particleboard, wallpaper, durable press fabrics, paints, combustion appliances,	Cancer and respiratory effects
Polycyclic Aromatic Hydrocarbons (PAHs)†	Cooking, wood burning, and other combustion	Cancer
Benzene and other organic air toxics†	Solvents, glues, cleaners, building materials, moth repellents, dry-cleaned clothing, air fresheners	Cancer; respiratory effects; liver, kidney, and brain damage

Pollutant (Contd.)	Indoor Sources (Contd.)	Potential Health Effects (Contd.)
Phthalates and other endocrine disruptors†	Plastics	Hormonal effects, developmental abnormalities
Asbestos†	Building materials in older homes	Lung cancer, asbestosis, mesothelioma
Particulate Matter ∞	Wood stoves, fireplaces, cooking, candles, aerosol sprays	Lung cancer, cardiovascular effects, respiratory effects
Nitrogen Dioxide ∞	Unvented/malfunctioning gas appliances, other combustion appliances	Respiratory effects
Carbon Monoxide ∞	Unvented/malfunctioning gas appliances, woodstoves, fireplaces, vehicles in attached garage	Headache; nausea; can be fatal at very high concentrations
Ozone ∞	Some air "purifiers", office machines	Respiratory effects
Lead ∞, †	Historic lead paint	Neurological effects

∞ Criteria air pollutants
† Air toxic pollutants

Indoor Air Quality Resources

Schools
The EPA developed a comprehensive "Tools for Schools" kit. This kit is available on the EPA website, and can be used by school facilities managers to create an effective indoor air quality program.[11] Washington State University took EPA's kit and streamlined it into a user-friendly checklist.[12]

While the kit is readily available and most schools have received it, few Puget Sound area schools are actually using it. Only a fraction of schools have performed walk-throughs using the kit to identify indoor air quality concerns.[13][14][15][16] This is due to resource limitations of both health officials and, to a lesser extent, school facilities managers.

Homes
The American Lung Association of Washington has developed a program that sends volunteers into homes to assess indoor air quality and make simple

recommendations to reduce exposures. Through this program, the Lung Association has trained hundreds of volunteers, who have reached thousands of homes in the Puget Sound region.[17]

County and state public health agencies, as well as the EPA Region 10, have minimal resources to take calls from people with indoor air quality concerns. The majority of calls reported to these entities concern mold.

Office Buildings
Indoor air quality concerns in office buildings are typically handled by the Department of Labor and Industry and/or Occupational Safety and Health, as they cover employees, not private citizens or children. Best management practices, green building, and green cleaning are some of the resources available to achieve better indoor air quality in office buildings.[18]

Indoor Air Quality Solutions and Priorities

Public outreach and education are two main components of any successful indoor air quality program. Many solutions are simple and inexpensive, such as substituting off-gassing materials, ventilating by opening windows or cleaning clogged intakes, using greener cleaning supplies, and reducing track-in by removing carpeting. Studies show that education and simple recommendations are effective.[19, 20]

The Future & Challenges of Indoor Air Quality

Addressing indoor air quality is vital to reduce exposures and health risks from air pollution, yet there's no existing comprehensive program. The resources available to local and state public health agencies, the American Lung Association of Washington, and other partners to reduce health risks from indoor air pollution are inadequate to effectively implement indoor air quality programs.

Children, a susceptible population, are exposed to indoor air pollution in schools.[21] Indoor air quality is not a priority in schools until it becomes a problem. Only a fraction of public and private schools in our Agency's jurisdiction have received school walk-throughs and follow-up.

In contrast, in a jurisdiction where local and state health agency efforts are supplemented by a local air agency (Northwest Clean Air Agency), all of the public schools have had walk-throughs and indoor air quality follow-up.

Although there are many parties involved in indoor air quality, they're all functioning with limited resources. There may be a role, large or small, for local air agencies to align with existing partners to implement indoor air quality programs.

For More Information

- The American Lung Association of Washington www.alaw.org
- EPA's Tools for Schools Kit http://www.epa.gov/iaq/schools/toolkit.html
- EPA's Basic Information About Indoor Air Quality http://www.epa.gov/iaq/ia-intro.html
- California Air Resources Board Indoor Air Quality and Personal Assessment Program http://www.arb.ca.gov/research/indoor/indoor.htm
- Washington State Department of Health Indoor Air Quality Program http://www.doh.wa.gov/ehp/ts/iaq.html
- Northwest Clean Air Agency's Indoor Air Quality Page http://www.nwair.org/aqPrograms/indoorAir.htm
- Health Indoor Air for America's Homes Project http://www.montana.edu/wwwcxair/home_tour.htm

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[1] Sheldon et al. *Indoor Pollutant Concentrations and Exposures*. Research Triangle Institute (ARB contract no: A133-156). 1994.

[2] Payne-Sturges, D., et al. *Personal Exposure meets risk assessment: a comparison of measured and modeled exposures and risks in an urban community.* Environmental Health Perspectives, 112(5):589-598.

[3] California Air Resources Board. Report to the California Legislature: Indoor Air Pollution in California. July 2005. http://www.arb.ca.gov/research/indoor/ab1173/rpt0705.pdf. This report places the potential cancer risk from exposure to ten door indoor air pollutants just slightly less than the potential cancer risk from exposure to ambient diesel exhaust. The risk is largely driven by formaldehyde and p-dichlorobenzene. P-dichlorobenzene is found in mothballs,.

[4] Lance A Wallace. *Comparison of Risks from Outdoor and Indoor Exposure to Toxic Chemicals*. Environmental Health Perspectives. 1991. Volume 95, pp. 7-13. This study looked at upper bound risks from 12 VOCs and found that indoor air concentrations accounted for 80-100% of their total risk.

[5] California Air Resources Board. Report to the California Legislature: Indoor Air Pollution in California. July 2005.

[6] Center for Disease Control. Secondhand Smoke Fact Sheet. February 2004. http://www.cdc.gov/tobacco/factsheets/secondhand_smoke_factsheet.htm.

[7] EPA. Asthma and Indoor Environments. http://www.epa.gov/asthma/triggers.html.

[8] Morbidity and Mortality Weekly Report of the U.S. Centers for Disease Control and Prevention, 2000 Behavioral Risk Factor Surveillance System Survey. August 17, 2001,

[9] The EPA's original list of Hazardous Air Pollutants: http://www.epa.gov/ttn/atw/188polls.html Washington State's toxic air pollutants: http://www.pscleanair.org/reg3/asil.pdf.

[10] California Air Resources Board. Report to the California Legislature: Indoor Air Pollution in California. July 2005. http://www.arb.ca.gov/research/indoor/ab1173/rpt0705.pdf. Table is adapted from Table ES-1.

[11] EPA's Tools for Schools Kit. http://www.epa.gov/iaq/schools/toolkit.html.

[12] Washington State University and Region 10 EPA. Tools for Schools in 3 Easy Steps. ftp://198.147.238.10/energy.wsu.edu/pubs/building/iaq/schools/3step_iaq_program.pdf.

[13] Personal Communication. Kathy Himes with Sid Forman, King County Public Health. Spring, 2005. A survey showed that less than 5% of schools in King County use the Tools for Schools program – very little recognition.

[14] Personal Communication. Kathy Himes with Dave Delong, Pierce County Public Health. Spring 2005. 26 out of roughly 400 schools (6.5%) in Pierce County have received indoor air quality walk-throughs as part of a State Department of Health grant. Some school districts have their own indoor air quality people (Tacoma, Clover Park, and Peninsula), but the program is typically reactive.

[15] Personal Communication. Kathy Himes with Bonnie Halverson, Kitsap County Public Health. Spring 2005. 8 Kitsap schools have received indoor air quality walk-throughs as a part of a State Department of Health grant. This is only one third of 22 schools listed in only the Central Kitsap school district. http://www.cksd.wednet.edu/information/new_keyfacts.htm.

[16] Personal Communication. Kathy Himes with Rick Soholco, Snohomish County Public Health. Spring 2005. None of the Snohomish schools have received indoor air quality walk-throughs as part of State Department of Health grant. Schools are monitored for carbon dioxide (a surrogate for ventilation) as part of the school safety program.

[17] American Lung Association Master Home Environmentalist Program. http://www.alaw.org/air_quality/master_home_environmentalist/.

[18] EPA. An Office Building Occupant's Guide to Indoor Air Quality. http://www.epa.gov/iaq/pubs/occupgd.html.

[19] Takaro et al. *Effect of Environmental Intervention to Reduce Exposure to Asthma Triggers in Homes of Low-income Children in Seattle. Journal of Exposure Analysis and Environmental Epidemiology.* 2004. Volume 14 (suppl 1) S133-143.

[20] Leung et al. *Behavioral Changes Following Participation in a Home Health Promotional Program in King County, Washington.* Environmental Health Perspectives. 1997. Volume 105 (10) 1132-1135.

[21] California Air Resources Board. Report to the California Legislature: Indoor Air Pollution in California. July 2005. An investigation of both portable and traditional classrooms found that nearly all rooms exceeded chronic helath guidelines for cancer.