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July 1, 2015

VIA EMAIL – tstevenson@cpsc.gov

Mr. Todd Stevenson, Secretariat
U.S. Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814

Re: 16 C.F.R. § 1051 Petition for Rulemaking to Protect Against Consumer
Products Containing Additive Organohalogen Flame Retardants

Dear Mr. Stevenson –

In response to a May 19, 2015 letter from Patricia Pollitzer to me, attached please find a revised Petition for Rulemaking under 16 C.F.R. section 1051, and supporting statements.

If you would like hard copies of these documents, we'd be happy to provide them.

Thank you very much for your assistance.

Sincerely,

Eve Gartner

Cc: Ms. Patricia Adkins, Executive Director
Mr. Scott Wolfson, Communications Director

UNITED STATES CONSUMER PRODUCT SAFETY COMMISSION

In re: 16 CFR § 1051 Petition for Rulemaking

No. HP 15-1

Petitioners:

**American Academy of Pediatrics
American Medical Women's Association
Consumer Federation of America
Consumers Union
Green Science Policy Institute
International Association of Fire Fighters
Kids in Danger
Philip J. Landrigan, M.D., M.P.H.
League of United Latin American Citizens
Learning Disabilities Association of American
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June 30, 2015

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PETITION FOR RULEMAKING

Petitioners American Academy of Pediatrics, American Medical Women's Association, Consumer Federation of America, Consumers Union, Green Science Policy Institute, International Association of Fire Fighters, Kids in Danger, Philip J. Landrigan, M.D., M.P.H., League of United Latin American Citizens, Learning Disabilities Association of America, National Hispanic Medical Association, and Worksafe ("Petitioners"), hereby petition the Consumer Product Safety Commission ("CPSC") to adopt rules to protect consumers and children from the health hazards caused when toxic flame retardant chemicals are used in four categories of household products. Due to their inherent physico-chemical properties, additive organohalogen flame retardants 1) are toxic and 2) migrate out of products *regardless of how the product is used*; thus there is a nexus between the mere presence of products containing these chemicals and exposures that put consumers at risk of harm. To protect consumers from this risk, we ask the CPSC to promulgate regulations under the Federal Hazardous Substances Act ("FHSA") declaring that children's products, furniture, mattresses and the casings surrounding electronics are banned hazardous substances if they contain any non-polymeric, additive organohalogen flame retardant.

I. Introduction

When used in non-polymeric,¹ additive² form, organohalogen flame retardants³

¹ Due to their high molecular weights, polymeric organohalogen flame retardants are believed to be not readily bioavailable, and thus may be less likely to be harmful to humans. Therefore,

migrate from consumer products, leading to widespread human exposures. These exposures occur because of the semi-volatile property of these chemicals that results in migration of the chemicals and the chemicals' adsorption into house dust; there is no way to direct consumers to use affected products in a way that would eliminate exposures. As a result, 97 percent of people living in the United States have measurable quantities of organohalogen flame retardants in their blood, as estimated from the national biomonitoring program conducted by the Centers for Disease Control and Prevention ("CDC").⁴

This presents serious public health concerns because all organohalogen flame retardant chemicals, as a class, are toxic due to their physical, chemical and biological properties. These chemicals have been associated with many adverse human health impacts, including: reproductive impairment (e.g., abnormal gonadal development, reduced number of ovarian follicles, reduced sperm count, increased time to pregnancy); neurological impacts (e.g., decreased IQ in children, impaired memory, learning deficits, altered motor behavior, hyperactivity); endocrine disruption and interference with thyroid hormone action (potentially contributing to diabetes and

they are not addressed by this petition. The term "organohalogen flame retardants" will be used henceforth in this petition to refer to non-polymeric chemicals only.

² Additive (as opposed to reactive) flame retardants are not chemically bound to the products containing them, thus they can migrate out of products, resulting in human exposure.

³ Organohalogen chemicals are created by combining carbon molecules with one of the halogen elements. Organohalogen flame retardants (also referred to as halogenated flame retardants) contain bonds between carbon and the elements bromine or chlorine. This class includes brominated and chlorinated phosphate ester flame retardants.

⁴ Factual statements in this Introduction are addressed with citations in the accompanying statements and in the body of this Petition below.

obesity); genotoxicity; cancer; and immune disorders. These chemicals also have a disproportionately negative health effect on vulnerable populations, including children.

The use of flame retardants in the four product categories at issue is not required by any legally binding flammability standard. In addition, exposures to flame retardants that migrate from consumer products into homes cannot be adequately prevented or controlled with warning labels. Migration of these semi-volatile chemicals from common household products cannot be prevented, and knowledge that these toxic chemicals migrate from products into the indoor environment does not give consumers the ability to take meaningful measures to avoid exposures.

To stop future exposures and minimize the resulting health risks, we ask the CPSC to declare, under its FHSA authority, that

- any durable infant or toddler product,⁵ children's toy,⁶ child care article,⁷ or other children's product⁸ (other than children's car seats) that contains additive organohalogen flame retardants, is a "banned hazardous substance"; and
- any article of upholstered furniture⁹ sold for use in residences and containing additive organohalogen flame retardants is a "hazardous substance" and a "banned hazardous substance"; and
- any mattress¹⁰ or mattress pad¹¹ with additive organohalogen flame retardants is a "hazardous substance" and a "banned hazardous substance"; and

⁵ We use the term "durable infant or toddler product" as it is defined in 15 U.S.C. § 2056a(f).

⁶ We use the term "children's toy" as it is defined in 15 U.S.C. § 2057c(g)(1)(B).

⁷ We use the term "child care article" as it is defined in 15 U.S.C. § 2057c(g)(1)(C).

⁸ We use the term "children's product" as it is defined in 16 C.F.R. § 1200.2(a)(1).

⁹ We use the term "upholstered furniture" as it is defined in the CPSC's Notice of Proposed Rulemaking proposing a "Standard for the Flammability of Residential Upholstered Furniture," 73 Fed. Reg. 11702 (March 4, 2008), Proposed 16 C.F.R. § 1634.2(a).

- any electronic device with additive organohalogen flame retardants *in its plastic casing* is a “hazardous substance” and a “banned hazardous substance.”

It is imperative that CPSC’s regulation cover all organohalogen flame retardants as a class when used in consumer products. This class of chemicals is foreign to the mammalian body and inherently toxic, due to its physical, chemical and biological properties. Industry has historically responded to the dangers posed by one organohalogen flame retardant by replacing it with one or more other organohalogens that are, by virtue of their chemical properties, also harmful. This exposes consumers to a series of “regrettable substitutions” from one harmful flame retardant to another, as explained below. The way to end this cycle of toxicity is to ban all products in the categories at issue here if they contain any organohalogen flame retardant. We believe it is appropriate for the ban on these products to apply only if the additive organohalogen flame retardant has been intentionally added and is not present as a contaminant from the manufacturing process. However we leave it to the expertise of the Commission to determine the appropriate detection level for its regulation.

This petition is supported by the following statements, which we submit with this Petition:

Human Exposures from Presence in Consumer Products

- Miriam Diamond, Ph.D., Professor in the Department of Geography, Chemical Engineering and Applied Chemistry, University of Toronto, on the mechanisms and evidence for the migration of organohalogen flame retardants from consumer products when used in additive form.

¹⁰ We use the term “mattress” as it is defined in 16 C.F.R. § 1632.1(a).

¹¹ We use the term “mattress pad” as it is defined in 16 C.F.R. § 1632.1(b).

- Ruthann Rudel, M.S., Director of Research at the Silent Spring Institute, and Research Associate in the Brown University Department of Pathology and Laboratory Medicine, on human exposure to organohalogen flame retardants from consumer products.

Known Human Health Risks Associated with Organohalogen Flame Retardants

- Kim Harley, Ph.D., Associate Adjunct Professor in Maternal and Child Health and Associate Director for Health Effects, Center for Environmental Research and Children's Health at UC Berkeley, on effects associated with the widely used organohalogen flame retardant pentabromodiphenyl ether (pentaBDE) in low-income Mexican-American children and their mothers in the Salinas Valley, California.
- Julie Herbstman, Ph.D., Assistant Professor in the Department of Environmental Health Sciences at the Columbia University Mailman School of Public Health, on the impact of prenatal exposure to pentaBDE on children's thyroid hormone levels, neurodevelopment, and IQ.
- Ted Schettler, MD, MPH, physician and the Science Director of the Science and Environmental Health Network, on the human health concerns associated with organohalogen flame retardants.
- Susan Kasper, Ph.D., Associate Professor in Environmental Health, University of Cincinnati College of Medicine, on the reproductive and carcinogenic effects of organohalogen flame retardants used as polybrominated diphenyl ethers (PBDE) replacements.

Hazards and Class Characteristics of Organohalogen Flame Retardants

- David Eastmond, Ph.D., Professor and Chair of the Department of Cell Biology and Neuroscience, and Research Toxicologist at UC Riverside, on hazardous properties of 83 non-polymeric organohalogen flame retardants.
- Terry Collins, Ph.D., Teresa Heinz Professor of Green Chemistry and Director of the Institute for Green Science at Carnegie Mellon University, on the intrinsic chemical properties of organohalogen flame retardants that result in a high potential for adverse human health effects.
- Rolf Halden, Ph.D., Director of the Center for Environmental Security at the Biodesign Institute, Professor in the Ira A. Fulton School for Sustainable Engineering and the Built Environment, Senior Sustainability Scientist in the Global Institute of Sustainability at Arizona State University, and adjunct faculty at the Johns Hopkins Bloomberg School of Public Health, on the characteristic hazards of organohalogen flame retardants and the need to regulate them as a class.

- David Epel, Ph.D., Jane and Marshall Steel Jr. Professor Emeritus of Biological and Marine Sciences at the Hopkins Marine Station of Stanford University, on the mechanisms through which most organohalogen flame retardants bypass cellular defenses, permeate cell membranes, and avoid metabolism and elimination.

Toxicity and Health Risks from Burning Organohalogen Flame Retardants

- Donald Lucas, Ph.D., scientist at the Lawrence Berkeley National Laboratory and Researcher in the School of Public Health at UC Berkeley (retired), on increased chronic and acute fire toxicity when organohalogen flame retardants are present in products that burn.
- Sharyle Patton, Director of the Commonwealth Environmental Health Program in Bolinas, California, on biomonitoring studies of firefighters' levels of organohalogen flame retardants, dioxins and furans, possibly linked to higher cancer incidence in these workers.
- Roland Weber, Ph.D., independent consultant at POPs Environmental Consulting, on end-of-life concerns for products containing organohalogen flame retardants, including the production of dioxins and furans.

II. Interests of Petitioners

This petition is brought by the following physician and organizations on behalf of their patients, members and the entire United States population, virtually all of whom are exposed to hazardous flame retardant chemicals in the organohalogen class as a result of their use in consumer products.

Medical and Learning Disabilities Petitioners

The American Academy of Pediatrics is a non-profit professional organization of 62,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults.

The American Medical Women's Association ("AMWA") is an organization that functions at the local, national, and international level to advance women in medicine and improve women's health. Founded in 1915, AMWA is the oldest multi-specialty organization of women physicians. As the vision and voice of women in medicine for nearly a century, AMWA empowers women to lead in improving health for all, within a model that reflects the unique perspective of women.

Philip J. Landrigan, M.D. is a pediatrician, epidemiologist and Director of the Children's Environmental Health Center at Mt. Sinai School of Medicine in New York.

The Learning Disabilities Association of America ("LDA") is the country's oldest volunteer-run organization serving people with learning disabilities, their families, educators and health professionals, with affiliate offices in more than 40 states and thousands of members nationwide. LDA's "Healthy Children Project" seeks to raise awareness of environmental factors, including toxic chemicals, that are contributing to neurodevelopmental disorders, and to promote changes to policies and practices to reduce those factors. An area of particular concern for LDA is children's unique vulnerability to harm from toxic chemical exposures, beginning at conception.

Established in 1994, the National Hispanic Medical Association is a non-profit association representing the interests of 50,000 licensed Hispanic physicians in the United States. NHMA's vision is to be the national leader to improve the health of Hispanic populations. Our mission is to empower Hispanic physicians to lead efforts to improve the health of Hispanic and other underserved populations in collaboration with

the state Hispanic medical societies, resident and medical student organizations, and other public and private sector partners.

Fire Fighters and Other Worker Petitioners

International Association of Fire Fighters (“IAFF”) is the driving force behind nearly every advance in the fire and emergency services in the 21st century. With headquarters in Washington, DC, and Ottawa, Ontario, the IAFF represents more than 300,000 full-time professional fire fighters and paramedics in more than 3,100 affiliates. IAFF members protect more than 85 percent of the population in communities throughout the United States and Canada. In 2014, IAFF adopted a Resolution which committed the organization to “work to ensure that the use of carcinogenic flame retardants and other toxic chemicals are eliminated and safer alternatives or methods are pursued.”¹²

Worksafe, Inc. is a California-based non-profit organization dedicated to promoting occupational safety and health through education, training, and advocacy. Worksafe pursues public policy initiatives related to the improvement of worker health and safety, including the elimination of toxic hazards that disproportionately impact the workers exposed and other vulnerable populations. Consumer product policies have significant implications for the people who are exposed to organohalogen flame retardants through their work, including during the manufacturing process when these

¹² IAFF (2013). Resolution No. 34 – Flame retardants, toxic chemicals and their relationship to the increase of cancer in fire fighters. Retrieved March 3, 2015 from <http://iaffconvention2014.org/resolution-no-34/>.

chemicals are added to products, and during fires when products containing these chemicals burn and create toxic fumes that harm emergency responders.

Vulnerable Population Petitioner

With approximately 132,000 members throughout the United States and Puerto Rico, the League of United Latin American Citizens (LULAC) is the largest and oldest Hispanic Organization in the United States. Headquartered in Washington, DC, with 1,000 councils nationwide, LULAC advances the economic condition, educational attainment, political influence, housing, health and civil rights of Hispanic Americans. LULAC's programs, services and advocacy address the most important issues for Latinos, meeting critical needs of today and the future.

Consumer Advocate Petitioners

The Consumer Federation of America is an association of more than 250 non-profit consumer groups that, since 1968, has sought to advance the consumer interest through research, education, and advocacy.

Consumers Union, the public policy and advocacy division of Consumer Reports, is an expert, independent, nonprofit organization with more than one million online activists whose mission is to work for a fair, just, and safe marketplace for all consumers and to empower consumers to protect themselves. Consumer Reports is the world's largest independent product-testing organization, which uses its more than 50 labs, auto test center, and survey research center to rate thousands of products and services annually.

Kids In Danger is a nonprofit organization dedicated to protecting children by improving children's product safety. Banning children's products and other categories of goods that contain dangerous chemicals, organohalogens, is the only way to limit children's exposure.

Science Petitioner

Scientists from the Green Science Policy Institute have been at the forefront of research and communication around the hazards posed by organohalogen flame retardants in consumer products for decades. Their research in the 1970s documented exposure to and toxicity of brominated and chlorinated flame retardants in children's pajamas, and their product testing in the 2000s found that halogenated flame retardant chemicals were being used in a majority of furniture and children's products tested.

III. The Cycle of "Regrettable Substitution" of Organohalogen Flame Retardants Must End

Past attempts to protect consumers from organohalogen flame retardants in household products have been unsuccessful because when one toxic flame retardant is banned or phased out due to its toxicity, it is replaced with another chemical in the same class – a phenomenon that has been termed "regrettable substitution." As Deborah Rice, a former EPA toxicologist who works for the Maine Center for Disease Control and Prevention, told The Chicago Tribune with respect to regrettable substitution of flame retardants: "By the time the scientific community catches up to

one chemical, industry moves on to another and they go back to their playbook of delay and denial.”¹³

The experience with the polybrominated diphenyl ether (“PBDE”) family of flame retardants illustrates the problem. Until 2005, pentabromodiphenyl ether commercial mixture (“pentaBDE”) was widely used as a flame retardant in residential seating furniture and in baby products, and octabromodiphenyl ether commercial mixture (“octaBDE”) was used in plastics for personal computers and small appliances. Until 2013, decabromodiphenyl ether (“decaBDE”) was widely used as a flame retardant in plastic electronic enclosures and fabrics. These organohalogen PBDEs, however, have now been shown to present a range of very serious human health risks, including immune and endocrine disruption, and adverse reproductive and neurodevelopmental effects.^{14,15,16,17,18,19,20} As a result, pentaBDE and octaBDE commercial mixtures have

¹³ Michael Hawthorne, *Toxic Roulette*, Chicago Tribune, May 10, 2012, <http://www.chicagotribune.com/news/watchdog/flames/ct-met-flames-regulators-20120510,0,4262292.story>.

¹⁴ Stapleton, H.M.; Eagle, S.; Anthopolos, R.; Wolkin, A.; & Miranda, M.L. (2011). Associations between polybrominated diphenyl ether (PBDE) flame retardants, phenolic metabolites, and thyroid hormones during pregnancy. *Environmental Health Perspectives*, 119(10), 1454-59. doi: 10.1289/ehp.1003235.

¹⁵ Betts, K.S. (2010). Endocrine damper? Flame retardants linked to male hormone, sperm count changes. *Environmental Health Perspectives*, 118(3), A130. doi: 10.1289/ehp.118-a130b.

¹⁶ Chevrier, J.; Harley, K.G.; Bradman, A.; Gharbi, M.; Sjödin, A.; & Eskenazi, B. (2010). Polybrominated diphenyl ether (PBDE) flame retardants and thyroid hormone during pregnancy. *Environmental Health Perspectives*, 118(10), 1444-49. doi: 10.1289/ehp.1001905.

¹⁷ Gascon, M.; Vrijheid, M.; Martínez, D.; Forns, J.; Grimalt, J.O.; Torrent, M.; & Sunyer, J. (2011). Effects of pre and postnatal exposure to low levels of polybromodiphenyl ethers on neurodevelopment and thyroid hormone levels at 4 years of age. *Environment International*, 37(3), 605-11. doi: 10.1016/j.envint.2010.12.005.

been banned in a dozen U.S. states²¹ and phased out by the U.S. chemical industry. DecaBDE has been voluntarily phased out for most uses, including all consumer uses, by the three U.S. producers of flame-retardants, as a result of negotiations with the U.S. Environmental Protection Agency (EPA).²² Due to their previous use, however, PBDEs remain in products found in millions of homes, are present in the bodies of almost all people living in this country, and will persist in the environment for decades.²³ Moreover, although the U.S.-based PBDE manufacturers agreed to phase out these products, no law or regulation prohibits products containing PBDEs from being imported into this country.

¹⁸ Herbstman, J.B.; Sjödin, A.; Kurzon, M.; Lederman, S.A.; Jones, R.S.; Raugh, V.; Needham, L.L.; Tang, D.; Niedzwiecki, M.; Wang, R.Y.; & Perera, F. (2010). Prenatal exposure to PBDEs and neurodevelopment. *Environmental Health Perspectives*, 118(5), 712-19. doi: 10.1289/ehp.0901340.

¹⁹ Eskenazi, B.; Chevrier, J.; Rauch, S.A.; Kogut, K.; Harley, K.G.; Johnson, C.; Trujillo, C.; Sjödin, A.; & Bradman, A. (2013). In utero and childhood polybrominated diphenyl ether (PBDE) exposures and neurodevelopment in the CHAMACOS study. *Environmental Health Perspectives*, 121(2), 257-62. doi: 10.1289/ehp.1205597.

²⁰ Costa, L.G., & Giordano, G. (2007). Developmental neurotoxicity of polybrominated diphenyl ether (PBDE) flame retardants. *Neurotoxicology*, 28(6), 1047-67. doi: 10.1016/j.neuro.2007.08.007.

²¹ See Cal. Health & Safety Code §§ 108920 to 108923; D.C. Code § 8-108.02; Haw. Rev. Stat. §§ 332D-1 to 332D-3; 410 Ill. Comp. Stat. 48/1 to 48/99; Me. Rev. Stat. tit. 38, § 1609; Md. Code Ann., Envir. §§ 6-1201 to 1205; Mich. Comp. Laws §§ 324.14721 to .14725; Minn. Stat. §§ 325E.385 and .386; N.Y. Env'tl. Conserv. Law § 37-0111; R.I. Gen. Laws § 23-13.4-1; Vt. Stat. Ann. tit. 9, § 2973; Wash. Rev. Code §§ 70.76.005 to .110.

²² U.S. EPA. *Polybrominated Diphenyl Ethers (PBDEs) Action Plan Summary*. Retrieved March 2, 2015, from <http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/pbde.html>.

²³ Centers for Disease Control and Prevention (2009). *Fourth National Report on Human Exposure to Environmental Chemicals*, at 311-13. Retrieved March 3, 2015, from <http://www.cdc.gov/exposurereport/>.

Of critical importance to this petition, the organohalogen flame retardants used since the PBDE phaseouts have many of the same properties as PBDEs: they are semi-volatile and migrate out of products into the environment, causing human exposures during normal use, and they have been shown to be toxic. For example:

- After pentaBDE was phased out in 2006 due to its toxicity, tris (1,3-dichloro-2-propyl) phosphate (TDCPP), also known as chlorinated tris, became one of the major pentaBDE replacements in polyurethane foam used in furniture and products for children and babies.²⁴ TDCPP was recently found by the state of California to be a “known carcinogen,” and added to the list of chemicals requiring warning labels under California Proposition 65 law.²⁵ Research shows that TDCPP exposure is associated with altered hormone levels in men and lower semen quality.²⁶
- One of the replacements for TDCPP in polyurethane foam is Firemaster® 550, a mixture of two organophosphate and two organohalogen chemicals, which are also now known to be toxic. Firemaster® 550 is an endocrine disruptor that has been associated with weight gain, early onset of puberty and cardiovascular health effects.²⁷ A senior EPA

²⁴ TDCPP has a dark history. After brominated tris (2,3-dibromopropyl) phosphate (TDBPP) was banned as a flame retardant in children’s pajamas in the late 1970s as a mutagen and suspected carcinogen, it was replaced with chlorinated tris (TDCPP). Blum, A., & Ames, B.N. (1977). Flame-retardant additives as possible cancer hazards. *Science*, 195(4273), 17-23. doi: 10.1126/science.831254. After studies in the 1970s showed that TDCPP is also mutagenic, this chemical too was phased out from children’s pajamas. See Gold, M. D.; Blum, A.; & Ames, B.N. (1978). Another flame retardant, tris-(1,3-dichloro-2-propyl)-phosphate, and its expected metabolites are mutagens. *Science*, 200(4343), 785-87. doi: 10.1126/science.347576. However, because TDCPP was not banned, it emerged as a replacement flame retardant for pentaBDE in furniture and children’s products until its toxicity was “rediscovered.”

²⁵ California EPA, Office of Environmental Health Hazard Assessment (“OEHHHA”), Reproductive and Cancer Hazard Assessment Branch (2011). *Evidence on the Carcinogenicity of Tris(1,3-Dichloro-2-Propyl) Phosphate*. Retrieved March 3, 2015, from http://oehha.ca.gov/prop65/hazard_ident/pdf_zip/TDCPP070811.pdf. OEHHHA, Chemicals Known to the State to Cause Cancer or Reproductive Toxicity (2014). Retrieved March 3, 2015, from http://oehha.ca.gov/prop65/prop65_list/files/P65single060614.pdf.

²⁶ Meeker, J.D., & Stapleton, H.M. (2010). House dust concentrations of organophosphate flame retardants in relation to hormone levels and semen quality parameters. *Environmental Health Perspectives*, 118(3), 318-23. doi: 10.1289/ehp.0901332.

²⁷ Patisaul, H.B.; Roberts, S.C.; Mabrey, N.; McCaffrey, K.A.; Gear, R.B.; Braun, J.; Belcher, S.M.; & Stapleton, H.M. (2013). Accumulation and endocrine disrupting effects of the flame retardant

administrator expressed serious concerns with this mixture and has doubts about its expedited approval as a replacement for pentaBDE.²⁸ Nonetheless, Firemaster® 550 continues to be used in large quantities in polyurethane foam in consumer products.

- One of the major replacements for decabromodiphenyl *ether* (decaBDE) in televisions and other electronics is decabromodiphenyl *ethane* (DBDPE). As sales and usage for the decaBDE have declined, sales and usage for the DBDPE have increased. These two chemicals are very similar in structure and properties. After a comparatively short period of usage, DBDPE has been measured in biota around the world at levels greater than those of the decaBDE, suggesting that it may be even more persistent and bioaccumulative than the very similar chemical it replaced.²⁹

We must end this cycle of “regrettable substitutions” in which new organohalogen flame retardants are added to consumer products, only to find that—like the organohalogens they are replacing—they migrate from products, resulting in toxic exposures. To protect the public, we ask the CPSC to regulate all products at issue in this petition if additive organohalogen flame retardants as a class are present in them

mixture Firemaster® 550 in rats: an exploratory assessment. *Journal of Biochemical and Molecular Toxicology*, 27(2), 124-36. doi: 10.1002/jbt.21439.

²⁸ Hawthorne, *Toxic Roulette*, *supra* note 13; Testimony of Jim Jones, Acting Assistant Administrator, Office of Chemical Safety and Pollution Prevention U.S. EPA, before the U.S. Senate Committee on Environment and Public Works (Jul. 24, 2012). Retrieved March 3, 2015 from http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=bef3d3ec-ff01-4d25-b0bd-ce38fb37edb3 (“EPA may have made a different determination in 1995 if TSCA required the submission of more robust hazard, exposure, and use data needed to adequately assess risk. . .”).

²⁹ Betts, K. (2009). Glut of data on “new” flame retardant documents its presence all over the world. *Environmental Science & Technology*, 43(2), 236-37. doi: 10.1021/es8032154.

above levels set by the CPSC.³⁰ As explained below, the CPSC has the authority to take this action, and we urge it to do so.

IV. The CPSC Has Authority to Regulate These Products

The CPSC has clear authority to take the actions requested in this petition. Under the FHSA, the CPSC “may by regulation declare to be a hazardous substance . . . any substance or mixture of substances,”³¹ which is “toxic,”³² if such substance “may cause substantial personal injury or substantial illness during or as a proximate result of any customary or reasonably foreseeable handling or use.”³³ The FHSA defines “toxic” to mean any substance that has “the capacity to produce personal injury or illness to man through ingestion, inhalation, or absorption through any body surface.”³⁴ CPSC’s regulation explains that “[s]ubstantial personal injury or illness means any injury or illness of a significant nature. It need not be severe or serious. What is excluded by the word ‘substantial’ is a wholly insignificant or negligible injury or illness.”³⁵ A household product classified as a “hazardous substance” cannot be sold without a warning label.

³⁰ Regulating consumer products containing organohalogen flame retardants under the FHSA is not a complete solution to the hazards presented when toxic flame retardants migrate out of consumer products. As discussed below, newer flame retardants that are organophosphates rather than organohalogens are also semi-volatile and migrate out of products, and growing evidence suggests they may pose unacceptable human health risks.

³¹ 15 U.S.C. § 1262(a)(1).

³² 15 U.S.C. § 1261(f)(1)(A)(i).

³³ 15 U.S.C. § 1261(f)(1)(A).

³⁴ 15 U.S.C. § 1261(g).

³⁵ 16 C.F.R. § 1500.3(c)(7)(ii).

Any “article intended for use by children, which is a hazardous substance, or which bears or contains a hazardous substance in such manner as to be susceptible of access by a child,” is automatically deemed a “banned hazardous substance.”³⁶ In the case of a household article classified as a “hazardous substance,” but not intended for use by children, the CPSC may classify it as a “banned hazardous substance” despite its labeling, if the CPSC determines that

notwithstanding [any] cautionary labeling . . . , the degree or nature of the hazard involved in the presence or use of such substance in households is such that the objective of the protection of the public health and safety can be adequately served only by keeping such substance, when ... intended or packaged [for use in the household], out of the channels of interstate commerce.³⁷

The CPSC has recognized that the FHSA “defines the term ‘toxic’ very broadly,” and “[t]his broad statutory definition covers both acute and chronic toxicity.”³⁸ While the CPSC regulations and guidelines discuss the particular chronic hazards of cancer, neurotoxicity, and developmental or reproductive toxicity, “*the definition is not limited to these hazards, but includes other chronic hazards.*”³⁹ The determination of what is “toxic” under the FHSA “is a complex matter requiring the assessment of many

³⁶ 15 U.S.C. § 1261(q)(1)(A). Special rules apply to articles like chemical sets that are inherently hazardous if they are appropriately labeled and are intended for use by mature children. *Id.*

³⁷ 15 U.S.C. § 1261(q)(1)(B).

³⁸ *Labeling Requirements for Art Materials Presenting Chronic Hazards; Guidelines for Determining Chronic Toxicity of Products Subject to the FHSA; Supplementary Definition of “Toxic” under the Federal Hazardous Substances Act*, 57 Fed. Reg. 46,626, 46,656 (Oct. 9, 1992).

³⁹ *Id.* at 46657 (emphasis added).

factors.”⁴⁰ There is no formula for what is “toxic,” and no requirement that risks meet any particular threshold before regulation is warranted. As the Court of Appeals for the D.C. Circuit has explained: “There is no indication in the language of the [FHSA] or its legislative history that the Commission was bound to develop a precise ‘body count’ of actual injuries that will be reduced by each regulatory provision.”⁴¹

Courts have not questioned the conclusion that a variety of household products containing chemicals, such as Drano (a drain declogger) and Liquid Wrench (a spray lubricant) are “hazardous substances” within the meaning of the FHSA.⁴² In addition, under the Consumer Product Safety Improvement Act of 2008, Congress declared that

⁴⁰ 57 Fed. Reg. 46,626, 46,657. In 2008, the FHSA was amended to make it easier for the CPSC to issue regulations finding that a substance is a “hazardous” or “banned hazardous” substance. Prior to the 2008 amendments, proceedings for the issuance of regulations under the FHSA were governed by section 701 of the Federal Food, Drug and Cosmetic Act (“FFDCA”). 21 U.S.C. § 371. Some case law suggested that the FFDCA set a high bar for regulation. *Cf. Consumer Fed’n of Am., v. CPSC*, 883 F.2d 1073 (D.C. Cir. 1989) (upholding the CPSC’s denial of a petition to ban the use of methylene chloride in household products because it did not meet the FFDCA standard). Since that case was decided, Congress dropped the requirement that FHSA regulations meet the FFDCA’s “reasonable grounds” standard. *See* Pub. Law 110-314 § 204(b)(2) (Aug. 14, 2008). Instead, proceedings to ban a “hazardous substance” are governed solely by provisions of the FHSA. 15 U.S.C. § 1261(q)(2) (“Proceedings for the issuance . . . of regulations [related to banning a “hazardous substance”] shall be governed by the provisions of subsections (f) through (i) of section 1262 of this title,” except in the event of imminent hazard when more streamlined procedures may apply). The 2008 amendment signifies Congressional intent to make it easier for the CPSC to regulate under the FHSA.

⁴¹ *Forester v. CPSC*, 559 F.2d 774, 788 (D.C. Cir. 1977).

⁴² *See Miles v. S.C. Johnson & Son, Inc.*, No. 00 C 3278, 2002 Westlaw 31655188, at *1 (N.D. Ill. Nov. 25, 2002) (“CPSC has determined that sodium hydroxide, the primary ingredient in Drano, is a hazardous substance.”); *Wagoner v. Exxon Mobil Corp.*, 832 F. Supp. 2d 664, 668 (E.D. La. 2011) (“Defendant does not argue that its Liquid Wrench product contains a banned hazardous substance”); *cf. Leibstein v. LaFarge N. Am., Inc.*, 689 F. Supp. 2d 373, 381 (E.D.N.Y. 2010) (it is undisputed that cement product is a “hazardous substance” because it is corrosive).

any children's product containing lead over a certain level is a "banned hazardous substance" within the meaning of the FHSA.⁴³

Courts have also given significant deference to the CPSC's determinations that a product is a "hazardous substance." For example, the Second Circuit Court of Appeals agreed with the CPSC that foam spray paint (essentially food-colored shaving cream) intended for use by children is a "hazardous substance" under the FHSA.⁴⁴ The court "defer[red] to the agency's interpretation of the substantial injury requirement" because it was not arbitrary, capricious or manifestly contrary to law.⁴⁵ The court emphasized that the statute only required that the product "may cause" substantial injury, and did not require that the product would "likely" cause injury.⁴⁶

There is solid precedent for regulating classes of products under the FHSA. In *Toy Manufacturers of America, Inc. v. CPSC*, 630 F.2d 70 (2d Cir. 1980), a trade association of toy manufacturers challenged a rule issued under the FHSA, which banned toys intended for use by young children that present hazards because of small parts. The toy industry argued that the FHSA was intended to deal only with specific, individual articles, and "not with a broad range of products at the same time."⁴⁷ The court soundly rejected this argument, saying: "Certainly, nothing in the FHSA explicitly

⁴³ 15 U.S.C. § 1278a(a)(1).

⁴⁴ *United States v. Articles of Banned Hazardous Substances Consisting of an Undetermined Number of Cans of Rainbow Foam Paint*, 34 F.3d 91 (2d Cir. 1994).

⁴⁵ 34 F.3d at 97.

⁴⁶ *Id.* at 97-98.

⁴⁷ 630 F.2d at 74.

limits the employment of its banning procedures to situations involving only individual products”⁴⁸ The court went on to note that “[t]he legislative history appears clear in favoring general prescriptive regulations of *the broadest, most comprehensive type* and would favor case-by-case proceedings only where such general prescriptive regulations prove impossible.”⁴⁹ The court relied on language from the FHSAs legislative history in which the Senate Report states:

It is intended that most determinations made by the (CPSC) will be in the form of general prescriptive rules, further amplifying the definition of . . . hazardous substances where necessary.⁵⁰

More recently, in the context of a petition under the FHSAs to ban sulfuric acid drain openers, a request the CPSC had received and rejected several times before, Commissioner Thomas H. Moore wrote separately to explain why the CPSC was again denying the request. Commissioner Moore stated:

Each time the Commission has dealt with this issue it has expressed unease and concern about the severity of the injuries that can be caused by drain openers. What has stymied the Commission each time, I think, is that *the remedy proposed by the petitioners—the banning of one particular type of chemical drain opener, those made with sulfuric acid—is not expected to solve the problem because of the likelihood that consumers will simply switch to other chemical drain openers, either acid or alkaline, which can be just as dangerous as the sulfuric acid drain openers they would be replacing.* The Commission is not limited to taking the narrow action proposed by the petitioners. Instead of continuing to express concern, but dismissing the issue because of the limitations of

⁴⁸ *Id.*

⁴⁹ *Id.* (citation omitted) (emphasis added).

⁵⁰ S. Rep. No. 91-237, 91st Cong., 1st Sess. 5 (1969).

the proposed remedy, *perhaps we should be examining the entire class of chemical drain openers to see what can be done to make them all safer.*⁵¹

The class of organohalogen flame retardants in the product categories at issue here is like small parts in toys: these chemicals are intrinsically dangerous by virtue of their inherent characteristics. Consumer products in the four categories at issue pose hazards when they contain any organohalogen flame retardant because of the intrinsic tendency of these semi-volatile chemicals to migrate out of products and attach to other media, such as house dust. Thus, for purposes of being a “hazardous substance” under the FHSA, each foreseeable way that these four categories of products are used, including, handling, mouthing, lying on and within, sleeping on, sitting in, playing with, or watching (as in a television) can pose a risk of harm to consumers if organohalogen flame retardants are added to these product categories during manufacturing. Indeed, the products may cause substantial personal injury or substantial personal illness as a result of their mere presence in the household, which is plainly a foreseeable handling or use. See Section VII, below.

And like the chemical drain openers discussed by Commissioner Moore, it makes no sense for CPSC to regulate a product containing one organohalogen flame retardant only to see the same product manufactured with another flame retardant with the same physico-chemical properties.⁵² Based on the understanding that the FHSA “favor[s]

⁵¹ U.S. Consumer Product Safety Commission (2006). *Statement of the Honorable Thomas H. Moore on petition HP 04-2 request to ban sulfuric acid drain openers for consumer use.* Retrieved March 3, 2015, from http://www.cpsc.gov/pr/sado_moore.pdf.

⁵² The fact that sulfuric acid is a single chemical, not a chemical class, and that drain openers is a single product category are irrelevant distinctions for purposes of this Petition. The CPSC’s

general prescriptive regulations of the broadest, most comprehensive type and would favor case-by-case proceedings only where such general prescriptive regulations prove impossible,”⁵³ and the strong evidence described below that all chemicals in this class – due to their physico-chemical properties – are toxic and may cause substantial injury or illness, consumer products containing organohalogen flame retardants as a class must be understood as “hazardous substances” within the meaning of the FHSA.⁵⁴ Indeed, former CPSC Chair Tenenbaum recently said as much. In declaring that there is no need for crib mattresses to be manufactured with *any* chemical flame retardants, Chair Tenenbaum stated: “The law strictly prohibits children's products from having hazardous chemicals [meaning any flame retardant] that children could be exposed to and could foreseeably cause substantial illness or injury.”⁵⁵

expressed preference for remedying consumer risk without inviting a similarly risky product as its replacement is just as applicable here as with the drain openers.

⁵³ 630 F.2d at 74.

⁵⁴ Under the authority of the FHSA, products containing several chemical substances have been found to be “hazardous substances,” requiring labeling. These include: diethylene glycol; ethylene glycol; products containing 5% or more benzene; methyl alcohol; turpentine; toluene, and xylene. When the FDA (which administered the FHSA at the time these regulations were adopted) first proposed to regulate products containing these chemicals as “hazardous substances,” it said it was doing so based on “human experience” and “together with opinions of informed medical experts.” 28 Fed. Reg. 2686, 2686 (Mar. 19, 1963).

⁵⁵ Patricia Callahan & Michael Hawthorne, *Chemicals in the Crib*, Chicago Tribune, Dec. 8, 2012, http://articles.chicagotribune.com/2012-12-28/news/ct-met-flames-test-mattress-20121228_1_tdcpp-heather-stapleton-chlorinated-tris.

V. Regulating Products Containing Flame Retardants Should Be a Commission Priority

Household products to which organohalogen flame retardants have been added fall squarely within the priorities for CPSC regulation. The CPSC has long been aware of and concerned about the use of toxic flame retardants in consumer products. In recent years, Commissioners have explicitly recognized that the use of organohalogen flame retardants in consumer products is unnecessary and dangerous.⁵⁶ The Chicago Tribune reported that at a congressional hearing in July 2012, then-Chair Tenenbaum “urged lawmakers to grant special authority that could speed the removal of hazardous flame retardants from new upholstered furniture, including sofas that can contain up to two pounds of the chemicals in their foam cushions.”⁵⁷ The only measure that would ensure

⁵⁶ For example, six years ago, when the CPSC proposed a national residential furniture flammability standard, it said that it “developed the proposed standard *mindful of the continuing uncertainty about potential health and environmental effects of FR [flame retardant] chemical usage*, with an objective of achieving significant reductions in fire deaths and injuries from upholstered furniture fires caused by smoking materials while minimizing reliance on FR additives in fabrics and filling materials to meet that objective.” *Standard for the Flammability of Residential Upholstered Furniture*, 73 Fed. Reg. 11,702, 11,709 (proposed Mar. 4, 2008) (emphasis added).

⁵⁷ Subsequently, Chair Tenenbaum stated:

I was pleased to read that the Governor of California recently directed that state's Bureau of Home Furnishings to revisit state rules that effectively require the use of flame retardant in many household upholstered furniture items, and I know Commission staff is monitoring this work closely. I am hopeful that Commission staff will generate a rule that will bring safer, more fire resistant upholstered furniture into homes across the nation.

US Consumer Product Safety Commission (Aug. 2, 2012). *Statement of Inez M. Tenenbaum, Chairman, U.S. Consumer Product Safety Commission, Before the U.S. House Committee on Energy and Commerce Subcommittee on Commerce, Manufacturing, and Trade; “Oversight of the Consumer Product Safety Commission.”* Retrieved March 3, 2015, from <http://www.cpsc.gov//PageFiles/121027/tenenbaum08022012.pdf>.

hazardous organohalogen flame retardants are absent from furniture is for the CPSC to ban furniture containing those chemicals under the FHSA, as we seek here.

It is fully consistent with the CPSC's "Policy on establishing priorities for commission action"⁵⁸ to prioritize the regulation of products containing any organohalogen flame retardant in order to prevent future injuries, especially to children, given the pervasiveness of consumer products containing these chemicals and the inability of consumers to avoid contact with them. Under the CPSC's "Policy on establishing priorities for commission action," the agency must prioritize action on:

- products where the probability of exposure to the hazard is high due to "the number of units of the product that are being used by consumers, the frequency with which such use occurs, and the likelihood that in the course of typical use the consumer would be exposed to the identified risk of injury";⁵⁹
- preventing product-related injury to children, the handicapped, and senior citizens;⁶⁰ and
- "products, although not presently associated with large numbers of frequent or severe injuries, [where] ... there is reason to believe that the products will in the future be associated with many such injuries."⁶¹

All of these considerations are present here: 1) the affected products are ones that most people use daily, such as chairs, sofas, mattress pads, computers and other electronics; 2) children are at particular risk for several reasons: they tend to spend more time on or near the floor (crawling, playing, and so on) where they are exposed to hazardous dust; they have hand-to-mouth behaviors that result in their ingestion of this

⁵⁸ 16 C.F.R. § 1009.8.

⁵⁹ 16 C.F.R. § 1009.8 (c)(7).

⁶⁰ 16 C.F.R. § 1009.8 (c)(6).

⁶¹ 16 C.F.R. § 1009.8 (c)(3).

material; they may be exposed during critical developmental windows of rapid growth and brain development during which they are particularly vulnerable to these toxins; and children's products in particular are likely to contain flame retardants; and 3) there is strong reason to believe that continued use of additive organohalogen flame retardants in the four product categories will result in future illness and injury, just like the now-banned or discontinued PBDEs.

The CPSC has additional cause to act swiftly to protect consumers and children from the products at issue in this petition when they contain organohalogen flame retardants. As described below in Section VII-B, for reasons that are not fully understood, the highest human levels of harmful flame retardants in the general population have been found in young children from communities of low socio-economic status, and communities of color.⁶² This presents an environmental injustice. Pursuant to Executive Order 12898, the CPSC must act to "achiev[e] environmental justice . . . by . . . addressing . . . [the] disproportionately high and adverse human health or environmental effects of its programs [and] policies . . . on minority populations and low-income populations."⁶³ The CPSC's failure to regulate household products containing hazardous substances in the form of organohalogen flame retardants, despite the abundant evidence that these chemicals are pervasive in the homes and

⁶² Quirós-Alcalá, L.; Bradman, A; Nishioka, M.; Harnly, M.E.; Hubbard, A.; McKone, T.E.; & Eskenazi, B. (2011). Concentrations and loadings of polybrominated diphenyl ethers in dust from low-income households in California. *Environment International*, 37(3):592-96. doi: 10.1016/j.envint.2010.12.003.

⁶³ Exec. Order No. 12,898 (Feb. 11, 1994), at 1.

bodies of people across the country, and especially in people of color and of lower incomes, must be corrected as soon as possible.

For all these reasons, regulating the product categories at issue here when they contain additive organohalogen flame retardants should be a priority for the CSPC.

VI. Organohalogen Flame Retardants Are Pervasive in the Product Categories Covered by This Petition, But Are Not Required by Any Flammability Standard

In Section VI-A below, we present evidence that organohalogen flame retardants are often present in the four product categories at issue here. In Section VI-B below, we explain that these flame retardants are not used to meet any flammability standard.

A. Additive Organohalogen Flame Retardants Are Used Extensively in the Consumer Product Categories Covered by This Petition

A large percentage of the products in the categories at issue in this petition contain organohalogen flame retardants as a result of the flame retardants being intentionally added to the products, as detailed below.

1. Infant and Children's Products

Testing has identified organohalogen flame retardants in the foam in nursing pillows, crib mattresses, strollers, baby carriers, sleep mats, and changing table pads.

For example:

- A. A 2011 study of baby products sold throughout the United States found flame retardant chemicals in a range of foam-containing products, such as nursing pillows, crib mattresses, strollers, baby carriers, sleep mats, and changing table

pads.⁶⁴ Out of foam samples collected from 101 commonly used baby products, 80 samples were found to have an identifiable flame retardant additive, and 79 of these contained organohalogens.

- B. In 2012, the Chicago Tribune analyzed foam used in crib mattresses, and found that three then-popular brands of baby mattresses tested positive for organohalogen flame retardants.⁶⁵
- C. A 2012 survey of flame retardants in sleep products found evidence for the presence of organohalogen flame retardants in all foam samples from 29 sleeping mats from nursery schools and day care centers in the California Bay Area.⁶⁶
- D. A study published in 2012 documents extensive use of organohalogen flame retardants in infants' and children's products. The report provides the results of tests carried out on 20 foam-containing products purchased across the United States at major retailers, including baby changing mats and nursing pillows. Seventeen (85%) of the 20 products tested contained organohalogen flame retardants.⁶⁷

The fact that a significant proportion of tested juvenile products has been found to contain organohalogen flame retardants suggests that a high percentage of *all* infant and children's products contain these chemicals. While consumers use these products in different ways (as toys, as carriers, as seating, and so on), the unifying feature is that infants and children come in contact with all of them, and if the product contains any organohalogen flame retardant in additive form, the use of the product — indeed, the

⁶⁴ Stapleton, H.M.; Klosterhaus, S.; Keller, A.; Ferguson, P.L.; van Bergen, S.; Cooper, E.; Webster, T.F.; & Blum, A. (2011). Identification of flame retardants in polyurethane foam collected from baby products. *Environmental Science & Technology*, 45(12), 5323-31. doi: 10.1021/es2007462.

⁶⁵ Patricia Callahan, *Chemicals in the Crib*, *supra* note 55.

⁶⁶ Gaw, C. (2012). *Sleeping on Toxins? A Study of Flame Retardants in Sleep Products*. Retrieved March 3, 2015, from http://nature.berkeley.edu/classes/es196/projects/2012final/GawC_2012.pdf.

⁶⁷ Organohalogen flame retardants identified included tris (1,3-dichloro-2-propyl) phosphate (TDCPP), tris (2-chloroethyl) phosphate (TCEP), and tris (1-chloro-2-propyl) phosphate (TCPP), with chlorinated Tris (TDCPP) found in 80% of the products tested. Washington Toxics Coalition and Safer States (2012). *Hidden Hazards in the Nursery*. Retrieved March 3, 2015, from <http://watoxics.org/publications/hidden-hazards>.

mere presence of the product in the home — will result in exposure to the flame retardant chemical because of the semi-volatile property of these chemicals, as discussed below in Section VII.

2. Residential Furniture

Most residential seating furniture in use in this country contains additive organohalogen flame retardants. One 2012 study tested 102 samples of polyurethane foam from residential sofas purchased across the United States between 1985 and 2010 and found that 85% contained flame retardants.⁶⁸ One of the objectives of this study was to determine which chemicals were being used after the phase-out of pentaBDE in 2005. In furniture purchased before 2005, organohalogen flame retardants were detected in 63% of the samples tested (pentaBDE in 39% of the samples, followed by TDCPP in 24%). In furniture purchased in 2005 or later, organohalogen flame retardants were detected in over 90% of the samples (most common being TDCPP in 52% and components associated with the Firemaster® 550 mixture in 18% of the samples). In other words, the 2005 phase-out of pentaBDE led to the use of other organohalogen flame retardants in polyurethane foam used in upholstered furniture.

3. Mattresses and Mattress Pads

An informal 2012 survey of 28 foam mattresses and 55 mattress pads used by adults found organohalogen flame retardants in 29% and 50% of the samples

⁶⁸ Stapleton, H.M.; Sharma, S.; Getzinger, G.; Ferguson, P.L.; Gabriel, M.; Webster, T.F.; & Blum, A (2012). Novel and high volume use flame retardants in US couches reflective of the 2005 PentaBDE phase out. *Environmental Science & Technology*, 46(24), 13,432-39. doi: 10.1021/es303471d.

analyzed.⁶⁹ This was confirmed by the website of the American Chemistry Council / North American Flame Retardant Alliance, which lists foam mattresses as one of the product areas where flame retardants are used.⁷⁰

4. Electronics Enclosures

Flame retardants in additive form are commonly used in plastic casings for televisions and other electronic devices.⁷¹ (To be clear, this petition does not address the flame retardants in reactive form in electronic circuit boards where the flame retardants are chemically bound to the product. This petition focuses exclusively on organohalogen flame retardants in additive form used in the plastic casings for electronic devices.) DecaBDE was commonly used in plastic casings for televisions and electronics before it was phased out by the EPA due to its toxicity. Although decaBDE is no longer used in plastic electronic casings, other similar organohalogen flame retardants such as DBDPE have replaced it.⁷²

⁶⁹ Gaw, C., Singla, V.; Peaslee, G.; & Busener, S. (2013). Flame retardants in foam from various consumer products. On file with Green Science Policy Institute.

⁷⁰ North American Flame Retardant Alliance lists foam mattresses as one of the products in which flame retardants are commonly used. North American Flame Retardant Alliance, American Chemistry Council. *Flame Retardant Basics*. Retrieved March 03, 2015, from <http://flameretardants.americanchemistry.com/FR-Basics>.

⁷¹ North American Flame Retardant Alliance lists Electronics and Electrical Devices as one of the four product areas where flame retardants are commonly used including in casings for televisions and other electronic devices. *Id.*

⁷² Betts, Glut of data, *supra* note 29.

B. Flame Retardants Are Not Required by Any Federal or State Flammability Standard

The widespread use of organohalogen flame retardants in consumer products described immediately above is not required in order to comply with any government-adopted flammability standard. The extensive use of organohalogen flame retardants in juvenile products and residential furniture began with a 1975 California flammability standard called Technical Bulletin 117 (TB 117).⁷³ However, after an extensive regulatory review process, the California Bureau of Electronics and Appliance Repair, Home Furnishings and Thermal Insulation (“BEARHFTI”) recently revised TB 117, replacing the old flammability standard with a new one that can be met without flame retardants,⁷⁴ and exempting 17 juvenile products from flammability requirements.

In addition, no federal furniture flammability standard has been adopted, and the flammability standard proposed by the CPSC in 2008 was specifically designed so it

⁷³ State of California, Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation (2000). Technical Bulletin 117: Requirements, Test Procedure and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture. Retrieved March 3, 2015, from <http://www.bhfti.ca.gov/industry/117.pdf>. The TB 117 requirements included a 12-second open flame test for furniture and juvenile products filling materials. This requirement was often met by adding flame retardant chemicals to polyurethane foam filling. In part because of the size of the California market, TB 117 became a *de facto* national standard, resulting in nationwide sale of furniture and juvenile products containing flame retardant chemicals.

⁷⁴ State of California, Department of Consumer Affairs, Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation (2013). Initial Statement of Reasons. Retrieved March 3, 2015, from <http://www.bhfti.ca.gov/about/laws/isr.pdf>. TB 117-2013 categorically exempts 17 categories of juvenile products made with foam (including strollers, infant carriers, nursing pillows, booster seats, bassinets, and highchairs) from regulation. Cal. Code Regs tit. 4, § 1374.2(c).

could be met without use of flame retardants.⁷⁵ Thus, no flammability standard currently in effect requires chemical flame retardants to be added to residential furniture or juvenile products, with the exception of car seats,⁷⁶ which are not covered by this petition.

As of 2006, the CPSC has two flammability standards that apply to adult mattresses – a smolder standard in 16 C.F.R. section 1632, and an open flame standard in 16 C.F.R. section 1633. Flame retardants are not needed to meet either of these standards. Like the TB 117-2013 furniture smolder standard discussed above, the mattress smolder standard can be met by selecting smolder-resistant fabrics. In addition, the open flame standard was designed so manufacturers have the option of not using flame retardant chemicals, as confirmed by a “Question and Answer” document prepared by CPSC Staff:

The regulation does not specify the use of FR chemicals to meet the 12 requirements. Manufacturers are free to choose the means of complying with the regulation and this may include the use of inherently flame resistant materials and FR barriers, in addition to FR chemicals. If the manufacturer

⁷⁵ In the preamble to the 2008 Notice of Proposed Rulemaking for a federal furniture flammability standard, the CPSC states:

In October 2004, the staff held a public meeting to present the direction of what would become the staff's 2005 draft standard. The staff analyzed comments received at that meeting as well. The proposed standard takes account of that analysis. Staff received comments on its 2005 draft standard, continued its research and analysis *and developed a revised, 2007 draft proposal that focused primarily on preventing smoldering ignitions and reducing the need for flame retardant chemicals. This notice presents the 2007 draft as the Commission's proposed standard.*

Standard for the Flammability of Residential Upholstered Furniture, *supra* note 56.

⁷⁶ Children's car seats are regulated by the National Highway Traffic Safety Administration.

chooses to use FR chemicals, the regulation does not require tests for durability after exposure to moisture.⁷⁷

Indeed, former CPSC Chair Tenenbaum acknowledged that barrier technologies could be used to meet the CPSC's mattress standards. She stated that the CPSC "strongly encourage[s] all mattress manufacturers to comply with our performance standard through the use of barrier technologies and *to avoid using any potentially harmful chemicals to which children can be exposed.*"⁷⁸

Finally, there are no federal or state regulations requiring the use of flame retardant chemicals in plastic electronic enclosures.

VII. Use of Additive Organohalogen Flame Retardants in Household Products Leads to Human Exposure

When consumer products in these four categories contain organohalogen flame retardants in additive form, the actual and foreseeable use of the products will result in human exposures to the chemicals, as described below. This exposure causes a risk of human harm.

A. Organohalogen Flame Retardants Are Semi-Volatile, Meaning They Are Released into the Air, Persist and Lead to Human Exposures

Two considerations greatly influence the likelihood that a chemical substance will migrate out of a consumer product: (1) whether the substance is additive or

⁷⁷ U.S. Consumer Product Safety Commission, Office of Compliance, Standard for the Flammability (Open Flame) of Mattress Sets, 16 C.F.R. Part 1633, Questions and Answers. Retrieved March 3, 2015, from <https://www.cpsc.gov//PageFiles/117413/mattqa.pdf>.

⁷⁸ Patricia Callahan, *Chemicals in the Crib*, *supra* note 55.

reactive, and (2) whether or not it is semi-volatile. Unlike reactive flame retardants, additive flame retardants are not chemically bound to the material of the consumer product and are thus more likely to be released into the home environment, leading to human exposure. Additionally, as explained in Dr. Miriam Diamond's accompanying statement, organohalogen flame retardants as a class are semi-volatile organic compounds ("SVOCs"). When used in additive form in consumer products, SVOCs are released slowly from products and, once released, tend to adsorb onto other solid phases such as dust particles, human and animal skin, clothes, and so on. In addition, exposures occur as a result of direct transfer when touching a product containing additive flame retardants is followed by hand-to-mouth contact. This is true of all additive organohalogen flame retardants. In addition, all organohalogen flame retardants are, by their nature, persistent in the indoor environment.^{79,80} In sum, based on the physico-chemical properties of additive organohalogen flame retardants as a class, these chemical substances will migrate out of consumer products and persist in the indoor environment, leading to human exposures. These exposures occur regardless of how the product is used.

Extensive empirical evidence supports this conclusion. Many studies show that organohalogen flame retardants are present in indoor air and house dust. Most

⁷⁹ Weschler, C.J. & Nazaroff, W.W. (2008). Semivolatile organic compounds in indoor environments. *Atmospheric Environment*, 42(40), 9018-40. doi: 10.1016/j.atmosenv.2008.09.052.

⁸⁰ Shin, H.; McKone, T.E.; Tully, N.S.; Clifton, M.S.; & Bennett, D.H. (2013). Indoor residence times of semivolatile organic compounds: model estimation and field evaluation. *Environmental Science & Technology*, 47(2), 859-67. doi: 10.1021/es303316d.

research is on the PBDE flame retardants because they have been in use the longest. For instance, a 2004 Canadian study measured concentrations of PBDEs in indoor air from 74 homes and in outdoor air at seven sites.⁸¹ The researchers detected PBDEs in all indoor air samples, but not in all of the outdoor air samples, with levels indoors approximately 50 times higher on average than outdoors. A 2006 UK study also found that PBDE concentrations were one order of magnitude higher indoors compared to outdoors.⁸² These higher incidences and levels of PBDEs in indoor air are consistent with the migration of flame retardants from indoors consumer products.

A recent study of 139 California households found PBDEs in the majority of dust samples and many floor wipe samples.⁸³ Another study found measurable levels of PBDEs, as well as three other additive organohalogen flame retardants – hexabromobenzene, tris (1-chloro-2-propyl) phosphate (TCPP), and tetrabromobisphenol A (TBBPA) – emitted from office equipment to indoor air.⁸⁴

⁸¹ Wilford, B.H.; Harner, T.; Zhu, J.; Shoeib, M.; & Jones, K.C. (2004). Passive sampling survey of polybrominated diphenyl ether flame retardants in indoor and outdoor air in Ottawa, Canada: implications for sources and exposure. *Environmental Science & Technology*, 38(20), 5312-18. doi: 10.1021/es049260x.

⁸² Harrad, S.; Hazrati S.; & Ibarra, C. (2006). Concentrations of polychlorinated biphenyls in indoor air and polybrominated diphenyl ethers in indoor air and dust in Birmingham, United Kingdom: implications for human exposure. *Environmental Science & Technology*, 40(15), 4633-38. doi: 10.1021/es0609147.

⁸³ Bennett, D.H.; Moran, R.E.; Wu, X.M.; Tolve, N.S.; Clifton, M.S.; Colon, M.; Weathers, W.; Sjödin, A.; Jones, R.; & Hertz-Picciotto, I. (2014). Polybrominated diphenyl ether (PBDE) concentrations and resulting exposure in homes in California: relationships among passive air, surface wipe and dust concentrations, and temporal variability. *Indoor Air*. doi: 10.1111/ina.12130.

⁸⁴ Destailats, H.; Maddalena, R.L.; Singer, B.C.; Hodgson, A.T.; & McKone, T.E. (2008). Indoor pollutants emitted by office equipment: A review of reported data and information needs. *Atmospheric Environment*, 42(7), 1371-88. doi: 10.1016/j.atmosenv.2007.10.080.

Newer studies on the organohalogen flame retardants used as PBDE replacements show that these too migrate from products into the air and end up in dust. For example, a 2006 study in Boston, Massachusetts, analyzed dust samples from 19 homes and found several alternate and new brominated flame retardants: hexabromocyclododecane (HBCD), 1,2-bis (2,4,6,-tribromophenoxy) ethane (BTBPE), DBDPE, and the brominated components found in Firemaster® 550: 2-ethylhexyl 2,3,4,5-tetrabromobenzoate (TBB) and bis (2-ethylhexyl) 3,4,5,6-tetrabromophthalate (TBPH).⁸⁵

As described in the accompanying statement from Ruthann Rudel, the Silent Spring Institute tested dust in California homes for the presence of flame retardants between 2006 and 2011, and found that over 50% of those homes contained 41 different organohalogens, and at least one contained as many as 55 flame retardant chemicals.⁸⁶

Most commonly found were: PBDE mixtures; components of Firemaster® 550; HBCD; TBBPA; tetrabromobisphenol A-bis(2,3-dibromopropylether) (TBBPA-BDBPE); DBDPE; TDBPP; TDCPP; TCPP; and TCEP. The study also found that concentrations of Firemaster® 550 components TBB, TBPH and triphenyl phosphate (TPhP) increased from 2006 to 2011, as the use of Firemaster® 550 increased to replace the pentaBDE commercial mixture. On the other hand, levels of pentaBDE (which was phased-out in

⁸⁵ Stapleton, H.M.; Allen, J.G.; Kelly, S.M.; Konstantinov, A.; Klosterhaus, S.; Watkins, D.; McClean, M.D.; & Webster, T.F. (2008). Alternate and new brominated flame retardants detected in U.S. house dust. *Environmental Science & Technology*, 42(18), 6910-16. doi: 10.1021/es801070p.

⁸⁶ Dodson, R.E.; Perovich, L.J.; Covaci, A.; Van den Eede, N.; Ionas, A.C.; Dirtu, A.C.; Brody, J.G.; & Rudel, R.A. (2012). After the PBDE phase-out: a broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*, 46(24), 13,056-66. doi: 10.1021/es303879n.

2005) decreased significantly in dust samples from those households that had purchased new consumer products between 2006 and 2011.^{87,88} Similarly, a study of 26 foam-containing consumer products purchased between 2003 and 2009 in the U.S. found TDCPP and TCPP in 15 and 4 of the samples respectively, and detected them in house dust at levels comparable, or even greater, than the levels of PBDEs.^{89,90} In one study, a significant positive correlation ($p < 0.05$) was found between concentrations of the organohalogen flame retardants BTBPE, DBDPE and TBPH in mattresses and the corresponding concentrations in floor dust ($n=16$).⁹¹

Of particular concern is that organohalogen flame retardants – both PBDEs and their replacements – are ubiquitous in dust found in child care centers and preschools: PBDEs, brominated components of Firemaster® 550, tris (2-chloroethyl) phosphate (TCEP) and TDCPP (all organohalogen flame retardants) were detected in 100% of the

⁸⁷ *Id.*

⁸⁸ This is evidence that once flame retardants are removed from consumer products, their presence in household dust eventually decreases, thus leading to decreased exposure.

⁸⁹ Stapleton, H.M.; Klosterhaus, S.; Eagle, S.; Fuh, J.; Meeker, J.D.; Blum, A.; & Webster, T.F. (2009). Detection of organophosphate flame retardants in furniture foam and U.S. house dust. *Environmental Science and Technology*, 43(19), 7490-95. doi: 10.1021/es9014019.

⁹⁰ Measurable amounts of four non-PBDE organohalogen flame retardants were also found in house dust in Belgium: BTBPE and DBDPE were identified in 85% and 100% of Belgium house dust samples respectively; TBB and TBPH were found in 31% and 97% of house dust samples respectively. Ali, N.; Harrad, S.; Goosey, E.; Neels, H.; & Covaci, A. (2011). "Novel" brominated flame retardants in Belgian and UK indoor dust: implications for human exposure. *Chemosphere*, 83(10), 1360-65. doi: 10.1016/j.chemosphere.2011.02.078.

⁹¹ Ali, N.; Dirtu, A.C.; Van den Eede, N.; Goosey, E.; Harrad, S.; Neels, H.; 't Mannetje, A.; Coakley, J.; Douwes, J.; & Covaci, A. (2012). Occurrence of alternative flame retardants in indoor dust from New Zealand: indoor sources and human exposure assessment. *Chemosphere*, 88(11), 1276-82. doi: 10.1016/j.chemosphere.2012.03.100.

dust sampled in 40 California early childhood educational facilities between May 2010 and May 2011.⁹²

B. The Migration of Organohalogen Flame Retardants Out of Products Leads to Human Exposure

Humans are exposed to organohalogen flame retardants that migrate from consumer products into the air and settle in house dust as a result of the actual and foreseeable use of the products at issue in this petition. The inadvertent ingestion and absorption of contaminated house dust is a major pathway of exposure to organohalogen flame retardants for the general population.⁹³ An EPA review published in 2008 found that ingestion of organohalogen flame retardants in household dust accounted for over 80% of the overall exposure of study participants to these chemicals, with the remaining exposure primarily due to ingestion of contaminated food products.⁹⁴ A 2007 Massachusetts study found that inhalation of PBDEs from indoor air due to their presence in consumer products may also account for a significant

⁹² Bradman, A.; Castorina, R.; Gaspar, F.; Nishioka, M.; Colón, M.; Weathers, W.; Egeghy, P.P.; Maddalena, R.; Williams, J.; Jenkins, P.L.; & McKone, T.E. (2014). Flame retardant exposures in California early childhood education environments. *Chemosphere*, 116, 61-66. doi: 10.1016/j.chemosphere.2014.02.072.

⁹³ Jones-Otazo, H.A.; Clarke, J.P.; Diamond, M.L.; Archbold, J.A.; Ferguson, G.; Harner, T.; Richardson, G.M.; Ryan, J.J.; & Wilford, B. (2005). Is house dust the missing exposure pathway for PBDEs? An analysis of the urban fate and human exposure to PBDEs. *Environmental Science & Technology*, 39(14), 5121-30. doi: 10.1021/es048267b.

⁹⁴ Lorber, M. (2008). Exposure of Americans to polybrominated diphenyl ethers. *Journal of Exposure Science & Environmental Epidemiology*, 18(1), 2-19. doi: 10.1038/sj.jes.7500572.

proportion of human exposures to these chemicals.⁹⁵ More recent research suggests that product-to-hand transfer followed by hand-to-mouth transfer is the main path of exposure to organohalogen flame retardants.^{96,97}

Biomonitoring studies confirm that flame retardants are present in people. The 2003-2004 National Health and Nutrition Examination Survey (“NHANES”) conducted by the Centers for Disease Control and Prevention (“CDC”), found at least one PBDE congener in 97% of the study participants, reported to be representative of the U.S. population.⁹⁸ The latest CDC report⁹⁹ found several PBDEs and 2,2',4,4',5,5'-hexabromobiphenyl (BB 153, known commercially as Firemaster® BP-6) at levels ranging from 1.2 to 28.2 ng/g lipid in human serum. Teenagers (ages 12 to 19) had higher body burdens than adults for all flame retardants measured. Mexican Americans and non-Hispanic blacks had higher levels than the non-Hispanic white population. The fact that

⁹⁵ Allen, J.G.; McClean, M.D.; Stapleton, H.M.; Nelson, J.W.; & Webster, T.F. (2007). Personal exposure to polybrominated diphenyl ethers (PBDEs) in residential indoor air. *Environmental Science & Technology*, 41(13), 4574-79. doi: 10.1021/es0703170.

⁹⁶ Watkins, D.J.; McClean, M.D.; Fraser, A.J.; Weinberg, J.; Stapleton, H.M.; Sjödin, A.; & Webster T.F. (2011). Exposure to PBDEs in the office environment: evaluating the relationships between dust, handwipes, and serum. *Environmental Health Perspectives*, 119(9), 1247-52. doi: 10.1289/ehp.1003271.

⁹⁷ Stapleton, H.M.; Eagle, S.; Sjödin, A.; & Webster, T.F. (2012). Serum PBDEs in a North Carolina toddler cohort: associations with handwipes, house dust, and socioeconomic variables. *Environmental Health Perspectives*, 120(7), 1049-54. doi: 10.1289/ehp.1104802.

⁹⁸ Sjödin, A.; Wong, L.; Jones, R.S.; Park, A.; Zhang, Y.; Hodge, C.; Dipietro, E.; McClure, C.; Turner, W.; Needham, L.L.; & Patterson Jr., D.G. (2008). Serum concentrations of polybrominated diphenyl ethers (PBDEs) and polybrominated biphenyl (PBB) in the United States population: 2003-2004. *Environmental Science & Technology*, 42(4), 1377-84. doi: 10.1021/es702451p.

⁹⁹ Centers for Disease Control and Prevention (2015). *Fourth National Report on Human Exposure to Environmental Chemicals, Updated Tables, February 2015*. Retrieved March 4, 2015, from <http://www.cdc.gov/exposurereport/>.

communities of color bear disproportionately high levels of flame retardant chemicals, coupled with the disproportionate exposure and toxicity borne by children (and developing fetuses) presents environmental justice concerns. Another recent study detected 2,3,4,5-tetrabromobenzoic acid (TBBA), a urinary metabolite of the Firemaster® 550 component TBB, in 72.4% of the 64 study participants, indicating widespread exposure to Firemaster® 550 in the home environment.¹⁰⁰

Studies have also documented exposure of pregnant women to organohalogen flame retardants, which is of particular concern because there are strong links between prenatal exposures to these chemicals and reduced IQ and greater hyperactivity in children.¹⁰¹ All pregnant participants in the 2003-2004 NHANES study had measurable levels of at least one PBDE in their bodies.¹⁰² A study of 416 predominantly immigrant pregnant women living in Monterey County, California, detected pentaBDE congeners in 97% of serum samples.¹⁰³ In addition, flame retardant chemicals are transferred from

¹⁰⁰ Hoffman, K.; Fang, M.; Horman, B.; Patisaul, H.B.; Garantziotis, S.; Birnbaum, L.S.; & Stapleton, H.M. (2014). Urinary tetrabromobenzoic acid (TBBA) as a biomarker of exposure to the flame retardant mixture Firemaster® 550. *Environmental Health Perspectives*, 122(9), 963-69. doi: 10.1289/ehp.1308028.

¹⁰¹ Chen, A.; Yolton, K.; Rauch, S.A.; Webster, G.M.; Hornung, R.; Sjödin, A.; Dietrich, K.N.; & Lanphear, B.P. (2014). Prenatal polybrominated diphenyl ether exposures and neurodevelopment in U.S. children through 5 years of age: The HOME study. *Environmental Health Perspectives*, 122(8), 856-62. doi: 10.1289/ehp.1307562.

¹⁰² Woodruff, T.J.; Zota, A.R.; & Schwartz, J.M. (2011). Environmental chemicals in pregnant women in the United States: NHANES 2003-2004. *Environmental Health Perspectives*, 119(6), 878-85. doi: 10.1289/ehp.1002727.

¹⁰³ Castorina, R.; Bradman, A.; Sjödin, A.; Fenster, L.; Jones, R.S.; Harley, K.G.; Eisen, E.A.; & Eskenazi, B. (2011). Determinants of serum polybrominated diphenyl ether (PBDE) levels among pregnant women in the CHAMACOS cohort. *Environmental Science Technology*, 45(15), 6553-60. doi: 10.1021/es104295m.

the mother to the baby during breastfeeding,¹⁰⁴ a potentially major route of exposure for infants. Fetuses and newborn infants are especially at risk when exposed to toxics such as organohalogen flame retardants because their brains and organ systems are in a critical developmental window.

In general, exposure to flame retardants in house dust is highest for toddlers and young children.¹⁰⁵ A study of 20 mothers and their children aged 1.5 to 4 found that the children had typically 2.8 times higher total PBDE levels than their mothers.¹⁰⁶ The authors suggest that this occurs due to the young children's frequent hand-to-mouth activity, dietary preferences, and breastfeeding. In a North Carolina study, levels of PBDEs on toddlers' hands correlated with serum PBDE levels, suggesting that the frequent hand-to-mouth contact exhibited by young children is a major exposure pathway.¹⁰⁷ In a separate study, toddlers in homes with contaminated house dust had up to 100-fold greater estimated exposure levels compared to toddlers who were not exposed to contaminated dust.¹⁰⁸ CPSC exposure estimates suggest that infants could be exposed to higher levels of the organohalogen flame retardant TDCPP from juvenile

¹⁰⁴ Schecter, A.; Pavuk, M.; Päpke, O.; Ryan, J.J.; Birnbaum, L.; & Rosen, R. (2003). Polybrominated diphenyl ethers (PBDEs) in U.S. mothers' milk. *Environmental Health Perspectives*, 111(14), 1723-29. doi: 10.1289/ehp.6466.

¹⁰⁵ Stapleton, H.M.; Dodder, N.G.; Offenber, J.H.; Schantz, M.M.; & Wise, S.A. (2005). Polybrominated diphenyl ethers in house dust and clothes dryer lint. *Environmental Science & Technology*, 39(4), 925-31. doi: 10.1021/es0486824.

¹⁰⁶ Lunder, S.; Hovander, L.; Athanassiadis, I.; & Bergman, A. (2010). Significantly higher polybrominated diphenyl ether levels in young U.S. children than in their mothers. *Environmental Science and Technology*, 44(13), 5256-62. doi: 10.1021/es1009357.

¹⁰⁷ Stapleton, H.M., Serum PBDEs, *supra* note 97.

¹⁰⁸ Jones-Otazo, H. A., Is house dust the missing exposure pathway, *supra* note 93.

products compared to the average child's or adult's exposure from upholstered furniture.^{109,110,111} A recent study of 21 US mother-toddler pairs confirmed that toddlers have significantly higher concentrations of TDCPP metabolites in their urine compared to their mothers, consistent with increased hand to mouth behavior and elevated dust exposure.¹¹²

The highest levels of harmful flame retardants in the general population are found in young children from communities of low socioeconomic status and communities of color. For instance, a North Carolina study of 80 toddlers found PBDEs in 100% of the blood samples, and the sum of BDE-47, -99 and -100 (three of the pentaBDE congeners) was negatively associated with the father's level of education.¹¹³ Similarly, Zota et al. (2008), using data from the NHANES, found that individuals in lower income households (<\$20,000/year) had significantly higher PBDE exposures.¹¹⁴ Rose et al. (2010) also found higher body burdens of nearly all measured congeners (including BDE-47, -153, and -209) in 2-5 year-old Californian children in born to mothers with

¹⁰⁹ *Id.*

¹¹⁰ Stapleton, H. M., Identification of flame retardants, *supra* note 64.

¹¹¹ Babich, M. A., U.S. Consumer Product Safety Commission (2006). CPSC Staff Preliminary Risk Assessment of Flame Retardant (FR) Chemicals in Upholstered Furniture Foam. Retrieved March 4, 2015, from <http://www.cpsc.gov//PageFiles/106736/ufurn2.pdf>.

¹¹² Butt, C.M.; Congleton, J.; Hoffman, K.; Fang, M.; & Stapleton, H.M. (2014). Metabolites of organophosphate flame retardants and 2-ethylhexyl tetrabromobenzoate in urine from paired mothers and toddlers. *Environmental Science & Technology*, 48(17), 10432-38. doi: 10.1021/es5025299.

¹¹³ Stapleton, H.M., Serum PBDEs, *supra* note 97.

¹¹⁴ Zota, A.R.; Rudel, R.A.; Morello-Frosch, R.A.; & Brody, J.G. (2008). Elevated house dust and serum concentrations of PBDEs in California: unintended consequences of furniture flammability standards? *Environmental Science & Technology*, 42(21), 8158-64. doi: 10.1021/es801792z.

lower education.¹¹⁵ In another study of ethnically diverse 6-8 year-old girls in California, measured pentaBDE levels were higher in children with less educated care-givers.¹¹⁶ This study also found that black preadolescent girls had significantly higher levels than white girls.¹¹⁷ Similarly, using NHANES data, Sjödin et al. (2008) showed that, after adjusting for age, levels of BDE-47 and BDE-99 (but not BDE-100 and BDE-153) were significantly lower in white children as compared to Mexican American and black children.¹¹⁸

* * *

In sum, additive organohalogen flame retardants are present in the four categories of consumer products addressed by this petition (although no mandatory flammability standard requires this), and body burden testing demonstrates that humans are exposed to and absorb these chemicals when they migrate from household products as a result of reasonable and foreseeable use of these products. As shown below, these exposures present serious health risks due to the physical-chemical properties of organohalogen flame retardants as a class, which renders them toxic to humans.

¹¹⁵ Rose, M.; Bennett, D.H.; Bergman, Å.; Fängström, B.; Pessah, I.N.; & Hertz-Picciotto, I. (2010). PBDEs in 2-5 year-old children from California and associations with diet and indoor environment. *Environmental Science & Technology*, 44(7), 2648-53. doi: 10.1021/es903240g.

¹¹⁶ Windham, G.C.; Pinney, S.M.; Sjödin, A.; Lum, R.; Jones, R.S.; Needham, L.L.; Biro, F.M.; Hiatt, R.A.; & Kushi, L.H. (2010). Body burdens of brominated flame retardants and other persistent organo-halogenated compounds and their descriptors in US girls. *Environmental Research*, 110(3), 251-57. doi: 10.1016/j.envres.2010.01.004.

¹¹⁷ *Id.*

¹¹⁸ Sjödin, A., Serum concentrations of polybrominated diphenyl ethers (PBDEs), *supra* note 98.

VIII. Consumer Products in the Four Petition Categories Containing Any Organohalogen Flame Retardant in Additive Form Are “Hazardous Substances” Within the Meaning of the FHSA

Not only do organohalogen flame retardants in additive form migrate from consumer products leading to human exposures as a result of actual and foreseeable use, but exposure to any chemical in this class also poses human health risks, as described in detail below. Accordingly, these products are “hazardous substances” within the meaning of the FHSA.

We know that the consumer products in the four categories at issue here pose human health risks if they contain any additive organohalogen flame retardant because:

- a. Human exposure to all *studied* organohalogen flame retardants is associated with long-term chronic health effects, as described in the accompanying expert statements from Dr. Kim Harley, Dr. Julie Herbstman, Dr. Susan Kasper, Ruthann Rudel, and Dr. Ted Schettler.
- b. Inherent physical, chemical, and biological characteristics of organohalogen chemicals and the historical evidence of regrettable substitution within this chemical class suggest that the entire class of organohalogen flame retardants have (or are very likely to have) adverse health effects and therefore should be regulated as a class, as explained in the accompanying expert statements from Dr. David Eastmond, Dr. Terry Collins, Dr. Rolf Halden, and Dr. David Epel.
- c. When all organohalogen flame retardants burn, they release toxic byproducts, such as acutely toxic soot and smoke, and dioxins and furans, which are associated with long-term chronic health effects, as explained in the accompanying expert statements from Dr. Roland Weber, and Dr. Donald Lucas.

In sum, a consumer product containing *any* organohalogen flame retardant chemical in additive form has “the capacity to produce personal injury or illness” in humans when inhaled, swallowed, or absorbed through the skin – whether the injury or

illness is acute or chronic.¹¹⁹ This “may cause substantial personal injury or substantial illness during or as a proximate result of any customary or reasonably foreseeable handling or use.”¹²⁰ Because of these risks, any product in the four categories at issue here containing an organohalogen flame retardant chemical in additive form should be declared a “hazardous substance” and “banned hazardous substance” under the FHSA.

A. Exposure to Organohalogen Flame Retardants from Consumer Products Puts Human Health at Risk

All organohalogen flame retardants that have been studied have the capacity to cause long-term adverse health effects in humans who are exposed to them. Because PBDEs were used in consumer products for decades, large segments of the U.S. population were unwitting subjects in an experiment regarding how PBDEs affect human health. Over the last several years, scientists have studied the impacts of ongoing exposure to PBDEs and concluded that there are associations with neurotoxicity, adverse developmental and reproductive effects, and immune and endocrine disruption. The accompanying statements from Dr. Kim Harley, Dr. Susan Kasper and Dr. Julie Herbstman explain their key research findings on the impacts of PBDEs on human health.

The evidence that the newer organohalogen flame retardants are also toxic to humans is compelling, and most are also persistent and/or bioaccumulative. For example:

¹¹⁹ 15 U.S.C. § 1261(g).

¹²⁰ 15 U.S.C. § 1261(f)(1)(A).

- TDCPP was recently added to California’s Proposition 65 list of chemicals “known to the State to cause cancer.”¹²¹ TDCPP levels in house dust were associated with altered hormone levels in men recruited through an infertility clinic.¹²² An *in vitro* study suggests that TDCPP is toxic to the nervous system and affects cell development and DNA synthesis.¹²³
- TCEP was added to California’s Proposition 65 list of chemicals “known to the State to cause cancer” in 1992. In addition to cancer, TCEP has also been linked to reproductive toxicity^{124,125} and neurotoxicity^{126,127,128} based on animal studies. The EU classifies TCEP as a “Substance of Very High Concern” based on reproductive toxicity.¹²⁹
- One of the brominated components of Firemaster® 550, TBPH, is a structural analogue of the phthalate di(2-ethylhexyl) phthalate (DEHP), which is listed under Proposition 65 as known to the state of California to

¹²¹ California EPA, *Evidence on the Carcinogenicity of Tris(1,3-Dichloro-2-Propyl) Phosphate*, *supra* note 25; OEHHA, *Chemicals Known to the State to Cause Cancer or Reproductive Toxicity*, *supra* note 25.

¹¹⁴ Meeker, J. D., House dust concentrations of organophosphate flame retardants, *supra* note 26.

¹²³ Dishaw, L.V.; Powers, C.M.; Ryde, I.T.; Roberts, S.C.; Seidler, F.J.; Slotkin, T.A.; & Stapleton, H.M. (2011). Is the PentaBDE replacement, tris (1,3-dichloro-2-propyl) phosphate (TDCPP), a developmental neurotoxicant? Studies in PC 12 cells. *Toxicology and Applied Pharmacology*, 256(3), 281-89. doi: 10.1016/j.taap.2011.01.005.

¹²⁴ European Union (2009). *European Union Risk Assessment Report: Tris(2-chloroethyl)phosphate, TCEP*. CAS 115-96-8; EINECS 204-118-5. *Final Approved Version*. Retrieved March 4, 2015, from http://www.baua.de/en/Chemicals-Act-biocide-procedure/Documents/RAR-068.pdf?__blob=publicationFile&v=1.

¹²⁵ Washington State Department of Health (2011). *Children's Safe Products Act Rationale for Chemicals listed under Reporting Requirements*. Retrieved March 4, 2015, from <http://www.cj-elec.com/UploadPicFile/20121123141853694.pdf>.

¹²⁶ European Chemicals Agency (2009). *Support Document for Identification of Tris(2-Chloroethyl)Phosphate as a Substance of Very High Concern Because of its CMR Properties*. Retrieved March 4, 2015, from <http://echa.europa.eu/documents/10162/d0f5c171-5086-49c3-a6a3-3a31cb4e08eb>.

¹²⁷ European Union, *European Union Risk Assessment Report. Tris(2-chloroethyl)phosphate, TCEP*, *supra* note 124.

¹²⁸ Minnesota Department of Health (2013). *Toxicological Summary for Tris(2-chloroethyl)phosphate*. Retrieved March 4, 2015, from <http://www.health.state.mn.us/divs/eh/risk/guidance/gw/tcep.pdf>.

¹²⁹ European Chemicals Agency, *Support Document for Identification of Tris(2-Chloroethyl)Phosphate as a Substance of Very High Concern*, *supra* note 126.

cause cancer and developmental and reproductive toxicity. DEHP's monoester metabolite is the toxicologically active species. Studies in rats showed that TBPH's monoester metabolite also had toxicological activity, affecting thyroid hormone levels in pregnant dams and potentially affecting fetal testes development.¹³⁰ This raises concern that ingested TBPH could lead to toxicological effects in people. One epidemiological study found that the amount of TBPH in house dust was positively correlated with thyroid hormone levels in men seeking treatment for infertility.¹³¹

- Tetrabromobisphenol A (TBBPA), which is commonly used in plastic electronics enclosures, inhibited neurotransmitter uptake in rat brain synaptosomes,¹³² showed teratogenic effects for frog embryos,¹³³ and affected thyroid hormone functioning¹³⁴ and the reproductive system in experimental animals.¹³⁵ A recent cancer bioassay found clear evidence of carcinogenicity in female rats.¹³⁶

¹³⁰ Springer, C.; Dere, E.; Hall, S.J.; McDonnell, E.V.; Roberts, S.C.; Butt, C.M.; Stapleton, H.M.; Watkins, D.J.; McClean, M.D.; Webster, T.F.; Schlezinger, J.J.; & Boekelheide, K. (2012). Rodent thyroid, liver, and fetal testis toxicity of the monoester metabolite of bis-(2-ethylhexyl) tetrabromophthalate (TBPH), a novel brominated flame retardant present in indoor dust. *Environmental Health Perspectives*, 120(12), 1711-19. doi: 10.1289/ehp.1204932.

¹³¹ Johnson, P.I.; Stapleton, H.M.; Mukherjee, B.; Hauser, R.; & Meeker, J.D. (2013). Associations between brominated flame retardants in house dust and hormone levels in men. *Science of the Total Environment*, 445-446, 177-84. doi: 10.1016/j.scitotenv.2012.12.017.

¹³² Mariussen, E., & Fonnum, F. (2003). The effect of brominated flame retardants on neurotransmitter uptake into rat brain synaptosomes and vesicles. *Neurochemistry International*, 43(4-5), 533-42. doi: 10.1016/S0197-0186(03)00044-5.

¹³³ Shi, H.; Qian, L.; Guo, S.; Zhang, X.; Liu, J.; & Cao, Q. (2010). Teratogenic effects of tetrabromobisphenol A on *Xenopus tropicalis* embryos. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 152(1), 62-68. doi: 10.1016/j.cbpc.2010.02.013.

¹³⁴ Van der Ven, L.T.; Van de Kuil, T.; Verhoef, A.; Verwer, C.M.; Lilienthal, H.; Leonards, P.E.; Schauer, U.M.; Cantón, R.F.; Litens, S.; De Jong, F.H.; Visser, T.J.; Dekant, W.; Stern, N.; Håkansson, H.; Slob, W.; Van den Berg, M.; Vos, J.G.; & Piersma, A.H. (2008). Endocrine effects of tetrabromobisphenol-A (TBBPA) in Wistar rats as tested in a one-generation reproduction study and a subacute toxicity study. *Toxicology*, 245(1-2), 76-89. doi: 10.1016/j.tox.2007.12.009.

¹³⁵ Zatecka, E.; Ded, L.; Elzeinova, F.; Kubatova, A.; Margaryan, H.; Dostalova, P.; & Peknicova, J. (2013). Effect of tetrabromobisphenol A on induction of apoptosis in the testes and changes in expression of selected testicular genes in CD1 mice. *Reproductive Toxicology*, 35, 32-39. doi: 10.1016/j.reprotox.2012.05.095.

¹³⁶ Dunnick, J.K., et al., National Toxicology Program ("NTP"), National Institutes of Health, Public Health Service, US Department of Health and Human Services (2013). *NTP Technical Report on*

- Hexabromocyclododecane (HBCD) caused reproductive effects in experimental animals,¹³⁷ interfered with thyroid hormone homeostasis,¹³⁸ and inhibited neurotransmitter uptake in rat brain synaptosomes.¹³⁹ Neonatal exposure to HBCD was found to significantly affect spontaneous behavior, learning and memory in mice.^{140,141}
- Tetrabromoethylcyclohexane (TBECH), a flame retardant used in electrical cable coatings and high-impact plastic parts of appliances, is a mutagen¹⁴² and a strong androgen agonist, binding to and activating the human androgen receptor in human liver cells.¹⁴³
- 2,2-bis (bromomethyl) 1,3-propanediol (DBNPG) was found by the NTP to show clear evidence of carcinogenicity in rats and mice of both sexes in two-year cancer bioassays. It is listed as causing cancer under Proposition 65 and classified by the International Agency for Research on Cancer (IARC) as 2B carcinogen (i.e., possibly carcinogenic to humans). A

the Toxicology Studies of Tetrabromobisphenol A (CAS NO. 79-94-7) in F344/NTac Rats and B6C3F1/N Mice and Toxicology and Carcinogenesis Studies of Tetrabromobisphenol A in Wistar Han [CrI:WI(Han)] Rats and B6C3F1/N Mice (Gavage Studies) - NTP TR 587. Retrieved March 5, 2015, from http://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2013/october/draft_tr-587.pdf.

¹³⁷ Ema, M.; Fujii, S.; Hirata-Koizumi, M.; & Matsumoto, M. (2008). Two-generation reproductive toxicity study of the flame retardant hexabromocyclododecane in rats. *Reproductive Toxicology*, 25(3), 335-51. doi: 10.1016/j.reprotox.2007.12.004.

¹³⁸ Darnerud, P.O. (2003). Toxic effects of brominated flame retardants in man and in wildlife. *Environment International*, 29(6), 841-53. doi: 10.1016/S0160-4120(03)00107-7.

¹³⁹ Mariussen, E., The effect of brominated flame retardants, *supra* note 132.

¹⁴⁰ Eriksson, P.; Viberg, H.; Fischer, C.; Wallin, M.; & Fredriksson, A. (2002). A comparison on the developmental neurotoxic effects of hexabromocyclododecane, 2,2',4,4',5,5'-hexabromodiphenylether (PBDE 153) and 2,2',4,4',5,5',-hexachlorobiphenylether (PCB 153). *Organohalogen Compounds*, 57, 389-90. See <http://www.dioxin20xx.org/pdfs/2002/02-346.pdf>.

¹⁴¹ Eriksson, P.; Fischer, C.; Wallin, M.; Jakobsson, E.; & Fredriksson, A. (2006). Impaired behaviour, learning and memory, in adult mice neonatally exposed to hexabromocyclododecane (HBCDD). *Environmental Toxicology and Pharmacology*, 21, 317-22. doi: 10.1016/j.etap.2005.10.001.

¹⁴² McGregor, D.B.; Brown, A.G.; Howgate, S.; McBride, D.; Riach, C.; Caspary, W.J.; & Carver, J.H. (1991). Responses of the L5178Y mouse Lymphoma cell forward mutation assay. V: 27 coded chemicals. *Environmental and Molecular Mutagenesis*, 17(3), 196-219. doi: 10.1002/em.2850170309.

¹⁴³ Larsson, A.; Eriksson, L.A.; Andersson, P.L.; Ivarson, P.; & Olsson, P.E. (2006). Identification of the brominated flame retardant 1,2-dibromo-4-(1,2-dibromoethyl)cyclohexane as an androgen agonist. *Journal of Medicinal Chemistry*, 49, 7366-72. doi: 10.1021/jm060713d.

recent review identified DBNPG as a chemical likely to lead to premature ovarian failure in descendants following prenatal exposure based on studies in mice.¹⁴⁴

- 1,2-bis (2,4,6,-tribromophenoxy) ethane (BTBPE) was found in house dust, with levels positively associated with thyroid hormone levels in men recruited through an infertility clinic.¹⁴⁵ Additionally, one of its identified metabolites, 2,4,6-tribromophenol, is a thyroid disruptor.^{146,147}
- Tetrabromobisphenol A-bis (2,3-dibromopropylether) (TBBPA-BDBPE) inhibited sulfation of estradiol *in vitro* studies,¹⁴⁸ suggesting that it could also affect normal endocrine activity.

The Statement from Ruthann Rudel and accompanying bibliography and table identify additional studies on health effects of organohalogen flame retardants, including non-PBDE chemicals.

B. Organohalogen Flame Retardants Are Inherently Hazardous Substances and Therefore Should Be Regulated as a Class

Due to their inherent physical, chemical and biological structures and properties, organohalogen flame retardants have the capacity, as a class, to “produce personal injury or illness,” and they have the potential, as a class, to cause “substantial personal

¹⁴⁴ Béranger, R.; Hoffmann, P.; Christin-Maitre, S.; & Bonneterre, V. (2012). Occupational exposures to chemicals as a possible etiology in premature ovarian failure: a critical analysis of the literature. *Reproductive Toxicology*, 33(3), 269-79. doi: 10.1016/j.reprotox.2012.01.002.

¹⁴⁵ Johnson, P.I., Associations between brominated flame, *supra* note 131.

¹⁴⁶ Hamers, T.; Kamstra, J.H.; Sonneveld, E.; Murk, A.J.; Kester, M.H.; Andersson, P.L.; Legler, J.; & Brouwer, A. (2006). *In vitro* profiling of the endocrine-disrupting potency of brominated flame retardants. *Toxicological Sciences*, 92(1), 157-73. doi: 10.1093/toxsci/kfj187.

¹⁴⁷ Suzuki, G.; Takigami, H.; Watanabe, M.; Takahashi, S.; Nose, K.; Asari, M.; & Sakai, S. (2008). Identification of brominated and chlorinated phenols as potential thyroid-disrupting compounds in indoor dusts. *Environmental Science & Technology*, 42(5), 1794-800. doi: 10.1021/es7021895.

¹⁴⁸ Hamers, T., *In vitro* profiling, *supra* note 146.

injury or substantial illness.”¹⁴⁹ Thus, as a class, organohalogen flame retardants should be considered and designated as “hazardous substances.”

In order to assess the hazards of the class of organohalogen flame retardants, a research group at the University of California, Riverside performed a hazard screen of 83 non-polymeric organohalogen flame retardants, which included all such chemicals that this research group could identify as in use or available for potential use in consumer products in 2012.¹⁵⁰ The hazard screen, which was performed using the Washington State Department of Ecology’s Quick Chemical Assessment Tool (QCAT®) methodology,¹⁵¹ is described in detail in the accompanying statement from Dr. David Eastmond.

The 83 chemicals were screened for nine priority hazard categories (acute mammalian toxicity, carcinogenicity, reproductive toxicity, developmental toxicity, mutagenicity/genetic toxicity, endocrine disruption, acute aquatic toxicity, persistence, and bioaccumulation) and then each chemical was assigned a grade (A, B, C, D, or F). Some hazard data were available for about a third of the organohalogen flame retardants screened; for the others, the researchers employed Structure Activity Relationship (SAR) models. The initial grade results, which were based solely on

¹⁴⁹ 15 U.S.C. § 1261(f)(1)(A) (defining “hazardous substance”); 15 U.S.C. § 1261(g) (defining “toxic”).

¹⁵⁰ It is important to note that this study used all organohalogen flame retardants that could be identified as listed in use or potentially in use; the 83 chemicals were not selected on the basis of suspected toxicity.

¹⁵¹ Eastmond, D.A.; Bhat, V.S.; & Capsel K. (2012). *A Screening Level Assessment of the Health and Environmental Hazards of Organohalogen Flame Retardants*. Collegium Ramazzini, Capri, Italy.

available data or models and did not include “penalties” for data gaps (missing data),

were:

- F for 48 organohalogen flame retardants (58%), meaning that the chemicals are toxic and should not be used;
- D for 26 organohalogen flame retardants (31%), meaning that the chemicals are of high concern and should be avoided; and
- C for 9 organohalogen flame retardants (11%), meaning that the chemicals raise moderate concern and safer alternatives need to be found.

None of the chemicals studied received initial grades higher than C. To get the final grade, under the QCAT Hazard Assessment Methodology, penalties are assessed for excessive data gaps. In the case of the 83 organohalogen flame retardants, 78 chemicals (94%) received a final grade of F (due to toxicity and/or excessive data gaps), and the remaining five chemicals (6%) received a final grade of D (high concern). In other words, when the data gaps were taken into account, all of the organohalogen flame retardants screened were either of high concern or toxic. Based on these results, Dr. Eastmond concluded that all the organohalogen flame retardants with adequate available data “have the potential to pose significant hazards for human or environmental health.”

This conclusion is consistent with determinations made by California Environmental Protection Agency (“CalEPA”) as part of the California Environmental Contaminant Biomonitoring Program. Under this program, CalEPA designates chemicals for future biomonitoring studies. “Designated chemicals” are “chemicals that are known to, or strongly suspected of, adversely impacting human health or development,

based upon scientific, peer-reviewed animal, human, or in vitro studies.”¹⁵² Notably, all members of the chemical group “brominated and chlorinated organic compounds used as flame retardants” – in other words, organohalogen flame retardants – are “designated chemicals,” meaning they all are known to, or strongly suspected of, adversely impacting human health or development, based upon scientific, peer-reviewed animal, human, or in vitro studies.”¹⁵³

This conclusion is further supported by the accompanying statements of Dr. Epel, Dr. Collins, and Dr. Halden. Dr. Epel presents strong empirical evidence that their physical, chemical, and biological properties render the organohalogen flame retardants with low water solubility inherently toxic. They are able to pass into cells easily without being recognized by efflux transporters (the primary line of defense against toxic substances in the cell membranes of all organisms) and, once inside a cell, they are difficult to metabolize, leading to accumulation and potential adverse health effects. Furthermore, preliminary evidence suggests they can inhibit a cell’s defense system, and thus exacerbate the harmful effects of other chemicals. Because of their novelty to mammalian cells, even the more water-soluble organohalogen flame retardants may also bypass the cell’s defenses. Indeed, there are no naturally occurring chemicals in

¹⁵² Cal. Health & Safety Code § 105440(b)(6).

¹⁵³ See Biomonitoring California (2014). Designated Chemicals, October 2014. Retrieved March 3, 2015, from http://biomonitoring.ca.gov/sites/default/files/downloads/DesignatedChemicalList_October2014.pdf.

mammals that contain bromine or chlorine bonded to carbon, which is found in all organohalogen flame retardants.

Dr. Collins' statement explains how organohalogen flame retardants can modify a cell's DNA or disrupt its function, which can lead to cancer and/or epigenetic effects. In addition, some are known to have the potential to disrupt hormone action, which can cause adverse human health effects, even at very low levels of exposure.

Dr. Rolf Halden's statement further describes, the evidence that all organohalogen flame retardants have the potential to cause significant adverse health effects and should be regulated as a class.

C. Organohalogen Flame Retardants Also Warrant Regulation as a Class Because Hazardous Combustion Products from Products Containing these Chemicals Can Result in Significant Short- and Long-Term Health Impacts

The presence of organohalogen flame retardants also poses risks to consumers if the product in which they are used burns. Flame retardants can delay ignition, but do not prevent it. Products containing flame retardants will burn after seconds to minutes when exposed to a heat source. As explained in the accompanying statement from Dr. Don Lucas, when products containing organohalogen flame retardants burn, the combustion produces poisonous gases such as hydrochloric acid, hydrobromic acid, and phosgene, along with increased amounts of carbon monoxide and hydrogen cyanide relative to products that do not contain these chemicals. Inhalation of such toxic gases

and carbon monoxide is the main cause for fire deaths and injuries during fires.¹⁵⁴ The presence of these flame retardants in products that burn can also increase the amount of smoke and soot, which hinders escape from fire.¹⁵⁵ Therefore, the addition of halogenated flame retardants to furniture and other products can actually result in an increased likelihood of injury or death during a home fire due to increased levels of carbon monoxide, soot and other toxic combustion products. Not only does this endanger individuals inside the burning home, it increases risks for first responders.

Furthermore, when products containing organohalogen flame retardants burn, brominated and chlorinated dioxins and furans can be formed.¹⁵⁶ Dioxins and furans are known carcinogens,¹⁵⁷ immune suppressors, and endocrine disruptors,¹⁵⁸ and chlorinated dioxins and furans are carcinogenic and listed as unintentional persistent organic pollutants under the Stockholm Convention.¹⁵⁹ This is discussed in more detail in Dr. Roland Weber's accompanying statement.

¹⁵⁴ Hall Jr., J.R., National Fire Protection Association (2011). *Fatal Effects of Fire*. Retrieved March 3, 2015 from <http://www.nfpa.org/research/reports-and-statistics/demographics-and-victim-patterns/fatal-effects-of-fire>.

¹⁵⁵ *Id.*

¹⁵⁶ Ebert, J. & Bahadir, M. (2003). Formation of PBDD/F from flame-retarded plastic materials under thermal stress. *Environment International*, 29(6), 711-16. doi: 10.1016/S0160-4120(03)00117-X.

¹⁵⁷ IARC (2015). *Agents Classified by the IARC Monographs, Volumes 1–112*. Retrieved March 4, 2015, from <http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf>.

¹⁵⁸ Pohl, H.; Llados, F.; Ingerman, L.; Cunningham, P.; Raymer, J.; Wall, C.; & Gasiewicz, T. (1998). Toxicological profile for chlorinated dibenzo-p-dioxins. Retrieved March 3, 2015, from <http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=366&tid=63>.

¹⁵⁹ United Nations Environment Programme. The 12 initial POPs under the Stockholm Convention. Retrieved March 5, 2015, from <http://chm.pops.int/TheConvention/ThePOPs/The12InitialPOPs/tabid/296/Default.aspx>.

Firefighters, who are routinely exposed on the job to the byproducts of burning consumer products, have disproportionately high levels of four cancers associated with dioxin exposure – testicular cancer, melanoma, brain cancer, and esophageal cancer.^{160,161} The International Association of Fire Fighters (IAFF) recognizes the likelihood of an association between these high cancer rates and the presence of flame retardant chemicals in household products and resolves to “work to ensure that the use of carcinogenic flame retardants and other toxic chemicals are eliminated and safer alternatives or methods are pursued”¹⁶² The impact of flame retardants in consumer products on firefighters’ health is reviewed in the accompanying statement from Sharyle Patton.

The fact that the smoke from flame-retardant-treated products is more toxic than the smoke from un-treated products is a factor the CPSC must consider when it evaluates the toxicity of products containing organohalogen flame retardants.

Moreover, the concern about formation of furans and dioxins from the breakdown of organohalogen flame retardants may not be limited to firefighters. At least one study has found that the presence of additive brominated flame retardants

¹⁶⁰ LeMasters, G.K.; Genaidy, A.M.; Succop, P.; Deddens, J.; Sobeih, T.; Barriera-Viruet, H.; Dunning, K.; & Lockey, J. (2006). Cancer risk among firefighters: a review and meta-analysis of 32 studies. *Journal of Occupational and Environmental Medicine*, 48(11), 1189-202. doi: 10.1097/01.jom.0000246229.68697.90.

¹⁶¹ Bates, M.N. (2007). Registry-based case-control study of cancer in California firefighters. *American Journal of Industrial Medicine*, 50(5), 339-44. doi: 10.1002/ajim.20446.

¹⁶² IAFF, Resolution No. 34, *supra* note 12.

such as decaBDE in plastic electronics casings can lead to the formation of brominated furans simply from exposure to sunlight during normal use.¹⁶³

D. Organohalogen Flame Retardants in the Four Product Categories at Issue Here Need Not Be Replaced With Other Chemical Alternatives

The fact that organohalogen flame retardants are the focus of this Petition does not mean that Petitioners endorse their replacement with halogen-free organophosphate flame retardants. Non-halogenated organophosphate flame retardants are also semi-volatile and, when used in additive form, migrate out of consumer products. They have already been detected in house dust, at levels often higher than those of PBDEs,^{164,165} as well as in sediment, sewage sludge, and wildlife.^{166,167} Several non-halogenated organophosphate flame retardants have also been detected on hand wipes rubbed on children's skin,¹⁶⁸ in human blood,¹⁶⁹ in the

¹⁶³ Kajiwara, N.; Noma, Y.; & Takigami, H. (2008). Photolysis studies of technical decabromodiphenyl ether (DecaBDE) and ethane (DeBDethane) in plastics under natural sunlight. *Environmental Science and Technology*, 42 (12), 4404-09. doi: 10.1021/es800060j.

¹⁶⁴ Van der Veen, I., & de Boer, J. (2012). Phosphorus flame retardants: Properties, production, environmental occurrence, toxicity and analysis. *Chemosphere*, 88(10), 1119-53. doi: 10.1016/j.chemosphere.2012.03.067.

¹⁶⁵ Stapleton, H.M., Detection of organophosphate flame retardants, *supra* note 89.

¹⁶⁶ Van der Veen, I., Phosphorus flame retardants, *supra* note 164.

¹⁶⁷ Sundkvist, A.M.; Olofsson, U.; & Haglund, P. (2010). Organophosphorus flame retardants and plasticizers in marine and fresh water biota and in human milk. *Journal of Environmental Monitoring*, 12(4), 943-51. doi: 10.1039/b921910b.

¹⁶⁸ Stapleton, H.M.; Misenheimer, J.; Hoffman, K.; & Webster, T.F. (2014). Flame retardant associations between children's handwipes and house dust. *Chemosphere*, 116, 54-60. doi: 10.1016/j.chemosphere.2013.12.100.

¹⁶⁹ Jonsson, O.B.; Dyremark, E.; & Nilsson, U.L. (2001). Development of a microporous membrane liquid-liquid extractor for organophosphate esters in human blood plasma: identification of triphenyl phosphate and octyl diphenyl phosphate in donor plasma. *Journal of*

urine of pregnant women,¹⁷⁰ and in breast milk.¹⁷¹ Blood levels in children tend to be higher than in their mothers who would have been in many of the same places as their children.¹⁷²

Growing evidence suggests potential health concerns from exposures to non-halogenated organophosphate flame retardants. For instance, the non-halogenated organophosphate components of Firemaster® 550 affect development and cause heart defects in zebrafish.¹⁷³ Higher dust levels of the Firemaster® 550 component triphenyl phosphate (TPHP) were associated with hormone changes and decreased sperm counts in men.¹⁷⁴ A recent study also found evidence that TPHP may act as an obesogen,¹⁷⁵ and another in vitro study found that it has the potential to disrupt metabolism and act as a cytotoxicant.¹⁷⁶ In a recent study on reporter gene assays, TPHP and tricresyl phosphate

Chromatography B: Biomedical Sciences and Applications, 755(1-2): 157-64. doi: 10.1016/S0378-4347(01)00055-X.

¹⁷⁰ Hoffman, K.; Daniels, J.L.; & Stapleton, H.M. (2014). Urinary metabolites of organophosphate flame retardants and their variability in pregnant women. *Environment International*, 63, 169-72. doi: 10.1016/j.envint.2013.11.013.

¹⁷¹ Sundkvist, A.M., Organophosphorus flame retardants and plasticizers, *supra* note 167.

¹⁷² Butt, C.M., Metabolites of organophosphate flame retardants, *supra* note 112.

¹⁷³ McGee, S.P.; Konstantinov, A.; Stapleton, H.M.; & Volz, D.C. (2013). Aryl phosphate esters within a major PentaBDE replacement product induce cardiotoxicity in developing zebrafish embryos: potential role of the aryl hydrocarbon receptor. *Toxicological Sciences*, 133(1), 144-56. doi: 10.1093/toxsci/kft020.

¹⁷⁴ Meeker, J.D., House dust concentrations of organophosphate flame retardants, *supra* note 26.

¹⁷⁵ Pillai, H.K.; Fang, M.; Beglov, D.; Kozakov, D.; Vajda, S.; Stapleton, H.M.; Webster, T.F.; & Schlezinger, J.J. (2014). Ligand binding and activation of PPAR γ by Firemaster® 550: Effects on Adipogenesis and Osteogenesis *in Vitro*. *Environmental Health Perspectives*, 122(11), 1225-32. doi: 10.1289/ehp.1408111.

¹⁷⁶ Belcher, S.M.; Cookman, C.J.; Patisaul, H.B.; & Stapleton, H.M. (2014). In vitro assessment of human nuclear hormone receptor activity and cytotoxicity of the flame retardant mixture FM

(TCP) showed estrogen receptor agonistic activity; tributyl phosphate (TBP), TPhP and TCP showed androgen receptor antagonistic activity; and TBP, tris (2-ethylhexyl) phosphate (TEHP), tris (2-butoxyethyl) phosphate (TBEP), TPhP and TCP displayed pregnane X receptor agonistic activity.¹⁷⁷ This indicates that some organophosphate flame retardants are potential endocrine disruptors.

Consumer products containing organohalogen flame retardants are the focus of this petition because these chemicals are more pervasive and well-studied. Non-halogenated organophosphate flame retardants have not been as extensively studied yet, however more research is underway. Aromatic phosphate flame retardants were nominated by the CPSC for investigation by the NTP due to their structural similarities to known toxicants and the high risk of exposure to children.¹⁷⁸ Non-halogenated aromatic phosphates are also on the Designated Chemicals list for the California Environmental Contaminant Biomonitoring Program.¹⁷⁹

550 and its triarylphosphate and brominated components. *Toxicology Letters*, 228(2), 93-102. doi: 10.1016/j.toxlet.2014.04.017.

¹⁷⁷ Kojima, H.; Takeuchi, S.; Itoh, T.; Iida, M.; Kobayashi, S.; & Yoshida, T. (2013). In vitro endocrine disruption potential of organophosphate flame retardants via human nuclear receptors. *Toxicology*, 314(1), 76-83. doi: 10.1016/j.tox.2013.09.004.

¹⁷⁸ CPSC Staff (2005). Nomination of FR chemicals for NTP testing. Retrieved March 5, 2015 from http://ntp.niehs.nih.gov/ntp/htdocs/chem_background/exsumpdf/cpscfrsnomination_supp_062_508.pdf.

¹⁷⁹ See Biomonitoring California (2014). Designated Chemicals, June 2014. Retrieved March 3, 2015 from http://biomonitoring.ca.gov/sites/default/files/downloads/DesignatedChemicalsList_June2014.pdf. California Health and Safety Code section 105440 defines “designated chemicals” as “those chemicals that are known to, or strongly suspected of, adversely impacting human health or development, based upon scientific, peer-reviewed animal, human, or in vitro studies” Cal. Health & Safety Code § 105440(b)(6).

Accordingly, we ask CPSC not to adopt any regulation that would have the effect of increasing the use of non-halogenated phosphate-based flame retardants in consumer products.

IX. We Urge CPSC to Fill the Regulatory Gap That Puts Consumers at Risk

Despite the widespread and growing recognition that use of organohalogen flame retardants in several categories of consumer products poses genuine – and avoidable – health risks, no federal regulations protect consumers from these toxic products.

Although several states prohibit the manufacture of products containing PBDEs¹⁸⁰ and the manufacture of PBDEs in the U.S. has been “voluntarily” phased out, no federal law or regulation prohibits the *use* of PBDEs in consumer products or prohibits the sale of consumer products containing PBDEs.¹⁸¹ Moreover, PBDEs are still being produced in other countries such as China, yet no federal law or regulation prohibits the import of consumer products containing PBDEs that are manufactured outside of the United States.¹⁸² Without action by the CPSC, imported chairs, sofas and

¹⁸⁰ See note 21, *supra*.

¹⁸¹ PentaBDE and octaBDE are listed as Persistent Organic Pollutants (POPs) in Annex A of the Stockholm Convention, requiring elimination of their production and use by parties to the Convention. United Nations Environment Programme. *Convention on Persistent Organic Pollutants (Stockholm Convention), as amended in 2009*. Retrieved March 9, 2015, from <http://chm.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx>. The U.S. is not a party to the Convention.

¹⁸² EPA proposed a Significant New Use Rule under the Toxic Substances Control Act for certain PBDEs, which would require notice to EPA before articles containing PBDEs could be imported.

juvenile products containing PBDEs can still be sold in this country, despite the clearly documented health risks.

Legislatures and regulatory bodies around the globe have started to restrict the use of PBDE-replacement organohalogen flame retardants in consumer products. For instance, TDCPP and TCEP are banned in children's products and/or furniture in Maryland, New York and Vermont,¹⁸³ and regulated under California's Proposition 65 as known carcinogens.¹⁸⁴ TCEP is also included on Maine's and Minnesota's lists of "Chemicals of High Concern,"^{185,186} and on Washington's list of "Chemicals of High Concern to Children."¹⁸⁷ Three flame retardant chemicals —TCEP, TCPP, and TDCPP — are banned in the European Union (EU) above trace amounts in toys intended for use by children younger than 3 years old due to the risk of adverse health effects from these

Certain Polybrominated Diphenylethers; Significant New Use Rule and Test Rule, 77 Fed. Reg. 19,862 (proposed April 2, 2012). It is unclear if the Proposed Rule will be finalized.

¹⁸³ *E.g.*, Md. Code Ann., Health-Gen. § 24-306 (banning TCEP and TDCPP in child care products); N.Y. Env'tl. Conserv. Law § 37-0701, et seq. (banning TCEP and TDCPP in child care products); Vt. Stat. Ann. tit. 9, § 2974 (banning TCEP and TDCPP in residential upholstered furniture and children's products); see generally Safer States Bill Tracker, available at: <http://www.saferstates.com/bill-tracker/>.

¹⁸⁴ OEHHA, *Chemicals Known to the State to Cause Cancer or Reproductive Toxicity*, supra note 25.

¹⁸⁵ Maine Department of Environmental Protection. *Chemicals of High Concern*. Retrieved March 3, 2015, from <http://www.maine.gov/dep/safechem/highconcern/>.

¹⁸⁶ Minnesota Department of Health (2013). *Toxic Free Kids Act: Chemicals of High Concern*. Retrieved March 4, 2015, from <http://www.health.state.mn.us/divs/eh/hazardous/topics/toxfreekids/highconcern.html>.

¹⁸⁷ Department of Ecology, State of Washington. *Children's Safe Products Act: The Reporting List of Chemicals of High Concern to Children (CHCC)*. Retrieved March 4, 2015, from <http://www.ecy.wa.gov/programs/swfa/cspa/chcc.html>.

chemicals.¹⁸⁸ However, no federal law or regulation prevents the sale of consumer products containing any organohalogen flame retardant or prevents the use of any of these chemicals in any consumer products sold nationally, and there is overwhelming evidence that their use is pervasive.¹⁸⁹

To protect human health from the prenatal stage forward, we urge CPSC to regulate the four product categories described in this petition when they contain *any* organohalogen flame retardant – just as it broadly regulates small parts in toys and, as Commissioner Moore suggested, it should regulate all chemical drain openers.

X. Labeling Will Not Protect Human Health

The FHSA empowers the CPSC to ban “hazardous substances” in products if “notwithstanding [any] cautionary labeling . . . the degree or nature of the hazard involved in the presence or use of such substance in households is such that the objective of the protection of the public health and safety can be adequately served only by keeping such substance, when ... intended or packaged [for use in the household], out of the channels of interstate commerce.” In this circumstance, the

¹⁸⁸ European Commission Directive D029354/03, amending Appendix C of Annex II to Directive 2009/48/EC of the European Parliament and of the Council on the safety of toys, as regards TCEP, TCPP and TDCP. Retrieved March 4, 2015, from <http://ec.europa.eu/transparency/regcomitology/index.cfm?do=Search.getPDF&zEhJKHDIw8RP6FEoZ1GKtqDbby3gYP7DoFPCzj0pZY65SVAw47eF02NzJLXFBE77kGvLzo2Pu5uyjPyPEOHGhn1Yyu8a5hceFqN5ixnqYI=>.

¹⁸⁹ See Section VI, *infra*.

CPSC may declare the substance to be a “banned hazardous substance.”¹⁹⁰ Children’s products containing “hazardous substances” are automatically “banned hazardous substances,” irrespective of labeling.¹⁹¹

The consumer products at issue in this Petition meet the definition of “banned hazardous substances” when they contain any chemical in the organohalogen flame retardant class because labeling is not an adequate means of protecting public health. The knowledge that toxic chemicals migrate out of furniture, juvenile products, mattresses, mattress pads, and the casings of electronics and attach to house dust does not enable consumers to take protective action. The CPSC should not assume that consumers can vacuum and wipe up all of the dust contaminated with organohalogen flame retardants that is present in the average U.S. household. The only way to protect consumers from the genuine risks posed by these hazardous substances is to declare all products in the four specified categories to be “banned hazardous substances” if they contain any chemical in the organohalogen flame retardant class.

¹⁹⁰ 15 U.S.C. § 1261(q)(1)(B). The CPSC has promulgated regulations finding a variety of chemical substances to be “banned hazardous substances” under the FHSA, including: mixtures that are intended for application to interior masonry walls as a water repellant treatment and that are “extremely flammable”; carbon tetrachloride and mixtures containing it; liquid drain cleaners containing 10 percent or more by weight of sodium and/or potassium hydroxide; products containing soluble cyanide salts; and paint containing lead over a certain level. 16 C.F.R. § 1500.17.

¹⁹¹ 15 U.S.C. § 1261(q)(1)(A).

XI. Conclusion

Given the evidence that organohalogen flame retardants migrate from consumer products by virtue of their semi-volatile state and are absorbed by humans, and that these foreseeable exposures – especially during the earliest stages of human life – are associated with serious adverse health impacts, we petition the CPSC to regulate the four consumer product categories discussed above if they contain any chemical in the additive organohalogen flame retardant class.

Dated: June 30, 2015

Respectfully submitted,

Eve C. Gartner, Earthjustice
Rachel Weintraub, Consumer Federation of America

On behalf of

American Academy of Pediatrics
American Medical Women's Association
Consumer Federation of America
Consumers Union
Green Science Policy Institute
International Association of Fire Fighters
Kids in Danger
Philip J. Landrigan, M.D., M.P.H.
League of United Latin American Citizens
Learning Disabilities Association of American
National Hispanic Medical Association
Worksafe

FLAME RETARDANTS REFERENCED IN THIS PETITION

<i>Chemical</i>	<i>Abbreviation</i>
1,2-bis (2,4,6,-tribromophenoxy) ethane	BTBPE
2,2',4,4',5,5'-hexabromobiphenyl (Firemaster® BP-6)	BB 153
2,2-bis (bromomethyl) 1,3-propanediol	DBNPG
2,3,4,5-tetrabromobenzoic acid	TBBA
2-ethylhexyl 2,3,4,5-tetrabromobenzoate	TBB
Bis (2-ethylhexyl) 3,4,5,6-tetrabromophthalate.....	TBPH
Decabromodiphenyl ethane	DBDPE
Decabromodiphenyl ether.....	decaBDE
Di(2-ethylhexyl) phthalate	DEHP
Hexabromocyclododecane	HBCD
Octabromodiphenyl ether	octaBDE
Pentabromodiphenyl ether	pentaBDE
Polybrominated diphenyl ether.....	PBDE
Tetrabromobisphenol A.....	TBBPA
Tetrabromobisphenol A-bis (2,3-dibromopropylether)	TBBPA-BDBPE
Tetrabromoethylcyclohexane.....	TBECH
Tributyl phosphate.....	TBP
Tricrecyl phosphate.....	TCP
Triphenyl phosphate	TPhP
Tris (1-chloro-2propyl) phosphate	T CPP
Tris (1,3-dichloro-2-propyl) phosphate ("chlorinated tris")	TDCPP
Tris (2-butoxyethyl) phosphate.....	TBEP
Tris (2-chloroethyl) phosphate	TCEP
Tris (2-ethylhexyl) phosphate	TEHP
Tris (2,3-dibromopropyl) phosphate	TDBPP

Statements in Support of Petition for Rulemaking

Statement	Exhibit (w/ Hyperlink)
Statement of Terrence J. Collins	Exhibit A
Statement of Miriam L. Diamond	Exhibit B
Statement of David A. Eastmond.....	Exhibit C
Statement of David Epel	Exhibit D
Statement of Rolf Halden.....	Exhibit E
Statement of Kim Harley.....	Exhibit F
Statement of Julie Herbstman	Exhibit G
Statement of Susan Kasper	Exhibit H
Statement of Donald Lucas.....	Exhibit I
Statement of Sharyle Patton.....	Exhibit J
Statement of Ruthann Rudel	Exhibit K
Statement of Ted Schettler	Exhibit L
Statement of Roland Weber	Exhibit M

Exhibit A

Statement of Terrence J. Collins



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September 12, 2013

I, the undersigned, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, Terrence James Collins, am the Teresa Heinz Professor of Green Chemistry in the Department of Chemistry, and the Director of the Institute for Green Science at the Carnegie Mellon University.

My collaboration with environmental health scientists (EHS) has focused on developing appropriate tests to identify chemical properties that give rise to adverse human health effects at low doses through endocrine disruption. Our work has aimed to underpin the development of safe chemicals in general, including safe alternatives to organohalogen chemicals. I have attached a copy of my curriculum vitae and a list of my publications.

In a privately funded collaborative effort spanning five years, my EHS colleagues and I produced and published the Tiered Protocol for Endocrine Disruption (TiPED). This allows green chemists, for the first time, to design with state of the art scientific authority against endocrine disruptors. I am best known for inventing the first small molecule mimics of any of the great families of oxidizing enzymes. My TAML[®] activators are extensively patented and have been commercialized so I am a friend to the commercial development of chemicals. TAML[®] activators were TiPED tested in design to ensure no new endocrine disruptor would be commercially produced and those in development have passed all assays as not being endocrine active thus far.

2. Organohalogens used as flame retardants as a class have specific chemical properties that give them a high potential for causing adverse human health effects via multiple mechanisms. Organohalogens tend to bioaccumulate in human and animal tissues. This occurs because halogens, particularly bromine and chlorine, which are broadly used in flame retardants, often cause the organic chemicals to which they are attached to partition from environmental media (particularly water) into living tissues, where they bioaccumulate. This bioaccumulation is driven by the differential solubility of chemicals in fats, oils, lipids (such as what cell walls are made of) and other similar solvents compared with water and aqueous-like media. As organohalogens tend to be more lipophilic (fat-loving) than their non-halogenated analogues, they will bioaccumulate more readily.

3. Depending on the structure of the organic parent compound, the addition of halogen elements can either increase or decrease the compound's reactivity. Either change can impact the compound's toxicological profile leading to an increased risk of adverse health effects in humans. For alkylorganohalogens (such as most chlorinated organophosphate flame retardants), halogens tend to increase reactivity toward the chemical modification of key biomolecules, including DNA and the histone proteins around which DNA is wrapped. These modifications are likely to interfere with gene expression and to increase the likelihood of cancer. For

arylhydrocarbons (carbon ring-like structures with halogens appended, such as most brominated flame retardants), halogens tend to decrease reactivity, impeding the cell's ability to enzymatically break down the arylhydrocarbons thus increasing their lifetime in the cell.

4. Some organohalogen flame retardants are known to be potent endocrine disruptors, so their bioaccumulation leads to additional likelihood of harm to organisms via developmental damage associated with disruption of the endocrine hormone control of cellular development. Arylhydrocarbon organohalogens can mimic natural hormones that at very low concentrations regulate expression of proteins involved in cellular development. This developmental disruption, which appears to occur via disruption of hormone action, is a major cause of human health harm. The adverse health effects are often manifested at very low concentrations (in the range to which people are exposed) and can disrupt development starting *in utero*. Endocrine disruptors can activate gene expression resulting in abnormally high protein production (agonist), or suppress gene expression resulting in abnormal protein deprivation (antagonist). This disruption of the normal expression of control proteins can lead to cells that do not develop and multiply, are less healthy, have altered fates, and are more likely to develop cancer later in the life of the organism. This is one mechanism by which arylhydrocarbon organohalogens such as dioxins function to produce birth defects and cancer. In my professional opinion, such adverse effects should also be anticipated for arylhydrocarbon organohalogen flame retardants.

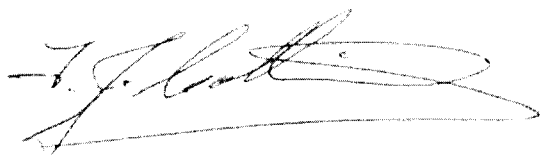
5. Organohalogen flame retardants can also disrupt DNA function. Arylhydrocarbon organohalogen flame retardants share chemical similarities with compounds that are known to stick to DNA by inserting into the DNA base pair structures. This intercalation can alter the normal function of DNA and can serve as a mechanism for initiating carcinogenesis.

6. When they burn, organohalogen flame retardants produce halogenated dioxins and furans, which are extremely persistent and extremely toxic to humans. This fundamental and thus far inescapable factor in the full life cycle of the entire class of organohalogen flame retardants is a large cause of harm to human health currently and out into the distant future.

7. To summarize, organohalogen flame retardants have highly persistent and toxic combustion by-products, readily bioaccumulate and can resist breakdown inside cells, can modify the DNA or disrupt its function, and can act as endocrine disruptors. To the best of my knowledge, there is no sound evidence showing a lack of health harm for any organohalogen flame retardants studied to date.

8. Based on the above arguments, I would urge the Consumer Product Safety Commission to regulate the use in consumer products of the entire class of non-polymeric additive organohalogen flame retardant chemicals.

Yours sincerely,

A handwritten signature in black ink, appearing to read "T. J. L. L. L.", with a long horizontal flourish extending to the right.

Biographical Sketch of Terrence J. Collins

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EDUCATION

University of Auckland, New Zealand

Bachelor of Science—1974

Master of Science with First Class Honors—1975

Doctor of Philosophy—1978

Advisor: Professor Warren R. Roper, FRS

Ph.D. Thesis: Thiocarbonyl Complexes of Ruthenium and Osmium.

Stanford University

Postdoctoral, with Professor James P. Collman—1978–1980

PROFESSIONAL EXPERIENCE

Carnegie Mellon University

Teresa Heinz Professor of Green Chemistry, 2010–present

Director, Institute for Green Science, 2008–present

Thomas Lord Professor of Chemistry, 2001–2010

Director, Institute for Green Oxidation Chemistry, 2001–2007

Professor of Chemistry, 1993–2001

Associate Professor of Chemistry, 1988–1992

California Institute of Technology

Assistant Professor of Chemistry, 1981–1987

Auckland Technical Institute

Lecturer (part-time), 1974–1977

PRIZES, AWARDS AND DISTINCTIONS

2013 – Fellow of the American Chemical Society

2011 – Chairman, Science Advisory Council, The Heinz Center

2011 – Trustee, The Heinz Center, Washington, DC (6-yr appointment)

2010 – Heinz Award for the Environment

2008 – Honorary Fellow of the Royal Society of New Zealand

2008 – Charles E. Kaufman Award of the Pittsburgh Foundation

2007 – Award of the New York Metropolitan Catalysis Society

2007 – Distinguished Alumnus Award, University of Auckland, New Zealand

2006 – Fellow of the International Union of Pure and Applied Chemists

2004 – Pittsburgh Award of the American Chemical Society

2004 – Award of the Baylor University ACS Students Affiliates for Outstanding Achievements in Green chemistry

2002 – Golden Goggles Award, Middle Tennessee State University

2001 – Honorary Professor, University of Auckland, 2001–present

1999 – Presidential Green Chemistry Challenge Award (1998)

1998 – Award of the Japanese Society of Pure and Applied Coordination Chemistry (1997) for leadership research in green chemistry.

1998 – Visiting Professor, Graduate School of Science, Osaka-City University

1996 – Distinguished Visiting Professor, University of Auckland

1986 – Alfred P. Sloan Research Fellow to 1988

1985 – Camille and Henry Dreyfus Teacher-Scholar to 1990

1982 – Occidental Research Corporation (Junior Faculty Award)

1977 – Lindsay Heathcote Briggs Memorial Prize (Best Ph.D. Thesis in Chemistry)

1975 – Postgraduate Scholarship in Chemistry

1973 – Senior Prize in Chemistry

RESEARCH INTERESTS

- Green chemistry
- Inorganic chemistry
- Homogeneous oxidation catalysis
- Design of green oxidants
- Alternative chemistry for oxidation processes that produce persistent pollutants
- Removing endocrine disrupting chemicals from technology
- Bioinorganic chemistry of high oxidation state transition metal species
- Toxicity and ecotoxicity of chemical processes and products
- Preparation of multinuclear transition metal ions with predetermined magnetic exchange coupling properties

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145. Collins, T. J., W. R. Roper, Neutral and cationic dithiocarbonyl complexes of osmium(II), *J. Organometal. Chem.* **1977**, *139*, C9.
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148. Collins, T. J., K. R. Grundy, W. R. Roper, and S. F. Wong, Cyclic transition metal carbene complexes from ring-closing reactions on the π -bound substrates CS_2 and CSe_2 1,3-dithiolan-2-ylidene and 1,3-diselenolan-2-ylidene complexes of ruthenium(II) and osmium(II), *J. Organometal. Chem.*, **1976**, *107*, C37.
149. Collins, T. J., W. R. Roper, Thioformyl and formyl complexes of osmium(II), *J. Chem. Soc., Chem. Comm.* **1976**, 1044.
150. T. J. Collins, W. R. Roper, K. G. Town, Synthesis of low-valent thiocarbonyl complexes via 1,2-elimination of methylthiol from cis-metal-hydridodithiomethyl-ester complexes. $\text{Os}(\text{CS})(\text{CO})_2(\text{PPh}_3)_2$ and $\text{IrCl}(\text{CS})(\text{PPh}_3)_2$, *J. Organometal. Chem.* **1976**, *121*, C41.
151. Clark, G. R., T. J. Collins, S. M. James, W. R. Roper, K. G. Town, Triphenyl phosphoniodithiocarboxylato-SS'-carbonylbis(triphenylphosphine)iridium(I) tetra-fluoro borate: X-ray structure of an apparent π -CS₂ complex of iridium, *J. Chem. Soc., Chem. Comm.* **1976**, 47.

Educational Leadership

- Creator of first university course in green chemistry: Introduction to Green Chemistry, 1992—first by many years.
- Founder and principal lecturer in free web course on green chemistry: Introduction to Green Chemistry, see: <http://igs.chem.cmu.edu/> About 10% of the total envisioned course had been produced and uploaded by March 2012.

Introduction to Green Chemistry

Course Overview: Over the past 150 years the field of chemistry has fostered almost no formal training in toxicity or ecotoxicity. We continue to train chemists to create new products and processes, but not educate them to be aware of the need to protect themselves, other people or the ecosphere from the results of their hard work. Green chemistry offers an alternative. The field was best defined by Paul Anastas in the 1990s as "the design of chemical products and processes that reduce or eliminate the use and generation of hazardous compounds." Stated broadly, this course helps students understand the notion of sustainability and how it applies to chemistry. It also explores the history of chemistry, outlines critical need for green chemistry, and the holistic principles that guide its practice as an emerging and important field of science.

Conference Best Papers/Posters

- Gupta, S. S., D. Lenoir, T. J. Collins, Rapid Destruction of Chlorophenols by Activated Hydrogen Peroxide in Presence of TAML Catalysts, IPOC 16, 16th International Conference on Physical Organic Chemistry, August 4–9, **2002**, San Diego, CA – Best Poster Award.
- Hangun-Balkir, Y., L. Alexandrova, S. K. Khetan, C. Horwitz, A. Cugini, D. D. Link, B. Howard, T. J. Collins, Oxidative desulfurization of fuels through TAML® activators and hydrogen peroxide, Pittsburgh-Cleveland Catalysis Society Meeting, Fortieth Annual Spring Symposium, May 10, **2002**, Pittsburgh PA – Best Paper Award.
- Wingate, K. G., M. J. Robinson, T. R. Stuthridge, T. J. Collins, L. J. Wright, Color and AOX Removal from Bleached Kraft Mill Wastewaters Using Catalytic Peroxide Activators, TAPPI International Environmental Conference, April 7-10, **2001**, Montreal, Canada - Best Paper from Water Quality Category.

SYMPOSIA ORGANIZED

- Member of International Advisory Board, Materials and technologies for green chemistry" in Tallinn, Estonia, September 5-9, 2011
- International Conference on Environment 2010, Green Technologies for Benefit of Bottom Billions, Penang, Malaysia, December 13–15, 2010
- Member of International Advisory Board, International Union of Pure And Applied Chemistry Conference 2010—Chemistry for Sustainable Development, Mauritius, July 26–30, 2010
- Member of International Advisory Board. Third International Conference on Green & Sustainable Chemistry, Delft, The Netherlands, July 1-5, 2007
- Advisory Board, Green Chemistry and Engineering Conference, Washington DC, 2005
- Member of International Advisory Board. Canada-US Joint Workshop on Innovative Chemistry in Clean Media, May 20-21, 2004
- Co-Chair, Green Chemistry and Engineering Conference, Washington DC, 2004
- Member of International Advisory Board. First International Conference on Green & Sustainable Chemistry, Tokyo March 13-15, 2003
- Co-Chair, Green Chemistry and Engineering Conference, Washington DC, 2003
- Member, National Advisory Board for the International Conference on Macrocyclic Chemistry, Lawrence, Kansas, scheduled for June 1994
- Chairman, 1986 Industrial Associates Conference on Oxidation Chemistry, Caltech, February 25–27, 1986.
- 1984 International Chemical Congress of Pacific Basin Societies, Symposium Organizer with Eiichi Kimura and Chris Reed of the Symposium on "New Developments in Coordination Chemistry: Oxygen and Oxidation", Honolulu, Hawaii, December 16 – 21, 1984

- Member, International Advisory Board and Report Editor, the International Workshop on “Activation of Dioxygen Species and Homogeneous Catalytic Oxidations”, Galzignano (Padova) Italy, June 28-29, 1984.

OTHER PROFESSIONAL ACTIVITIES (FROM 1998 ON) *selected examples*

- Interviewed by David Lemberg for “Science and Society”, June 21, 2007. Podcast available at <http://www.scienceandsociety.net/audio/collins.mp3>
- Lecture, “Green Chemistry; Sustaining a High Technology Civilization”, Environmental Health Lecture Series, Town Hall, Seattle, WA, January 24, 2007, broadcasted on NPR.
- Interviewed by Diane Horn (Producer and Host) of National Public Radio affiliate NEXP, Seattle for program “Mind Over Matters”
- Creating a New Chemistry, Air date: Week of 04/18/2007, Story length: 7:17, Producer: Reid R. Frazier, The Allegheny Front: environmental radio for Western PA
- Interviewed by Sarah Bennett of the Listener leading to the article, “Toxic Inheritance,” May 5– 11, 2007.
- Interviewed by Kim Hill for Radio New Zealand on Green Chemistry (37 minutes), Broadcast February 24, 2007
- Interviewed and profiled for the website of the Collaborative on Health and the Environment, 2006, <http://www.healthandenvironment.org/articles/homepage/614>
- Greening on Chemical World, December 13, 2006, Jennifer McGuiggan on GC and the Institute for Green Oxidation Chemistry, <http://www.popcitymedia.com/features/41greenchem.aspx>
- American Associate Editor of the Royal Society Journal, *Green Chemistry*—2001-2004.
- Member of Editorial Advisory Board of C&E News—2003-2005.
- Support of GC development for society in general and for less advantages states: Member of ACS Environmental Affairs Committee, Consultant to EPSCOR States on how to develop viable centers in green chemistry research, convener of International Conference on GC, Mumbai January, 2004.
- Brief to the National Academy of Sciences Committee investigating technologies for killing anthrax on letter supporting machines at Army facilities, November 2003.
- Member of the Advisory Group, National Academy of Sciences Roundtable on *Science and Technology in Support of a Transition Toward Sustainability*, March 2003.
- Instructor on the DVD of the ACS and Green Chemistry Institute “Green Chemistry: Meeting Global Challenges”, 2003.
- PI on grant from ACS-PRF that brought 22 winners of the Presidential Green Chemistry Challenge Award to Congress to meet with legislators and explain the progress and potential of green chemistry. Participated in what were regarded as highly successful meetings with three other Pennsylvania winners personally Senators Santorum and Specter and Congressmen, Doyle and Murphy, explaining the promise of Green Chemistry, November 28-29, 2003.
- Member, ACS Committee on Environmental Improvement, 2002 –, Associate Member, ACS Committee on Environmental Improvement, 1999 – 2001
- Featured on video of the ACS and the EPA, “Green chemistry: Innovations for a Cleaner World”.
- Quoted widely on the eight-hour 2002 TV component of the multimedia workshop for teacher professional development, “Reactions in Chemistry”, funded by CPB and the Annenberg Foundation.
- National Public Radio Interview with Ira Flatow
<<http://www.npr.org/rundowns/segment.php?wfld=1447823>>
- Integration and Transfer of Knowledge: Since 1998, delivered 145 lectures (>20 international conference plenary lectures and named lectures) outside Carnegie Mellon University on Green Chemistry as a field and the Collins Group research program, including >40 to the general public (279 outside lectures throughout career).
- Consultant for the Green Chemistry Gordon Conferences
- Member of the DOE panel to advise the government on how to spend ca. \$10 M per year for the funding of green chemistry.
- Member of the IUPAC Working Party on Green Chemistry. International consultant helping to script the workshop report for the Organization for Economic Cooperation and Development. Member of writers and coordinators for IUPAC white paper on Green Chemistry.
- United States Representative to the Organization for Economic Cooperation and Development Workshop on the Funding of Sustainable Chemistry, Tokyo, October 2000
- Member of International Advisory Committee for Japanese Green Chemistry Symposia Series.
- Published first definition of Green Chemistry - ‘Green Chemistry’, Collins, T. J. *Macmillan Encyclopedia of*

Chemistry, Volume 2, Simon and Schuster Macmillan, New York, 1997, 691-697.

- Published one of first educational articles in GC, “Introducing Green Chemistry in Teaching and Research”, T. J. Collins, *J. Chem. Ed.*, 1995, 72, 965–966.
- Participant at many national and international meetings designed to further green chemistry education as noted above.
- Developed first university course on Green Chemistry (taught since 1992).
- Member ACS, Royal Society of Chemistry, Royal Society of NZ, Technical Association of the Pulp and Paper Industry.
- Many interviews and expert opinions expressed in books, magazines and newspapers.

Video Presentations

- Professor Collins course “Introduction to Green Chemistry” is being developed for world-wide distribution—see <http://igs.chem.cmu.edu/> for a demo that shows the general idea—the final site will be approximately 10 times bigger and will include further world leading scholars as teachers for the different areas.
- The Collins Group Presidential Green Chemistry Challenge Award was featured on the ACS video: “Green Chemistry: Innovations for a Cleaner World”
- Professor Collins makes multiple appearances discussing green chemistry and sustainability science on an 8-hour educational series produced by Sally Heldrick under funding from the Annenberg Foundation and the Corporation for Public Broadcasting called “Reactions in Chemistry”, a Professional Development series for High School Teachers— <http://www.learner.org/channel/workshops/chemistry/>
- Professor Collins videotaped an online instruction course in green chemistry (July 23, 2004): <http://mts.sustainableproducts.com/modules/greenchem.html>

INVITED LECTURES, COLLOQUIA AND WEBINARS (in Reverse Chronological Order)

1. July 21, 2014,
2. July 9, 2014,
3. July 8, 2014,
4. July 8, 2014,
5. June 30, 2014,
6. May 21, 2014, Building the Chemical Dimension of a Sustainable Civilization Part II: How should university chemists train the sustainability leaders of the future, Great Lakes Green Chemistry Network and Michigan Green Chemistry Clearinghouse Webinar.
7. February 21, 2014, On “Introduction to Green Chemistry” at Carnegie Mellon University, The University Masters in Sustainability, Brunel University, Uxbridge, UK
8. February 20, 2014, Building the Chemical Dimension of a Sustainable Civilization: the compass and the code, Brunel University, Uxbridge, UK
9. November 25, 2013, Building the Chemical Dimension of a Sustainable Civilization, 1-hr Presentation to 180 H&SS students in Nico Slate Class on Innovation and Social Change, Carnegie Mellon University, Pittsburgh PA
10. November 18, 2013, TAML Activators: high performance peroxidase mimics for rapidly removing chemical (especially endocrine disruptors) and biological contaminants from water, EcoChem Conference, Basel, Switzerland
11. November 13, 2013, Building the Chemical Dimension of a Sustainable Civilization, 1-hr Presentation to freshman chemistry students in Newell Washburn’s Honors Chemistry Class, Carnegie Mellon University, Pittsburgh PA
12. November 6, 2013, Building the Chemical Dimension of a Sustainable Civilization, 2-hr Presentation to Architecture Students in Hartkopf Class, Carnegie Mellon University, Pittsburgh PA
13. November 3, 2013, **STUDENT SEMESTER INVITED LECTURE**, TAML* Activators: design, mechanisms of action and applications of the first full functional, small molecule peroxidase mimics, Chemical Engineering Department, Stanford University, Stanford, CA
14. November 3, 2013, **STUDENT LUNCHTIME PRESENTATION/DISCUSSION**, Building the Chemical Dimension of a Sustainable Civilization, Stanford University, Stanford, CA
15. October 24, 2013, The Design of Green Oxidation Catalysts for Environmental Solutions, **KEYNOTE LECTURE**, Michigan Green Chemistry & Engineering Conference Grand Rapids, MI
16. October 24, 2013, Building the chemical dimension of a sustainable civilization: reorienting the compass, resetting the thinking, Panel Presentation, Michigan Green Chemistry & Engineering Conference, Grand Rapids MI
17. October 15, 2013 Building the Chemical Dimension of a Sustainable Civilization, A 2-hour lecture to ca. 600 students, Central Catholic High School, Pittsburgh PA
18. October 3, 2013, TAML Activators: full functional peroxidase mimics for DoD projects, The Chemical and Biological

19. Defense Program's 2013 Enzyme Colloquium and Program Review, CSC Fairview Park Facility, Falls Church, VA. September 25, 2013, Building the Chemical Dimension of a Sustainable Civilization, II International Congress of Green Chemistry and Engineering, Monterrey, Mexico, 9/25/2013
20. August 20, 2013, High Performance Peroxidase Mimics for Rapidly Removing Chemical and Biological Threats from Water, International Seminars on Planetary Emergencies and Associated Meetings – 46th Session, Erice, Sicily.
21. June 20, 2013, Testing the tiered protocol for endocrine disruption (TiPED) with TAML activators, ACS Green Chemistry and Engineering Conference, The Bethesda North Marriott Hotel and Conference Center, Bethesda, MD
22. April 7, 2013, Two Approaches for Designing Against Endocrine Disruptors, ACS National Conference. Division of Organic Chemistry SESSION: Advances in Green Chemistry
23. March 21, 2013. TAML[®] Activators: design, mechanisms of action and applications of small molecule H₂O₂-activating catalyst, Chemistry Department Seminar, Carnegie Mellon University, Pittsburgh PA
24. February 27, 2013. TAML[®] Activators: design, mechanisms of action and applications of small molecule H₂O₂-activating catalysts, Harvard-MIT Inorganic Colloquium, MIT, Boston, MA
25. February 12, 2013. A Code of Sustainability Ethics, Evening Public Lecture, Environmental Research Center, University of West Virginia, Morgantown, WV
26. January 10, 2013. Two approaches for designing as green chemists against endocrine disruptors, QAFCO-TAMUQ CHEMISTRY CONFERENCE 2013, GREEN CHEMISTRY AND GREEN ENGINEERING, Texas A&M University at Qatar, Doha, Qatar
27. December 11, 2012, Setting the Stage: The Frontier of Toxicology and Molecular Design, Toxicology and Sustainable Molecular Design Conference University of Connecticut, Storrs, CT
28. November 19, 2012, Little Green Solutions to Pharmaceutical Pollution, delivered for me in combination with Susan Jobling, European Environment Agency European and the Center for Environment & Human Health (U. Exeter) Workshop on Strategies to Reduce Emissions of Pharmaceuticals and Metabolites to the Environment, Newquay, Cornwall.
29. November 13, 2012, Intellectual and practical challenges of building a sustainable marketplace, **KEYNOTE LECTURE**, Catching the Wave - Green Chemistry and Economic Development in the Great Lakes Region, Hyatt Regency, Chicago IL
30. November 8, 2012, Sustainability, Central Catholic High School, Pittsburgh, PA—90 minute lecture to ca. 350 students.
31. October 26, 2012, Honoring the Vision of Rachel Carson: On Behalf of the American Chemical Society, 6th Rachel Carson Legacy Conference, *Our Planet and Our Health*, Chatham University, Pittsburgh PA
32. October 25, 2012, On The Health and Global Environmental Consequences of Fracking the Marcellus Shale, Pittsburgh Filmmakers Melwood Screening Room, Pittsburgh, PA
33. October 4, 2012, Sustainability is the Premier Chemical Technology Challenge of the 21st Century, **PLENARY LECTURE**, Holiday Inn, Moon PA
34. September 13, 2012, Successful Degradation of 17 α -Ethinylestradiol and other Pharmaceutical Contaminants with Fe-TAML/H₂O₂, Terrence J. Collins*, Susan Jobling, Karla I. Arias Salazar, Matthew R. Mills, Alice Baynes, Nicola Beresford, Jonathan Porras, **POSTER PRESENTATION**, Low Dose Effects and Non-Monotonic Dose Responses for Endocrine Active Chemicals: Science to Practice, Benjamin Franklin Campus Charité-Universitätsmedizin, Berlin
35. June 18, 2012, What/How should Green Chemists Teach in Toxicity and Ecotoxicity?—Integrating fields to teach sustainability. Symposium on Green Chemistry Education: Teaching Toxicology and Molecular Design, Washington Marriott Wardman, Washington, DC
36. June 12, 2012, Energy and Sustainability, Health Care Without Harm— Symposium on Climate Change and Health, Mellon Institute Auditorium, Carnegie Mellon University, Pittsburgh, PA
37. June 6, 2012, What/How should Green Chemists Teach in Toxicity and Ecotoxicity? Integrating fields to teach sustainability. Symposium on Green Chemistry Education: Teaching Toxicology and Molecular Design, Washington Marriott Wardman
38. May 11, 2012, TAML Activators: purifying water of endocrine disruptors in a new (more cost-effective?) way, UKWIR (UK Water Industry Research), Queen Anne's Gate, London, England
39. May 10, 2012, TAML Activators: purifying water of endocrine disruptors in a new (more cost-effective?) way, Safeguarding Spring Symposium - Brunel University's Institute for the Environment Queen's Anniversary Prize Award Celebration, Brunel University, Uxbridge England
40. April 24, 2012, Green Chemistry: sustaining a high technology civilization, Pittsburgh Chemist's Club and Pittsburgh Environmental Working Group of the American Chemical Society, Spaghetti Warehouse, Pittsburgh, PA
41. April 6, 2012, Green Chemistry: setting the compass toward a sustainable future, Slippery Rock University, Slippery Rock, PA
42. March 26, 2012, TAML[®] Activators: mechanisms of action and applications, Symposium on Sustainable Inorganic Chemistry, ACS National Meeting, San Diego, CA
43. March 4, 2012, Green Chemistry: setting the compass toward a sustainable future, Wallace Stegner Center, S.J. Quinney College of Law University of Utah, Salt Lake City, UT
44. February 27, 2012, Green Chemistry and Sustainability, Carlow University, Pittsburgh PA
45. February 1, 2012, Green Chemistry: sustaining a high technology civilization, **THE SECOND HORIZONS@HEINZ ENVIRONMENTAL SALON**, The University Club, Washington, DC

46. December 12, 2011, TAML Activators: Design, mechanisms of action and applications of the first effective peroxidase mimics—cleaning water of chemical contaminants as nature would do it, Brunel University, Uxbridge, England
47. November 19, 2011, Compass, TEDx Pittsburgh, Nemacolin PA
48. November 8, 2011, The challenge of developmental disruptors for the chemical enterprise, University of Strasbourg, Strasbourg, France
49. November 8, 2011, Sustainability for Chemists: what does it mean? University of Strasbourg, Strasbourg, France
50. November 2, 2011, TAML Activators: Design, mechanisms of action and applications of the first effective peroxidase mimics—cleaning water of chemical contaminants as nature would do it, University of Strasbourg, Strasbourg, France
51. October 7, 2011, Green Science: on the responsibility of chemists to advance science with human health and the environment in mind Mid-Atlantic Association of Liberal Arts Chemistry Teachers Conference, **KEYNOTE**, Hamilton College, Clinton NY
52. September 22, 2011 Oxidizing organic chemicals with TAML catalysts and hydrogen peroxide: design, mechanisms of action and applications of faithful peroxidase mimics, **PLENARY**, Butlerov Congress—Kazan, Tatarstan, Russia
53. September 16, 2011, Green Chemistry: building a chemical economy that works for sustainability, Sustainable Chemistry Summit: from lab to market, **PLENARY**, Kingston, Ontario, Canada
54. August 29, 2011, Integrating Green Chemistry into the Wider Context of Sustainability Creating Innovation by Collaboration in Green Chemistry Among Industry, University Centers and Students, ACS Meeting—Denver
55. August 18, 2011, New green approaches to disinfection and water purification: or the future leaders who did the work. Green Chemistry Leadership Summit—Green Technologies for Developing Nations Workshop, Montego Bay, Jamaica,
56. June 9, 2011, Green Chemistry: what is it?, Presentation to Trustees and Staff of the Heinz Center, Washington, DC
57. May 4, 2011, The Design of TAML[®] Activators: effective small molecule mimics of the peroxidase enzymes, Blekinge Technical Institute, Sustainability Studies Group, Karlskrona, Sweden
58. May 4, 2011, Green Chemistry: on the responsibility of chemists to advance science with human health and the environment clearly in mind, Blekinge Technical Institute, to the Sustainability Studies students, Karlskrona, Sweden
59. April 8, 2011, Green Chemistry: on the responsibility of chemists to advance science with human health and the environment clearly in mind, **CRUM LECTURE: UNIVERSITY CONVOCATION ADDRESS**, Gordon College, Wenham, MA
60. April 7, 2011, The Design of TAML[®] Activators: effective small molecule mimics of the peroxidase enzymes, to the Science Students of Gordon College and environs, Wenham, Ma
61. March 24, 2011, TAML[®] Activators: design, mechanisms of action and applications of Effective peroxidase mimics, **DISTINGUISHED SCIENTIST SEMINAR**, Scripps Institute, March 22, 2011, La Jolla, CA
62. March 21, 2011, Why we need systematic, evolving methodology for assaying endocrine disruption properties to build a meaningful field of Green Chemistry, **OPENING ADDRESS**, Symposium on Linking Green Chemistry and Environmental Health Sciences, Cavallo Point, CA
63. December 7, 2010, Green Chemistry: sustaining a high technology civilization, Central Catholic High School, Pittsburgh, PA
64. December 2, 2010, Green Chemistry as a Strategy for Reducing Hazardous Chemicals in the Environment, Department of Environmental Medicine, University of Rochester Medical Center, Rochester, NY
65. December 1, 2010, Green Chemistry: sustaining a high technology civilization, Rochester Institute of Technology, Rochester, NY
66. November 4, 2010, Green Chemistry: sustaining a high technology civilization, **UNIVERSITY CONVOCATION**, Ohio Wesleyan University, Lecture to Science Faculty and Students, Delaware Ohio.
67. November 4, 2010, Green Chemistry: making water safer, Ohio Wesleyan University, Lecture to Science Faculty and Students, Delaware Ohio.
68. October 14, 2010, TAML Activators as Mimics of Peroxidase Enzymes: design, mechanisms of action and applications, **PLENARY LECTURE**, 2010 Pfizer Green Chemistry Symposium, San Diego CA
69. October 8, 2010, Molecular Design for Hazard Reduction and Remediation, United States Geological Survey Laboratory, Columbia, MO
70. October 7, 2010, Molecular Design for Hazard Reduction and Remediation, Symposium on Green Chemistry: Integrating Environmental Health Research and Chemical Innovation, University of Missouri—Columbia, MO
71. September 24, 2010, Rachel Carson Legacy Conference, Pittsburgh PA
72. August 24, 2010, Iron—TAML activators: Designing ligands to achieve peroxidase mimics, Fall ACS Meeting, Boston, MA
73. August 12, 2010, Green Chemistry: on the Responsibility of Chemists to Advance Science with Human Health and the Environment Clearly in Mind. 21st International Conference on Chemical Education), **PLENARY LECTURE**, Taipei, Taiwan
74. August 5, 2010, Green Chemistry: Sustaining a High Technology Civilization, Indian Institute of Technology, Kanpur, India
75. August 4, 2010, The Design of TAML Activators: effective small molecule mimics of the peroxidase enzymes, Indian Institute of Technology, Kanpur, India
76. August 3, 2010, Green Chemistry: Sustaining a High Technology Civilization, Indian Institute of Technology, Mumbai, India

77. August 2, 2010, The Design of TAML Activators: effective small molecule mimics of the peroxidase enzymes, National Chemistry Laboratory, Pune, India
78. July 30, 2010, Green Chemistry: Sustaining a High Technology Civilization, National Chemistry Laboratory, Pune, India
79. July 26, 2010, Green Chemistry: Sustaining a High Technology Civilization, Chemistry for Sustainable Development (ICPAC 2010), **PLENARY LECTURE**, Mauritius
80. July 5, 2010, The Design of TAML Activators: Effective Small Molecule Mimics of the Peroxidase Enzymes, International Conference on Porphyrins and Phthalocyanines, ICPP-6, Grand Hyatt Tamaya Resort, Santa Ana Pueblo, New Mexico
81. June 15, 2010, TAML Activators: New Hope for Cleaner Water, Green Remediation Conference, University of Massachusetts, Amherst
82. June 15, 2010, Green Remediation: The Environmental Perspective, **PLENARY**, Green Remediation Conference, University of Massachusetts, Amherst
83. May 27, 2010, Green Chemistry: sustaining a high technology civilization, A Rachel Carson Celebration of Biodiversity Honoring E. O. Wilson, Carnegie Music Hall, Pittsburgh, PA
84. May 3, 2010, Green Chemistry: chemists working to acknowledge, learn about and adapt to endocrine disruption, Endocrine Disruption **GORDON CONFERENCE**, Les Diablerets, Switzerland
85. April 20, 2010, Promise and Progress in Green Technology to Protect Future Generations, Second Annual Symposium—Environmentally Literate Healthcare Providers, University of Pittsburgh School of Medicine Center for Continuing Education in the Health Sciences and the Magee-Womens Hospital, Pittsburgh, PA
86. April 15, 2010, Green Chemistry and the Future: the example of iron-TAML activators, Bethany College, Bethany, WV
87. March 23, 2010, Iron-TAML activators of hydrogen peroxide: probing novel approaches for reducing and eliminating recalcitrant pollutants in water, Symposium on the Sustainability of Water Quality, ACS Conference, Moscone Center, San Francisco, California
88. March 23, 2010, Green Chemistry: the example of iron-TAML activators, Symposium on Chemical Applications of Mössbauer Spectroscopy, ACS Conference, Moscone Center, San Francisco, California
89. March 18, 2010, Policy Issues and the reform of the Toxic Substances Control Act (TSCA), Oxford Union Style Debate, Collins as Questioner, Green Chemistry Roundtable Series Manufacturing a Sustainable Economy, New Hazlett Theater, Pittsburgh PA
90. March 1, 2010, Green Chemistry and the Future: the example of iron-TAML activators, 90 minute interview with Terry Collins conducted by Lou Guillette and students, University of Florida, Gainesville, Florida
91. February 29, 2010, Green Chemistry and the Future: the example of iron-TAML activators, University of Tampa, Tampa, Florida
92. February 13, 2010, Green Chemistry in Pesticide Development and Degradation, **PLENARY**, Pesticide Stewardship Alliance, Hyatt Regency, Savannah, Georgia,
93. January 13, 2010, Green Chemistry Roundtable Series Manufacturing a Sustainable Economy—commentator—John Ehrenfeld address: author of Sustainability by Design, Collins as Questioner, ALCOA Headquarters, Pittsburgh, PA
94. December 7, 2009, Iron-TAML Activators: successful mimics of peroxidase enzymes that can transform water purification, University of Michigan, Ann Arbor, Michigan
95. November 29, 2009, Iron-TAML Activators: highly successful mimics of peroxidase enzymes for green chemical applications, **PLENARY LECTURE**, Inorganic Discussion Weekend, University of Guelph, Guelph, Ontario, 11/29/09
96. November 12, 2009, Green Chemistry: the bottom line must adapt to the germline, Philadelphia Area Alumni, University of Philadelphia, Philadelphia PA
97. November 11, 2009, Green Chemistry: the bottom line must adapt to the germline, Princeton Area Alumni, Hamilton, NJ
98. November 9, 2009, Green Chemistry: sustaining an high technology civilization, Pittsburgh Society for Coatings Technology, Harmer, PA
99. November 3, 2009, Green Chemistry: sustaining an high technology civilization, **HUGH AND NANCY LONG LECTURE**, Westminster College, New Wilmington, PA
100. October 30, 2009, Green Chemistry and the Future: the example of Iron-TAML Activators, Department of Chemistry, Cleveland State University, Cleveland,
101. October 23, 2009, Green Chemistry at Carnegie Mellon University: our approach to the tectonic importance of endocrine disruption e-hormone Conference, Tulane and Xavier Universities, New Orleans
102. October 14, 2009, Green Technologies for the Environment: Stimulating Eco Innovation for the Coming Sustainability Revolution, **PLENARY LECTURE**, Sheraton Bradley Hotel, Windsor Locks, CT
103. September 25, 2009, Green Chemistry: Sustaining an High Technology Civilization, **PLENARY LECTURE**, Rachel Carson Legacy Conference, When Chemicals Disrupt: Managing Our Risk, Manchester Craftsmen's Guild, Pittsburgh, Pennsylvania
104. September 15, 2009, Green Chemistry: Sustaining an High Technology Civilization, **UNIVERSITY PUBLIC LECTURE**, University of California, Berkeley, Berkeley, CA
105. September 14, 2009, Green Chemistry and the Future: the example of TAML activators, Department of Chemistry,

- University of California, Berkeley, Berkeley, CA
106. September 14, 2009, Green Chemistry and the Future: the example of Iron-TAML Activators, Department of Chemistry, University of California, Berkeley, Berkeley, CA
 107. August 23, 2009, Rethinking Remediation, 42nd Session of the International Seminars on Planetary Emergencies, Erice, Sicily, Italy
 108. August 21, 2009, Moving the chemical enterprise toward sustainability: Key issues, 42nd Session of the International Seminars on Planetary Emergencies, Erice, Sicily, Italy
 109. July 21, 2009, Iron-TAML activators with peroxide: an effective green chemical approach to the degradation of pharmaceutical agents in water, Green Pharma Summit, Ritz-Carlton Hotel, Philadelphia, PA
 110. July 8, 2009, Green Chemistry and the Future: the example of Iron-TAML Activators, Department of Chemistry, McGill University, Montreal, Canada
 111. May 16, 2009, It's Your World After All, Graduation Ceremony Mellon College of Science Honors Graduates, **KEYNOTE ADDRESS**, Carnegie Mellon University, Pittsburgh, PA
 112. May 16, 2009, It's Your World After All, Phi-Beta-Kappa Initiation Convocation **PLENARY**, Carnegie Mellon University, Pittsburgh, PA
 113. April 22, 2009, Green Chemistry: Sustaining an High Technology Civilization, Edinboro University of Pennsylvania, **UNIVERSITY LECTURE**, Edinboro, PA
 114. December 10, 2008, Iron-TAML activators: highly successful mimics of peroxidase enzymes for green chemical applications, **PLENARY LECTURE**, Blueprints for Sustainable Infrastructure, University of Auckland, New Zealand
 115. December 8, 2008, Iron-TAML Activators: effective small molecule mimics of peroxidase enzymes, Centre of Theoretical Chemistry and Physics, The New Zealand Institute for Advanced Study, Massey University Auckland, North Shore City, December 8, 2008
 116. November 13, 2008, Green Chemistry and the Future, Carnegie Mellon Alumni, LA Chapter, MEIM Center, LA
 117. November 15, 2008, Building the Technological Dimension of a Sustainable Civilization, **PLENARY LECTURE**, Siemens Science Competition, Heinz History Center, Pittsburgh, PA
 118. November 11, 2008, Pursuing Sustainable Technologies: People change people, Central Catholic High School, Pittsburgh PA
 119. October 16, 2008, Green Chemistry and Worker Health and Safety Training, NIEHS, Sheraton Chapel Hill, NC
 120. October 8, 2008, Environmental Health Sciences and Green Chemistry: Problems Meet Solutions—In Summary, **PLENARY LECTURE**, Beckman Center, Irvine CA
 121. September 19, 2008, Sustainability Determinants, Conference Introduction as Conference Co- Chair, Rachel Carson Legacy Conference, Duquesne University, Pittsburgh, PA
 122. September 17, 2008, Iron-TAML Activators: effective small molecule mimics of peroxidase enzymes, Department of Chemistry, University of Wisconsin, Madison
 123. August 18, 2008, Design, performance and mechanistic chemistry of FeIII-TAML activators, Graduate Student Symposium: Transitioning into Green Chemistry, ACS National Meeting, Sheraton Philadelphia City Center Hotel, Philadelphia, PA
 124. July 18, 2008, Green Chemistry and Technology Futures, Presented to the leadership of the United Steelworkers Union, New Haven, CT
 125. July 17, 2008, Iron-TAML activators: highly successful mimics of peroxidase enzymes—Lessons from kinetic and mechanistic studies, **INORGANIC CHEMISTRY GORDON CONFERENCE**, Salve Regina University, Newport, RI
 126. June 4, 2008, Green Chemistry and the Future, Presented to the University of Minnesota electronically from Yale University, New Haven, CT
 127. May 28, 2008, Green Chemistry and the Future, Presentation to Bobby Vagt, President, Heinz Endowments and several other officers, Pittsburgh, PA
 128. May 2, 2008, Green Chemistry and the Future, **UNIVERSITY CONVOCATION ADDRESS**, St. Olaf College, Northfield, Minnesota
 129. April 28, 2008, Green Chemistry and the Future, Presentation to the Upper School, Winchester Thurston Academy, Pittsburgh, PA
 130. April 16, 2008, Green Chemistry and the Future, Rachel Carson Spirit & Nature Conference, Chatham University, Pittsburgh, PA
 131. April 14, 2008, A life in search of sustainability: People change people, **JOURNEYS LECTURE**, Carnegie Mellon University, Pittsburgh, PA
 132. April 7, 2008, Undergraduate researchers excel in green chemistry and oxidation catalysis, **BECKMAN SCHOLARS 10-YEAR ANNIVERSARY PRESIDENTIAL PLENARY SYMPOSIUM**, ACS National Meeting, New Orleans
 133. March 17 2008, Green Chemistry and the Future, **CHARLES E. KAUFMAN AWARD ADDRESS**, Bridgeville, PA
 134. March 18 2008, Green Chemistry and the Future, North Central West Virginia American Chemical Society, Fairmont State University, Fairmont, WV
 135. March 14, 2008, Green Chemistry and the Future, Good Jobs, Green Jobs Conference, Convention Center, Pittsburgh, PA
 136. February 19, 2008, Green Chemistry and the Future, **AFTER-DINNER KEYNOTE LECTURE**, American Institute of Chemical Engineers, University of Pittsburgh, Pittsburgh, PA

137. February 14, 2008, Green Chemistry and the Future, Presentation to the Maine Legislature Standing Committee on Maine Resources, State Capitol, Augusta, ME
138. November 29, 2007, Green Chemistry and the Future, **KEYNOTE LECTURE**, *Health and Environmental Funders Network*, Airlie Conference Center, Warrenton, VA,
139. November 19, 2007, Learning and Developmental Disabilities Initiative National Teleconference, Priming for Prevention, Cyberspace, USA
140. November 14, 2007, The Vision, Research and Educational Program of the Institute for Green Oxidation Chemistry, Citizens for Global Solutions Pittsburgh and the Global Studies Program of the University Center for International Studies at the University of Pittsburgh, Pittsburgh, PA
141. October 26, 2007, Green Chemistry and the Future, **PLENARY LECTURE**, La Roche College, Pittsburgh, PA
142. October 26, 2007, The Vision, Research and Educational Program of the Institute for Green Oxidation Chemistry, Central Catholic High School, Pittsburgh, PA
143. October 10, 2007, The Vision, Research and Educational Program of the Institute for Green Oxidation Chemistry, Central Catholic High School, Pittsburgh, PA
144. October 4, 2007, Yale University, Green chemistry: sustaining a high technology civilization, New Haven, CT
145. September 26, 2007, Green Chemistry and Life Cycle Analysis, EPA Conference on "Pollution Prevention through Nanotechnology", Arlington, VA
146. September 25, 2007, GreenOx Catalysts, Inc.: the green chemistry behind a new Pittsburgh startup, Commercial Development and Marketing Association for the Chemicals Industry Annual Conference, Pittsburgh, PA
147. September 21, 2007, Green chemistry: sustaining a high technology civilization, **PLENARY LECTURE**, The Fire Retardant Dilemma Conference Series: Part 3, Berkeley, CA
148. September 20, 2007, Green chemistry: sustaining a high technology civilization, The Energy and Resources Group Fall 2007 Colloquium Series, U.C. Berkeley, Berkeley CA
149. September 11, 2007, Green Chemistry and the Future: Part B, Innovation Day 2007, Society of the Chemical Industry–Chemical Heritage Foundation, Philadelphia, PA
150. September 11, 2007, Green Chemistry and the Future: Part A, Innovation Day 2007, Society of the Chemical Industry–Chemical Heritage Foundation, Philadelphia, PA
151. August 29, 2007, Green Chemistry and the Future, **PLENARY LECTURE**, 20th Rocky Mountain Regional ACS Meeting (Joint with AIChE), Denver, CO
152. August 19, 2007, Green chemistry and sustainability: essential elements for chemical pedagogy, Boston ACS Meeting in Symposium on Green Chemistry as an Integral Component of Academic Sustainability Centers, Boston MA
153. August 8, 2007, Iron-TAML activators: effective green chemistry catalysts for the oxidative decomposition of Pharmaceuticals and Personal Care Products, 2007 Northeast Water Science Forum, Pharmaceuticals and Personal Care Products: state of the science, Portland, ME
154. August 6, 2007, Certain chemicals are disrupting your hormone system: what can GreenChemistry do protect you and your family? Workshop on Endocrine Disrupting Chemicals, Steelworkers Health, Safety and Environment Conference and the Steelworkers Joint Health, Safety and Environment Conference, Dearborn, MI
155. July 16, 2007, Green Chemistry: Sustaining an High Technology Civilization, University of Pittsburgh, Center on Race and Social Problems, School of Social Work, Pittsburgh, PA
156. July 16, 2007, Green Chemistry: Sustaining an High Technology Civilization, Lunch and Learn, Center for Environmental Oncology, Herberman Auditorium, UPMC Cancer Pavilion, Pittsburgh, PA
157. June 2, 2007, Iron-TAML activators: effective green chemistry catalysts for peroxide activation, Pan American Studies Institute in Green Chemistry, Universidad Iberoamericana, México City, México
158. June 1, 2007, Toxicity and Ecotoxicity: the vital GC challenge of the endocrine disruptors, Pan American Studies Institute in Green Chemistry, Universidad Iberoamericana, México City, México
159. June 6, 2007, Green Chemistry: Sustaining an High Technology Civilization, **KEYNOTE LECTURE**, First Israeli International Conference on Green Chemistry, Porter School of Environmental Studies, Tel Aviv University, Israel
160. May 31, 2007, Green Chemistry: "an ethical imperative", Pan American Studies Institute in Green Chemistry, Universidad Iberoamericana, México City, México
161. May 16, 2007, Iron-TAML activators: effective green chemistry catalysts for peroxide activation, **AWARD ADDRESS**, Catalysis Society of Metropolitan New York, Somerset, NJ
162. May 16, 2007, Green Chemistry: Sustaining an High Technology Civilization, ExxonMobil Research and Engineering Co, Annandale, NJ
163. April 23, 2007, Green Chemistry and the Future, King County Wastewater Treatment Authority and People for Puget Sound, Seattle, WA
164. April 23, 2007, Green Chemistry and the Future, Department of Ecology of Washington State, Olympia, WA
165. April 20, 2007, Green Chemistry and the Future, Women's Health and the Environment: new science, new solutions, Pittsburgh, PA
166. August 6, 2007, Green Chemistry: Sustaining an High Technology Civilization, **PLENARY LECTURE**, Steelworkers Health, Safety and Environment Conference and the Steelworkers Joint Health, Safety and Environment Conference, Dearborn, MI
167. April 4, 2007, Iron-TAML® activators: effective green chemistry catalysts for peroxide activation, Centre College,

- Danville, KY
168. March 26, 2007, Iron-TAML® activators: effective green chemistry catalysts for peroxide activation, Eckard Münck Bader Award Symposium, Chicago ACS, Chicago IL
 169. March 23, 2007, Converging Landscapes: Chemistry meets Toxicology meets the Environment — with a little emphasis on pharmaceuticals, Gordon Cain Conference 2007, New Chemical Bodies: Bio-Monitoring, Body Burden and the Uncertain Threat of Endocrine Disruptors, Chemical Heritage Foundation Conference, Philadelphia, PA
 170. February 27, 2007, Green Chemistry; Sustaining a High Technology Civilization, SCION, Rotorua, New Zealand
 171. February 22, 2007, Green Chemistry: In Search of an Ethics for the Technological Age, IPENZ and Engineers for Social Responsibility, University of Auckland, New Zealand
 172. February 21, 2007, Green Chemistry; Sustaining a High Technology Civilization, **AWARD AND UNIVERSITY LECTURE**, Maidment Theater, University of Auckland, Auckland, New Zealand
 173. January 25, 2007, Green Chemistry; Sustaining a High Technology Civilization, Lunch Round table Discussion, Summit on Environmental Challenges to Reproductive Health and Fertility, University of California, San Francisco, San Francisco, CA
 174. January 25, 2007, Green Chemistry; Sustaining a High Technology Civilization, Oregon Environmental Council Health Sciences Series, Multnomah Athletic Club, Portland, OR
 175. January 24, 2007, Green Chemistry; Sustaining a High Technology Civilization, Environmental Health Lecture Series, Town Hall, Seattle, WA
 176. January 24, 2007, Iron-TAML® activators: effective green chemistry catalysts for peroxide activation, University of Washington, Seattle, WA
 177. December 14, 2006, Green Chemistry and the Future, Presentation to Birchmere, VC, Pittsburgh, PA
 178. December 7, 2006, Green Chemistry and the Future, Presentation to the VC Firm Draper-Triangle, Pittsburgh, PA
 179. December 1, 2006, Green Chemistry and the Future, Presentation to the VC Firm Pennsylvania Early Stage Partners, Pittsburgh, PA
 180. November 15, 2006, Green Chemistry: Sustaining a High Technology Civilization, Greenbuild 2006, Denver, CO
 181. October 30, 2006, The Design and Development of Green Oxidation Catalysts: real steps toward a less polluted world, Presentation to 40 Venture Capitalists, Carnegie Mellon University, Pittsburgh, PA
 182. October 27, 2006, The Design and Development of Green Oxidation Catalysts: real steps toward a less polluted world, Louisiana State University, Baton Rouge, LA
 183. October 25, 2006, Green Chemistry and the Future, Presentation to the Heinz Endowments Board of Trustees, Carnegie Mellon University, Pittsburgh, PA
 184. October 17, 2006, Design, Study and Applications of Green Oxidation Catalysts, Kenyon College, Gambier, OH
 185. October 3, 2006, Green Chemistry: a personal view of the challenges and an update on TAML® activator chemistry, Presentation to 10 Classes of Central catholic High School, Pittsburgh, PA
 186. September 12, 2006, Greening Chemistry: what is it?, Egyptian First International Conference in Chemistry, Chemistry for Human Needs in Developing Countries, Sharm El-Shiekh, Egypt
 187. September 12, 2006, Greening Oxidation Catalysis, Egyptian First International Conference in Chemistry, Chemistry for Human Needs in Developing Countries, Sharm El-Shiekh, Egypt
 188. October 16, 2006, Green Chemistry: Sustaining a High Technology Civilization, **UNIVERSITY CONVOCATION ADDRESS**, Kenyon College, Gambier, OH
 189. September 14, 2006, Green Chemistry and Sustainability, Egyptian First International Conference in Chemistry, Chemistry for Human Needs in Developing Countries, **LEADER OF 2.5 HOUR ADDRESS AND DISCUSSION**, Sharm El-Shiekh, Egypt
 190. August 27, 2006, The Design and Development of Green Oxidation Catalysts: real steps toward a less polluted world, Green Chemistry **GORDON CONFERENCE**, Magdalen College, Oxford, United Kingdom
 191. August 17, 2006, The Design and Development of Green Oxidation Catalysts: real steps toward a less polluted world, Auckland University, Auckland, New Zealand
 192. August 16, 2006, The Design and Development of Green Oxidation Catalysts: real steps toward a less polluted world, Waikato University, Hamilton, New Zealand
 193. August 9, 2006, The Design and Development of Green Oxidation Catalysts: real steps toward a less polluted world, Monash University, Melbourne, Australia
 194. August 9, 2006, Designing Green Catalytic Oxidation Processes, Monash University Student Lecture, Melbourne, Australia
 195. July 3, 2006, TAML Oxidant Activators: Design, Chemistry and Applications, ICPP-4, Rome, Italy
 196. June 26, 2006, Green Oxidation Catalysis, 2006 Summer School on Green Chemistry, Washington, DC
 197. June 22, 2006, Solutions Science in Academia: green chemistry and what it offers biodiversity, Consultative Group on Biodiversity, Estes Park, CO
 198. June 6, 2006, Green Chemistry: making it in the real world, Collaborative on Health and the Environment Web Lecture Series
 199. May 18, 2006, Green Chemistry: systematically dealing with toxics, Great Lakes Binational Toxics Strategy Meeting, Delta Chelsea Hotel, Toronto, Canada
 200. May 9, 2006, Green Chemistry 101 Primer, NSCMP Core Group, Holiday Inn Rosslyn at Keybridge, Arlington VA

201. May 3, 2006, Green Chemistry and Sustainability, Pittsburgh Chemistry Olympics-Chevron Science Center, Pittsburgh, PA
202. April 25, 2006, The Design of Green Catalytic Oxidation Processes, Dickinson College, Carlisle PA
203. March 21, 2006, Green Chemistry 101, Veolia Water Leadership, Moon Township, PA
204. March 7, 2006, Green Chemistry: developing sustainable alternatives to polluting technologies, Society of Toxicologists Meeting, San Diego, CA
205. January 30, 2006, Green Chemistry 101, Presentation to >80 Environmental Advocate Organizations, Hotel Washington, Washington, DC
206. January 30, 2006, Green Chemistry 101, Presentation to ≈ 40 Environmental and Health Funding Foundations, Hotel Washington, Washington, DC
207. January 20, 2006, Green Chemistry at Carnegie Mellon University and Thinking about How to Make Pittsburgh the Capital City of the Sustainable Economy *Pittsburgh Green Drinks, Buffalo Blues*, Pittsburgh, PA
208. January 11, 2006, Degradation of Lipitor and Zoloft with Fe-TAML/H₂O₂ presentation with Dr. Yan Xiang, Pfizer Central Research, Groton, CT
209. December 14, 2005, Designing Green Oxidation Processes, Joint Japan-US Workshop on Sustainable Chemical Synthesis, Honolulu, HI
210. November 30, 2005, Design, Study and Applications of Green Oxidation Catalysts, Penn State Erie-The Behrend College, Erie, PA
211. November 5, 2005, Sustaining a High Technology Civilization, Elk Regional Health Center Women's Health Conference, St. Mary's, PA
212. November 4, 2005, Sustaining a High Technology Civilization, Carnegie Mellon University International Festival, Pittsburgh, PA
213. October 28, 2005, Designing Green Oxidation Technologies, Midwest Regional ACS Meeting— Green Chemistry Symposium, October 28, 2005, Joplin, MO
214. October 20, 2005, Design, Study and Applications of Green Oxidation Catalysts, Stanford University, Stanford CA
215. October 14, 2005, Greening Our Civilization Through Science, Pioneers Conference, San Rafael, CA
216. October 7, 2005, Greening Our Civilization Through Science, **PLENARY LECTURE**, Chemistry Discipline Faculty Workshop 2-year and 4-year Colleges of Minnesota State Colleges and Universities System, Minnesota Minneapolis Community and Technical College, Minneapolis MN
217. October 6, 2005, Green Chemistry and the Building of the Sustainable Economy, Activated Carbon Conference, **PLENARY LECTURE**, Moon Township, PA
218. October 4, 2005, Making Pittsburgh the Capital City of the Sustainable Economy, Technology Transfer Conference for Foundations and Economic Development Organizations, Carnegie Mellon University, Pittsburgh PA
219. September 21, 2005, Ethics, Toxicity, Ecotoxicity, Persistence, Bioaccumulation and Green Chemistry, Central Catholic High School, Pittsburgh, PA
220. August 29, 2005, TAML Green Oxidation Catalysis for Safely Destroying Pollutants and Microbes in Water, ACS Meeting, Washington, DC
221. July 30, 2005, Moderator of Panel Presentations on Green Chemistry, The Beckman Scholars Conference, Irvine, CA
222. July 11, 2005, Ethics, Toxicity, Ecotoxicity, Persistence, Bioaccumulation and Green Chemistry: Part II, Exxon Summer School on Green Chemistry, McGill University, Montreal, Canada
223. July 11, 2005, Ethics, Toxicity, Ecotoxicity, Persistence, Bioaccumulation and Green Chemistry: Part I, Exxon Summer School on Green Chemistry, McGill University, Montreal, Canada
224. July 9, 2005, Greening Oxidation Catalysis, Exxon Summer School on Green Chemistry, McGill University, Montreal, Canada
225. June 23, 2005, Designing Green Catalytic Oxidation Technologies, 2nd International Green Chemistry and Engineering Conference, Washington, DC
226. June 22, 2005, The Need for Incorporating Understanding of Toxicity and Ecotoxicity into Chemistry, 2nd International Green Chemistry and Engineering Conference, Washington, DC
227. June 21, 2005, Green Decontamination System for Chemical and Biological Weapons of mass Destruction, 2nd International Green Chemistry and Engineering Conference, Washington, DC
228. June 20, 2005, Greening Oxidation Catalysis—Student Workshop, 2nd International Green Chemistry and Engineering Conference, Washington, DC
229. June 17, 2005, Design, Mechanism of Action, and Applications of Green Oxidation Catalysts, **PLENARY LECTURE**, Annual Meeting of the Pittsburgh-Cleveland Catalysis Society, Pittsburgh, PA
230. June 1, 2005, Greening Oxidation Catalysis, Conference on Knowledge-Based Materials and Technologies for Sustainable Chemistry, **PLENARY LECTURE**, Tallinn, Estonia
231. May 30, 2005, Understanding Homogeneous Oxidation Catalysis: mechanistic investigation of the stability and function of iron-TAML peroxide activators, Eotvos University, Budapest, Hungary
232. May 26, 2005, A Green Oxidative Approach for Rapid Total Degradation of Thiophosphate Pesticides, 8TH HCH and Pesticides Forum for Central European and Eastern European, Caucasus and Central Asia Countries, Sofia, Bulgaria
233. May 19, 2005, Designing Green Oxidation Technologies” Lecture to Environmental Commissioner of Maine (Dawn Gallagher) and leaders of the Maine DEP and pulp and paper industry, Augusta, ME

234. July 29, 2005, **PLENARY LECTURE**, Bayer School of Natural and Environmental Sciences Undergraduate Research Symposium, Duquesne University, Pittsburgh PA
235. April 19, 2005, Sustainability Ethics and Chemistry: How to build a sustainable technology base, **PLENARY LECTURE**, Symposium on Universal Relationships and Responsibilities: Sustainable living practices for social and cultural wellbeing, Perth, Australia
236. March 31, 2005, Designing Green Oxidation Technologies, Commonweal Retreat on Green Chemistry, Bolinas, CA
237. March 30, 2005, Green Chemistry: Solving the Technical Challenges of Sustainability, Commonweal Retreat on Green Chemistry, Bolinas, CA
238. March 13, 2005, Green Oxidation Catalysts for Environmental Applications, Symposium on Environmental Applications of Inorganic Chemistry, San Diego ACS Meeting, San Diego, CA
239. February 25, 2005, Green Chemistry and Agriculture, **PLENARY LECTURE**, Southeastern Leadership Conference, Department of Agriculture, Savannah, GA
240. February 15, 2005, A Superior Decontamination System for Chemical and Biological Warfare and Defense, **KEYNOTE LECTURE**, Rydges Hotel, Melbourne, Australia
241. February 2, 2005, Greening Civilization through Science, lecture to the science students and Pennsylvania-Ohio Border Section of the ACS, New Wilmington, PA
242. December 9, 2004, Designing Green Oxidation Technologies, **PITTSBURGH AWARD ADDRESS**, Sheraton Hotel, Pittsburgh, PA
243. December 3, 2004, Greening Civilization Through Science, To the Science Students, Illinois Wesleyan University, Bloomington, IL
244. November 29, 2004, Designing Green Oxidation Technologies, To Governor John Baldacci & DEP Leadership, Augusta, ME
245. November 29, 2004, Designing Green Oxidation Technologies, To Commissioner Dawn Gallagher & DEP Leadership, Augusta, ME
246. November 18, 2004, Green Chemistry, Steinbrenner Institute Carnegie Mellon University, Pittsburgh, PA
247. November 13, 2004, A Novel Catalytic Oxidative Decontamination System for Chemical and Biological Warfare Defense, SERMACS, Durham, NC
248. November 3, 2004, Greening Our Civilization Through Science, Chatham College, Pittsburgh, PA
249. November 1, 2004, Research in Green Chemistry, SURG Lunch Seminar Series, Carnegie Mellon University, Pittsburgh, PA
250. October 21, 2004, Greening Our Civilization Through Science, **KEYNOTE LECTURE**, Mid-Atlantic Association of Liberal Arts College Teachers Annual Conference, Juniata College, Huntingdon, PA
251. October 20, 2004, The Design, Development and Utility of TAML Activators, Society of Environmental Journalists, Carnegie Mellon University, Pittsburgh, PA
252. October 20, 2004, Greening Our Civilization Through Science, Society of Environmental Journalists, Carnegie Mellon University, Pittsburgh, PA
253. October 19, 2004, Greening Our Civilization Through Science, **UNIVERSITY LECTURE**, Bowdoin College, Brunswick, ME
254. October 19, 2004, Designing Green Oxidation Technology, Bowdoin College, Brunswick, ME
255. October 8, 2004, Designing Green Oxidation Technology, Arch Chemicals, Southington, CT
256. September 30, 2004, Greening the Planet through Science, The Covenant at South Hills, Bower Hill Road, Mt. Lebanon, PA
257. September 20, 2004, Persistence, Bioaccumulation and Endocrine Disruption in Understanding Pollutants and How to Deal with Them, Faculty Workshop, Clemson University, Clemson, SC
258. September 20, 2004, Designing Green Oxidation Technology, Science Technology and Society University Lecture, Clemson University, Clemson, SC
259. September 20, 2004, Green Chemistry: Sustaining a High Technology Civilization, Honors Students Lecture, Clemson University, Clemson, SC
260. August 26, 2004, Greening the Planet through Science, **KEYNOTE LECTURE**, MCS Orientation, Carnegie Mellon University, Pittsburgh, PA
261. August 22, 2004, Designing Green Oxidation Technologies, **PLENARY LECTURE**, Symposium on Sustainability in the Chemical Industry—IEC, 228th ACS Conference, Philadelphia, PA
262. August 22, 2004, Understanding the Persistent Pollutant, Symposium on Green Chemistry for Graduate Students, 228th ACS Conference, Philadelphia, PA
263. August 6, 2004, The Ethics of Green Chemistry, ACS-PRF Green Chemistry Summer School, Carnegie Mellon University, Pittsburgh, PA
264. August 6, 2004, Designing Green Oxidation Technologies, ACS-PRF Green Chemistry Summer School, Carnegie Mellon University, Pittsburgh, PA
265. August 5, 2004, Understanding the Persistent Pollutant, ACS-PRF Green Chemistry Summer School, Carnegie Mellon University, Pittsburgh, PA
266. August 3, 2004, Greening Energy, ACS-PRF Green Chemistry Summer School, Carnegie Mellon University, Pittsburgh, PA

267. May 18, 2004, A Novel Catalytic Oxidative Decontamination System for Chemical and Biological Warfare Defense, Decontamination 2004 Conference, Palm Harbor, FL
268. May 5, 2004, Designing Green Oxidation Technologies, Department of Agriculture, Florence, SC
269. April 30, 2004, Green Chemistry: Sustaining a High Technology Civilization, University of Mexico, Mexico City, Mexico
270. April 21, 2004, Green Chemistry: Sustaining a High Technology Civilization, ACS Student Affiliates Lecture, Bethany College, WV
271. April 14, 2004, Green Chemistry: Sustaining a High Technology Civilization, CleanMed 2004 Conference, Philadelphia, PA
272. March 29, 2004, Green Oxidation Catalysts: Iron-TAML Activators of Oxygen and Peroxides, ACS Symposium on Non-Heme Iron Chemistry in Biology, 227th ACS National Meeting, Anaheim, CA
273. March 27, 2004, Green Chemistry: Sustaining a High Technology Civilization, After-Dinner Lecture DivCHED Annual Banquet, 227th ACS National Meeting, Anaheim, CA
274. March 27, 2004, The Precautionary Principle and Endocrine Disruption: Connections, Lecture to the ACS Committee on Environmental Improvement, 227th ACS National Meeting, Anaheim, CA
275. March 19, 2004, Designing Catalysts for Green Oxidation Technologies, Department of Chemistry, Eotvos University, Budapest, Hungary
276. March 18, 2004, Designing Catalysts for Green Oxidation Technologies, Department of Chemistry, University of Debrecen, Debrecen, Hungary
277. March 13, 2004, Techniques for Attracting Manuscripts, Royal Society of Chemistry Editor's Symposium, Glasgow, Scotland
278. March 5, 2004, Green Chemistry: Sustaining a High Technology Civilization, Department of Chemistry, Baylor University, Waco, TX
279. March 3, 2004, The Problem of the Persistent Pollutant, Southern Methodist University, Dallas, TX
280. March 2, 2004, The Design and Development of Green Oxidation Processes, Southern Methodist University, Dallas, TX
281. March 29, 2004, Designing Catalysts for Green Oxidation Technologies, Society Committee on Education, **EMINENT SCIENTIST LECTURE**, 227th ACS National Meeting, Anaheim, CA
282. March 4, 2004, Designing Chemical Technologies for Sustainability, **UNIVERSITY CONVOCATION ADDRESS**, Baylor University, Waco, TX
283. March 1, 2004, Green Chemistry: Sustaining a High Technology Civilization, Gartner Honors Lecture Series, **UNIVERSITY CONVOCATION ADDRESS**, Southern Methodist University, Dallas, TX
284. February 26, 2004, Green Chemistry: Sustaining a High Technology Civilization, Berea College, Berea, KY
285. February 25, 2004, Designing Chemical Technologies for Sustainability, **UNIVERSITY CONVOCATION ADDRESS**, Berea College, Berea, KY
286. February 20, 2004, The Design and Development of Green Oxidation Processes, ACS Affiliates Lecture, University of Pittsburgh, Pittsburgh, PA
287. February 5, 2004, The Design of Green Oxidation Processes, Science and Humanities Scholars, Carnegie Mellon University, Pittsburgh, PA
288. January 21, 2004, The Design of Green Oxidation Processes, ALCOA Sigma Xi Chapter, New Kensington, PA
289. December 13, 2003, Designing Catalysts for Green Oxidation Technologies, Department of Chemistry, University of Hawaii at Manoa, HI
290. December 2, 2003, Design of Techniques and Technologies that Unite the Future of Chemistry with the Pursuit of a Sustainable Civilization, New Zealand Institute of Chemistry Conference, **PLENARY LECTURE**, Nelson New Zealand
291. November 27, 2003, The Design and Development of Green Oxidation Technologies, Society of Pure and Applied Coordination Chemistry (JAPAN)-10, **PLENARY LECTURE**, Auckland New Zealand
292. November 24, 2003, Designing Catalysts for Green Oxidation Technologies, Department of Chemistry, University of Western Australia, Perth, Australia
293. November 21, 2003, Sustainability Ethics: directions for green chemistry education/R&D, **WHOLE STUDENT BODY LECTURE**, Miranda College, Delhi University, New Dehli, India
294. November 20, 2003, Development of Green Oxidation Catalysis for Water Purification, Indo-US S&T Forum Workshop on Green Chemistry, Connaught Hotel, Delhi, India
295. November 18, 2003, The Design of Green Oxidation Catalysts, Indo-US S&T Forum Workshop on Green Chemistry, Connaught Hotel, Delhi, India
296. November 17, 2003, Sustainability Ethics: directions for green chemistry education/R&D, Indo-US S&T Forum Workshop on Green Chemistry, Connaught Hotel, Delhi, India
297. November 13, 2003, Green Chemistry: Sustaining a High Technology Civilization, Department of Chemistry, University of Leiden, Netherlands
298. November 6, 2003, C&E News Editorial Advisory Board, Sustainability and Innovation: the good future for chemistry, **FOCUS LECTURE FOR BOARD MEETING**, American Chemical Society Headquarters, Washington, DC
299. November 3, 2003, Designing Catalysts for Green Oxidation Technologies, Pfizer Conference on Green Chemistry,

- Groton, CT
300. October 31, 2003, Designing Catalysts for Green Oxidation Technologies, Department of Chemistry, University of North Carolina, Chapel Hill, NC
 301. October 15, 2003, Design to Unite Chemical Research with the Pursuit of a Sustainable Civilization, **PLENARY LECTURE**, Annual Conference of the Brazilian Society of Analytical Chemists, Sao Luis, Brazil
 302. October 7, 2003, Design to Unite Chemical Research with the Pursuit of a Sustainable Civilization, **COLLEGE CONSORTIUM ADDRESS**: Twelve Small Colleges in the Chicago area at Benedictine University, Lisle, IL
 303. October 6, 2003, The Importance of *Sustainability Ethics, Toxicity and Ecotoxicity* in the Training of Future Chemists, Otterbein College, Columbus, OH
 304. October 5, 2003, Sustaining Ethics and Green Chemistry: Developing a Sustainable High Technology Civilization, **UNIVERSITY CONVOCATION**, Otterbein College, Columbus, OH
 305. October 2, 2003, Green Chemistry: Sustaining a High Technology Civilization, Hendrix College, Conway, AR
 306. October 1, 2003, Design to Unite Chemical Research with the Pursuit of a Sustainable Civilization, **UNIVERSITY CONVOCATION ADDRESS**, Hendrix College, Conway, AR
 307. September 25, 2003, Design to Unite Chemical Research with the Pursuit of a Sustainable Civilization, **KECK ENDOWED LECTURE**, Allegheny College, Meadville PA
 308. July 8, 2003, Sustainability Ethics, Pan American Advanced Studies Institute on Green Chemistry, Montevideo, Uruguay
 309. July 8, 2003, Persistence and Bioaccumulation in Understanding Pollutants and How to Deal with Them, Pan American Advanced Studies Institute on Green Chemistry, Montevideo, Uruguay
 310. July 8, 2003, The Importance of Moral and Sustainability Ethics in the Chemical Industry: Reflections on "Trade Secrets," Pan American Advanced Studies Institute on Green Chemistry, Montevideo, Uruguay
 311. July 8, 2003, Considerations on Safe Energy: Reflections on "Meltdown at Three Mile Island," Pan American Advanced Studies Institute on Green Chemistry, Montevideo, Uruguay
 312. July 11, 2003, "The Design of Green Oxidation Catalysts", Pan American Advanced Studies Institute on Green Chemistry, Montevideo, Uruguay
 313. July 8, 2003, Pan American Advanced Studies Institute on Green Chemistry, Montevideo, Uruguay
 314. June 29, 2003, "The Importance of Sustainability Ethics, Toxicity and Ecotoxicity in the Training of Future Chemists", in ACS Blue Ribbon Education Conference "Exploring the Molecular Vision Washington, DC"
 315. June 26, 2003, Training in Sustainability Ethics, Toxicity and Ecotoxicity: Fundamentals of a Safe America, Roundtable on Safety, Green Chemistry & Engineering Conference, Washington, DC
 316. May 24, 2003, New Iron Oxygen Chemistry, Eckard Münck 65th Birthday Symposium, Carnegie Mellon University, Pittsburgh, PA
 317. May 1, 2003, Designing Green Oxidation Catalysts, Massachusetts Green Chemistry Conference, Andover, MA
 318. April 26, 2003, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Society of Analytical Chemists of Pittsburgh Symposium on Green Chemistry, Duquesne University, Pittsburgh, PA
 319. April 30, 2003, Eliminating Persistent Pollutants with Green Catalysis, **PLENARY LECTURE**, Massachusetts Green Chemistry Conference, Andover, MA
 320. April 10, 2003, Green chemistry: Sustaining a high-technology civilization, **UNIVERSITY CONVOCATION ADDRESS**, University of Tennessee, Martin, TN
 321. April 10, 2003 The Problem of Endocrine Disruptors, University of Tennessee at Martin (Honors Students), Martin, TN
 322. April 10, 2003 The Problem of The Persistent Pollutant, University of Tennessee at Martin (Honors Students), Martin, TN
 323. April 9, 2003, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Kentucky Lake Section of ACS, Union City, TN May 19, 2003, "Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes", **PLENARY LECTURE**, EU COST Workshop on GC and EU Conference on GC, Poitiers, France
 324. March 23, 2003, Green chemistry: Sustaining a high-technology civilization, Division of Information Science, Symposium: Librarian Watch: Introduction to New Hot Areas in Chemistry, 225th ACS National Meeting, New Orleans, LA
 325. February 4, 2003, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, **PLENARY LECTURE**, Australia/New Zealand Biennial Conference on Inorganic Chemistry, University of Melbourne, Melbourne, Australia
 326. January 11, 2003, Designing Catalysts for Green Oxidation Technologies, **KEYNOTE ADDRESS**, New York Division of the American Chemical Society, Columbia University, New York, NY
 327. November 22, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, New York Academy of Sciences, New York, NY
 328. November 12, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, 3rd Green Chemistry Conference of Spain, Barcelona, Spain
 329. November 5, 2002, Designing Catalysts for Green Oxidation Technologies, Department of Chemistry, University of Rochester, Rochester, NY
 330. October 31, 2002, Green Chemistry: Sustaining a High Technology Civilization, Lectureship Series in Environmental Studies, Brown University, Providence, RI
 - 331.

332. October 24, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, 37th Annual Midwest ACS regional Conference, Symposium on Green Catalysis, Lawrence, KS
333. October 15, 2002, Green Chemistry: Achieving a Sustainable Economy, Roundtable Discussion, Conference on Nuevas tecnologías y sostenibilidad, Universidad Internacional Menéndez Pelayo, Valencia, Spain
334. October 16, 2002, Green Chemistry: Sustaining a High Technology Civilization, Conference on Nuevas tecnologías y sostenibilidad, Universidad Internacional Menéndez Pelayo, Valencia, Spain
335. October 9, 2002, Green Chemistry: Sustaining a High Technology Civilization, Central catholic High School (90 min. Presentation to 8 classes), Pittsburgh, PA
336. September 26, 2002, Green Chemistry: Sustaining a High Technology Civilization, Denison University, Granville, OH
337. September 23, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, **BAYER LECTURE**, Notre Dame University, South Bend, IN
338. September 16, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Center for Environmental Research and Technology, University of Bremen, Germany
339. September 8, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Green Chemistry **GORDON CONFERENCE**, Queens College Oxford, United Kingdom
340. August 15, 2002, Designing Catalysts for Green Oxidation Technologies, NSF Workshop on Environmentally Benign Process Research Needs, Jiminy Peak Resort, Berkshires, MA
341. July 26, 2002, Catalysis as a Tool for Replacing Polluting Processes with Green Chemical Technologies, Sixth Annual Beckman Scholars Symposium, Arnold and Mabel Beckman Center of the National Academies of Sciences, Irvine, CA
342. July 22, 2002, Sustainability Science and the Economy of the Future, First German Summer School on Green and Sustainable Chemistry, Freising, Germany
343. July 22, 2002, Designing Catalysts for Green Oxidation Technologies, **PLENARY LECTURE**, First German Summer School on Green and Sustainable Chemistry, Freising, Germany
344. June 26, 2002, Activation of Hydrogen Peroxide for Green Chemical Processes, **PLENARY LECTURE**, Sixth Green Chemistry and Engineering Conference, Georgetown University, Washington, DC
345. May 28, 2002, Activation of Hydrogen Peroxide for Green Chemical Processes, University of Hong Kong, Hong Kong
346. May 22, 2002, Activation of Hydrogen Peroxide for Green Chemical Processes, **PLENARY LECTURE**, 5th International Symposium on Green Chemistry—China, Hefei City, Anhui Province, China
347. May 15, 2002, Green Chemistry: Sustaining a High Technology Civilization, Central Catholic High School, Pittsburgh, PA
348. May 13, 2002, Green Chemistry: Sustaining a High Technology Civilization, Chemical Sciences Roundtable of the national Academy of Sciences, Georgetown, DC
349. April 10, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Symposium on Agricultural Application in Green Chemistry, 223rd National Meeting of the American Chemical Society, Orlando, FL
350. April 16, 2002, Green Chemistry: Sustaining a High Technology Civilization, **GOLDEN GOGGLES AWARD ADDRESS**, Middle Tennessee State University, Murfreesboro, TN
351. April 7, 2002, Novel Green Chemical Applications of TAML Activators of Hydrogen Peroxide, Symposium on Catalysis in Green Chemistry, 223rd National Meeting of the American Chemical Society, Orlando, FL
352. April 5, 2002, Darkness in El Dorado: interpretations for a better future, **PLENARY LECTURE**, International Conference on "Darkness in El Dorado", Cornell University, Ithaca, NY
353. April 4, 2002, Green Chemistry: Sustaining a High Technology Civilization, **UNIVERSITY CONVOCATION ADDRESS**, Augustana College, Rock Island, IL
354. March 27, 2002, Green Chemistry at Carnegie Mellon University, Dept. of Biological Sciences, Carnegie Mellon University, Pittsburgh, PA
355. February 14, 2002, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Dept. of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA
356. December 5, 2001, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, National Conference on Molecules for Life, Joint Meeting of the NZ Society for Biochemistry and Molecular Biology, NZ Institute of Chemistry and the NZ Biotechnology Association, Napier, New Zealand
357. November 19, 2001, Sustainability Science and the Economy of the Future, Osaka City University, Osaka, Japan
358. November 17, 2001, Sustainability Science and the Economy of the Future, Commemorative Symposium for KYOUSEI Center, Nara Women's University, Nara, Japan
359. November 16, 2001, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Green Chemistry Forum, Kyoto, Japan
360. November 15, 2001, Sustainability Science and the Economy of the Future, Osaka Prefecture University, Osaka, Japan
361. November 14, 2001, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Osaka City University, Osaka, Japan
362. October 26, 2001, Allegheny College, Meadville, PA
363. October 19, 2001, Shippensburg University, Shippensburg, PA
364. August 20, 2001, MCC-8: Symposium on metal ions, complexes and clusters in macromolecular systems, Polytechnic University, Brooklyn, NY
365. July 5, 2001, Green Chemistry: Sustaining a High Technology Civilization, Public Lecture, The Museum of Otago,

- Dunedin, New Zealand
366. July 5, 2001, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Department of Chemistry, University of Otago, Dunedin, New Zealand
367. July 2, 2001, 2001, Science and the Ethics of Sustainability, ChemEd Conference 2001, University of Canterbury, Christchurch, New Zealand
368. June 28, 2001, Green Chemistry: On the responsibility of chemists to promote sustainability, 90 Minute Lecture to Canterbury High School Teachers, St. Margaret's College, Christchurch, NZ
369. June 28, 2001, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, Department of Chemistry, University of Canterbury, Christchurch, New Zealand
370. June 18, 2001, Green Chemistry: Sustaining an High Technology Civilization, Reckitt-Benkiser, Montvale, NJ
371. December 5, 2001, Green Chemistry and the Economy of the Future, **KEYNOTE LECTURE**, National Conference on Molecules for Life, Joint Meeting of the NZ Society for Biochemistry and Molecular Biology, NZ Institute of Chemistry and the NZ Biotechnology Association, Napier, New Zealand
372. November 13, 2001, Catalytic Activation of Hydrogen Peroxide for Green Chemical Processes, **KEYNOTE LECTURE**, Second National Symposium of the Green & Sustainable Chemistry Network (GSCN), Yokohama, Japan
373. July 4, 2001, Green Chemistry: Sustaining an High Technology Civilization, **PLENARY LECTURE**, ChemEd Conference 2001, Department of Chemistry, University of Canterbury, Christchurch, New Zealand
374. June 29, 2001, Green Chemistry: On the responsibility of chemists to promote sustainability, **MELLOR LECTURE** of the New Zealand Institute of Chemistry and the Royal Society of New Zealand, Wellington, New Zealand
375. May 11, 2001, Green Chemistry: Sustaining an High Technology Civilization, Applied Physics Laboratory, Johns Hopkins University, Baltimore, MD
376. April 24, 2001, Green Chemistry: Sustaining an High Technology Civilization, **KEYNOTE ADDRESS** at the Innovation and pioneering celebration of Bayer USA, Moon, PA
377. April 12, 2001, Green Chemistry: Sustaining an High Technology Civilization, Department of Chemistry, University of Illinois, Urbana-Champaign, IL
378. April 2, 2001, Green Chemistry: On the responsibility of chemists to promote sustainability, 90 Minute Workshop given under auspices of the Society and Education Division, ACS National Meeting, San Diego, CA
379. March 7, 2001, Green Chemistry: Sustaining an High Technology Civilization, Oberlin College, Oberlin, OH
380. January 18, 2001, Green Chemistry: Sustaining an High Technology Civilization, Indian Institute of Technology,, Kharagpur, India
381. January 17, 2001, Green Chemistry: Sustaining an High Technology Civilization, Indian Association for the Cultivation of Science, Jadavpur, Calcutta, India
382. January 15, 2001, Green Chemistry: Sustaining an High Technology Civilization, Indian Institute of Technology, Kanpur, India
383. January 13, 2001, Green Chemistry: Sustaining an High Technology Civilization, US Environmental Protection Agency Research Laboratories, Cincinnati, OH
384. January 11, 2001, Green Chemistry: Sustaining an High Technology Civilization, IUPAC Conference on Green Chemistry, **PLENARY LECTURE**, New Dehli, India
385. November 7, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, Geneva College, Beaver Falls, PA
386. October 3, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, Unilever Research, Chester, England
387. November 1, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, Johns Hopkins University, Baltimore, MD
388. October 24, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, Yale University, New Haven, CT
389. October 3, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, Unilever Research, Chester, England
390. September 22, 2000, Catalytic peroxide activation: Pulp bleaching, color and AOX abatement, 8th International Activated Carbon Conference, Moon Township, PA
391. August 24, 2000, TAML® Peroxide Activators: Chemistry and Applications in Paper and Textile Effluent Treatment, 220th ACS National Meeting, Washington, DC
392. August 10, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, Atofina Corporation, King of Prussia, PA
393. August 1, 2000, Green Chemistry: On the Responsibility of Chemists to Promote Sustainability, Biennial Conference on Chemical Education, Ann Arbor, MI July 19, 2000, Catalytic Activation of Hydrogen Peroxide for Environmentally Significant Problems, **GORDON CONFERENCE** on Green Chemistry, (Moderator of this conference for the Gordon Conference Trustees), New London, CT
394. July 11, 2000, Sustaining a High Technology Civilization, Public Lecture 7:30–9:00 pm, Dunedin Public Library, Dunedin, New Zealand
395. July 2–6, 2000, SCICON Conference of New Zealand Science Educators, 90 MINUTE WORKSHOP, Green Chemistry: On the Responsibility of Chemists to Promote Sustainability, June 5, Massey University, Palmerston North,

- New Zealand
396. July 2–6, 2000, SCICON Conference of New Zealand Science Educators, **PLENARY LECTURE**, Sustaining a High Technology Civilization, June 4, Massey University, Palmerston North, New Zealand
397. July 4, 2000, Sustaining a High Technology Civilization, The Royal Society of New Zealand, The Science Museum, Palmerston North, New Zealand
398. June 29, 2000, Sustaining a High Technology Civilization, Public Lecture 7:30–9:00 pm, University of Auckland, Auckland, New Zealand
399. April 20, 2000, Green Chemistry and Sustainability, Environmental Club, Carnegie Mellon University, Pittsburgh, PA
400. March 28, 2000, Catalytic peroxide activation: Pulp bleaching, color and AOX abatement, 219th ACS National Meeting March 26-30, 2000, San Francisco, CA
401. February 22, 2000, The Design of Green Oxidation Systems, Department of Chemistry, University of Michigan, Ann Arbor, MI
402. February 16, 2000, The Design of Green Oxidation Systems, Synthetic Organic Chemical Manufacturers Association Annual Conference, New Orleans, LA
403. January 28, 2000, The Design of Green Oxidation Systems, Department of Chemistry, Youngstown State University, Youngstown, OH
404. January 12, 2000, The Design of Peroxide-Activating Catalysts, Unilever Research Headquarters, Port Sunlight, England
405. November 19, 1999, The Design of Green Oxidation Systems, Department of Chemistry, Virginia Polytechnical University, Blacksburg, VA
406. November 18, 1999, Green Chemistry: Sustaining a High Technology Civilization, Washington and Lee University, Lexington, VA
407. November 2, 1999, Catalysis is a Key to a Better Future for the Pulp and Paper Industry, TAPPI Pulping Conference, Renaissance Orlando, Orlando, FL
408. October 26, 1999, Green Chemistry: Sustaining a High Technology Civilization, Pittsburgh Chemist's Club, Durantes Restaurant, Pittsburgh, PA
409. October 16, 1999, Green Chemistry: Sustaining a High Technology Civilization, Carnegie Mellon Parents Day, Carnegie Mellon University, Pittsburgh, PA
410. October 15, 1999, Green Chemistry: Sustaining a High Technology Civilization, Allegheny Erie Society of Toxicology, Moon, PA
411. September 30, 1999, The Design of Green Oxidation Systems, Department of Chemistry and Biochemistry University of Pennsylvania, Philadelphia, PA
412. September 29, 1999, The Design of Green Oxidation Systems, Rohm and Haas Corporation, Springhouse, PA
413. September 23, 1999, Green Chemistry: Sustaining a High Technology Civilization, Central Catholic High School, Pittsburgh, PA
414. September 13, 1999, The Design of Green Oxidation Systems, Department of Biochemistry, University of Wisconsin, Madison, WI
415. September 8, 1999, The Design of Chemistry Labs of the 21st Century, Meeting of Architectural Firms and Govt. Agencies, Boston MA
416. August 12, 1999, The Design of Sustainable Oxidation Systems, GSF Research Center of München, Ingolstadter Landstr.1, 85764 Neuherberg, Germany
417. July 23, 1999, Green Chemistry: Sustaining a High Technology Civilization, Pennsylvania Governor's Science Institute, **PLENARY LECTURE**, Carnegie Mellon University, Pittsburgh, PA
418. July 1, 1999, The Seven Promises of Catalysis in the Pulp and Paper Industry, Green Chemistry and Engineering Conference, National Academy of Sciences, Washington, DC
419. April 26, 1999, The Seven Promises of Catalysis in the Pulp and Paper Industry, Lecture to the Bleaching Committee of TAPPI, Hattiesburg MS
420. April 22, 1999, The Design of Green Oxidants, To the Chemistry Teachers of Pittsburgh and their most gifted students, Central Catholic High School, Pittsburgh, PA
421. January 28, 1999, The Design of Green Oxidants, **GORDON CONFERENCE** on Metals in Biology, This 2 hour lecture was the Thursday evening after diner speech that both closed the Metals in Biology Gordon Conference and opened the young scientist Gordon Conference on Metals in Biology
422. January 25, 1999, Green Up or Clean Up: The Design of Green Oxidants, Conference on Organometallic Chemistry in the South Pacific to honor Warren Roper on the occasion of his 60th birthday, Auckland, New Zealand
423. November 5, 1998, The Design of Green Oxidants, University of Vermont, Burlington, VT
424. October 28, 1998, New Efficient, Selective, Totally Chlorine Free Wood Pulp Bleaching Technology, 1998 TAPPI Pulp Conference, Montreal, Canada
425. October 23-25, 1998, Green Chemistry: Sustaining a High Technology Civilization, EPA/NSF Green Chemistry Education Kick-off Meeting, National Academy of Sciences, Washington, DC
426. October 20, 1998, The Design of Green Oxidants, Unilever Research, Port Sunlight, England
427. August 25, 1998, New, Selective, Efficient, Totally Chlorine-Free Wood Pulp Bleaching Technology, Symposium to Honor Career of Daryle Busch (Current President-Elect of ACS), 216th ACS Meeting, Boston, MA

428. August 23, 1998, Green Chemistry Education, Green Chemistry Education: International Perspectives, ACS Symposium, ACS Meeting, Boston, MA
429. July 28, 1998, Green Chemistry: Sustaining a High Technology Civilization, **THE PLENARY LECTURER** to Gifted High School Students of Osaka at symposium on Green Earth Science, Osaka-City University, Osaka, Japan
430. July 27, 1998, The Design of Green Oxidants, Department of Material Science Osaka-City University, Osaka, Japan
431. July 25, 1998, The Design of Green Oxidants, **THE PLENARY LECTURER** 5th International Symposium of the Society Of Pure And Applied Coordination Chemistry of Japan, "Molecular Design of Functional Metal Complexes for Green Earth Science", Kogakuin University, Tokyo Japan, July 25, **AWARD LECTURE** for the 1997 Prize of Society of Pure And Applied Coordination Chemistry of Japan
432. July 22, 1998, The Design of Green Oxidants, **GORDON CONFERENCE** on Inorganic Chemistry, Salve Regina College, Newport, RI
433. July 1, 1998, The Design of Green Oxidants, Green Chemistry and Engineering Conference, National Academy of Sciences, Washington, DC
434. June 12, 1998, The Design of Green Oxidants, NSF Inorganometallic Workshop, Knoxville, TN
435. May 12, 1998, Development of Long-Lived Hydrogen Peroxide Activators for Pulp Bleaching, Annual Spring Meeting of the Pulp Bleaching Committee of the Association of The Pulp and paper Industry, Wisconsin Rapids, WI
436. January 30, 1998, The Design of Green Oxidants, **KEYNOTE LECTURE**, Annual Meeting of the Chemistry Department Heads and Full Professors of Australia, Canberra, Australia
437. September 30, 1997, "The Development of Green Oxidants": **PLENARY LECTURE**, International Conference on Green Chemistry: Challenging Perspectives, Venice, Italy
438. June 23, 1997, "The Development of Green Oxidants": **PLENARY LECTURE**, 1997 Green Chemistry and Engineering Conference, Implementing Vision 2020 for the Environment, National Academy of Sciences, Washington, DC
439. 1996, Designing Ligands for Oxidizing Complexes, Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, PA
440. November 6, 1996, Academy of Life-Long Learning, Carnegie Mellon University, Pittsburgh, PA
441. September 3, 1996, The Design of Green Oxidants, Department of Chemistry, Victoria University, Wellington, New Zealand
442. September 3, 1996, Ligand-Design Based Approaches for Controlling Exchange Coupling, Department of Chemistry, Victoria University, Wellington, New Zealand
443. July 29–August 30, 1996 Ten lectures, Distinguished Visitor, Department of Chemistry, University of Auckland, Auckland New Zealand
444. August 14, 1996, Distinguished Scientist Seminar, Department of Chemistry, University of Auckland, Auckland New Zealand
445. July 27, 1996, Invited speaker at the First **GORDON CONFERENCE** on Environmentally Benign Organic Chemistry, New England College, Henneker, NH
446. August 7, 1996, Distinguished Scientist Seminar, Department of Chemistry, University of Auckland, Auckland New Zealand
447. March 27, 1996, Massachusetts Institute of Technology, Boston, MA
448. March 17, 1996, North Carolina State University, Raleigh, NC
449. January 30, 1996, International Meeting on Macrocyclic Chemistry, Wellington, New Zealand
450. September 17, 1995, NATO Workshop, *Magnetism: A Supramolecular Function*, Carcans, France
451. June 27, 1995, First Midwest Meeting in Bioinorganic Chemistry Meeting, Minneapolis, MN
452. May 25, 1995, Clorox Chemical Company, Pleasanton, CA
453. May 24, 1995, Electrochemical Society International Meeting, Reno, NV
454. February 24, 1995, Hamilton College, Clinton, NY
455. February 8, 1995, University of Delaware, Newark, DE
456. July 1994, Industrial and Government visitors to the Environmental Open House, Carnegie Mellon University, Pittsburgh, PA
457. September 15, 1994, University of Vermont, Burlington, VT
458. August 2, 1994, 13th Biennial Conference on Chemical Education, Bucknell University, Lewisburg, PA
459. July 13, 1994, EPA Workshop on Green Design, Cincinnati, OH
460. Jan 19, 1994, Air Products Corporation, Allentown, PA
461. October 15, 1993, Baylor University, Waco, TX
462. October 13, 1993, University of Texas, Austin, TX
463. September 30, 1993, Columbia University, New York, NY
464. September 29, 1993, Princeton University, Princeton, NJ
465. September 28, 1993, University of Pennsylvania, Philadelphia, PA
466. March 5, 1993, University of Kansas, Lawrence, KS
467. March 4, 1993, Kansas State University, Manhattan, KS

468. February 26, 1993, ARCO Chemical Company, MD
469. January 19, 1993, Air Products, Allentown, PA
470. October 15, 1992, Gettysburg College, Gettysburg, PA
471. October 1, 1992, Rensselaer Polytechnic Institute, Troy, NY
472. May 7-8, 1992 – Participant in NSF National Workshop on the teaching of Chemistry in Undergraduate Laboratories, Washington, DC
473. April 27, 1992 – ARCO Chemical Company, MA
474. April 8, 1992 – Invited speaker in the Symposium on New Reagents in Inorganic and Organometallic Chemistry, National ACS Meeting, San Francisco, CA
475. November 11, 1991 – Departmental Colloquium, University of Chicago, Chicago, IL
476. October 1, 1991 – Yale University, New Haven, CT
477. April 18, 1991 – Inorganic seminar to faculty and students of University of Akron, Kent State University, Mt. Union College, and several other colleges, Kent, OH
478. March 28, 1991 – Indiana University, Bloomington, IN
479. March 1, 1991 – ARCO Chemical Company, MD
480. February 1, 1991 – **PLENARY LECTURE**, International Conference on Inorganic Chemistry, University of Waikato, Hamilton, New Zealand
481. August, 27 1990 – National ACS Conference – Symposium on "Ligand Design in Regulating Redox Reactions", Washington, DC
482. April 19, 1990, Pittsburgh/Cleveland Catalysis Soc., Cleveland, OH
483. April 17, 1990 – Pennsylvania State University, College Station, PA
484. †April 27, 1990: Seminar on *ITEC* to Pennsylvania High School and College Teachers at the University of Pittsburgh, Pittsburgh, PA
485. †April 6, 1990 – Seminar on *ITEC* to Pennsylvania Science Educ. Soc. Allegheny College, Meadville, PA
486. †January 11, 1990 – Education Directorate Officers, NSF, Washington, DC
487. December 6, 1989 – University of Delaware, Newark, DE
488. October 24, 1989 – University of Maryland, College Park, MD
489. October 6, 1989 – Duquesne University, Pittsburgh, PA
490. November 18, 1988 – Santa Clara University, Santa Clara, CA
491. †October 11, 1989 – Lord Corporation and Foundation Executives, Pittsburgh, PA
492. †July 26, 1989 – Pittsburgh High School Teachers, Pittsburgh, PA
493. †May 24, 1989 – Presentation to Merck Representatives at CMU (leading ultimately to Corporate Grant), Pittsburgh, PA
494. †May 22, 1989 – Select Group of CMU Trustees, Pittsburgh, PA
495. †March 21, 1989 – International Conference on Global Crises, Chicago, IL
496. November 10, 1988 – W. R. Grace Company, MD
497. October 27, 1988 – Clemson University, Clemson, SC
498. October 4, 1988 – Mellon College of Science Research Seminar, Pittsburgh, PA
499. †September 19, 1988, Duquesne University Presentation to High School Teachers, Pittsburgh, PA
500. †July 21 1988, The Chemical Manufacturers Association, The National Science Foundation, The American Chemical Society, Washington, DC
501. †June 28, 1988, The Mobay Corporation Administration, Pittsburgh, PA
502. †May 18, 1988, The Kresge Foundation, Detroit, MI
503. †May 11, 1988, Calgon Carbon Company, Pittsburgh, PA
504. April 20, 1988 – Bucknell University, Lewisburg, PA
505. April 7, 1988 – Kent State University, Kent, OH
506. †April 4, 1988, The Duquesne Club presentation to Pittsburgh Corporate Executives (leading ultimately to Corporate Grant), Pittsburgh, PA
507. †March 29, 1988, The Dreyfus Foundation, New York, NY
508. March 23, 1988 – The University West Virginia, Morgantown, WV
509. February 11, 1988 – The University of Pittsburgh, Pittsburgh, PA
510. December 4 1987 – Baylor University, Waco, TX
511. January 1987 – Standard Oil, Cleveland, OH
512. January 1987 – The University of Southern California, Los Angeles CA
513. November 20, 1986 – Carnegie Mellon University, Pittsburgh, PA
514. November 14, 1986 – Amoco Chemical Company, Chicago, IL
515. November 4, 1986 – Dow Chemical Company, Midland, MI
516. November 3, 1986 – Dow Chemical Company, Midland, MI
517. October 7, 1986 – University of Southern California, Los Angeles, CA
518. September, 1986 – University of Nebraska, Lincoln, NE
519. February 25–27, 1986 – Organizer of and speaker in the Industrial Associates Conference on Oxidation Chemistry held

- at Caltech, Pasadena, CA
520. December 4, 1985 – Simon Fraser University, Burnaby, British Columbia, Canada
 521. December 3, 1985 – Departmental Seminar at the University of British Columbia, Vancouver, British Columbia, Canada
 522. December 2, 1985 – University of Washington, Seattle, WA
 523. November 22, 1985 – University of California, Berkeley, Berkeley, CA
 524. November 20, 1985 – University of California, Davis, Davis, CA
 525. November 19, 1985 – Stanford University, Stanford, CA
 526. November 16, 1985 – Northwestern University, Evanston, IL
 527. November 15, 1985 – Northwestern University, Evanston, IL
 528. November 14, 1985 – Hope College, Holland, MI
 529. November 12–13, 1985 – University of Illinois, Champaign–Urbana, IL
 530. November 11, 1985 – SOHIO, Cleveland, OH
 531. November 6, 1985 – University of Chicago, Chicago, IL
 532. October 24, 1985 – Carleton College, Northfield, MN
 533. October 23, 1985 – 3M Company, St. Paul, MN
 534. October 22, 1985 – ACS Inorganic Topical Group Seminar, University of Minnesota, St. Paul, MN
 535. October 21, 1985 – University of Wisconsin, Madison, Madison, WI
 536. October 17, 1985 – Ohio State University, Columbus, OH
 537. October 16, 1985 – Iowa State University, Ames, IA
 538. October 15, 1985 – University of Iowa, Iowa City, IA
 539. October 14, 1985 – Washington University, St. Louis, MO
 540. October 10–11, 1985 – Invited speaker in Symposium on Oxidation Chemistry at Monsanto Company, St. Louis, MO
 541. July 29–August 2, 1985–Invited speaker at the Organometallic **GORDON CONFERENCE**, Hawthorne College, Antrim, NH
 542. June 10–12, 1985 – Invited speaker in Symposium on Unusual Oxidation States at the ACS Regional Meeting, Purdue University, West Lafayette, IN
 543. May 24, 1985 – Harvard/MIT joint seminar in Inorganic Chemistry, Cambridge, MA
 544. May 21, 1985 – University of California, Los Angeles, Los Angeles, CA
 545. May 17, 1985 – Exxon Research and Engineering Company, Annandale, NJ
 546. May 15, 1985 – GTE Laboratories, Waltham, MA
 547. May 14, 1985 – Texaco Inc., Beacon Hill, NY
 548. May 13, 1985 – Air Products and Chemicals, Inc., Allentown, PA
 549. April 22–26, 1985 – Invited speaker at the US/USSR Symposium on Environmentally Related Catalysis, Moscow, USSR
 550. April 19, 1985 – Rohm and Haas Company, Spring House, PA
 551. April 18, 1985 – Columbia University, New York, NY
 552. January 24, 1985 – Departmental Seminar, Harvey Mudd College, Claremont, CA
 553. October 26, 1984 – University of California, Santa Barbara, Santa Barbara, CA
 554. December 16–21, 1984 – 1984 International Chemical Congress of Pacific Basin Societies, (One of the organizers of and speakers in the Symposium on "New Developments in Coordination Chemistry: Oxygen and Oxidation"), Honolulu, HI
 555. September 24–28, 1984 – Invited participant at the Fourth International Symposium on Homogeneous Catalysis, Leningrad, USSR
 556. July 9, 1984 – Cambridge University, Cambridge, England
 557. July 5, 1984 – Oxford University, Oxford, England
 558. June 24–29, 1984 – Member of the International Advisory Committee and speaker in the International Oxidations", Padova, Italy Symposium and Advanced Research Workshop on "Activation of Dioxygen Species and Homogeneous Catalytic Oxidation Chemistry"; Report Editor
 559. June 8, 1984 – Rohm and Haas Company, Spring House, PA
 560. June 6, 1984 – Invited speaker at the symposium entitled "Advances in Catalytic Science – New Eyes/New Insights," University of Delaware, Newark, Delaware and participant in the annual review meeting of the Center for Catalytic Science and Technology, DE
 561. June 4, 1984 – E. I. du Pont de Nemours and Company, Wilmington, DE
 562. May 30–June 2, 1984 – Invited speaker at the 1984 National Science Foundation Organometallic Chemistry Workshop, The University of North Carolina, Chapel Hill, NC
 563. May 29, 1984 –Dow Chemical Company, Midland, MI
 564. May, 1984 – University of California, San Diego, La Jolla, CA
 565. April 17, 1984 – University of Southern California, Los Angeles, CA
 566. April 8–12, 1984 – Invited speaker in Symposium on Carbon Dioxide Chemistry at the 187th National ACS Meeting, St. Louis, MO

- 567. March 15, 1984 – University of California, Irvine, Irvine, CA
- 568. August 8–12, 1983 – Invited speaker at the 1983 Inorganic Chemistry **GORDON CONFERENCE**, (Brewster Academy), Wolfeboro, NH
- 569. April 15, 1983 – California State University, Northridge, Northridge, CA
- 570. March 20–25, 1983 – Session Chairman, 185th National ACS Meeting, Seattle, WA
- 571. March 20–25, 1983 – 185th National ACS Meeting, Seattle, WA
- 572. March 16–18, 1983 – Invited speaker at the Conference on Frontiers of Catalysis, California Institute of Technology, 22 Gates, Pasadena, CA
- 573. February 28, 1983 – Loma Linda University, La Sierra Campus, Loma Linda, CA
- 574. June 23–26, 1981 – Invited speaker at the 1981 NSF National Organometallic Chemistry Workshop, Asilomar, Pacific Grove, CA

Exhibit B

Statement of Miriam L. Diamond



Earth Sciences UNIVERSITY OF TORONTO

February 6, 2015

I, Miriam L. Diamond, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. Personal Information. I am a Professor in the Department of Earth Sciences at the University of Toronto with cross appointments in the Department of Chemical Engineering and Applied Chemistry, Dalla Lana School of Public Health, School of the Environment, and Department of Physical and Environmental Sciences at the University of Toronto. I received a B.Sc. from the University of Toronto in 1976, a M.Sc. in Zoology from the University of Alberta in Edmonton Alberta in 1980, a M.Sc.Eng. in Mining Engineering from Queen's University in Kingston, Ontario, and a PhD. in Chemical Engineering and Applied Chemistry from University of Toronto in 1990. My research concerns the sources, emissions and fate of environmental chemicals and exposure of these chemicals to humans and ecosystems. I am a Fellow of the Royal Geographic Society. I have served on the Board of Directors and Executive Committee of the Society of Environmental Toxicology and Chemistry, and have been an Associate Editor of the journal *Environmental Science and Technology*, the leading journal in the field, since 2012. I have held the INNOLEC Science Guest Chair in Chemistry, Masarykova Univerzita, Czech Republic, been a visiting scholar in the Department of Applied Environmental Science at Stockholm University, and the Joseph R. Meyerhoff Visiting Professorship at the Weizmann Institute in Israel. In 2008 I was appointed by the Minister of Environment of the Province of Ontario to co-chair the Toxics Reduction Scientific Expert Panel that brought in Canada's first Toxic Reduction Act. I have served on numerous advisory panels for the U.S. Environmental Protection Agency and on a National Academies of Sciences expert panel, and I am a member of the Canadian Chemicals Management Plan Science Committee. I have attached my CV and list of publications.

2. Personal Expertise. A major focus of my research has been documenting emissions and fate of semi-volatile organic compounds or SVOCs (those with boiling points between 240° and 400°C according to WHO 1997¹) in the indoor and outdoor urban environments. In 2005 we published the first paper to show that household dust, and not diet, was a major exposure route of the flame retardant polybrominated diphenyl ethers (PBDEs). This marked a radical shift in understanding sources and pathways of these and other SVOCs that are used in consumer products.² We were also the first to quantitatively estimate the emissions and fate of PBDEs in an indoor environment using a mathematical model that we developed^{3,4} and, in conjunction with Prof. Stuart Harrad of the University of Birmingham, we measured house dust levels of organohalogen flame retardants.^{5,6,7} Additionally, we documented the release into the indoor environment of deca-BDE, although it had not been expected to migrate from the products to which it was added because of its very low vapour pressure.⁸

3. Working with colleagues, we have measured concentrations of PBDEs in indoor dust, and in indoor and outdoor air that originate from indoor products and building materials.^{9,10,11,12} Our data show that PBDEs migrate from consumer products into the indoor air and dust, and from there make it into the outdoor environment. In this study, we measured the geographic pattern of PBDE outdoor air concentrations at locations across Toronto, Canada, and found that it coincides with the inventory of PBDE-containing products found indoors.^{13,14,15} In other words, we determined that PBDEs were migrating from consumer products into the indoor air, and then into outdoor air. The only plausible explanation for this spatial pattern of PBDEs in outdoor air is that the PBDEs migrated out of consumer products, as industries using PBDEs do not have this geographic pattern in Toronto.



4. Other organohalogen flame retardants in addition to PBDEs migrate from consumer products into the indoor environment, including into house dust. We determined this by sampling and analyzing 12 additive organohalogen flame retardants plus PBDEs in the surface wipes of casings of electronic and electrical equipment and the dust of 35 homes in the Toronto area.¹⁶ We found particularly elevated concentrations of penta-, octa- and decaBDE mixtures, tris(1,3-dichloro-2-propyl)phosphate (TDCPP), tetrabromobenzotriazole (TBB), bis(2-ethylhexyl) tetrabromophthalate (TBPH), decabromodiphenyl ethane (DPDPE) and octabromotrimethylphenylindane (OBIND) in both surface wipes and house dust samples.^{17,18,}

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5. In points 3 and 4, I explained that specific organohalogen flame retardants migrate from consumer products to indoor and outdoor air based on evidence from measurements. We know that organohalogen flame retardants as a class (not just the specific chemicals we identified in house dust) tend to migrate out of consumer products because they are typically used in additive form (i.e. not chemically bonded to the materials containing them) and because of their physical-chemical properties.²⁰ The first critical physical-chemical property is that organohalogen flame retardants are semi-volatile organic compounds (SVOCs) and the second property is that these compounds are persistent indoors:

i) Organohalogen flame retardants as a class are SVOCs²⁰. According to the U.S. EPA,²¹ a chemical can be classified as a SVOC if its boiling point (a physical-chemical property) is greater than that of water and may vapourize (change from liquid or solid phase to vapour phase as measured by a chemical's vapour pressure) at or above room temperatures. A SVOC can exist simultaneously in a solid phase (i.e., as a flame retardant in a polymer), AND in the vapour phase (i.e., in air). The significance of these flame retardants being SVOCs is that over time, some of the molecules of an organohalogen flame retardant added to a polymer will migrate into air. The migration is purely a function of the chemical being a SVOC and that it is added to, rather than reacted with or bound to, the polymer.

ii) Organohalogen flame retardants are persistent indoors. Their persistence is a desired property for a flame retardant, i.e., the molecule will not break down during the life time of the product to which it has been added. However, the implication of this persistence is that the chemical will not break down indoors after it has migrated from the product.

6. The phenomenon of human exposure to constituents in house dust has been well established in the asthma and allergy field.²² As noted above, our exposure analysis demonstrated that house dust is also a major source of human exposure to penta- and octaBDEs.²³ This finding has been corroborated by other exposure studies, including studies of organohalogen flame retardants in addition to PBDEs.^{24,25,26,27} However, the most recent research suggests that organohalogen concentrations in house dust may be a proxy for another exposure pathway, that of direct transfer from product-to-hand, followed by hand-to-mouth transfer.^{28,29} In other words, the most recent research indicates that humans are exposed to organohalogen flame retardants by touching consumer products in which these chemicals are present in additive form and by touching house dust which also contains organohalogen flame retardants. The measurement of organohalogen flame retardants in house dust is thus an indicator of the levels of organohalogen flame retardants in the home that residents come into contact with, both when they touch consumer products containing these chemicals and when they touch or inhale the dust itself.

7. In summary, there is a sufficient body of knowledge to conclude that all organohalogen flame retardants – because they are SVOCs – will tend to migrate out of the consumer products in which they are present in



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additive form, resulting in human exposure. Once released indoors, organohalogen flame retardants will accumulate in indoor dust, and they are persistent in the indoor environment. Humans are exposed to organohalogen flame retardants as a result of direct contact with consumer products and with indoor dust containing these compounds. The inevitability of this human exposure, combined with the evidence showing that these compounds have toxicity, leads to the conclusion that all organohalogen flame retardants present in consumer products in additive form pose significant risks to human health.

I therefore urge the CSPC to ban the use of additive organohalogen flame retardants in the four consumer product categories covered in this petition.

Miriam Diamond

Miriam Diamond, Ph.D.
Professor,
University of Toronto



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- ¹ WHO, World Health Organization. 1997. Environmental Health Criteria 192, International Programme on Chemical Safety. Geneva. 81 p. ISBN 9241571926.
- ² JONES-OTAZO H, JP CLARKE, ML DIAMOND, JA ARCHBOLD, G FERGUSON, T HARNER, MG RICHARDSON, JJ RYAN, B WILFORD. 2005. Is house dust the missing exposure pathway for PBDEs? An analysis of urban fate and human exposure to PBDEs. *Environ Sci Technol.* 39:5121-5130.
- ³ ZHANG X., ML DIAMOND, SJ HARRAD, C IBARRA. 2009. Multimedia modeling of PBDE emissions and fate indoors. *Environ Sci Technol.* 43(8):2845-2850.
- ⁴ ZHANG X, M ROBSON, ML DIAMOND, C IBARRA, SJ HARRAD. 2011. Polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) indoors in Toronto: concentrations, air/dust distribution, sources and emissions. *Environ Sci Technol.* 45:3268-3274.
- ⁵ ABDALLAH MA-E, S HARRAD, C IBARRA, M DIAMOND, L MELYMUK, M ROBSON, A COVACI. 2008. Hexabromocyclododecanes in indoor dust from Canada, the United Kingdom and the United States. *Environ Sci Technol.* 42(2):459-464.
- ⁶ HARRAD S, C IBARRA, M DIAMOND, L MELYMUK, M ROBSON+, J DOUWES, L ROOSENS, AC DIRTU, A COVACI. 2008. Polybrominated diphenyl ethers in domestic indoor dust from Canada, New Zealand, United Kingdom and United States. *Environ Internat.* 34:232-238.
- ⁷ HARRAD S, C IBARRA, M ROBSON, L MELYMUK, X ZHANG, M DIAMOND, J DOUWES. 2009. Polychlorinated biphenyls in indoor dust from Canada, New Zealand, United Kingdom and United States: implications for human exposure. *Chemosphere.* 76(2):232-238.
- ⁸ BUTT CM, ML DIAMOND, J TRUONG, MG IKONOMOU, AFH TER SCHURE. 2004. Spatial distribution of polybrominated diphenyl ethers in southern Ontario as measured in indoor and outdoor window organic films. *Environ Sci Technol.* 38:724-731.
- ⁹ HARRAD S, C IBARRA, M DIAMOND, L MELYMUK, M ROBSON, J DOUWES, L ROOSENS, AC DIRTU, A COVACI. 2008. Polybrominated diphenyl ethers in domestic indoor dust from Canada, New Zealand, United Kingdom and United States. *Environ Internat.* 34:232-238.
- ¹⁰ HARRAD S, C IBARRA, M ROBSON+, L MELYMUK, X ZHANG, M DIAMOND, J DOUWES. 2009. Polychlorinated biphenyls in indoor dust from Canada, New Zealand, United Kingdom and United States: implications for human exposure. *Chemosphere.* 76(2):232-238.
- ¹¹ ZHANG X, M ROBSON, ML DIAMOND, C IBARRA, SJ HARRAD. 2011. Polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) indoors in Toronto: concentrations, air/dust distribution, sources and emissions. *Environ Sci Technol.* 45:3268-3274.
- ¹² MELYMUK L, M ROBSON, PA HELM, ML DIAMOND. 2012. PCBs, PBDEs and PAHs in Toronto air: spatial and seasonal trends and implications for contaminant transport. *Sci Total Environ.* 429:272-280. doi:10.1016/j.scitotenv.2012.04.022
- ¹³ MELYMUK L, M ROBSON, PA HELM, ML DIAMOND. 2012. PCBs, PBDEs and PAHs in Toronto air: spatial and seasonal trends and implications for contaminant transport. *Sci Total Environ.* 429:272-280.
- ¹⁴ MELYMUK L, M ROBSON, PA HELM, ML DIAMOND. 2013. Application of land use regression to identify sources and assess spatial variation in urban SVOC concentrations. *Environ Sci Technol.* 47(4):1887-1895.
- ¹⁵ CSISZAR SA, SM DAGGUPATY, ML DIAMOND. 2013. SO-MUM: a coupled atmospheric transport and multimedia model used to predict intraurban-scale PCB and PBDE emissions and fate. *Environ Sci Technol.* 47:436-445.
- ¹⁶ ABBASI G, SAINI, A, GOOSEY, E, DIAMOND M. Forthcoming. 2014. Halogenated flame retardants in Canadian house dust. *Integr Environ Assess Manag.*



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- ¹⁷ GOOSEY, ER, SANAI A, ABBASI G, CHAUDHURI S, DIAMOND ML. 2013. Sources and multimedia partitioning of BFRs indoors. *Organohalogen Compd.*
- ¹⁸ GOOSEY E., A SAINI, S CHAUDHURI, ML DIAMOND. 2013. Assessment of the prevalence and exposure to new flame retardants (NFRs) in Canadian indoor environments. Report to Health Canada. 93 pp.
- ¹⁹ ABBASI G, SAINI, A, GOOSEY, E, DIAMOND M. Forthcoming. 2014. Halogenated flame retardants in Canadian house dust. *Integr Environ Assess Manag.*
- ²⁰ SERODIO, D. 2015. Novel halogenated and organophosphate flame retardants: do novel flame retardants have the same environmental fate as the compounds they are replacing? M.A.Sc. Thesis, Department of Earth Sciences, University of Toronto.
- ²¹ <http://www.epa.gov/reg3hwmd/bf-lr/regional/analytical/semi-volatile.htm>
- ²² ROBERTS JW, WT BUDD, MG RUBY, D CAMANN, RC FORTMANN, RG LEWIS, LA WALLACE, TM SPIITLER. 1992. Human exposure to pollutants in the floor dust of homes and offices. *J Expo Anal Environ Epi.* 2:127-146.
- ²³ JONES-OTAZO H, JP CLARKE, ML DIAMOND, JA ARCHBOLD, G FERGUSON, T HARNER, MG RICHARDSON, JJ RYAN, B WILFORD. 2005. Is house dust the missing exposure pathway for PBDEs? An analysis of urban fate and human exposure to PBDEs. *Environ Sci Technol.* 39:5121-5130.
- ²⁴ JOHNSON PI, STAPLETON HM, SJODIN A, MEEKER JD. 2010. Relationships between polybrominated diphenyl ether concentrations in house dust and serum. *Environ Sci Technol.* 44:5627-5632.
- ²⁵ KARLSSON M, JULANDER A, VAN BAVEL B, HARDELL L. 2007. Levels of brominated flame retardants in blood in relation to levels in household air and dust. *Environ Int.* 33(1):62-69.
- ²⁶ LORBER M. 2008. Exposure of Americans to polybrominated diphenyl ethers. *J Exposure Sci Environ Epi.* 18(1):2-19.
- ²⁷ WU N, HERMANN T, PAEPKE O, TICKNER J, HALE R, HARVEY E, LA GUARDIA M, MCCLEAN MD, WEBSTER TF. 2007. Human exposure to PBDEs: associations of PBDE body burdens with food consumption and house dust concentrations. *Environ Sci Technol.* 41(5):1584-1589.
- ²⁸ WATKINS DJ, MCCLEAN, MD, FRASER AJ, WEINBERG J, STAPLETON HM, SJODIN A, WEBSTER TF. 2011. Exposure to PBDEs in the office environment: evaluating the relationships between dust, handwipes, and serum. *Environ Health Persp.* 119:1247-1252.
- ²⁹ STAPLETON HM, EAGLE S, SJOEDIN, WEBSTER TF. 2012. Serum PBDEs in a North Carolina toddler cohort: associations with handwipes, house dust, and socioeconomic variables. *Environ Health Persp.* 120(7):1049-1054.

MIRIAM LEAH DIAMOND - CURRICULUM VITAE

A. BIOGRAPHICAL INFORMATION

1. PERSONAL

Name: **Miriam Leah Diamond**

University address: Department of Earth Sciences
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Toronto, Ontario
Canada, M6G 2T3

Phone: (416) 533-1303

Citizenship: Canadian

2. DEGREES

B.Sc., 1976, Biology, University of Toronto, Toronto, Ontario

M.Sc., 1980, Zoology, University of Alberta, Edmonton, Alberta

“Plumage variability in redpolls (*Carduelis flammea* and *C. hornemanni*, L): A test of Rohwer's status signalling hypothesis”.
Thesis supervisor: W.A. Fuller.

M.Sc.Eng., 1984, Mining Engineering, Queen's University, Kingston, Ontario

“An environmental investigation of the Kognak River at Cullaton Lake Gold Mine”.
Thesis supervisor: J.A. Meech

Ph.D., 1990, Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Ontario

“Modelling the fate and transport of arsenic and other inorganic chemicals in lakes”.
Thesis supervisor: D. Mackay

3. EMPLOYMENT

- 2012-present Associate Editor, *Environmental Science and Technology*
- 2012-present Professor, University of Toronto, Department of Earth Sciences
- 2012-present Cross-appointed to School of the Environment
- 2010-present Cross-appointed to Department of Physical and Environmental Sciences, University of Toronto at Scarborough
- 2003-present Cross-appointed, University of Toronto, Dalla Lana Faculty of Public Health Sciences
- 2007-2012 Cross Appointed to Centre of the Environment
- 2007-2008 Research Director, Centre for Environment
- 2002-2012 Professor, University of Toronto, Department of Geography
- 2001-2002 Acting Director, Collaborative Program in Toxicology, Institute for Environmental Studies
- 1997-2002 Associate Professor, University of Toronto, Department of Geography.
- 1997-present Member, School of Graduate Studies.
- 1999-2003 Associate, Center for Environmental Research, Education and Training, University of Maryland, Baltimore County
- 1993-1997 Assistant Professor, University of Toronto, Department of Geography.
- 1992-present Cross-appointed Professor, Department of Chemical Engineering and Applied Chemistry.
- 1995-1997 Public Health Associate, City of Toronto Department of Public Health.
- 1991-1993 Assistant Professor, University of Toronto, Innis College and Department of Geography.
- 1990-1991 Research Associate, University of Toronto, Institute for Environmental Studies.
- 1990 Post-Doctoral Fellow, University of Toronto, Institute for Environmental Studies.
- 1989 Lecturer, University of Toronto, Institute for Environmental Studies.
- 1985-present Consultant, Self-Employed:
- California Air Resource Board, review of proposal for diesel fuel additive 2010.
 - Lake Onondaga Review panel, 2007-present.
 - Environment Canada, 2004.
 - United States Environmental Protection Agency, 2003.
 - CH2M Hill, Subcontractor for Carson River Superfund Site, 2000-2003.
 - Expert witness, Ontario Municipal Board Hearing, Oak Ridges Moraine, 2001-2002.
 - Health Promotion and Environmental Protection Office, City of Toronto, 2000-2001.
 - Environment Canada, National Water Research Institute, 1998-1999.
 - Environment & Ecology, Inc., Technical Advisor and subcontractor for Carson River Superfund Site, Spring 1993-1998.
 - Minnesota Pollution Control Agency, 1993-1994, 1995-1996.
 - Technical advisor to project funded by the Ontario Min of the Environment, Bay of Quinte RAP, 2001-2003.
 - Ontario Ministry of Environment, Water Resources Branch, 1989-1990.
 - City of Toronto, Environmental Protection Office, 1990, 1991.
 - Environment Canada, National Water Research Institute, 1989-1990.
 - Environment Canada, National Water Research Institute, 1989.
 - Environment Canada, Inland Waters Directorate April-June, 1988.
 - Federal Department of Energy, Mines and Resources, Canada Centre for Remote Sensing, 1985.
- 1984 Limnologist, Ontario Ministry of Natural Resources, Ontario Geological Survey, Geophysics/Geochemistry Section, Toronto, Ontario.

Maternity leaves Sept to Dec 1991, and Feb to May 1995.

Sabbatical leaves January to December 1998, July to Dec 2002, July 2008 to June 2009.

4. HONOURS AND AWARDS

- 2014 Visiting Scientist, Stockholm University, Department of Applied Environmental Science.
2011 INNOLEC Science Guest Chair in Chemistry, Masarykova Univerzita, Czech Republic.
2010 Fellow of the Royal Geographical Society
2007 Canadian Environmental Scientist of the Year, Royal Canadian Geographical Society.
2005 Joseph R. Meyerhoff Visiting Professorship. Weizmann Institute, Israel.
1999-02, 04, 05 Dean's Excellence Award, Faculty of Arts and Science, University of Toronto
1999 2003 Premier's Research Excellence Award, Province of Ontario.
1990 Ontario Ministry of the Environment Excellence in Research Award to Students.
1989-1990 George Burwash Langford Prize for distinctive contributions to environmental research and services to the Institute for Environmental Studies.
1988 John Brown Memorial Prize for Research in Environmental Science and Occupational Health, University of Toronto.
1981-1982 Max Bell Scholarship for Northern Studies, McGill University.
1976 Innis College Medal.

5. PROFESSIONAL AFFILIATIONS AND ACTIVITIES

Current Memberships:

- Society of Environmental Toxicology and Chemistry
American Chemistry Society
International Association for Great Lakes Research
Canadian Association on Water Quality

Activities:

- 2014- Binational Chemicals of Mutual Concern Identification Task Team (ITT) under the Annex 3 of the Great Lakes Water Quality Agreement
2013-2016 Member, Canadian Chemicals Management Plan Science Committee
2013- Member, The Anthropocene Project: Anthropocene Curriculum. Sponsored by Haus der Kulturen der Welt (HKW) in cooperation with the Max Planck Society, Deutsches Museum, the Rachel Carson Center for Environment and Society, and the Institute for Advanced Sustainability Studies.
2012-2013 Co-chair, Ontario Ministry of Environment, "Toxics Reduction Program Living List Multi-Stakeholder Group" (part of activities under the Toxic Reduction Act)
2011 Member, US EPA Science Advisory Board Panel, Review of Technical Support Document, "National-scale Mercury Risk Assessment Supporting the Appropriate and Necessary Finding for Coal- and Oil-Fired Electric Generating Units.
2010-2011 ILSI Risk 21 Project, Working Group on Exposure Science. Sponsored by HESI.
2010-2011 Member, Committee on Blue Water Navy Vietnam Veterans and Agent Orange Exposure. National Academies, Institute of Medicine, U.S. May 2010-June 2011.
2009- , Member, Board of Directors, Canadian Environmental Law Association
2009 US EPA, Review Panel Member, Environmental Sciences Division, May 2009, Las Vegas, Nevada
2008 Co-chair, Toxics Reduction Scientific Expert Panel.
2007-2010 Co-chair, Organizing committee, Annual conference of the International Association of Great Lakes Research held in Toronto May 2010
2007-2011 Member, Science Advisory Board of the International Joint Commission
2006-2013 Member, Canadian Environmental Assessment Agency, Review Panel for Participant Funding Program.
2007-2008 Member, Health-Environment Linkages Expert Panel organized by Statistics Canada

- 2006-2007 Member, Environmental Assessment Working Group sponsored by Health Canada and Environment Canada
- 2006-2011 Member, Editorial Advisory Board, *Environmental Science and Technology*
- 2006-2008 Member of review panel, Water Quality Model of Onondaga Lake.
- 2006 Panel member, Science Advisory Board, U.S. Environmental Protection Agency. Review of EPI Suite models.
- 2005-2008, Member, Board of Directors, Canadian Environmental Law Association
- 2003-2005 Member of local organizing committee, Dioxin 2005. International Conference held in Toronto August 2005.
- 2003-2006 Physical Environment Research Interest Group Director, Centre for Urban Health Initiatives, 6 year support from Canadian Institutes for Health Research.
- 2003 Review committee, Lake Ontario Mass Balance Project
- 2000-2001 Hearing of the Ontario Municipal Board, Oak Ridges Moraine. Expert witness for Save the Rouge Inc.
- 2001-2003 Executive Committee, Board of Society of Environmental Toxicology and Chemistry
- 2000-2003 Board member of Society of Environmental Toxicology and Chemistry
- 1998-2000 Member of Expert Resource Group, for review of Copper and Zinc Smelting Guidelines, Canadian Environmental Protection Act, Environment Canada.
- 1998-2000 Member of Peer Review Panel of Hudson River PCBs RI/FS Phase 2 Reports, Preliminary Model Calibration Report. Sponsored by U.S. EPA.
- 1998-2001 Member of Steering Committee, "How Healthy is the Moira?". In conjunction with the Frost Centre and Environment and Resource Management Dept. of Trent University.
- 1998-2001 Member of Science Review Panel, Lake Michigan Mass Balance Model Project. Sponsored by U.S. EPA.
- 1997-2000 Member of Publications Committee, International Association for Great Lakes Research
- 1996-present Member of Working Group on Fate and Exposure Modeling sponsored by SETAC.
- 1996 Invited participant in 26th Pellston Workshop "Reassessment of Metals Criteria for Aquatic Life Protection: Priorities for Research and Implementation", Society of Environmental Toxicology and Chemistry, Pensacola, Florida, Feb 10-14, 1996.
- 1994-1999 Associate Editor of *Water Quality Research Journal of Canada*.
- 1994-1998 Vice-Chair, Canadian Standards Association Committee on Life Cycle Impact Assessment of Pulp & Paper Production Phase.
- 1993-1994 Member of Working Group on Site Remediation, Waterfront Regeneration Trust.
- 1993-1994 Member of Technical Advisory Committee, International Association of Great Lakes Research.
- 1992 Invited participant in "ASEAN Conference on Women and Technology", CIDA, Bangkok, Thailand.
- 1991-2001 Board Member of the Canadian Environmental Law Association.
- 1991-1992 Member of "Gender, Science and Development", international working group of IFIAS.

B. ACADEMIC HISTORY

6. a. RESEARCH ENDEAVORS

Fate and transport of inorganic and organic contaminants in the environment.

1. Fate of contaminants in lakes.
 - a. Field, experimental and mass balance modelling analysis of the fate and transport of arsenic in Moira Lake, focusing on role of contaminated sediments and sediment-water exchange processes.*
 - b. Experimental analysis of chemical sediment-water exchange and sorption processes.*

- c. Field and experimental analysis of trace metal fate and sediment-water exchange in urban aquatic systems, e.g., stormwater detention ponds.*
 - d. Mass balance modelling of mercury fate in lakes (Great Lakes, shield lakes), and contaminated systems (Lahontan Reservoir, Nevada).*
 - e. Mass balance modelling of contaminants in Arctic and Subarctic lakes and food webs.*
 - i. Collaborator in the Amituk Lake Project, Northern Contaminants Program of the Arctic Environmental Strategy, Dept. of Indian Affairs and Northern Development (1993-1995).*
 - ii. Fate of organic contaminants and mercury in lakes and food webs of the Upper Yukon River Basin and lakes on Bear Island, arctic Norway.*
 - iii. Collaborator in Bear Island (Norway) Project, lake and food web modeling*.
 - iv. Measurement of current use chemicals in Arctic air and water
 - f. Mass balance modelling of contaminants and polyunsaturated fatty acids in Great Lakes and food webs, "Areas of Concern" Bay of Quinte, Hamilton Harbour and Spanish Harbour, and Lake Winnipeg. Contributor to development of Remedial Action Plans (RAPs) and Lake Wide Management Plans (Lake Erie, Lake Ontario).
 - g. Coupling our multispecies mass balance model with chemical speciation-complexation and toxicity models.
2. Fate of contaminants in urban areas.
 - a. Determining ambient concentrations and fate processes of semi-volatile organic contaminants (and metals*) in urban media, including development of analytical methods and event-based sampling of urban streams
 - b. Developing Multimedia Urban Model (MUM) with application to Toronto. Includes spatial and temporal resolution, merging air dispersion module, linkage to GIS.
 - c. Exploring the composition, rate of accumulation, chemical exchange rates, and effects on overall contaminant fate, of thin films on impervious surfaces.*
 3. Fate of contaminants in indoor environments and human exposure.
 - a. Measurement of indoor concentrations and fate of semi-volatile organic compounds, notably halogenated and organophosphate flame retardants, phthalates and PAH.
 - b. Development of Multimedia Indoor Model or MIM.
 - c. Development of indoor passive air sampling methods.
 4. Contaminated site remediation*
 - d. Evaluating environmental and health impacts of site remediation processes.*
 - e. Life-cycle assessment, developing a method to evaluate impacts of site remediation processes. In collaboration with Environmental Protection Office, City of Toronto. *

Exposure and Health Effects of Contaminants in the Environment

5. Evaluating potential health effects
 - a. Collaboration on the toxicology of complex mixtures from urban areas.*
 - b. Development of integrated ecological and human health risk assessment models for the estimation of the effects of urban contaminants.*
 - c. Balancing potential health benefits and risks from omega 3-fatty acids and contaminants in fish.
6. Estimating human exposure
 - a. Estimating human exposure to indoor.
7. Urban agriculture*
 - a. Evaluating health benefits and potential risks from urban agriculture, e.g., Kampala Uganda, Toronto, Ontario.*
8. Life Cycle Assessment
 - a. See 4f.

- b. Within Life Cycle Impact Assessment, development of characterization factors for metals including fate and effects modelling (related to 1g)

Chemical Management

9. Quantifying inventories and Material Flow Analysis of regulated chemicals (PCBs, PBDEs).
10. Analysis of policies, legislation and regulations related to chemical management, as well as flammability codes and standards.
11. Measurement and estimation of physical-chemical properties of semi-volatile organic compounds of concern
12. Planetary Boundary for Chemical Pollution.
13. Chemical Footprint

* Currently inactive

6. b. RESEARCH AWARDS AND CONTRACTS

Awards:

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|-----------|--|
| 2014-2015 | NSERC Equipment Grant, “Chemical analysis of semi-volatile organic compounds in outdoor and indoor environments” \$150,000. With G Evans, J Wallace, J Siegel. |
| 2014-2016 | Chemical Management Plan (CMP) of Health Canada and Environment Canada. CMP Monitoring and Surveillance Fund. Monitoring Organophosphorus Flame Retardants in Canadian homes. M Diamond, L Jantunen, S Harris. \$100,000 over 2 years. |
| 2014-2017 | Health Canada. Clean Air Regulatory Agenda (CARA) “Monitoring and modelling of residential indoor semi volatile organic compounds.” S Harris (Cancer Care Ontario), Miriam Diamond, Paul Villeneuve (Health Canada), Liisa Jantunen (Environment Canada), \$507,100 over 3 years split between University of Toronto and Cancer Care Ontario |
| 2013-2015 | Ontario Ministry of Environment “Characterizing organophosphorus flame retardants in the air and surface water of the Greater Toronto Area”, ML Diamond with P Helm (Ontario Ministry of Environment), L Jantunen (Environment Canada), \$59,280 over 2 years. |
| 2013-2014 | CIHR Catalyst Grant. “Early-life environment and chronic allergic disease: leveraging a prospective study to discover the epigenetic signature.” AK Ellis (Queen’s), ML Diamond, JR Brook (Environment Canada), MS Kobor (University of British Columbia), ML North (Queen’s), \$100,000 for 1 year. My share is 31%. |
| 2013-2014 | Health Canada “Passive air sampling and personal monitoring for semi-volatile organic compounds” ML Diamond, \$9999. |
| 2013-2014 | Northern Contaminants Program. Dept of Aboriginal Affairs and Northern Development. Polycyclic aromatic compounds, flame retardants and other persistent organic pollutants in Canadian Archipelago air and water. \$33,000 for 1 year. L. Jantunen PI. 5 investigators. |
| 2012-2013 | Health Canada, “Multimedia Indoor Model, literature search and beta version of model”, \$9 360 for 1 year. |
| 2012-2013 | Health Canada, “Passive air sampling and personal monitoring for semi-volatile organic compounds”, \$10,000 for 1 year. |
| 2012-2013 | International Aluminum Institute, “Freshwater Ecotoxicity Characterization Factor for Aluminum – Addressing effects of speciation on fate, exposure & toxicity in Life Cycle Impact Assessment”, \$69,000 for 1 year. |
| 2012-2015 | NSERC Accelerator award, \$40,000/yr for 3 years. |
| 2012-2017 | NSERC Discovery, "Emissions, fate, exposure and management of chemical |

- contaminants indoors, outdoors and globally." \$34,000/yr.
- 2012-2019 Industry Canada, AllerGen Network Centre of Excellence, \$36,500,000. J Denburg PI.
- 2011-2012 Great Lakes Research Initiative, funded by the U. S. Environmental Protection Agency. "Great Lakes Polybrominated Diphenyl Ether (PBDE) Institutional Reduction". A. Soehl, M. Diamond, M. Murray. \$65,000 to Diamond as subcontractor.
- 2011-2012 Health Canada, Sources, "Concentrations and Route of Exposure to New Flame Retardants", M. Diamond \$24,499 for 1 year.
- 2011-2012 AllerGen NCE, Strategic Initiatives Research Funding Opportunities Program. "Method for measuring phthalate concentrations representative of exposure". M. Diamond, J. Brook, T. Takaro, A. Wheeler, \$32,900 for 1 year.
- 2009-2012 Hudson Bay Mining and Smelting "Assessment of metal dynamics and ecotoxicity in Ross Lake (MB, Canada) using a coupled metal fate/transport, speciation toxicity (TRANSPEC-Tox) model", M Diamond, \$64,818 total.
- 2011 Environment Canada "Reconnaissance study of coal tar sealcoat application in the GTA and an estimate of related PAH emissions". M Diamond, \$22,000 for 1 year.
- 2010-2012 Great Lakes Commission, Great Lakes Atmospheric Deposition program "How effective are our chemical management policies in reducing Lake Ontario fish contaminant burdens?", M Diamond, P Helm, S. Backus, L Jantunen, M Shoeib \$90,000 US over 3 fiscal years.
- 2010-2011 Ontario Ministry of Environment, Canada-Ontario Agreement, "Determination of Contaminant Loadings from Toronto's Tributaries", M Diamond, \$36,000 over 2 years
- 2010 Canada Foundation for Innovation. "The Canadian Aerosol Research Network (CARN): Climate, air pollution and human health in 2020", J. Abbott, G. Evans et al., \$15148327.
- 2009-2011 Canadian Chemical Management Plan, through Health Canada, via AllerGen Network Centre of Excellence "Novel Approaches for Assessing Exposure to Phthalates" R Allen, M Brauer, J Brook, M Diamond, G Evans, T Takaro \$702,426 over 2 years.
- 2009-2010 Ontario Ministry of Environment "Determination of the relative importance of urban contaminant input pathways to Lake Ontario for selected contaminants", M Diamond, \$50,000.
- 2008-2010 Ontario Ministry of Environment "The testing, optimization and validation of an in-situ large volume surface water sampling device" M. Diamond, \$50,000.
- 2008-2013 CIHR Emerging Collaborative Grant "Santé tenant compte du genre et du sexe", D Mergler, E Balka, K Lippel, K Messing, SA Ritz, J Saint-Charles, M Diamond et al. \$1 million over 5 years.
- 2007-10 NSERC Collaborative Research & Development Grant "LCIA for metals: Improving toxicity characterization factors and applying it to the Canadian environmental context", M Diamond, D Mackay, \$144,985 over 3 years.
- 2007-09 Great Lakes Commission, Great Lakes Atmospheric Deposition program "Urban sources and loadings of toxics to Lake Ontario from an Integrated Measurements and Modelling Approach", M Diamond, P Helm, P Blanchard, S. Backus, \$149,450 US over 2 years.
- 2007-2012 NSERC Discovery, "Connecting chemical sources, emissions, fate and exposure", \$31,090/yr.
- 2006 Environment Canada, National Water Research Institute "Modeling the distribution and fate of pharmaceuticals in Hamilton Harbour", M Diamond \$10,000.
- 2006-09 SETAC-UNEP "Improvement of characterisation factors in Life Cycle Impact Assessment of ecotoxicity (Fate – Exposure – Effects)", M Diamond, D Van De Meent, et al. \$265,500 over 3 years.
- 2005-06 Health Canada "Contaminant and nutrient concentrations in specialty raw and cooked fish and shellfish", \$20,000.
- 2004-06 Environment Canada "Cities: Contaminant fate and effects" M Diamond, \$18,000.

- 2005-06 Toronto and Region Conservation Authority “Toronto tributary study”, \$30,000.
- 2005-06 Ontario Ministry of Environment “Toronto tributary study, pilot study”. \$50,000.
- 2005 Ontario Ministry of Environment “Modelling of polychlorinated naphthalenes in the Lake Ontario food web”, \$9000.
- 2004-05 Ontario Ministry of Environment “Mass balance modelling of metals in Spanish Harbour”, \$27,000.
- 2004-05 Ontario Ministry of Environment “Mass balance modelling of PCBs in Hamilton Harbour”. \$57,000.
- 2004 NSERC Research Tools and Instruments “Analysis of persistent organic pollutants in impacted systems by GC-MS”. \$113,564.
- 2004-2008 CIHR Research Centre Grant “Centre for Urban Health Initiatives”, \$400,000 per year for 6 years. J. Myles PI, Co-applicant.
- 2004-2006 CORILA (Consortium for Coordination of Research Activities Concerning the Venice Lagoon System) “Contaminant fate in the Venice Lagoon: development of an integrated fate model”. 30,000 Euros per year for 3 years.
- 2004-2006 Quinte Conservation Council “Updating the existing model of contaminant fate in the Bay of Quinte”, \$65,000.
- 2003 Ontario Ministry of the Environment “Review of mercury modelling work drafted for contaminated sediment conditions in Peninsula Harbour”. \$10,000.
- 2003-2007 NSERC Discovery Grant “Multimedia contaminant fate and effect in impacted systems”, \$26,500 per year for 4 years.
- 2003 Canadian Network of Toxicology Centres, Metals in the Environment (MITE), “Modelling of Metal Speciation and Movement in a Shield Watershed and Lake”, with G. Spiers (Laurentian University), \$11,000.
- 2002-2006 NSERC Strategic, “Cities: Contaminant fate and effects”, \$411,218 over 4 years, with Co-investigators B. Branfireun and T. Harner.
- 2002-2005 CRESTech, “Contaminant fate and effects in urban areas: development of a decision-support model”, \$150,000 over 3 years.
- 2002-2003 NSERC, Collaborative Research and Development Grant, “Development of a lake systems fate model”, \$17,392 per year for 2 years, with MDA Consulting.
- 2002-2005 CIDA, “Urban agriculture in Kampala, Uganda – health impact assessment and options for improvements”, \$150,000, Prain G, Cole, DC, Lee-Smith D, Diamond M, Kapinga R.
- 2001-2004 CFCAS, “Improvements to air quality models: airborne pollutant-surface film interactions.” \$320,000 total over 3 years, James Donaldson, PI (UofT Chemistry) and Paul Makar (Environment Canada).
- 2001-2002 Canadian Chlorine Coordinating Committee (C4), “Sources and fate of semi-volatile organic compounds in urban and surrounding areas.” \$78,500 total, with G.A. Stern, Freshwater Institute.
- 2000-2002 NSERC, Collaborative Research and Development Grant, “Modelling metal speciation and fate in mine impacted lakes”, \$26,087 per year for 2 years, with L. Evans, Univ. of Guelph.
- 2000-2002 Hudson Bay Mining and Smelting Co. Limited, “Modelling metal speciation and fate in mine impacted lakes”, \$15,000 per year for 2 years, with L. Evans, Univ. of Guelph. \$10,000 in 2002.
- 2000 NSERC Equipment Grant, Gas chromatograph with ECD/FID detector, \$47,195.
- 1999-2004 Premier’s Research Excellence Award, \$20,000 per year for 5 years.
- 1999-2002 Toxic Substances Research Initiative, “Urban air toxics: Source signature and health effects”, \$148,750 per year for 3 years, PI, with B. McCarry (McMaster), T. Harner, T. Bidleman and T. Dann (Environment Canada), P.Harper (Hospital for Sick Children).
- 1999-2003 NSERC Operating Grant, “Multimedia contaminant fate and dynamics in impacted

- systems”, \$17,850 per year for 3 years.
- 1999 NSERC Equipment Grant, Hydrolab Datasonde 4 (with K. Bolton, J. Desloges, B. Branfireun), \$18,776.
- 1999 Dean’s Instructional Initiative Grant, “Development of innovative teaching methods for non-science students”, \$1,000.
- 1999-2001 Canadian Network of Toxicology Centres, Metals in the Environment (MITE), “Modelling of Metal Speciation and Movement in a Shield Watershed and Lake”, with L. Evans (Univ of Guelph), \$56,500 per year.
- 1995-2000 NSERC Operating Grant, “Contaminant fate and dynamics in aquatic systems”, \$14,300 per year.
- 1998-2000 Canadian Chlorine Coordinating Committee, “Multimedia fate and toxicological impacts of chlorinated organic compounds in urban areas”, \$49,500 per year for 2 years, PI, with McCarry (McMaster), Muir (National Water Research Institute), Stern (Freshwater Institute), Harper (Hospital for Sick Children).
- 1999-2002 Minnesota Department of Transportation “Developing a decision tool to predict the ecotoxicological impacts of transportaiton-related chemicals”, \$US100,000 per year for 3 years, with co-PI D. Biesboer (University of Minnesota).
- 1998-1999 Canadian Network of Toxicology Centres, Metals in the Environment (MITE), “Modelling of Metal Speciation and Movement in a Shield Watershed and Lake”, \$6,133.
- 1998-1999 Department of Indian and Northern Affairs, “Contaminant dynamics in lakes of the Upper Yukon River Basin”, \$15,000.
- 1995-1997 Ontario Ministry of Environment & Energy, “Full cycle assessment of environmental and health impacts of site remediation options”, \$50,000.
- 1995-1996 Ontario Ministry of Environment & Energy, “Quantifying chemical release from in-place pollution”, \$18,000.
- 1995-1997 Friends of the Spanish River, “Spanish Harbour sediment mass balance study - enhanced application of the QWASI fugacity/aquivalence model”, \$25,000
- 1993, 94, 97 Department of Indian and Northern Affairs, student travel grant, \$1,500; \$2,000, \$1900, \$2200.
- 1993 Dean’s Instructional Initiative Grant, “Development of environmental science curriculum for non-science students”, \$1,000.
- 1993 NSERC Equipment Award to J. Desloges (V.R. Timmer, J. Gerits, M. Diamond).
- 1993 Ontario Ministry of the Environment, “Hamilton Harbour sediment mass balance study: enhanced application of the QWASI fugacity/aquivalence model”, \$10,000.
- 1992-1997 Department of Indian and Northern Affairs, “Modelling inorganic and organic contaminants in Arctic freshwater lakes”, 1992, \$22,000; 1993, \$23,000; 1994 \$28,000; 1995 \$9,000; 1996, \$24,000, \$1997 \$20,000.
- 1992-1995 NSERC Operating Grant, “Study of the fate and transport of contaminants in aquatic systems”, \$19,000 per year.
- 1992, 1993 Environmental Youth Corps, \$4,000 each year, 1993 jointly held with E. Fawcett, Dept. of Physics.
- 1991-1993 Connaught Fund, University of Toronto, Phase I New Staff Grant, \$10,000.

Contracts:

- 2014 Environment Canada and Health Canada, Chemical Management Plan. “Review of Draft Screening Assessment Report from the Petroleum Sector Stream”
- 2006-07 Toronto Public Health and International Joint Commission. “Review of air pollution-traffic-health connections”, \$4,500.
- 2004 Environment Canada “Review of mercury contamination in Peninsula Harbour”, \$22,000.

- 2003 United States Environmental Protection Agency, "Guidance document on ecological risk assessment for metals: metal sediment chemistry". \$2,000.
- 2002 International Joint Commission, "Forecast and analysis of urban development in the Great Lakes Basin", \$5,000 for our subcontract with GHK International.
- 2001 Bay of Quinte Conservation Authority, Bay of Quinte Remedial Action Plan, "Assessing the feasibility of updating the Bay of Quinte mass balance model", \$10,000.
- 2001 Environment Canada, "Analysis of Urban Development Impacts", \$5,000.
- 2001-2002 CH2M Hill, Sacramento, California, "Lahontan Reservoir Mercury Project", \$46,900
- 2000-2001 City of Toronto, Health Promotion and Environmental Protection, "Conducting a feasibility study for an environmental GIS for the City of Toronto", \$16,500.
- 1998-1999 National Water Research Institute, "Lake Erie LaMP Pollutant Modelling - Background Review", \$20,000.
- 1995-1997 Ecology & Environment Inc., "Development of mercury mass balance model for the Lahontan Reservoir, Nevada", \$US20,000
- 1993-94,95-96 Minnesota Pollution Control Agency, "Extension of the Minnesota fugacity/aquivalence model to treat multiple, interconverting species", US\$11,950; US\$5,000.
- 1991 City of Toronto, Environmental Protection Office, Assist with development of methodological for constructing historical landuse database, \$3,000. Contract held with S. MacRitchie.
- 1990 City of Toronto, Environmental Protection Office, "Review of potential environmental and health effects of site remediation technologies", \$5,000. Contract held with S. MacRitchie.
- 1989-90,90-91 Ontario Ministry of the Environment, "Development of a mass balance model for the Bay of Quinte", \$37,000, \$28,000. Contract held with D. Mackay, Institute for Environmental Studies, U of T.
- 1989,1990 Environment Canada, National Water Research Institute, "Review and modelling of sediment-water exchange processes", \$6,000, \$12,000.
- 1988 Environment Canada, Inland Waters Directorate "Assessing the feasibility of using evaluative models in the development of Canadian Sediment Quality Guidelines", \$5,000. Contract held with T. Clark, MCM Consulting.

C. SCHOLARLY AND PROFESSIONAL WORK

H Index of 29, Total Citations 2707 (Web of Science,30 April, 2014 excluding self-citations).

7. REFEREED PUBLICATIONS

7. a. Articles

103. POSTUMA L, A BJØRN, MC ZIJP, M BIRKVED, **ML DIAMOND**, MZ HAUSCHILD, MAJ HUIJBREGTS, C MULDER, D VAN DE MEENT. 2014. Beyond safe operating space: Finding chemical footprinting feasible. *Environ Sci Technol* 48(11): 6057-6059. DOI: 10.1021/es501961k

102. NORTH ML, TK TAKARO, **ML DIAMOND**, AK ELLIS. 2014. Effects of phthalates on the development and expression of allergic disease and asthma. *Annals of Allergy, Asthma & Immunology*. 112(6): 496-502. DOI: 10.1016/j.anai.2014.03.013

101. BROMMER S, JANTUNEN L, BIDLEMAN TF, HARRAD S, **DIAMOND ML**. 2014. Determination of vapor pressures for organophosphate esters. *J Chem Eng Data*. 59(5): 1441-1447. DOI: 10.1021/je401026a10.1021/je401026a In press.

100. MELYMUK L, M ROBSON, SA CSISZAR, PA HELM, G KALTENECKER, B GILBERT, S BACKUS, L BRADLEY, P BLANDARD, L JANTUNEN, **ML DIAMOND**. 2014. From the city to the lake: loadings of PCBs, PBDEs, PAHs and PCMs from Toronto to Lake Ontario. *Environ Sci Technol* 48(7): 3732–3741.
99. GANDHI N, **ML DIAMOND**, R RAZAVI, SP BHAVSAR, EM HODGE, SB GEWURTZ, GB ARHONITSIS. 2014. A modeling assessment of contaminant fate in the Bay of Quinte, Lake Ontario: 2. Organic chemicals. *Aquatic Ecosys Health Management* 17(2): 137-150. DOI: 10.1080/14634988.2014.910442
98. CSISZAR SA, **ML DIAMOND**, SM DAGGUPATY. 2014. The magnitude and spatial range of current-use urban PCB and PBDE emissions estimated using a coupled multimedia and air transport model. *Environ Sci Technol* 48:1075-1083.
97. MELYMUK* L, M ROBSON+, PA HELM, **ML DIAMOND**. 2013 Application of land use regression to identify sources and assess spatial variation in urban SVOC concentrations. *Environ Sci Technol*. 47(4): 1887-1895. <http://pubs.acs.org/doi/abs/10.1021/es3043609>
96. PANTAZOPOULOS P, JM SAWYER*, ME TURYK, **M DIAMOND**, SP BHAVSAR, D MERGLER, S SCHANTZ, N RATYNAYAKE, DO CARPENTER. 2013. Fatty acids in Great Lakes trout and whitefish. *J Great Lakes Res* 39: 120-127.
95. RYAN MJ, KA KIDD, MV CROFT, S GEWURTZ*, **M DIAMOND**, L KINNEAR, P ROACH. 2013. Biotic interactions in temporal trends (1992-2010) of organochlorine contaminants in the aquatic food web of Lake Laberge, Yukon Territory. *Sci Total Environ* 44:80-92.
94. RAWN DFK, K BREAKELL, V. VERIGIN, S A TITTELMIER, L DEL GOBBO*, **M DIAMOND**, L VANDERLINDEN, D. SIT. 2013. Impacts of cooking technique on polychlorinated biphenyl and polychlorinated dioxins/furan concentrations in fish and fish products with intake estimates. *J Agric Food Chem* 61: 989-997. <http://pubs.acs.org/doi/abs/10.1021/jf304010n>
93. CSISZAR* SA, SM DAGGUPATY, **ML DIAMOND**. 2013. SO-MUM: a coupled atmospheric transport and multimedia model used to predict intraurban-scale PCB and PBDE emissions and fate. *Environ Sci Technol*.47: 436-445. <http://pubs.acs.org/doi/ipdf/10.1021/es3033023>
92. MELYMUK* L, M ROBSON+, PA HELM, **ML DIAMOND**. 2012. PCBs, PBDEs and PAHs in Toronto air: spatial and seasonal trends and implications for contaminant transport. *Science of the Total Environment* 429: 272-280. doi:10.1016/j.scitotenv.2012.04.022
91. CSISZAR* SA, **ML DIAMOND**, LJ THIBODEAUX. 2012. Modeling urban films using a dynamic multimedia fugacity model. *Chemosphere*. 87: 1024-1031.
90. TURYK ME, SP BHAVSAR, W BOWERMAN, E BOYSEN, M CLARK, **ML DIAMOND**, D MERGLER, P PANTAZOPOULOS, S SCHANTZ, DO CARPENTER. 2012 Risks and benefits of consumption of Great Lakes fish. *Environ Health Persp* 120: 11-18. doi:10.1289/ehp.1003396
89. KLÁNOVÁ J, **M DIAMOND**, K JONES, G LAMMEL, R LOHMANN, N PIRRONE, M SCHERINGER, C BALDUCCI, T BIDLÉMAN, KAREL BLÁHA, L BLÁHA, K BOOIJ et al. 2011. Identifying the research and infrastructure needs for the global assessment of hazardous chemicals ten years after establishing the Stockholm Convention. *Environ Sci Technol* 45(18): 7617-7619.

88. GANDHI* N, SP BHAVSAR*, **ML DIAMOND**. 2011. Critical load analysis in hazard assessment of metals using a unit lake model. *Environ Toxicol & Chem* 30(9): 2157–2166.
87. GANDHI* N, **ML DIAMOND**, MAJ HUIJBREGTS, J GUINEE, WJGM PEIJNENBURG, D VAN DE MEENT. 2011. Implications of considering metal bioavailability in estimates of freshwater ecotoxicity: Examination of two case studies. *Int J LCA* 16(8): 774-787. DOI:10.1007/s11367-011-0317-3.
86. ZHANG* X, M ROBSON+, **ML DIAMOND**, C IBARRA, SJ HARRAD. 2011. Polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) indoors in Toronto: concentrations, air/dust distribution, sources and emissions. *Environ Sci Technol* 45: 3268-3274.
85. MELYMUK* L, M ROBSON+, **ML DIAMOND**, L BRADLEY, S BACKUS. 2011. Wet deposition loadings of organic contaminants to Lake Ontario: assessing the influence of precipitation from urban and rural sites. *Atmos Environ.* 45(28): 5042-5049. DOI: 10.1016/j.atmosenv.2011.02.007
84. CSISZAR* S, N GANDHI*, R ALEXYS, DT BENNIE, J STRUGER, C MARVIN, **ML DIAMOND**. 2011. Equivalence revisited – an activity based model to assess environmental behaviour of ionic compounds and its application to pharmaceuticals in Hamilton Harbour. *Environment International* 37(5): 821-828.
83. GANDHI* N, **DIAMOND ML**, RAZAVI* R, BHAVSAR* SP, HODGE* EM. 2011. A modeling assessment of contaminant fate in the Bay of Quinte, Lake Ontario: 1. Metals. *Aquatic Ecosystem Health and Management*. 14(1):85-93.
82. MELYMUK* L., M. ROBSON+, P. HELM, **M.L. DIAMOND**. 2011. Evaluation of passive air sampler calibrations: selection of sampling rates and implications for the measurement of persistent organic pollutants in air. *Atmos Environ.* 45(10):1867-1875.
81. GANDHI* N, M HUIJBREGTS, D VAN DE MEENT, W PEIJNENBURG, J GUINEE, E WEBSTER, D MACKAY, **ML DIAMOND**. 2011. Implications of geographic variability on estimating comparative toxicity potentials of Cu, Ni and Zn in freshwaters of Canadian ecoregions. *Chemosphere* 82(2):268-77.
80. GANDHI* N, **ML DIAMOND**, D VAN DE MEENT, M HUIJBREGTS, A DE KONING J GUINEE, W PEIJNENBURG. 2010. A new method for calculating metals' comparative toxicity potentials for freshwater ecotoxicity: application to copper, nickel and zinc. *Environ Sci Technol.* 44(13):5195-5201.
79. ROBSON+ M, L MELYMUK*, S CSISZAR*, A GIANG*, **ML DIAMOND**, PA HELM. 2010. Continuing sources of PCBs: the significance of building sealants. *Environ Internat* 36:506-513.
78. HARRAD S, C DE WIT, M A-E ABDALLAH, C BERGH, JA BJ BJORKLUND, A COVACI, PO DARNERUD, J DE BOER, **M DIAMOND**, S HUBER, P LEONARDS, M MANDALAKIS, C OSTMAN, LS HAUG, C THOMSEN, TF WEBSTER. 2010. Indoor contamination with hexabromocyclodecanes, polybrominated diphenyl ethers, and perfluoroalkyl compounds: an important exposure pathway for people? *Environ Sci Technol.* 44(9):3221-3231.
77. **DIAMOND ML**, MELYMUK*, L., S. CSISZAR*, M. ROBSON+. 2010. Estimatio of PCB stocks,

emissions and urban fate: will our policies be effective? *Environ Sci Technol* 44(8):2777–2783.

76. SOMMERFREUND* J, **ML DIAMOND**, M FRIGNANI, G CAPODAGLIO, M GERINO, L BELLUCI, S GIULIANI, C MUGNAI+. 2010. Contaminant fate and transport in the Venice Lagoon: results from a multi-segment model. *Environ Ecotox Safety*. 73: 222-230. “Highlighted Article”

75. SOMMERFREUND* J, GB ARHONDITSIS, **ML DIAMOND**, M FRIGNANI, G CAPODAGLIO, M GERINO, L BELLUCCI, S GIULIANI, C MUGNAI+. 2010. Examination of the uncertainty in contaminant fate and transport modeling: a case study in the Venice Lagoon. *Environ Ecotox Safety*. 73:231-239. “Highlighted article”

74. **DIAMOND ML**, GANDHI* N, WJ ADAMS, SP BHAVSAR, C BULLE, P CAMPBELL, A DUBREIL, A FAIRBROTHER ET AL. 2010. The Clearwater Consensus: The estimation of metal hazard in fresh water. *Internat J LCA* 15(2): 143-147. DOI 10.1007/s11367-009-0140-2

73. DEL GOBBO* L, ARCHBOLD J, ECKLEY C, ROBSON+ M, **DIAMOND M**, VANDERLINDEN L. 2010. Mercury and Omega-3 fatty acid concentrations of fish sampled from markets in Toronto: consumption scenarios balancing risks and benefits for childbearing women. *Can J Dietetic Practice and Res*. 71(1): 41-46.

72. GEWURTZ SB, SP BHAVSAR, PW CROZIER, **ML DIAMOND**, PA HELM, CH MARVIN, EJ REINER. 2009. Perfluoroalkyl contaminants in window film from Toronto, Ontario, Canada, and an assessment of carpet as a possible source. *Environ Sci Technol*. 43:7317-7323.

71. HARRAD S, C IBARRA, M ROBSON+, L MELYMUK*, X ZHANG*, **M DIAMOND**, J DOUWES. 2009 Polychlorinated biphenyls in indoor dust from Canada, New Zealand, United Kingdom and United States: implications for human exposure. *Chemosphere*. 76(2):232-238.

70. ZHANG* X., **ML DIAMOND**, SJ HARRAD, C IBARRA. 2009. Multimedia modeling of PBDE emissions and fate indoors. *Environ Sci Technol* 43(8): 2845-2850.

69. WONG* F, ROBSON+ M, **ML DIAMOND**, S HARRAD, J TRUONG+. 2009. Concentrations and chiral signature of POPs in soils and sediments: a comparative urban vs. rural study in Canada and UK. *Chemosphere* 74: 404-111.

68. GEWURTZ* SB, N GANDHI*, GN CHRISTENSEN, A EVENSET, D GREGOR, **ML DIAMOND**. 2009. Application of a food web model to determine the relative influence of lake morphology, nutrients, and contaminant loadings on the dynamics of polychlorinated biphenyls in a high arctic food web. *Environ. Sci. Pollut. Res*. 16(2):176-190.

67. DEL GOBBO* L, TITTELMIER S, PEPPER K, TAGUE B, VANDERLINDEN L. **DIAMOND, M**. 2008. Cooking reduces perfluorinated compound concentrations in fish. *J Agricult Food Chem*. 56(16):7551-7559.

66. ECKLEY CS, B BRANFIREUN, **M DIAMOND**, PC VAN METRE, F HEITMULLER. 2008. Atmospheric mercury accumulation and washoff processes on impervious urban surfaces. *Atmos Environ* 42:7429-7438.

65. WU* R, T HARNER, **ML DIAMOND**. 2008. Evolution rates and PCB content of surface films that develop on impervious urban surfaces. *Atmos. Environ*. 42(24):6131-6143.

64. WU* RW, T HARNER, **ML DIAMOND**, B WILFORD. 2008. Partitioning characteristics of PCBs in urban surface films. *Atmos. Environ.* 42(22):5696-5705.
63. BHAVSAR SP, N GANDHI, **ML DIAMOND**, AS LOCK, G SPIERS, MC ALFARO DE LA TORRE. 2008. Effects of estimates from different geochemical models on metal fate predicted by coupled speciation-fate models. *Environ. Toxicol. Chem.* 27(5):1020-1030.
62. HARRAD S, C IBARRA, **M DIAMOND**, L MELYMUK*, M ROBSON+, J DOUWES, L ROOSENS, AC DIRTU, A COVACI. 2008. Polybrominated diphenyl ethers in domestic indoor dust from Canada, New Zealand, United Kingdom and United States. *Environ Internat.* 34: 232-238.
61. ABDALLAH MA-E, S HARRAD, C IBARRA, **M DIAMOND**, L MELYMUK*, M ROBSON+, A COVACI. 2008. Hexabromocyclododecanes in indoor dust from Canada, the United Kingdom and the United States. *Environ. Sci. Technol.* 42(2):459-464.
60. BHAVSAR* SP, N GANDHI*, **ML DIAMOND**. 2008. Extension of coupled multispecies metal transport and speciation (TRANSPEC) model to soil. *Chemosphere* 70(5):914-924.
59. GANDHI* N, S BHAVSAR*, **ML DIAMOND**, JS KUWABARA, M MARVIN-DIPASQUALE. 2007. Development of mercury speciation, fate and bioaccumulation (BIOTRANSPEC) model: application to the Lahontan Reservoir. *Environ. Toxicol. Chem.* 26(11): 2260-2273.
58. MOREAU-GUIGON E, A MOTELAY-MASSEI, T HARNER, K POZO, **M DIAMOND**, M CHEVREUIL, H BLANCHOUD. 2007. Vertical and Temporal Distribution of Persistent Organic Pollutants in Toronto. 1. Organochlorine Pesticides. *Environ Sci Technol* 41(7):2172-2177.
57. ARCHBOLD* JA, R HULL, **ML DIAMOND**. 2007. Potential importance of inhalation exposures for wildlife using screening-level ecological risk assessment. *Human Ecol. Risk Assess.* 13(4):870-883.
56. **DIAMOND ML**, EM HODGE*. 2007. From source to effect: urban contaminant dynamics. *Environ. Sci Technol.* Feature article. 41(11): 3796-3805.
55. GALARNEAU* E, PA MAKAR, M SASSI, **ML DIAMOND**. 2007. Estimation of atmospheric emissions of six semivolatile PAHs in Canada and the U.S.A. by use of an emissions processing system. *Environ. Sci. Technol.* 41:4205-4213.
54. KWAMENA N-O, JP CLARKE*, TF KAHAN, **ML DIAMOND**, DJ DONALDSON. 2007. Assessing the importance of heterogeneous reactions of polycyclic aromatic hydrocarbons in the urban atmosphere using the Multimedia Urban Model. *Atmos. Environ.* 41(1):37-50.
53. GEWURTZ* SB, N GANDHI*, GA STERN, WG FRANZIN, B ROSENBERG, **ML DIAMOND**. 2006. Dynamics of PCBs in the food web of Lake Winnipeg. *J. Great Lakes Res.* 32:712-727.
52. GANDHI* N, S BHAVSAR*, SB GEWURTZ*, **ML DIAMOND**, A EVENSET, GN CHRISTENSEN, D GREGOR. 2006. Development of a multi-chemical food chain model: application to PBDE in Lake Ellasjoen, Bear Island, Norway. *Environ. Sci. Technol.* 40:4714-4721.

51. NABULO G, H ORYEM-ORIGA, **M DIAMOND**. 2006. Assessment of lead, cadmium and zinc contamination of roadside soils, surface films and vegetables in Kampala City, Uganda. *Environ. Res.* 101:42-52.
50. KLEIN G, EM HODGE*, **ML DIAMOND**, T DANN, G STERN, MS DENISON, P HARPER. 2006. Gas-phase ambient air contaminants exhibit significant dioxin- and estrogen-like activity in vitro. *Environ Health Perspec.* 114(5): 697-703.
49. HARNER T, M SHOEIB, **M DIAMOND**, M IKONOMOU, G STERN. 2006. Passive sampler derived air concentrations of PBDEs along an urban-rural transect: spatial and temporal trends. *Chemosphere* 64:262-267.
48. HARRAD SJ, **ML DIAMOND**. 2006. Exposure to polybrominated diphenyl ethers (PBDEs) and polychlorinated diphenyls (PCBs): Current and future scenarios. *Atmos. Environ.* 40:1187-1188.
47. GEWURTZ* SB, R LAPOSA*, **ML DIAMOND**, N GANDHI*, GN CHRISTENSEN, T SKOTVOLD. 2006. A comparison of contaminant dynamics in arctic and temperate fish: a modelling approach. *Chemosphere* 63:1328-1341.
46. SIMPSON AJ, B LAM*, **ML DIAMOND**, DJ DONALDSON, B LEFEBVRE, A MOSER, A WILLIAMS, N LARIN, M KVASHA. 2005. Assessing the molecular composition of urban surface films through a symbiotic array of nuclear magnetic resonance approaches. *Chemosphere.* 63(1):142-152.
45. JONES-OTAZO* H, **ML DIAMOND**, M RICHARDSON. 2005. An international comparison of screening-level risk assessment approaches. *Risk Analysis.* 25(4): 841-853.
44. LAM* B, **ML DIAMOND**, AJ SIMPSON, PA MAKAR, J TRUONG+, NA HERNANDEZ-MARTINEZ*. 2005. Chemical composition of surface films and implications for atmospheric chemistry. *Atmos. Environ.* 39: 6578-6586.
43. MOTELAY-MASSEI A, T HARNER, M SHOEIB, **M DIAMOND**, G STERN, B ROSENBERG. 2005. Using passive air samplers to assess urban-rural trends for persistent organic pollutants and polycyclic aromatic hydrocarbons. 2. Seasonal trends for PAHs, PCBs, and organochlorine pesticides. *Environ. Sci. Technol.* 39:5763-5773.
42. JONES-OTAZO* H, JP CLARKE*, **ML DIAMOND**, JA ARCHBOLD*, G FERGUSON, T HARNER, MG RICHARDSON, JJ RYAN, B WILFORD. 2005. Is house dust the missing exposure pathway for PBDEs? An analysis of urban fate and human exposure to PBDEs. *Environ. Sci. Technol.* 39: 5121-5130.
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BJØRN A, **ML DIAMOND**, M BIRKVED, MZ HAUSCHILD. Development of a chemical footprint indicator as a measure of the planetary boundary for chemical pollution of freshwater ecosystems. Resubmitted ES&T. Sept 2014.

ABBASI G, AM BUSER, A SOEHL, M MURRAY, ML DIAMOND. Stocks and flows of PBDEs from use to waste in U.S. and Canada from 1970-2020. *Environ Sci Technol* Submitted Aug 2014.

MOCHUNGONG P, G ABBASI, ML DIAMOND, J ZHU. Polybrominated diphenyl ethers and alternative brominated flame retardants in furniture and electric and electronic devices collected from the Greater Toronto Area, Canada. *J Hazardous Mat* Submitted Sept 2014.

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GANDHI H, ML DIAMOND. Freshwater ecotoxicity characterization factors for aluminum. *J Int LCA* In prep.

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Krol A, Serodio A, Diamond ML. 2014. Improving the multimedia indoor model for svocs with a multi-layered foam furniture submodel. REF FOR DIOXIN CONF.

Okeme JO, Poole J, Jantunen L, Serodio, D, Diamond ML. 2014. Vapor pressures and octanol-air partition coefficients of novel brominated flame retardants, organophosphate flame retardants, and selected polybrominated biphenyl ethers. REF FOR DIOXIN CONF.

Serodio D, Diamond ML, Zhang X, Bonnell 4, Sundin N. 2014. Alternative halogenated and organophosphate flame retardants: estimated physical-chemical properties and environmental persistence of 86 novel flame retardants. REF FOR DIOXIN CONF.

Diamond M, 2014. Flame retardants: what have we learned? Invited presentation 97th Canadian Chemistry Conference, Vancouver, International Symposium Chemicals of Emerging Concern.

Abbasi G., Buser A., De Leon F., Diamond M. 2014. Global Flow of Contaminants: From Our Products in North America to Our Waste Around the World. SETAC Europe, 24th Annual meeting; 2014 May 11-15, Basel,

Switzerland. Platform.

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VIGHI M, BACKHAUS T, DIAMOND M, HAUSCHILD M, HOLUBECK I, LOHMANN R, MOLANDER S, PERSSON L, SALA S, SCHERINGER M, VILLA S, ZETZSCH C. 2014. Defining planetary boundaries for chemicals: a proposal for persistent Organic Contaminants (POPs). SETAC Europe, 24th Annual Meeting, Basel, Switzerland. Poster.

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Saini A, Okeme J, **Diamond ML**, Rauert C, Harrad S. 2014. Sorption of SVOCs to fabrics: Towards determining the role of clothing in human exposure. SETAC Europe, 24th Annual meeting; 2014 May 11-15, Basel, Switzerland. Platform.

Diamond M, Bjørn A, Birkved M, Hauschild MZ. 2014. Chemical footprint assessment: presentation of method and application to a case study involving different spatial scales. SETAC Europe 24rd Annual Meeting, Basel, Switzerland. Platform.

ABBASI G, R. WEBER, ML DIAMOND. 2013. Flow of PBDEs in WEEE from US & Canada to Nigeria. 34th Annual Meeting of SETAC North America, Nashville Nov. 17-21, 2013. Poster

GANDHI N. M.L. DIAMOND. 2013. Aluminum: Development of Comparative Toxicity Potentials for Freshwater Archetypes to be used in Environmental Impact Assessments. SETAC North America 34th Annual Meeting, Nashville.

DIAMOND ML, E GOOSEY, G ABBASI, A SAINI, F DE LEON, D SERODIO. 2013. Can we get beyond PBDEs: what have we learned?? SETAC North America, 34th Annual Meeting, Nashville.

DIAMOND ML, M SCHERINGER, C DE WIT, R LOHMANN. 2013. How should we define a planetary boundary for chemical pollution. SETAC Europe, 23rd Annual Meeting, Glasgow UK. Oral presentation.

BJORN A, M. HAUSCHILD, M BIRKVED, **M DIAMOND**. 2013. Approaching the planetary boundary for chemical pollution through a chemical footprint indicator – exploring feasibility via two case studies. SETAC Europe, 23rd Annual Meeting, Glasgow UK. Poster Corner Presentation.

GOOSEY E, S CHAUDHURI, **M DIAMOND**, A SAINI. 2013. Flame retardant (FR) and phthalate spatial variability indoors. SETAC Europe, 23rd Annual Meeting, Glasgow UK. Oral Presentation.

ABBASI G, **M DIAMOND**, R WEBER. 2013. Assessing the mass flow of PBDEs from North America to Nigeria via “used” products. SETAC Africa. South Africa, September.

GOOSEY E, S CHAUDHURI, M DIAMOND, A SAINI. 2013. Flame retardant spatial variability indoors: dust, air and window wipes. 6th International Symposium on Flame Retardants. San Francisco April 7-10, 2013. Poster.

ABBASI G, A BUSER, A SOEHL, M MURRAY, ML DIAMOND. 2013. The fate of PBDEs in the use and waste phases following changes of PBDE levels in products; a SFA application. 6th International Symposium on Flame Retardants. San Francisco April 7-10, 2013. Poster.

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Abbasi G., Buser A., Diamond M., Soehl A., Murray M. Present and future of PBDE inventory in Toronto; An SFA application. SETAC North America Conference. Long Beach, USA 2012. Poster

Chaudhuri, S.R., A. Saini, E. Goosey, H. Qi, M. Venier, M. Diamond. 2012 Phthalates and flame retardants: indoor concentrations, dermal wipes and urine biomonitoring. SETAC North America Conference. Long Beach, USA. Poster.

Yacoob S, ML Diamond, R. Santore. 2012. Assessing metal toxicity based on a combined unit world and kinetic modeling approach. SETAC North America Conference. Long Beach, USA. Poster.

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GOOSEY E, ML DIAMOND, **A SAINI, SR CHAUDHURI, G ABBASI.** 2012. “Novel” flame retardants in Toronto; homes, work and in the park”. 13th Annual Workshop on Brominated and Other Flame Retardants. Winnipeg, June 4-5, 2012. Oral.

∅**DIAMOND ML.** 2012. A planetary boundary for chemical pollution. SETAC Europe 22nd Annual Meeting and SETAC World Congress. Platform Presentation. Berlin, May 20-24, 2012.

∅**DIAMOND ML, L MELYMUK, S CSISZAR, E GOOSEY, G ABBASI, PA HELM.** 2012. Tracing contaminants from urban sources to fate. SETAC Europe 22nd Annual Meeting and SETAC World Congress. Platform Presentation. Berlin, May 20-24, 2012.

YACOUB S, ML DIAMOND, C GUEGEN. 2012. What’s causing toxicity at a zinc-copper mine site? SETAC Europe 22nd Annual Meeting and SETAC World Congress. Poster Presentation. Berlin, May 20-24, 2012.

∅**DIAMOND ML.** 2011. The history of environmental chemistry – the Mackay era and beyond. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Invited oral presentation.

DIAMOND ML, HELM PA, CSISZAR SA, MELYMUK L, ROBSON M, BACKUS S, DAGGUPATY

S, GIANG A. 2011. What we found in our backyard. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Oral presentation.

MELYMUK L et al. PCBs, PBDEs, and PAHs in the urban atmosphere: spatial and seasonal trends and implications for contaminant transport. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Poster presentation.

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HELM PA, GILBERT B, M ROBSON, L MELYMUK, DIAMOND ML. 2011. Transport of PCBs, PBDEs, PAHs, and Polycyclic musks via urban tributaries to Lake Ontario, Canada. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Oral presentation.

CSISZAR SA, DAGGUPATY S, DIAMOND ML. 2011. Predicting urban scale atmospheric PCB and PBDE emissions and fate using the BLFM-MUM model. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Oral presentation.

CHAUDHURI S, S. VERKOYEON, DIAMOND ML. 2011. Intensive indoor measurements and biomonitoring of phthalates: implications for exposure. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Poster presentation.

SAWYER J, ML DIAMOND, M ARTS, G ARHONDITSIS, N GANDHI. 2011. Modelling polyunsaturated fatty acids (PUFA) in freshwater fishes: a kinetic approach. SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Poster presentation.

YACOOB S, ML DIAMOND, N GANDHI. 2011. What's Causing Toxicity at a Zinc – Copper Mine Site? SETAC North America 32st Annual Meeting, Boston, USA, November 13 - 17. Poster presentation.

GANDHI N, MAJ HUIJBREGTS, D VAN DE MEENT, WJGM PEIJNENBURG, J GUINEE, ML DIAMOND. 2011. Development of a new modeling framework to address issues of metal fate and effects in LCIA. SETAC Europe, Milan, May 2011. Platform presentation.

GANDHI N, MAJ HUIJBREGTS, D VAN DE MEENT, WJGM PEIJNENBURG, J GUINEE, ML DIAMOND. 2011. Revised method of hazard and ecological risk assessments for calculating Comparative Toxicity Potentials of metals for which BLMs are not available. SETAC Europe, Milan, May 2011. Poster presentation.

DIAMOND ML, HELM PA, CSISZAR SA, MELYMUK L, ROBSON M, BACKUS S, BRADLEY L, GILBERT B, DAGGUPATY S, JANTUNEN LM. 2011. From sources to urban fate: a contrast of PCBs, PBDEs, PAHs and synthetic musks. SETAC Europe, Milan, May 2011. Platform presentation.

HELM P, M ROBSON, G KALTENECKER, B GILBERT, ML DIAMOND, L MELYMUK, C BRIMACOMBE, T CHEN, T KOLIC, EJ REINER 2011. Urban tributaries as a pathway of PCBs, PBDEs, PAHs, and polycyclic musks to adjacent Lake Ontario, Canada. SETAC Europe, Milan, May 2011. Poster presentation.

DIAMOND ML, CHAUDHURI S, MUKWEDEYA E. 2011. Measurement and modelling of phthalates indoors". AllerGen, Allergy, Genes and Environment Network. Sixth Annual Research Conference,

February 6-8,2011, Vancouver, BC.

SAWYER J, N GANDHI, **ML DIAMOND**, G ARHONDITSIS, M KOOPS. 2010. Transfer and accumulation of polychlorinated biphenyls and polyunsaturated fatty acids through the Bay of Quinte and Hamilton Harbour food web. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

GANDHI N, SB GEWURTZ, PA HELM, SP BHAVSAR, **ML DIAMOND**. 2010 Application of a food web model to evaluate mechanisms controlling biomagnifications of polychlorinated naphthalenes in a Lake Ontario food web. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

GANDHI N, MAJ HUIJBREGTS, D VAN DE MEENT, WJGM PEIJNENBURG, J GUINEE, **ML DIAMOND**. 2010 Development of a new framework to address issues of metal fate and effects in hazard/risk assessment tools for regulatory evaluations. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

GANDHI N, MAJ HUIJBREGTS, D VAN DE MEENT, WJGM PEIJNENBURG, J GUINEE, **ML DIAMOND**. 2010 Application of a new method for calculating ecotoxicity potentials of metals in global freshwaters – A critical analysis of metal hazard assessment. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

GANDHI N, MAJ HUIJBREGTS, D VAN DE MEENT, WJGM PEIJNENBURG, J GUINEE, **ML DIAMOND**. 2010. Implications of geographic differences on estimating exposure and ecotoxicity potential of metals – Application to freshwaters of Canadian ecoregions. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

GANDHI N, MAJ HUIJBREGTS, D VAN DE MEENT, WJGM PEIJNENBURG, J GUINEE, **ML DIAMOND**. 2010. Revised method of hazard and Life Cycle Impact assessments for calculating Comparative Toxicity Potentials of metals for which BLMs are not available. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

Robson, M.E., Melymuk, L.E., Gilbert, B., Helm, P.A. Csiszar, S.A., **Diamond, M.L.** 2010. Polycyclic Musks in the urban environment: Sources trends and fate Poster, SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

Melymuk L, ME. Robson, **ML Diamond**, PA Helm. 2010. Atmospheric Fate and Transport of Selected Organic Pollutants in the Greater Toronto Area. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

Melymuk, L.E., Robson, M., Csiszar, S.A., Diamond, M.L. , Daggupaty, S., Helm,P.A., Backus, S. Bradley, L. and Jantunen, L 2010. Urban Sources and Loadings of Toxics to Lake Ontario from an Integrated Measurements and Modeling Approach. SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11.

Csiszar, S.A., S. Daggupaty, **M.L. Diamond**, L. Melymuk, M. Robson 2010. BLFM-MUM: A coupled atmospheric transport and multimedia model used to study PCBs in Toronto. Platform presentation submitted to the SETAC North America 31st Annual Meeting, Portland, USA, November 7 - 11

Csiszar, S.A., S. Daggupaty, M.L. Diamond, L. Melymuk, M. Robson. 2010 BLFM-MUM: A coupled atmospheric transport and multimedia model used to study PCBs in Toronto: Modeling Urban Films.

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Robson, M.E., Melymuk, L.E., Gilbert, B., Helm, P.A. Csiszar, S.A., Diamond, M.L. 2010. Persistent organic pollutants in rivers: The effects of urbanization and high flow events. Poster, Urban Environmental Pollution Conference, Boston, MA.

Diamond, M.L., S.A. Csiszar, L. Melymuk, M. Robson, P.A. Helm, S. Backus, S. Daggupaty, L. Jantunen, P. Blanchard. 2010. Concentrations, Emissions and Fate of Legacy and Current Use/Production POPs from Toronto, Canada. Oral presentation. Urban Environmental Pollution Conference, Boston, USA, June 20 - 23.

Melymuk, L.E., Robson, M.E., Csiszar, S.A., Diamond, M.L., Helm, P.A. 2010. Atmospheric fate and transport of selected organic pollutants in the Greater Toronto Area. Poster, Urban Environmental Pollution Conference, Boston, MA

Melymuk, L.E., Robson, M.E., Diamond, M.L., Bradley, L., Backus, S. 2010. Urban sources and loadings of organic contaminants to Lake Ontario: assessing the influence of precipitation from urban and rural sites. Poster, Urban Environmental Pollution Conference, Boston, MA

Robson, M., Melymuk, L.E., Csiszar, S.A., Diamond, M.L.*, Daggupaty, S., Helm, P.A., Backus, S., Jantunen, L. 2010. Urban Sources and Loadings of Toxics to Lake Ontario from an Integrated Measurements and Modeling Approach. Poster, SETAC, European Annual Meeting, Seville, Spain.

DIAMOND, ML, SA CSISZAR, N GANDHI, R ALEXY, DT BENNY, J STRUGER, C MARVIN. 2010. Equivalence revisited – an activity based model to assess environmental behaviour of ionic compounds. Platform presentation, Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Seville, Spain.

Robson M, Melymuk LE, Csiszar SA, **Diamond ML**, Daggupaty S, Helm PA, Backus S and Jantunen L. 2010. Urban Sources and Loadings of Toxics to Lake Ontario from an Integrated Measurements and Modeling Approach. Poster. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Seville, Spain.

Gandhi N. M Huijbregts, D van de Meent, W Peijnenburg⁴, J Guinée, E Webster, D Mackay, ML Diamond. 2010. Implications of Geographic Variability on Estimating Comparative Toxicity Potentials of Metals in Freshwaters of Canadian Ecoregions. Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Seville, Spain.

N Gandhi, M Huijbregts, D van de Meent, W Peijnenburg, J Guinée, ML Diamond. 2010. Application of the New Method for Calculating Comparative Toxicity Potential of Metals in Global Freshwater-types. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Seville, Spain.

Csiszar, S.A., S. Daggupaty, **M.L. Diamond.** 2010 BLFM-MUM: A coupled atmospheric transport and multimedia model used to study PCBs in Toronto: Modeling Urban Films. Poster IAGLR 53rd Annual Conference on Great Lakes Research, Toronto, May 17 - 21.

Melymuk, L.E., Robson, **M., Diamond,** M.L., Bradley, L., Backus, S, 2010. Urban Sources and Loadings of Organic Contaminants to Lake Ontario: assessing the influence of precipitation from urban and rural sites. Oral presentation, International Association for Great Lakes Research Annual Conference, Toronto, ON.

Robson, M., Melymuk, L.E., Helm, P.A., Gilbert, B., **Diamond, M.L.**, Backus, S, Jantunen, L. 2010. Urban Sources and Loadings of Toxics to Lake Ontario from the Greater Toronto Area. Poster, International Association for Great Lakes Research Annual Conference, Toronto, ON.

ROBSON M, L MELYMUK, **ML DIAMOND**, PA HELM, S BACKUS, P BLANCHARD. 2009. Polycyclic musks in Toronto rivers: the effects of urbanization and high flow events. International Association of Great Lakes Research, 52nd Annual Conference, Toledo, Ohio.

DEL GOBBO L, J SAWYER, C ECKLEY, **M DIAMOND**, J ARCHBOLD, L VANDERLINDEN, G TOMY. 2009. How much of which fish should we eat? Consumption guidance for Toronto market fish based on contaminants and omega-3 fatty acids. International Association of Great Lakes Research, 52nd Annual Conference, Toledo, Ohio.

MELYMUK L, M ROBSON, A GIANG, S CSISZAR, **M DIAMOND**, P HELM. 2009. Continuing sources of PCBs: the significance of building sealants. International Association of Great Lakes Research, 52nd Annual Conference, Toledo, Ohio.

Robson, M., Melymuk, L.E., Diamond, M. Helm, P., Gilbert, B. 2008. Comparison of Chemical Profiles in Urban Rivers during Base Flow and Storm Events”. Oral presentation, International Association for Great Lakes Research Annual Conference, Peterborough, ON.

DIAMOND ML. 2009. Science meets policy – and politics! 44th Central Canadian Symposium on Water Quality Research.

DIAMOND ML. 2009. An overview of Bisphenol A. Special Symposium on Bisphenol A. 44th Central Canadian Symposium on Water Quality Research.

GANDHI*, N., M.L. DIAMOND, D. VAN DE MEENT, M. HUIJBREGTS, A. DE KONING, J. GUINEE, W. PEIJNENBERG. 2008. New method for calculating metal characterization factors in Life Cycle Impact Assessment. Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Platform.

DIAMOND, ML. 2008. A long range view of long range transport of POPs. Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Invited platform presentation to open session.

MUGNAI, C., SOMMERFREUND, J.K., G.B. ARHONDITSIS, **M.L. DIAMOND**, M. FRIGNANI, G. CAPADAGLIO, M. GERINO, L. BELLUCCI and S. GIULIANI. 2008. Modeling Venice Lagoon fate and transport of POPs and metals in two different wind regimes. Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Poster.

GANDHI*, N., M.L. DIAMOND, D. VAN DE MEENT, M. HUIJBREGTS, A. DE KONING, J. GUINEE, W. PEIJNENBERG. 2008. Influence of aquatic chemistry on fate and toxicity estimates of metals in hazard assessment. Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Platform.

DIAMOND, ML, CSISZAR S, ZHANG X. 2008. Where is my bisphenol A coming from? Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Platform.

ZHANG*, X., **M.L. DIAMOND**, S. HARRAD and C. IBARRA. 2008. Polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) in indoor environments in Toronto. Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Poster.

ROBSON, M, L MELYMUK, P HELM, A GIANG, ML DIAMOND. 2008. Continuing sources of PCBs: the significance of building sealants. Soc. Environ. Toxicol. Chem. (SETAC) North America, Annual Meeting, Tampa, Florida. Poster.

GANDHI, N., M.L. DIAMOND, D. VAN DE MEENT, M. HUIJBREGTS, A. DE KONING, J. GUINEE, W. PEIJNENBERG, B. KOELMANS. 2008. Improvements in estimating metal characterization factors in Life Cycle Impact Assessment – Incorporation of metal speciation into fate and effects calculations. Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Warsaw, Poland.

GEWURTZ S., N. GANDHI*, S. BHAVSAR, G. TOMY, **M. DIAMOND**, K. LAW. 2008. Application of a multi-chemical food web model to assess the dynamics of PBDEs in the food web of Lake Winnipeg, Canada. Brominated Flame Retardants Workshop, Victoria, B.C.

ZHANG, X*, Z., ROBSON*, M., **M. DIAMOND**, S. HARRAD, C. IBARRA. 2008. What controls the emissions and fate of PBDEs indoors. Brominated Flame Retardants Workshop, Victoria, B.C.

GALARNEAU, E., P.A. MAKAR and **M.L. DIAMOND**. 2008. Atmospheric fate of semivolatile PAHs in North America. Abstract submitted to SETAC World Congress, Australia.

Robson, M. ,Melymuk, L., Diamond, M. Helm, P., Gilbert, B., 2007. Persistent organic pollutants in urban environments Invited Presentation, Urban Atmosphere Workshop, hosted by Baltimore Ecosystem Study, National Science Foundation. Baltimore, MA.

GANDHI*, N., **M.L. DIAMOND**, D. VAN DE MEENT, W. PEIJNENBURG, M. HUIJBREGTS, j. GUINEE, G. HUPPES and B. KOELMANS. 2007. Estimation of characterization factors for metals in Life-cycle Impact Assessment of ecotoxicity – analysis of metal speciation, fate and effects issues. Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC), 28th Annual Meeting, Milwaukee.

DIAMOND*, M.L., S. HARRAD, X. ZHANG, L. MELYMUK, S. CSISZAR, J.P. CLARKE, N. GANDHI, S. GEWURTZ, H. JONES-OTAZO. 2007. Cities: from contaminant emissions to exposure. Symposium presentation. Soc. Environ. Toxicol. Chem. (SETAC), 28th Annual Meeting, Milwaukee.

ZHANG*, X., **M.L. DIAMOND**, S. HARRAD and C. IBARRA. 2007. PBDEs – Behaviour in indoor environment – a mass balance fugacity model approach. Symposium presentation. Soc. Environ. Toxicol. Chem. (SETAC), 28th Annual Meeting, Milwaukee.

MELYMUK*, L., M. ROBSON, **M.L. DIAMOND** and P. HELM. 2007. Concentrations and fluxes of persistent organic pollutants to Lake Ontario via the Greater Toronto Area. Symposium presentation. Soc. Environ. Toxicol. Chem. (SETAC), 28th Annual Meeting, Milwaukee.

GEWURTZ*, S., P. CROZIER, **M.L. DIAMOND**, et al. 2007. Perfluoroalkyl contaminants in window film before and after a carpet installation. Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC), 28th Annual Meeting, Milwaukee.

CSISZAR*, S., N. GANDHI, **M.L. DIAMOND**, R. ALEXY, D. BENNIE, J. STRUGER and C. MARVIN. 2007. New model for pharmaceuticals: description and application to Hamilton Harbour.

Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC), 28th Annual Meeting, Milwaukee.

GAHNDI*, N. S. BAHVSAR*, **M.L. DIAMOND**. 2007. Development of a generic method for hazard analysis of substances: Addressing metal speciation, fate and Ecotoxicity Issues. Mining and the Environment International Conference" held in Sudbury during October 19 - 26, 2007. Gandhi won second prize for the best student oral presentation.

MELYMUK, L., S. CSISZAR, J.P. CLARKE, **M.L. DIAMOND***, B. BRANFIREUN, P. HELM and T. HARNER. 2007. Are PCBs legacy POPs? Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Porto, Portugal.

GANDHI*, N., **M.L. DIAMOND**, D. VAN DE MEENT, M. HUIJBREGTS, J. GUINEE, G. HUPPES, W. PEIJNENBERG and B. KOELMANS. 2007. Estimation of characterization factors for metals in Life Cycle Impact Assessment of ecotoxicity – addressing metal fate, exposure and effects. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Porto, Portugal.

CSISZAR*, S.A., **M.L. DIAMOND**, J.P. CLARKE, M.A. BELMONT, L.E. MELYMUK, S.J. HARRAD, P.C. VAN METRE, F.T. HEITMULLER, M. RAO, T. HARNER and B. BRANFIREUN. 2007. Estimating emissions and fate of PCBs and PBDEs from European and North American cities. Platform presentation. 50th Annual Conf Internat. Assoc. Great Lakes Res. Pittsburgh, Penn.

SOMMERFREUND, J.K., G.B. ARHONDITSIS, **M.L. DIAMOND***, M. FRIGNANI, G. CAPADAGLIO, M. GERINO, L. BELLUCCI and S. GIULIANI. 2007. Uncertainty, data limitations and modelling: case study of contaminant fate modelling in the Venice Lagoon. Platform presentation. 50th Annual Conf Internat. Assoc. Great Lakes Res. Pittsburgh, Penn.

MELYMUK*, L., S.A. CSISZAR, **M.L. DIAMOND**, P. HELM, T. HARNER and B. BRANFIREUN. 2007. Are PCBs legacy POPs? An assessment of current PCB use in urban areas. Platform presentation. 50th Annual Conf Internat. Assoc. Great Lakes Res. Pittsburgh, Penn.

GANDHI*, N., R. ALEXIY, S. CSISZAR, M. BELMONT, **M.L. DIAMOND**, D. BENNIE, J. STRUGER, C. MARVIN. 2007. New Model for pharmaceuticals: description and application to Hamilton Harbour. 50th Annual Conf Internat. Assoc. Great Lakes Res. Pittsburgh, Penn.

GALARNEAU*, E., MAKAR, P.A., SASSI, M., **DIAMOND, M.L.** 2007. Atmospheric Emissions and Modelled Regional Fate of Semivolatile Polycyclic Aromatic Hydrocarbons (PAHs) in the Great Lakes Basin. Abstract submitted to 50th Annual Conf Internat. Assoc. Great Lakes Res. Pittsburgh, Penn.

MELYMUK, L., S. CSISZAR, J.P. CLARKE, **M.L. DIAMOND***, B. BRANFIREUN, P. HELM and T. HARNER. 2007. Are PCBs legacy POPs? Platform presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Porto, Portugal.

GANDHI*, N., **M.L. DIAMOND**, D. VAN DE MEENT, M. HUIJBREGTS, J. GUINEE, G. HUPPES, W. PEIJNENBERG and B. KOELMANS. 2007. Estimation of characterization factors for metals in Life Cycle Impact Assessment of ecotoxicity – addressing metal fate, exposure and effects. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC) Europe, Annual Meeting, Porto, Portugal.

CSISZAR*, S.A., R. ALEXIY, N. GANDHI, M. BELMONT, **M.L. DIAMOND**, D.T. BENNIE, J. STRUGER and C. MARVIN. 2007. Pharmaceuticals as environmental contaminants: modelling, distribution and fate (Triclosan, Naproxen, Ibuprofen and Gemfibrozil in Hamilton Harbour). Poster

presentation. Pharmaceuticals and personal care products in the Canadian Environment: Research policies and directions. Niagara-on-the-Lake, Canada.

SOMMERFREUND, J.A., ARHONDITSIS, G. and **DIAMOND***, M.L. 2007. A probabilistic approach for contaminate fate and transport modelling. Canadian Assoc. Water Quality, Burlington, Ont. Platform.

GEWURTZ, S.B., N. GANDHI, S.P. BHAVSAR*, M.L. **DIAMOND**, G.T. TOMY and K. LAW. 2006. Application of a multi-chemical food web model to assess the dynamics of PBDEs in the food web of Lake Winnipeg, Canada. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

DIAMOND, M.L., L. MELYMUK, S. CSISZAR, M. BELMONT, P. HELM and J.P. CLARKE. 2006. Are PCBs legacy POPs? Assessment of current use in an urban area. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

ROBSON*, M., L. MELYMUK, M. **DIAMOND**, B. GILBERT, P. HELM and T. CHEN. 2006. Concentrations of Polycyclic Aromatic Hydrocarbons in River Sediments in the Greater Toronto Area. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

DIAMOND*, M.L., M.A. BELMONT, L.E. MELYMUK*, J.P. CLARKE*, S.J. HARRAD, P.C. VAN METRE, F.T. HEITMULLER, M. RAO and T. HARNER. 2006. More on the fate of PBDEs in cities — a Tale of 3 cities. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

DIAMOND, M.L., S.P. BHAVSAR and N. GANDHI. 2006. Advances in coupled fate and speciation modeling of metals. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

GANDHI*, N., S. BHAVSAR, J.P. CLARKE, L. MELYMUK, S. CSISZAR and M.L. **DIAMOND**. 2006. Assessing the long-term cycling of PCBs in Hamilton Harbour. Oral Presentation. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

GANDHI, N., S.P. BHAVSAR, M.L. **DIAMOND**, D. VAN DE MEENT, M. HUIJBREGTS, J. GUINEE, H. HUPPES, W. PIJNENBERG and B. KOELMANS. 2006. Estimation of Characterization Factors for Metal Fate, Exposure and Effects Issues. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 27th Annual Meeting, Montreal.

DIAMOND, M.L., N. GANHDI, S.P. BHAVSAR, R. RAZAVI, E. HOGDE, J.P. CLARKE, H. LING. 2006. Modelling toxics in Areas of Concern: Lessons learned from Bay of Quinte, Hamilton Harbour. 49th Annual Conf. Internat. Assoc. Great Lakes Res. Windsor, Ont. Platform presentation.

CLARKE, J.P. and M.L. **DIAMOND***. 2006. PCB Dynamics in a city: Application of Multi-media Urban Model. 49th Annual Conf. Internat. Assoc. Great Lakes Res. Windsor, Ont. Platform presentation.

RAZAVI, R., E. HODGE, M.L. **DIAMOND***, G. ARHONDITSIS. 2006. Contaminant fate in Bay of Quinte: A modelling assessment. 49th Annual Conf. Internat. Assoc. Great Lakes Res. Windsor, Ont. Platform presentation.

SOMMERFREUND*, J., M.L. **DIAMOND**, S. GUILANI, M. FRIGNANI, G. CAPODAGLIA. 2006. Modelling contaminants in the Venice Lagoon. 49th Annual Conf. Internat. Assoc. Great Lakes Res. Windsor, Ont. Platform presentation.

THIBODEAUX*, L. and **M. DIAMOND**. 2006. An air-to-surface film chemodynamic model for PAH partitioning to urban surfaces. SETAC Europe, Den Haag, Netherlands. Platform presentation.

BHAVSAR, S.P., **M.L. DIAMOND***, N. GANHDI. 2006. A coupled multispecies metal transport and speciation (TRANSPEC II) model for soil and water. SETAC Europe, Den Haag, Netherlands. Platform presentation.

J.P. CLARKE, **M.L. DIAMOND***. 2006. PCB dynamics in a city: Application of the Multi-media Urban Model (MUM-Fate). SETAC Europe, Den Haag, Netherlands. Poster presentation.

SOMMERFREUND*, J., **M.L. DIAMOND**, S. GUILANI, M. FRIGNANI, G. CAPODAGLIA. 2006. Modelling contaminants in the Venice Lagoon. SETAC Europe, Den Haag, Netherlands. Poster presentation.

Bhavsar, S, Gandhi, N, ***Diamond, M.** 2005. Estimating Critical Loads of metals to surface aquatic systems using a coupled metal TRANsport-SPECiation-TOXicity (TRANSPEC-TOX) model. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 26th Annual Meeting, Baltimore, Maryland.

*Gewurtz, S., Helm, P., Gandhi, N., Bhavsar, S., **Diamond, M.**, Marvin, C., Whittle, D. 2005. Application of a food web model to evaluate the mechanisms controlling polychlorinated naphthalene concentrations in a Lake Ontario food web. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), Baltimore, Maryland.

Gandhi, N., Bhavsar, S., Gewurtz, S., ***Diamond, M.**, Evenset, A., Christensen, G., Gregor, D. 2005. Development of a multi-chemical food chain model: Application to study debromination and bioformation of PBDEs. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 26th Annual Meeting, Baltimore, Maryland.

*Sommerfreund, J., Gandhi, N., Bhavsar, S., Gewurtz, S., **Diamond, M.**, Guiliani, S. and M. Frignani. 2005. A fugacity based assessment of fate and transport of organic contaminants in the Venice Lagoon, Italy. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 26th Annual Meeting, Baltimore, Maryland.

Hernandez-Martinez, N., J. Truong and **M.L. Diamond**. 2005. Variability in surface films on impervious surfaces. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 26th Annual Meeting, Baltimore, Maryland.

DIAMOND, M.L., J. ARCHBOLD, S. BHAVSAR, J. CLARKE, E. HODGE, H. JONES-OTAZO, T. LABENCKI, J. TRUONG, F. WONG and M. MONABBITI 2005. Contaminants in cities: fate, exposure and potential health effects. 4th Annual Urban Health Conference, Toronto. Poster presentation.

*KENNEDY, C. and **M.L. DIAMOND** 2005. Sources and fate of chemical in the urban metabolism. 55th Annual Canadian Chemical Engineering Conference. Toronto, Oct. Oral presentation.

*SOMMERFREUND J., N. GANDHI, S. BHAVSAR, S. GEWURTZ, S. GUILANI, M. FRIGNANI and **M.L. DIAMOND**. 2005 A fugacity/aquivalence-gased assessment of contaminant fate and transport I the Venice Lagoon, Italy. 55th Annual Canadian Chemical Engineering Conference. Toronto, Oct. Poster presentation.

***DIAMOND, M.L.**, J.P. CLARKE, N. HERNANDEZ-MARTINEZ, T. LABENCKI, B. LAM, E. HODGE, H. JONES-OTAZO. 2005. Contaminants in the city: sources and fate. 55th Annual Canadian Chemical Engineering Conference. Toronto, Oct. Oral presentation.

BHAVSAR, S., N. GANDHI and **M.L. DIAMOND***. 2005. Connecting metal loadings with ecotoxicity in lakes using a coupled modelling approach. 55th Annual Canadian Chemical Engineering Conference. Toronto, Oct. Oral presentation.

***DIAMOND, M.L.**, C. BUTT, B. LAM, J. TRUONG, N. HERNANDEZ-MARTINEZ, T. LABENCKI, R. WU, A. SIMPSON. 2005. The Composition and implications of atmospherically-derived films on impervious surfaces. Israel Society of Ecology and Environmental Quality and Science, Annual Meeting, Rehovot, Israel.

*RAZAVI, R., N. GANDHI, S.P. BHAVSAR, S.B. GEWURTZ, B. JONES and **M.L. DIAMOND**. 2005. Chemical dynamics in the Bay of Quinte, Lake Ontario: a comparative modelling approach. 48th Annual Conf. Internat. Assoc. Great Lakes Res. Chicago, Il. Poster presentation.

*BHAVSAR, S.P., **DIAMOND, M.L.**, and GANDHI, N. 2005. Extension of coupled multispecies metal TRANsport and SPECiation (TRANSPeC) model to soil compartment. 48th Annual Conf. Internat. Assoc. Great Lakes Res. Chicago, Il. Oral presentation.

GEWURTZ, S.B., GANDHI, N., CHRISTENSEN, G.N., EVENSET, A., GREGOR, D., STERN, G.A., FRANZIN, W.G., RYAN, M., and **DIAMOND, M.L.** 2005. A Comparison of the mechanisms controlling PCB bioaccumulation in lakes of different latitudes: a modeling approach. 48th Annual Conf. Internat. Assoc. Great Lakes Res. Chicago, Il. Oral presentation.

*GANDHI, N., BHAVSAR, S.P., GEWURTZ, S.B., **DIAMOND, M.L.**, RUSMIR-WOODS, C., and BOYD, D. 2005. Assessing long-term PCB cycling in Hamilton Harbour - An application of integrated fate-transport and food web model. 48th Annual Conf. Internat. Assoc. Great Lakes Res. Chicago, Il. Oral presentation.

*GANDHI, N., BHAVSAR, S.P., **DIAMOND, M.L.**, MORASH, P., and ANDERSON, J. 2005. Impacts of metal dissolution kinetics on recovery of metal contaminated sediments – an application of extended TRANSPeC model to Spanish Harbour. 48th Annual Conf. Internat. Assoc. Great Lakes Res. Chicago, Il. Oral presentation.

HERNANDEZ-MARINTEZ, N., J. TRUONG, **M.L. DIAMOND**. 2005. Variability and temporal trends in urban film composition. 48th Annual Conf. Internat. Assoc. Great Lakes Res. Chicago, Il. Poster presentation.

*WU, R.W., T. HARNER, **M.L. DIAMOND**, A. MOTELAY-MASSEI, C.M. BUTT. 2005. Surface organic films: growth dynamics and response to meteorology. Oral presentation. SETAC Europe. Lille France.

*MOTELAY-MASSIE, A. T. HARNER, P. VAN METRE, C. ECKLEY, B.J. MAHLER, **M. DIAMOND**, B. BRANFIREUN. 2005. Diurnal variations of air-surface exchange for organic pollutants in urban areas. Abstract submitted for oral presentation. SETAC Europe. Lille France.

*GEWURTZ, S.B., N. GANDHI, G.N. CHRISTENSEN, A. EVENSET, D. GREGOR, G.A. STERN, W. FRANZIN, M. RYAN. **M.L. DIAMOND**. 2004. A comparison of the mechanisms controlling POP

bioaccumulation in lakes of different latitudes: a modelling approach. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

*BHAVSAR, S.P., N. GANHDI, J. ARCHOLD, M.L. DIAMOND, R. GOULET. 2004. BIOTRANSPEC-ERA: A model to estimate metal speciation-fate-bioaccumulation and toxicological hazard for LCIA. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

*BHAVSAR, S.P., **M.L. DIAMOND**, N. GANDHI. 2004. Extension of coupled multispecies metal TRANsport and SPECiation (TRANSPeC) model to soil compartment. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

*GEWURTZ, S.B., R. LAPOSA, N. GANDHI, G. CHRISTENSEN, A. EVENSET, D. GREGOR, **M.L. DIAMOND**. 2004. Accumulation of POPs in a high arctic food web: influence of temperature, nutrients, and loadings. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

*LAM, B., ***M.L. DIAMOND**, A.J. SIMPSON, J. TRUONG, N.A. HERNANDEZ, J.D. DONALDSON. 2004. Chemical composition of surface films and their related implications to atmospheric chemistry. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

*HERNANDEZ, N.A., **M.L. DIAMOND**, J. TRUONG, J. DONALDSON. 2004. Variability and reproducibility of surface films on impervious urban surfaces. Poster presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

WONG, F., **M.L. DIAMOND***, M. ROBSON, S.J. HARRAD, T.F. BIDDLEMAN, J. TRUONG. 2004. Chiral signature of PCBs and organochlorine pesticides along an urban-rural transect. Oral presentation. Soc. Environ. Toxicol. Chem. (SETAC), 25th Annual Meeting, Portland, Oregon.

*GANDHI, N., S.B. *GEWURTZ, S.P. BHAVSAR, G.N. CHRISTENSEN, A. EVENSET, D. GREGOR, T. SKOTVOLD, **M.L. DIAMOND**. 2004. A coupled fate-transport and food chain model for PBDEs in the High Arctic: application to Lake Ellasjoen, Bear Island, Norway. 3rd International Workshop on Brominated Flame Retardants. Toronto, Canada. Poster.

JONES-OTAZO, H., J.P. CLARKE, J. ARCHBOLD, **M.L. DIAMOND**, J.J. RYAN, G. FERGUSON. 2004. A preliminary comparison of Canadian PBDE exposures from oral and inhalation routes. 3rd International Workshop on Brominated Flame Retardants. Toronto, Canada. Poster.

ARCHBOLD, J.A., R.N. HULL, **M.L. DIAMOND**. 2004. Take a deep breath – its time to reconsider wildlife inhalation risk. SETAC Laurentian, Ottawa, Canada. Poster.

*GEWURTZ, S.B., N. GANDHI, G.A. STERN, W. FRANZIN, **M.L. DIAMOND**. 2004 Dynamics of POPs in the biota of Lake Winnipeg: a modeling approach. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Oral presentation.

*GEWURTZ, S.B., R. LAPOSA, N. GANDHI, G.N. CHRISTENSEN, A. EVENSET, D. GREGOR, T. SKOTVOLD, **M.L. DIAMOND**. 2004. A comparison of contaminant dynamics in arctic and temperate fish. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Poster presentation.

*HERNANDEZ, N. **M.L. DIAMOND**, J. TRUONG, D.M. LAPIERRE, B.L. FRYER. 2004.

Contaminant fate in organic films on impervious urban surfaces. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Poster presentation.

*LABENCKI, T.L., **M.L. DIAMOND**, J. TURONG, D.M. LAPIERRE, B.A. BRANFIREUN. 2004. Characterization of wash-off from urban impervious surfaces. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Oral presentation.

*GANDHI, N. S.P. BHAVSAR, **M.L. DIAMOND**, D. GREGOR, A. EVENSET, G.N. CHRISTENSEN. 2004. Concentrations in the aquatic food chain of Lake Ellasjoen, Bear Island, Norway. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Poster presentation.

JONES-OTAZO, H., J.P. CLARKE, ***M.L. DIAMOND**, J. ARCHBOLD, J. RYAN, E.M. HODGE, Q.-T. LIU, J. TRUONG, C.M. BUTT, M. IKONOMOU. 2004. Predicted urban loadings and risk of human health effects from multimedia exposure to semi-volatile organic contaminants. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Oral presentation.

BUTT, C.M., R.W. *WU, T. HARNER, **M.L. DIAMOND**, B.A. BRANFIREUN. 2004. Characterization of surface organic films in urban centers. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Poster presentation.

*CAMPBELL, L.M., D.G. DIXON, M. EVANS, **M.L. DIAMOND**, S.B. GEWURTZ, R.E. HECKY, K.A. KIDD, L. LOCKHART, D.C.G. MUIR, G.A. STERN. 2004. Mercury trophodynamics across latitudes. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Oral presentation.

*BHAVSAR, S.P., J. TRUONG, **M.L. DIAMOND**, B.J. FRYER. 2004. Spatial and temporal variations of metals in film on exterior surfaces of glass windows: a promising passive air sampler. 47th Annual Conf. Internat. Assoc. Great Lakes Res. Waterloo, Ont. Oral presentation.

MAKAR, P.A., **M. DIAMOND**, D.J. DONALDSON, J. TRUONG, A. ASAD, N.H. MARTINEZ, E. DEMOU and H. VISRAM. 2004. Organic absorptive partitioning: theoretical predictions and comparisons to measurements. European Geophysical Union Annual Meeting, Nice, France.

WONG, F., **M. DIAMOND***, J. TRUONG, M. ROBSON, S. HARRAD, T. BIDDLEMAN. 2003. Accumulation and chiral analysis of organic chemicals in forest soils along an urban-rural gradient. Soc. Environ. Toxicol. Chem. (SETAC) 24th Annual Meeting in North America, Austin, TX. Oral presentation.

* **DIAMOND, M.L.**, J.A. ARCHBOLD, S.P. BHAVSAR, M. MONABBATI. 2003. Fugacity in the city: MUM-Fate and MUM-Risk. Soc. Environ. Toxicol. Chem. (SETAC), 24th Annual Meeting, SETAC in North America, Austin, TX. Oral presentation.

*LABENCKI, T., **M. DIAMOND**, J. TRUONG, D. LAPIERRE, B. BRANFIREUN. 2003. Characterization of wash-off from urban impervious surfaces. Soc. Environ. Toxicol. Chem. (SETAC), 24th Annual Meeting in North America, Austin, TX. Poster presentation.

*GANDHI, N., S.P. BHAVSAR, **M.L. DIAMOND**, E. BYRON, J.S. KUWABARA, M. MARVIDIPASQUALE, W. PRASKINS. 2003. Application of BIOTRANSPEC model to estimate mercury speciation, fate and bioaccumulation in Lahontan Reservoir, Nevada. Soc. Environ. Toxicol. Chem. (SETAC), 24th Annual Meeting in North America, Austin, TX. Oral presentation.

*JONES-OTAZO, H., **M.L. DIAMOND**, J. CLARKE, G.M. RICHARDSON. 2003. An international comparison of screening-level risk assessment modelling approaches. Soc. Environ. Toxicol. Chem. (SETAC), 24th Annual Meeting in North America, Austin, TX. Oral presentation.

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MACKAY*, D., M.L. DIAMOND and W. STIVER. 1990. Modelling sediment-water interactions. Paper presented at Symp. on Organic Substances in Sediments and Water, Amer. Chem. Soc. Meeting, Boston, Mass.

DIAMOND*, M.L., W. STIVER and D. MACKAY. 1989. The Linear Additivity Principle and its use for assessing chemical contributions from contaminated sediments. Paper presented at Soc. Environ. Toxicol. Chem., 10th Annual Meeting, Toronto.

MACKAY*, D., W.Y. SHIU and M.L. DIAMOND. 1989. Characteristics of contaminant condensation in cold climates. Paper presented at Soc. Environ. Toxicol. Chem., 10th Annual Meeting, Toronto.

DIAMOND*, M.L. and D. MACKAY. 1989. Extending the fugacity approach to inorganic chemical behaviour in lakes: estimating contributions from contaminated sediments. Paper presented at 40th Amer. Inst. Biol. Sci. Meeting, Toronto.

DIAMOND*, M.L. and D. MACKAY. 1989. Modelling chemicals in the Great Lakes: Applying a novel equilibrium criterion, "equivalence". Paper presented at 32nd Conf. of Internat. Assoc. for Great Lakes Research, Madison, Wisconsin.

MACKAY*, D., **M.L. DIAMOND** and W. STIVER. 1989. A simple method for estimating chemical profiles in sediments. Paper presented at 32nd Conference of Internat. Assoc. for Great Lakes Research, Madison, Wisconsin.

MACKAY*, D. and **M.L. DIAMOND**. 1988. Aquivalence: A “new improved” substitute for fugacity in environmental modeling and interpretation. Paper presented at Soc. Environ. Toxicol. Chem., 9th Annual Meeting, Arlington, Virginia.

DIAMOND*, **M.L.**, D. MACKAY, S. LANDSBERGER, and A.G. CHENG. 1988. Modelling arsenic dynamics in a contaminated lake. Paper presented at Internat. Conf. Trace Metals in Lakes, Hamilton.

DIAMOND*, **M.L.** and D. MACKAY. 1988. Modelling the movement of inorganic chemicals in lakes. Paper presented at 31st Conf. of Internat. Assoc. for Great Lakes Research, Hamilton, Ontario.

DIAMOND*, **M.L.**, D. MACKAY, D. PHALP and S. LANDSBERGER. 1988. First a sink, then a source: arsenic dynamics in Moira Lake sediments. Paper presented at Conf. Can. Soc. Limnol., Ottawa.

DIAMOND*, **M.L.**, R.J. CORNETT and D. MACKAY. 1986. Modelling the fate of arsenic in lakes. Poster presented at Technology Transfer Conf., Ontario Ministry of the Environment, Toronto.

* author presenting the paper

♀ invited presentation

11. INVITED LECTURES

- 2014 “What have we learned (or not learned) from PBDEs?”, Institute for Chemical and Bioengineering, ETH (Swiss Federal Institute of Technology) Zurich. May 8, 2014. 1 hour.
- 2014 “What have we learned (or not learned) from PBDEs?”, Swedish University of Agriculture, Stockholm. May 6, 2014. 1 hour.
- 2013 “Following the paths travelled by halogenated flame retardants”, University of Manitoba, March 15, 2013. 1 hour.
- 2013 “Following the paths travelled by halogenated flame retardants”, Brace Centre for Water Resources Management, McGill University, January 31, 2013. 1 hour.
- 2013 “The Flame Retardant Story”, McMaster University, McMaster Institute for Environment and Health. January 19, 2013 1 hour.
- 2013 “The Flame Retardant Story”, Environment Canada, Air Quality Research Division. 1 hour.
- 2012 “Recent advances in metal characterization”, co-sponsored by University of Copenhagen (Faculty of Sciences) and Danish Technical University (Dept of Environ Engineering)
- 2012 “The flame retardant story”. Stockholm University. In the series “Lectures in Contaminant Science”, and a 2nd lecture at IVL Swedish Environmental Research Institute, Stockholm.
- 2011 “Tracing chemicals from source to exposure”. Lecture & webinar at Ontario Agency for Health Protection and Promotion. May 2011.
- 2011 “Stockholm Convention in the context of preventative engineering, alternatives assessment, and sustainability re: POPs”. Plenary address at “RECETOX Workshop. Identifying the research needs in the global assessment of toxic compounds ten years after the signature of the Stockholm Convention”. Brno, Czech Republic, 22-24 May 2011.
- 2011 Emerging pollutants. Innolec Lectures. Masarykova Univerzita, Czech Republic.
- 2010 Where are chemicals in the lakes coming from and what does it mean? Toronto and Region Conservation Authority, Great Lakes Evening,
- 2010 Sources of brominated flame retardants: BFRs - from source to lake. Webinar organized

- by the Great Lakes Commission.
- 2010 Tracing the pathways of polybrominated diphenyl ethers. CML Leiden University, The Netherlands.
- 2010 Connecting metal emissions with ecotoxicology through modelling. Departments of Chemistry and Physics, Trent University.
- 2010 Where the water hits the road – urban water pollution issues. University of Maryland at Baltimore.
- 2009 Contaminants in Us -- Much Ado about Nothing or Serious Stuff? Dept of Chemistry, University of Winnipeg. Departmental seminar.
- 2009 The Science, Art and Politics of Chemical Management. SETAC Laurentian Annual Meeting, Plenary Talk.
- 2009 Source to sink to management and beyond: the story of PCBs. Dept. of Chemistry, Umeå University, Sweden.
- 2009 Can we manage our toxics? From science to policy to politics. Duke University, North Carolina.
- 2008 The Simpsons, Toxic Chemicals and the Future. Centre for Environment, University of Toronto.
- 2008 The Simpsons, the Chemical Management and the Future of the World. Ontario Ministry of Environment.
- 2008 Bisphenol A and Ontario's Toxic Reduction Strategy", Ontario Ministry of Environment, Drinking Water Division, Drinking Water Symposium, Toronto, June 17, 2008,
- 2008 How did that chemical that was inside my computer get inside me? Royal Canadian Institute seminar series.
- 2008 Urban Thin Films. AirUCI* Annual Workshop, Invited opening talk, University of California at Irvine. *Atmospheric Integrated Research: Understanding Chemistry at Interfaces.
- 2007 Approaching sustainability: cities, contaminants and health. University of Saskatchewan
- 2007 Tress and People in Cities: How do we best achieve health benefits? International Congress "A Global Vision of Forestry in the 21st Century", Faculty of Forestry, University of Toronto.
- 2007 Connecting the dots between contaminant emissions and exposure in cities. CEAS Seminar Series. Dept. of Chemical Engineering. University of Manchester.
- 2007 Connecting the dots between contaminant emissions and exposure. Division of Environmental Health and Risk Management. University of Birmingham.
- 2006 POPs in the City. Plenary lecture, 1st Network Conference on Persistent Organic Pollutants: human exposure and impacts, University of Birmingham.
- 2006 Chemical contaminants in Toronto: Concentrations to potential effects. Health Canada Workshop, Place Matters: Health Difference in Ontario Cities and Neighbourhoods.
- 2006 Brominated flame retardants – from source to exposure. Environmental Physician's Group of Ontario Medical Association, seminar series "Clinical Reviews".
- 2005 Brominated flame retardants: environmental pathways and human exposure. Dept. of Environmental Chemistry and Energy, Weizmann Institute, Israel.
- 2005 Tracing contaminant sources and potential health effects: the Toronto experience. Environment & Health seminar series, Institute for Environmental Studies, University of Toronto.
- 2004 9/11: The chemical signature. University of Birmingham.
- 2004 The fate, exposure & potential risks of persistent organic pollutants in urban areas. Makerere University.
- 2004 Air pollution-health connections: complexity at its best. Guest speaker, Symposium on Windsor Air Quality, sponsored by Windsor Essex County Environment Committee,

- Windsor, Ontario.
- 2003 Surface films on impervious surfaces: implications for contaminant fate and effects. PPG Industries (Pittsburgh Plate and Glass), Glass Technology Center, Pittsburgh, PA.
- 2003 Cities: The Good, the Bad and the Ugly. Invited seminar, Great Lakes Institute for Environmental Research, University of Windsor.
- 2003 Multimedia Movement and Risk of Contaminants in Urban Areas. SETAC, Laurentian Chapter. Keynote address.
- 2002 Contaminant Fate and Effects in Urban Areas. Invited seminar, Meteorological Service of Canada, Environment Canada.
- 2002 Cities: Contaminant Fate and Effects. Invited seminar, Health Canada.
- 2002 Urban Toxics Monitoring in Toronto. Binational Toxics Strategy Integration Workgroup Meeting, co-sponsored by Environment Canada and the United States Environmental Protection Service. Windsor.
- 2002 Estimating the fate, bioavailability and potential toxicological risk posed by metals in the environment. Keynote address, International Workshop on Life Cycle Assessment and Metals. Co-sponsored by UNEP, SETAC, APEC-GEMEED, ICM and NRCan. Montreal.
- 2002 Methods of Model Validation: Principles and Examples. Invited presentation at International Workshop on "Design of exposure multi-media models and conditions for application to soil pollutants: an international workshop." Organized by Institut de Veille Sanitaire, France.
- 2001 Urbanization: Effects on Contaminant Fate. Dept. of Environmental Engineering, Ryerson University.
- 2000 Current issues in urban air pollution. Presentation to the Environmental Assessment and Appeal Board of the Ontario Ministry of the Environment.
- 2000 Multimedia models: description and assessment for air quality modelling. Workshop on Combining Environmental Fate and Air Quality Modeling, Sponsored by the Reactivity Research Working Group Subgroup 3 on Atmospheric Availability and Environmental Fate, Research Triangle Park, NC.
- 2000 Chemical contaminants in urban areas and their potential impacts on human and ecosystem health. Issues in Urban Health. 22nd University College Symposium. Jan 31 to Feb 4, 2000.
- 1999 Fate and transport of toxics in urban ecosystems. Department of Geography, University of Maryland, Baltimore County and Baltimore Ecosystem Study.
- 1999 Behaviour of arsenic in Moira Lake. "How Healthy is the Moira" workshop, Trent University.
- 1999 Contaminants in urban areas: movement and effects. Environment and Health Seminar Series, Institute for Environmental Studies and Gage Occupational and Environmental Health Unit, University of Toronto.
- 1998 The multi-media movement of contaminants in urban areas and their accumulation on impervious surfaces. York University, Department of Geography Graduate Programme.
- 1997 Multi-media chemical distribution in urban areas: the role of organic films. State University of New York at Albany, Department of Environmental Health and Toxicology, School of Public Health.
- 1997 An overview of multi-media modelling and its use as a decision-making tool. Minnesota Department of Transportation.
- 1997 Mercury in aquatic systems. Invited presentation at "Mercury elimination and reduction symposium", Organized by Pollution Probe. Toronto, Ontario.
- 1997 Mercury cycling in the environment and its toxicological implications. Environment and Health Seminar Series, Institute for Environmental Studies and Gage Occupational and Environmental Health Unit, University of Toronto.

- 1996 Can we build habitable cities without damaging the environment? Public forum on “Mitigation of Environmental Impacts of Urban Development”. Co-sponsored by the York Chapter, Professional Engineers Organization and the Rotary Club of Richmond Hill.
- 1996 Mercury: what models can tell us. Seminar sponsored by: Severson Environmental Services, Inc., Dept. of Civil Engineering, Great Lakes Program and NYS Center for Hazardous Waste Management, University of Buffalo.
- 1994 Contaminants in Arctic Lakes: Behaviour and Fate. Ecology Seminar Series, Co-sponsored by Departments of Botany and Zoology, University of Toronto.
- 1992 A simple model of mercury dynamics in a lake. Ontario Hydro, Research Division, Toronto.

D. LIST OF COURSES

12. a. UNDERGRADUATE COURSES TAUGHT

- 2014-present ESS 299Y. UNDERGRADUATE RESEARCH OPPORTUNITY. Clara Thaysen. Contaminant-Fabric Dynamics: Experiments assessing sorption and release.
- 2013-present BIG 102Y. THE INTERNET: SAVING CIVILIZATION OR TRASHING THE PLANET? One of three instructors for this high profile 1st year course.
- 2010-2013, 2015 GGR 308. PHYSICAL ASPECTS OF THE CANADIAN ARCTIC AND SUBARCTIC. Chief cook and bottle washer.
- 2009-2013 JGE 236Y. HUMAN INTERACTIONS WITH THE ENVIRONMENT. Course coordinator, co-taught. 2012 offered as a ½ course.
- 2006-2008 JEG 221Y ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT. Course coordinator (with S. Scharper in 2006-07). Delivery of 1/3 of lectures plus participation in 3 panel discussions, review, etc. Jointly offered by Geography and Centre for Environment.
- 2001-02, 04 GGR 307S SOIL AND WATER: LANDSCAPE PROCESSES. Responsible for course that includes lectures, group research projects, problem set and exam.
- 2000-07 SCI 199Y1 ENVIRONMENTAL CHANGE. Co-taught with Tony Davis or Danny Harvey. IMAGES AND INDICATORS: MEASURING ENVIRONMENTAL PERFORMANCE. Co-taught with Virginia Maclaren.
- 1997-98 GGR 299Y RESEARCH OPPORTUNITY PROGRAM. Diane Leal and John Roppa.
- 1994-2006 GGR 233Y ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE DEVELOPMENT. Spring term. Co-lectured with J. Newton in 1994. Enrolment starts at 200, with about 150 finishing. Enrolment in 2003 is 180. Responsible for lectures, supervising T.A.s, assignments and final exam (marked part thereof). The course introduces students in the Environment and Resource Management Program with the scientific (basic and applied) basis of environmental issues.
- 1994-95 GGR 491Y INDEPENDENT RESEARCH I. Lisa Sumi (co-supervised with J. Gerits and M. Alae, National Water Research Institute).

- 1997-98 Katina Kominos.
 1992-93 Andrew Rodie (co-supervised with J. Gerits);
 2003 Alison Bodurtha.
 2013 Brielle Carriero (half credit)
- 1993-2002 ENV 221Y APPROACHES TO ENVIRONMENTAL ISSUES I. Team taught with Prof. J. Grant, Prof. S. Scharper and Dr. M. Winfield. My component is 6 weeks. Enrolment 60 to 85. Provides students with the approaches taken to environmental issues by various disciplines, using a case study as a unifying theme. I teach the environmental science/physical geography component, discussing the scientific concepts and approaches specific to the case study.
- 1993-97 ENV 200Y ASSESSING GLOBAL CHANGE: SCIENCE AND THE ENVIRONMENT. Prof. A. Zimmerman coordinates and lectures for most of the course, with my component being 2 to 3 weeks. Enrolment about 300. Science breadth course. Goal is to expose non-science students with the science behind environmental issues.
- 2008-09 ENV 498Y INDEPENDENT RESEARCH IN ENVIRONMENT. David Berliner
 2000 Christina Lee (co-supervised with D. MacDonald).
 1995-96 Jean-Guy Pageau
 1997-98 Kirsten Fertuck
- 1993-94 INI 491Y INDEPENDENT STUDY. Tulio Bugada, Steve Drescher, Steven Ogilvie.
 1992-93 Neil Banerjee (co-supervised with S.D. Scott, Geology, Geotechnical Engineering); Maria Terra (co-supervised with L. Grima).
 1991-92 Leslie Megson (co-supervised with R. Shimizu, Institute for Environmental Studies), Michelle Perera.
- 2010-11 CHE 499Y THESIS (CHEMICAL ENGINEERING)
 Evelyn Mukwedeya "Spatial and temporal variations of phthalate concentrations in Vancouver homes"
- 2009-10 Vivian Cheung
 2005-06 Jennifer Sears
 2004-05 Queenie Cheung
 2003-04 Bushra Drir
 2001-02 Ian Collins
 1999-00 Liam Moore, Trinh Tieu
 1993-94 Alan Teare
- 1992-2012 GGR 409F CONTAMINANTS IN THE ENVIRONMENT. Enrolment up to 30. From 1993 to present, physical science course. Responsible for all components of course. Lectures are supplemented with tutorials to provide students with a scientific understanding of the processes and factors controlling contaminant behaviour and effects in the environment. Problem sets introduce quantitative methods to estimate chemical fate, including simple mathematical modelling.
- 1992 (spring), 1992-93 INI 220Y ENVIRONMENTAL FACTORS AND DECISION MAKING.
 Enrolment 100. Responsible for lectures, supervising T.A.s, assignments and final exam (marked the latter). Provided students with tools for environmental assessment and sectoral impacts. Included guest lectures.

1992, 1993 INI 320Y CANADIAN ENVIRONMENTAL ISSUES. Spring term. Enrolment 80. Responsible for lectures, course organization, supervising T.A.s and marking portion of student reports. Co-taught with Dr. Beth Savan in 1992-93. Using principles of adult education, students were guided through two research projects in the term.

12. b. GRADUATE COURSES TAUGHT

1992-2013 JGE 1212H CONTAMINANTS IN THE ENVIRONMENT. Offered in conjunction with GGR 409 in 1992-93 and 1994-95, 1995-onwards (science version), offered as stand-alone social science course in 1993-94 and 1995-96. Enrolment varies from 5 to 13. Course has shifted from first catered to all graduate students, next for social science and planning students, and finally for science and health students. Course introduces scientific concepts behind environmental concerns and discusses policy and scientific aspects of selected environmental topics. Now offered as JGE 1212H, jointly listed with Centre for Environment.

2010 GGR 1200F PHYSICAL GEOGRAPHY CORE COURSE. Co-taught with W. Gough.

1996-1997 GGR 1213S FATE OF CONTAMINANTS IN LAND AND WATER. Co-taught with K. Bolton in 1996. Physical science course covering contaminant-soil interactions (Bolton) and multimedia contaminant dynamics (Diamond).

1995-1997 GGR 1400H CURRENT RESEARCH APPROACHES IN ENVIRONMENTAL GEOGRAPHY. Introduction to research methods, and development and vetting of research proposal. Directly supervise my graduate students and contribute to lectures.

1995-96, 01, 03 GGR 1149H READINGS IN SELECTED TOPICS. Judy Fedorowick, Sherry Eaton, Sarah Gewurtz, Lise Sabatier

1994-95 GGR 1400H CURRENT RESEARCH APPROACHES IN ENVIRONMENTAL GEOGRAPHY. Co-coordinator (with R. Jaakson), enrolment about 10.

1993-94 GGR 1400H CURRENT RESEARCH APPROACHES IN ENVIRONMENTAL GEOGRAPHY. Course coordinator.

2000 MSC 4000 SEMINARS IN ENVIRONMENT AND HEALTH. Team taught with F. Silverman and D. Cole. Seminar course designed to expose students to current topics and researchers in the multidisciplinary field.

1990-91 ESE 1008S ENVIRONMENTAL MANAGEMENT II: REMEDIAL ACTION PLANS IN THE GREAT LAKES. Course coordinator and lecturer, co-designed course (with G. Krantzberg).

1989 ESE 1014F AQUATIC CHEMISTRY. Developed and coordinated course, lectured and evaluated students.

1989 ESE 1006S MAN-ENVIRONMENT THEORY II. Co-coordinator. Lectured and provided project supervision.

Short Courses:

2000-2002 "Fundamentals of Risk Assessment", Short course offered by Professional Development

Centre, Faculty of Applied Science and Engineering. Co-taught with M. Monabbati and J. Archbold.

Guest Lectures in University Courses:

- 2012 Guest lecture in Faculty of Medicine, Determinants of Community Health (DOCH) course, Year 1, Semester 2. 1 hour lecture with 2 ours prep. " health promotion, including individual and community-level health promotion strategies, as well as health protection, including a focus on environmental and occupational health." Developed lecture in 2011-2012, delivered lecture in May 2, 2012-2013.
- 2013 Guest lecture, ENV 100, Oct 11, 2012, 2 hours
- 2013 Guest lecture, ENV 221, late October & early November. 2, 1 hour lectures = 2 hours total
- 2008-2013 JEH 445 (Assisted with design of course curriculum)
- 2004-2012 ES 9030 Environmental Applied Science and Management Program, Ryerson University
- 1987-2013 PCL 473/JNP 1014Y Interdisciplinary Toxicology.
- 1999 MSC4000 Seminars on Environment and Health.
- 1990,92,94,97,00,01 JNP 1016S Graduate Seminar in Toxicology.
- 1992-1993 GGR 1200H Physical Geography Core Course.
- 1992 ESE 1014S Aquatic Chemistry.
- 1990 POL 102 Introduction to Issues in Canadian Politics.
- 1990 CHE 201F Physico-Chemical Principles I.

12. c. THESES SUPERVISION

Department of Earth Sciences, M.Sc., Theses:

- 2012-present Daniela Serodio. Physical-chemical properties and persistence of organic flame retardants.

Department of Geography, Ph.D. Theses:

- 2011-present Golnoush Abbasi. Material flow analysis of PBDEs as a result of changes in policies from 1970-2020.
- 2007-2014 Jennifer Sawyer. Evaluating the transfer and accumulation of polyunsaturated fatty acids in freshwater food webs: a modeling approach Winner of 2010 International Assoc Great Lakes Res Graduate Student Award, 2011 Winner of J.E.R. Ross Scholarship from Dept of Geography UofT. Maternity leave spring 2012-current.
- 2000-2005 Sarah Gewurtz. An evaluation of factors controlling the dynamics of persistent organic pollutants in aquatic food webs: a modeling approach. Winner of Canadian Water Quality Association Graduate Fellowship. NSERC Scholar.
- 1996-1998 Neely Law. Transferred Ph.D. to University of North Carolina.

Department of Geography, M.Sc., Theses:

- 2006-2008 Xianming Zhang. Measurement and modelling of indoor concentrations of PCBs and PBDEs.
- 2005-2007 Lisa Melymuk. The multi-media movement of trace organic contaminants in an urban and urbanizing watershed. NSERC Scholar.
- 2005-2007 Liana del Gobbo. Risks and benefits: Contaminant and omega 3 fatty acid concentrations in fish and seafood consumed by the South-East Asian community.
- 2003-2005 Rosa Wu. Films on impervious surfaces: accumulation properties, contaminant concentrations and partitioning characteristics. Co-supervised with T. Harner, Environment Canada.
- 2002-2004 Tanya Labencki. Film-water exchange from impervious surfaces.
- 2001-2005 John Clarke. Applying the Multimedia Urban Model to measured PCBs, PAH and PBDEs

- in urban areas. Part-time student.
- 2001-2004 Heather Jones-Otazo. Development of MUM-FamRisk to estimate potential health effects of contaminant exposure in urban areas. Winner of 2003 Gordon Cressy Student Leadership Award, Labatt Fellowship, John Brown Award and Goerge Burwash Langford Prize, Univ of Toronto. NSERC Scholar.
- 2000-2003 Josephine Archbold. The Multimedia Urban Model: development and application of a screening-level ecological risk assessment model. Winner of 2002 Gordon Cressy Student Leadership Award, Sperrin Chant Masonic Award in Toxicology.
- 2000-2003 Craig Butt. Chemical and physical characterization of organic films on an impervious surface. Winner of 2002 Gordon Cressy Student Leadership Award, Labatt Fellowship.
- 1999-2002 Fiona Wong. Investigating persistent organic pollutants in soils along an urban-rural gradient. 1999-2002.
- 2001 Erin Hodge. Aryl hydrocarbon receptor mediated toxicity of the complex mixture of organic film from urban impervious surfaces. Co-supervised with P. Harper, Dept. of Pharmacology.
- 2000 Sheryl Law. Factors affecting the occurrence, isomer ratio and enantioselective degradation of hexachlorocyclohexane in arctic and temperate aquatic systems. 1998-00.
- 1999 Shannon Vickers. Metal accumulation and sediment-water exchange in an urban wet detention pond. Co-supervised with K. Bolton. 1997-99.
- 1999 Yau-Fei Chan. The effect of arsenic speciation on sorption and desorption to and from natural sediment. Co-supervised with K. Bolton. 1997-99. NSERC Scholar
- 1999 Sarah Gingrich. Chemical characterization of an organic film on impervious surfaces.
- 1996 Neely Law. Developing a simple model of chemical distribution in an urban watershed. 1994-96.
- 1993 Helen Wen Ling. Application of the QWASI fugacity/aquivalence model to assessing the fate of contaminants in the water and sediments of Hamilton Harbour. D. Mackay, co-supervisor. 1991-93.

Department of Geography, M.Sc., Research Papers:

- 1999 Marcy Burchfield. Characterizing scale dependent changes in spatial pattern of an urban land cover classification and the effects on a chemical fate and transport model. Co-supervised with F. Csillag. 1998-99.
- 1996 Glynn Gomes. The fate of organic contaminants in wet water detention ponds. 1995-96.
- 1996 Sherry Eaton. Application of the QWASI fugacity model to selected PAHs in Mohawk Lake, Brantford: An assessment of contaminant dynamics and system recovery. 1993-96, part time; 1994-96*.
- 1996 Judy Fedorowick. A multi-media inventory of pollutant loadings to the Don River watershed. 1992-96, part time; 1994-96*.
- 1996 Virginia Heffernan. Estimating *in situ* degradation rates for petroleum products in the Lower Don Lands, Toronto, Ontario. 1993-96. Leave of absence 6/94-1/95; 1/95-1/96, part time.
- 1995 Peter Jackson. Weekday-weekend variations of tropospheric ozone in the Metropolitan Toronto Region. 1993-95. 5/94-1/95, part time.
- 1994 James Helfield. Evaluating the use of wetlands in the Lower Don Lands. 1993-94.
- 1994 Margaret Faye. The role of primary production in the removal of arsenic from the waters of Moira Lake. 1992-94.

Department of Geography, M.A., Research Papers:

- 1993 Fredrick Bernard. Regulatory framework pertaining to toxics in Canada -- Southern Ontario in-service PCB case study. 1989-93, part time; 1992-93*.

Department of Geography, M.Sc.Pl.:

- 1997 Mark James. Analysis of the PCB destruction program at the contaminated site of General Electric in City of Toronto.
- 1993 Yvette Ali. A strategy for integrated pollution prevention and planning for Ontario.
- 1993 Rita Mezei. Site remediation planning process in Ontario: the need for reform. J. Whitney, co-supervisor.

Department of Chemical Engineering and Applied Chemistry, Ph.D. Theses:

- 2010-2013 Sri Chaudhuri. Measuring and understanding the indoor fate of, and exposure to phthalate esters. Withdrew April 2013.
- 2007-2012 Susan Csiszar. Estimating urban scale semi-volatile organic compound emissions and fate using a coupled multimedia and atmospheric transport model. OGS
- 2007-2012 Lisa Melymuk. Semi-volatile organic contaminants in the urban atmosphere: spatial and seasonal distributions and implications for contaminant transport. Winner of Eco-Tech Founders Award, 2007-08, Winner Sperrin Chant Masonic Award 2008, NSERC Scholar, Winner of Edward Jarvis Tyrrell Fellowship of 2011.
- 2006-2011 Nilima Gandhi. Improvements in hazard and Life Cycle Impact Assessment method for metal in freshwaters: addressing issues of metal speciation, fate, exposure and ecotoxicity. 2 NSERC Centennial Scholarship. Winner John R. Brown Prize 2008, Winner of Chris Lee Award from the Society of Environmental Toxicology & Chemistry and the International Copper Institute, 2010, Winner of Ray Langford Prize, Centre for Environment 2011.
- 2002-2007 Elisabeth Galarneau. Particle-gas partitioning of PAH: analysis and modelling.
- 2002-2005 Satyendra Bhavsar. Development of a coupled metal transport-speciation model for surface aquatic systems and its extension to soil.
- 1999 Mehran Monabbati. Effect of salinity and organic matter content of sediments on the sediment-water exchange of arsenic. 1994-99.

Department of Chemical Engineering and Applied Chemistry, M.A.Sc. Theses:

- 2013-present Jimmy Truong. Organophosphosphate flame retardants and plasticizers in the Greater Toronto Area.
- 2012-present Anna Krol. Development and evaluation of the Indoor Multimedia Assessment Model.
- 2010-2013 Sumera Yacoob. Examining Model Predictions of Zinc and Copper Aqueous Speciation and Freshwater Ecotoxicity: Case Study of Ross Lake, Flin Flon, Manitoba, Canada.
- 2006-2007 Susan Csiszar. The fate of PCBs and PBDEs in urban areas: application of the Multimedia Urban Model. By-pass to PhD.
- 2004-2007 Julie Sommerfreund. Evaluation of contaminant fate in the Venice Lagoon using a multi-segment fugacity/aquivalence model and a probabilistic uncertainty analysis.
- 2004-2006 Roshanak Razavi. Contaminant fate in the Bay of Quinte: a modeling assessment.
- 2003-2004 Harshan Radhakrishnan. Optical imaging and investigation of the development of organic films. Co-supervised with S.Liss, Ryerson University. Changed supervisors.
- 2003-2005 Nadia Martinez Hernandez. Chemical characterization of organic films.
- 2001-2003 Nilima Gandhi. Modelling mercury in the Lahontan Reservoir and food web, Nevada.
- 2000-2002 David Schryer. Multimedia Urban Model: refinement and application. Withdrew.
- 1999-2002 Satyendrakumar Bhavsar. Coupling chemical speciation and fate models: estimating the fate of metals in Ross Lake, Manitoba. By-pass to Ph.D.
- 2000 David Priemer. The multimedia urban model: assessing the fate and transport of semivolatile organic compounds in urban areas. 1998-00. NSERC Scholar.
- 1999 Ayan Chakraborty. Modelling organic contaminants in lakes of the Upper Yukon River basin. Withdrew.
- 1999 Paul Helm. Degradation of α -Hexachlorocyclohexane and organochlorine contaminant

- fate in high arctic lakes. 1996-99. NSERC Scholar.
- 1997 Murali Ganapathy. Modelling mercury dynamics in the Lahontan Reservoir, Nevada. 1995-97.
- 1994 Hilary Freitas. Modelling organic and inorganic chemicals in Arctic lakes. 1992-94.

Department of Chemical Engineering and Applied Chemistry, M. Eng. Papers:

- 1995 Makoto Kawai. A preliminary model to estimate chemical behaviour in lakes of the Upper Yukon River Basin. 1993-95; 1994-95*.
- 1994 Lennox Gibbs. A seasonal model for arsenic dynamics in Moira Lake. 1993-94; 1994*.
- 1994 Rochmi Widjajanti. Developing environmentally sound technology for the palm oil industry. 1991-94; 1993-94*.

* Time under my supervision.

Dalla Lana School of Public Health, M.Sc. Theses or research projects:

- 2013 Caryn Thompson. Analysis of phthalate concentrations indoors (withdrew from project)
- 2012-present Fe de Leon. Flammability standard setting in Canada.
- 2003-2005 Shelby Yamamoto. The status and potential health risks of PAH in Kampala, Uganda. Co-supervisor with Donald Cole. Winner of Eric Krause Award.

Department of Physical and Environmental Sciences, Ph.D. Theses:

- 2012-present Joseph Okeme. Indoor passive air sampling of semi-volatile organic compounds.
- 2011-present Aman Sanai. The role of clothing in human exposure to semi-volatile organic compounds.

Additional Graduate Related Activities:

Ph.D. Supervisory Committees University of Toronto

- 2012-present Matt Binington, PhD committee member, (Dept Physical & Environ Sci, UTSC).
- 2012 John Westgate, Final PhD defense committee member (Dept of Chemistry)
- 2011-2012 Serguei Stremilov, UTSC Physical and Environmental Sciences, Member of reading & comprehensive examination committee. (Dept Physical & Environ Sci, UTSC).
- 2010-present Alex Gudinov., Member of reading committee. (Dept Physical & Environ Sci, UTSC).
- 2010 Fiona Wong. Dept of Chemistry, University of Toronto. Member of Senate oral committee. (Dept of Chemistry)
- 2010-2012 Christina Quinn. Dept of Chemistry, University of Toronto. Member of Senate oral committee. (Dept of Chemistry)
- 2010-2011 Xianming Zhang, Dept of Chemistry, University of Toronto. Member of reading and PhD committees. (Dept of Chemistry)
- 2007-2014 Kelly Sabaliauskas, Dept of Chemical Engineering. Member of reading committee.
- 2008-2013 Maryam Ramin, Dept. of Physical and Environmental Science, UTSC. Member of reading committee.
- 2008 Fiona Wong, Dept. of Chemisty, Member of qualifying oral committee
- 2007 Gillian Daly, Dept. of Chemical Engineering. Member of final PhD examination committee.
- 2007 Sarah Hershorn. Dept. of Geology. Member of final PhD examination committee.
- 2006-2010 Julian Cleary, Dept. of Geography, Member of comprehensive examination committee.
- 2003-2007 Chris Eckley, Dept. of Geography. Member of reading committee and defense committees.
- 2000-2007 Adam Cornwell. Dept. of Geography. Member of reading committee and department defence committee.
- 2007 Chris Warren, Trent University. External Examiner on Ph.D. oral defense.
- 1999-2004 Levi Waldron. Faculty of Forestry. Member of reading and final examination committee.
- 1999-2002 Paul Helm. Dept. of Chemical Engineering. Member of reading committee.

- 1999–2009 Liisa Jantunen. Dept. of Chemical Engineering. Member of reading committee.
 1997 Tom Harner. Dept. of Chemical Engineering. Member of examination committee.
 1997-2001 Jonathan Schwartz. Dept. of Political Science. Member of reading committee.
 1997-1999 Chris Desousa, Dept. of Geography. Member of reading, comprehensive exam, departmental defense and final defense committees.
 1996-2000 James Smith, Dept. of Geography. Member of reading and comprehensive exam comm.
 1996 Steven Young, Dept. of Material Science and Metallurgy. Member of reading and examination committee, Internal examiner for Senate oral.
 1994-1998 Annameiki Farenhorst, Dept. of Geography. Member of reading and exam. committee.
 1995-2000 Cathy Cottrell. Dept. of Chemical Engineering. Member of reading, departmental defense and final defense committees.
 1995-1998 Edwin Tam. Dept. of Civil Engineering. Member of reading, comprehensive exam, departmental and final defense committees.
 1994 Frank Wania, Dept. of Chemical Engineering. Member of Dept. and Senate oral committees.
 1993 Kathleen Jagger. Dept. of Geography. Member of oral comprehensive examination committee.

Master's Committees, Dept. of Geography

- 2010 Nyssa Clubine, M.Sc.
 2008 Tony Zhang, M.Sc.
 2004 Yvonne Feng, M.Sc.
 2003 Angelika Bayer, M.Sc.
 2002 Carl Mitchell, M.Sc.
 2001 Maggie Young, M.Sc.
 Frank Donnelly, M.A.
 Kyle Hodder, M.Sc.
 Carrie Lillyman, M.Sc.
 1999 Andrew Cornwell, M.Sc.
 Vivian Campbell, M.Sc.
 1997 James Sterling, M.Sc.
 Anastasia Svirejava, M.Sc.
 Dan Fitzgerald, M.Sc.
 Eric Krause, M.A.
 Sue Asprey, M.Sc.Pl.
 1996 Heather Alexander, M.A.
 Keilly Griffiths. M.Sc.Pl.
 Neil Mallen. M.Sc.Pl.
 Andrew Rodie, M.Sc.
 1994 Sue Dickson. M.Sc.
 Claire Woolveridge. M.A.
 Larry Dufay. M.A.
 Val Aloe. M.Sc.Pl.
 1993 Sarah Cowell. M.Sc.
 Simon Bengier. M.Sc.
 Sean Ledgerwood. M.A.
 1992 Huang Zhen. M.Sc.
 Kerry Lakatos-Hayward. M.Sc.Pl.

Master's Committees, Dept. of Chemical Engineering and Applied Chemistry

- 2010 Bernadette Assamoi. M.Sc.Eng. project defense

2007 Kelly Sabaliauskas, M.A.Sc. bypass oral.
2002 Elizabeth Gilmore, M.A.Sc.
2000 Yan Liang, M.Eng.
1994 Penny Vlahos. M.A.Sc.
1993 Shirley Thompson. M.Eng.
1991 Robert Caron. M.A.Sc.

Master's Committees, other departments and universities

2006 Christopher Warren. Trent University. External examiner.
2002 David Wasserstein. Institute of Medical Sciences. Internal examiner.
2002 Gail Klein, Dept. of Pharmacology. External examiner.
2002 Charlotte Corda, Dept. of Pharmacology. External examiner.
1999 Matt McLeod. Trent University. External examiner.
1992 Fereshteh Hashemi, Dept. of Botany. M.Sc.

External PhD Examiner

2013 Michael Owsianiak, Danish Technical University
2013 Paul Messing, University of Manitoba
2012 Karen Søgaard Christiansen, University of Copenhagen
2011 Karen Lavin, University of Otago, New Zealand
2010 Anneke Sleeswijk, Leiden University, The Netherlands
2010 Emma Goosey, University of Birmingham
2009-10 Nadia Abdelouahab, Université de Québec à Montréal. External reviewer.
2009 Kristina Sundqvist, University of Umeå, Sweden
2007 Cecile Bulle, Dept of Chemical Engineering, Ecole Polytechnique, Montreal, Quebec.
External examiner for PhD

Additional Supervisory Activities:

Post-Doctoral Fellows

2014-present Congqiao Yang, Ph.D.
2010-2013 Emma Goosey, Ph.D.
2007-2009 Cristian Mugnai, Ph.D. (visiting from Italy)
2006-2010 Matthew Robson, Ph.D.
2005-2006 Marco Belmont, Ph.D.
1999-2002 Qintao Liu, Ph.D.
1999-2001 Bagher Bahavar, Ph.D.
1999-2002 Mehran Monabbati, Ph.D.
1998-1999 Nisheeth Bahadur, Ph.D.

Visiting Scholars

2011-2012 Anping Zhang, Assoc. Prof, Zhejiang University, Hangzhou, China. Spending most of his time at Environment Canada.
2011-2012 Qi Hong, Assoc. Prof, Harbin Inst Technology, Nanjing, China
2010 Deqi Xiong, Ph.D., Dalian Maritime University, China
2006 Radka Alexy, Ph.D.

Visiting Students

2013 Sandra Brommer, University of Birmingham, U.K. PhD candidate. 3 month visit.
2012 Maria Bialo, National School for Water and Environmental Engineering of Strasbourg (ENGEES)

Research Associates

2013	Jimmy Truong
2012	Daniela Serodio
2011	Clayton Catching
2010-2011	Stefanie Verkoyoen
2008-2009	Catherine Abreu
2007-2008	Liana del Gobbo, M.Sc.
2003-2005	Nilima Gandhi, M.Sc.
2004	Julie Sommerfreund, B.Sc.
2003-2004	Buuan Lam, B.Sc.
2001-04, 06	Dianne Lapierre
2001-2004	Erin Hodge, M.Sc.
2001-2006	Jennifer Truong, B.Sc.
2000-2001	Trinh Tieu, B.A.Sc.
2000-2001	Marcy Burchfield, M.Sc.
1999-2000	Sarah Gingrich, M.Sc.
1998-1999	Edwin Tam, Ph.D.
1995-97	Cynthia Page, M.A.Sc.
1994	Lennox Gibbs, M.Eng.
1994	Hilary Freitas, M.A.Sc.
1993-1994	Helen Ling, M.Sc.

NSERC Undergraduate Research Award Recipients

2001	Kim Tsoi, Department of Chemical Engineering and Applied Chemistry.
2000	Jennifer Truong, Department of Geography.
1994	Ilan Kelman, Department of Chemical Engineering and Applied Chemistry.
1993	Rebecca Laposa, Department of Geography.

Undergraduate Summer Assistants

2013	Angela Huang
2012	Kevan Saba
2008 & 2009	Amanda Giang
2008	Kristina Dean
2007-2008	Catherine Abreu
2006	Kate Liss, Jennifer Cheung
2005	Kate Liss
2004	Veronica Lo, Rina Goldberg
2003	Bushra Drir, Talya Manoim
2002	Dianne Lapierre, Azadeh Zarashkian, Ylva Olsson
2001	Dianne Lapierre, Jennifer Truong
2000	Trinh Tieu, Dianne Lapierre.
1999	Asif Jalil, Julia Tsai.
1998	Sheryl Law*.
1997	Julie Phillips
1996	Wilfred Tan, Judy Josefowicz (part-time)
1995	Judy Josefowicz (part-time)
1994	Martha Scroggie (part-time)
1993	David Tu, Martha Scroggie, Melissa Fotiadis
1992	Andrew Rodie, Hilary Freitas, Rebecca Laposa, Michelle Perera

* Environmental Youth Corps

Ontario Work-Study Plan Students

2014	Clara Thaysen
2013	Grant de Jeong
2013	Patrick Feghali
2012	Esmail Mansouri
2011-12	Vanessa Ymele
2006-07	Calvin Au
2005-06	Amy Leung
1999-00	Amelia Du
1995-1996	Laura Alionte
1992-1993	Andrew Rodie

12. d. OTHER TEACHING AND LECTURES

Annual	Guest lecture at Ryerson University, Environmental program.
2012	Mathematical modeling approaches to understanding environmental fate and behaviour of flame retardants. IVL Swedish Environmental Research Institute, Stockholm. Part of the INFLAME research project of the European Union. April 23,24, 2012.
2012	Interdisciplinary research. Held at University of Birmingham. Part of the INFLAME research project of the European Union. January 18-19, 2012.
2007	“Brominated flame retardants: from release to exposure”, UTSC, Dept of Physical & Environmental Sciences and Centre for Environment, Master of Environmental Science.
2007	“Connecting the dots between contaminant emissions and exposure”, University of Toronto, Moving Canada towards Sustainability. A forum to discuss global environmental issues.
2007	“Urban Contributions of Contaminant Load to Lake Ontario”. Lake Ontario Lake-wide Management Plan (LaMP) annual meeting, Niagara, N.Y. Organized by Environment Canada and U.S. EPA.
2007	“Loadings and fate of PCBs in Hamilton Harbour from a mass balance perspective”. Hamilton Harbour Remedial Action Plan (RAP) meeting.
2007	“What if the chemicals are toxic or persistent?” Urban Metabolism workshop held at University of Toronto. Organized by Prof. Chris Kennedy, Dept of Civil Engineering. Sponsored by Toronto & Region Conservation Authority.
2007	“Computer models in Great Lakes Decision-making”. A panel discussion held at 49 th Annual Conf. Internat. Assoc. Great Lakes Res. Windsor, Ont.
2006	“Brominated flame retardants: from release to exposure”, Ryerson University, Environmental Applied Science & Management Program.
2006	“What’s the burning issue with brominated flame retardants?” Physical Geography Research Day. Fall 2006.
2006	Polybrominated Diphenyl Ethers: Exposure pathways and human exposure. SENES Consultants.
2006	Brominated flame retardants – from source to exposure. Environmental Physician’s Group of Ontario Medical Association, seminar series “Clinical Reviews”.
2004	“Contaminants around us: the Toronto experience”, Centre for Urban Health Initiatives. University of Toronto.
2004	“Polybrominated diphenyl ethers: connecting sources and exposure”, Environmental Chemistry Seminar Series, Dept. of Chemistry, University of Toronto.
2004	“Chemical contaminants in the environment: from release to effects”, Gartner Lee Ltd.
2003	“Cities: contaminant fate and effects”, Toronto & Region Conservation Authority.
2002	“Water Quality”, “Women in Science”. Later Life Learning, Innis College.
2000	“Toxins in the Environment – Sources, Movement and Control Measures”. Public lecture

- 1999 in Green Waves Eco Talks organized by the Festive Earth Society.
 “Persistent Organic Pollutants: Fate in an Urban Environment and Potential Health Effects”. Presentation to Toronto Public Health Department, Health Promotion and Environmental Protection, City of Toronto.
- 1999 Arsenic cycling in Moira Lake. Presentation in workshop organized by “How Healthy is the Moira?” committee.
- 1996 Science Outreach. Lecture for girls 9 to 14 on research and career opportunities.
- 1992 Saturday Morning Seminar Series for Secondary School Students. Lecture on Great Lakes water quality.
- 1988 Tutorial Assistant, University of Toronto, Dept. of Chemical Engineering
- 1980-1981 Tutorial Assistant, McGill University, Dept. of Biology
- 1976-1979 Tutorial Assistant, University of Alberta, Dept. of Zoology

E. ADMINISTRATIVE POSITIONS

13. a. SERVICE ON COMMITTEES AND ORGANIZATIONS

Initiatives:

- 1998-2004 Initiation, organization and Vice-chair of “Women in Arts and Science Committee”, advisory to Dean of Arts and Science.
- 1997 Organized and chaired “Research Day” of Institute for Environmental Studies.
- 1997 Organized “The Great Debate” with Ruth Grier and Michael Bliss.
- 1996, 2000, 10 Organized or co-organized “Physical Geography Research Day” series to be held twice yearly as a forum for faculty and graduate students.
- 1994-1996 Involved with initiative to develop analytical facilities at University of Toronto. Member of ad hoc committee for ANALEST (Analytical Laboratory for Environmental Teaching).
- 1994 Developed M.Sc. Thesis option for Dept. of Geography and IES Collaborative Program.
- 1993 Initiated change of undergraduate program from “Physical Geography” to “Physical and Environmental Geography”

Major:

- 2011-2012 Dean’s working group on Environment and Resources, also curriculum committee for Environmental Science program
- 2011-2014 Provostial Assessor, Faculty of Nursing, search committees, promotions committee
- 2010-2012 Member, University Tribunal Committee
- 2010-2012 Vice-Chair, Planning and Budget Committee of Academic Board
- 2009-2012 Member, Honourary Degree Committee of Academic Board
- 2009-2010 Member, Academic Policy and Planning Committee of Academic Board
- 2007-present Coordinator, Physical Geography Building
- 2007-2009 Chair, Council of the Faculty of Arts and Sciences
- 2007-2010 School of Graduate Studies, Tenure Assessor
- 2007 Dean’s ad hoc committee on Earth & Planetary Sciences
- 2007 Dean’s representative, Dept. of Geology, search committee, Radiogenic Isotope Geochemistry
- 2004-05 Member, Search committee, Chair of Department of Geology
- 2004-05 Member, Search committee, Dept. of Geography, physical geography search
- 2004-05 Member, Search committee, Department of Physical Sciences, UTSC
- 2004-2008 Vice-Chair, Planning and Budget Committee of Academic Board, University of Toronto
- 2004-05 Governance Committee, Department of Geography
- 2003-04 Academic Planning Committee, Department of Geography.

- 2003-04 Search Committee, Department of Physics (Condensed Matter, CRC).
- 2003-2008 Member, Planning & Budget Committee of Academic Board, University of Toronto.
- 2003 Ad hoc Committee on Governance, advisory to Dean of Arts & Science.
- 2002 Search Committee, Physical Geography, St. George campus.
- 2001-2012 Member of Academic Board of Governing Council, University of Toronto.
- 2001 Search Committee, Technician, Physical Geography.
- 2001 Search Committee, Soil Science position, Scarborough College.
- 2000, 01 Search Committee, Physical Geography position, St. George campus.
- 2000 Graduate Admissions Committee, Member.
- 2000 Search Committee, Senior Hydrology position, Geography, St. George campus.
- 1999 Search Committee, Soil Science position, Scarborough College.
- 1999 Search Committee, Environment and Resource Management position in Geography, St. George campus.
- 1998 Search Committee, Hydrology position in Geography, St. George campus.
- 1998-99 5 Year Review Committee for Institute for Environmental Studies.
- 1998 Search Committee, Hydrology position at Erindale College.
- 1997 Chair of the Weigand Lecture committee. Organized and hosted seminars for two invited speakers.
- 1996 Physical Geography Research Day. Organized and chaired first of on-going series.
- 1994 Discover Science. Organized volunteers for demonstration in Physical Geography.
- 1994 Search Committee, Hydrology position at Erindale College.
- 1994 Science Options. Organized Dept. of Geography Information Booth. Rewrote information sheet on "Programs in Physical Geography"
- 1994 Member of Environmental Protection Subcommittee on Grounds/Water Use/Biodiversity.
- 1993-1996 Women in Science Committee, Faculty of Arts and Science
 Related activities:
- Women in Science Faculty Advisor, Dept. of Geography;
 - Panelist, "Challenges and Solutions: Balancing an academic career and family responsibilities", Workshop for Women Faculty and Librarians, April 15, 1997.
 - "Women in Science" luncheons. Co-organized and moderated discussions. Co-sponsored by Dept. of Geography and Faculty of Arts and Science. 1996, 1994;
 - Forum on Women in Science, "Graduate School and Beyond". Moderated panel discussion. April, 1993.
- 1992-1993 Division of the Environment, Science Subcommittee.
- 1992 WHMIS and laboratory safety seminar. Co-organizer of seminar for Dept. of Geography.
- 1991-1993 Innis College Environmental Programme Committee.
- Minor:**
- 2010-2011 Provostial Assessor, Search Committee, Faculty of Physical Education and Health
- 2009 Member, Search Committee, Graduate Chair of Dept. of Geography
- 2006 Centre for the Environment: Member of advisory committee of Collaborative Program on Environment & Health.
- 2003-2008 Life Sciences Awards Committee, University of Toronto
- 2004-05 Search Committee, Paleoclimatographer Dept. of Geology (half of search)
- 2004-2005 Member, Ontario Graduate Student Scholarship Panel.
- 2004-05 Promotion Committee, tenure committee, Department of Geography
- 2003-04 Senior Committee, Department of Geography.
- 2003 Research Advisory Committee, Institute for Environmental Studies
- 2001 Member of Advisory Committee for Environmental Management Certificate Program, Professional Development Centre.
- 2000, 2003 Innis College Curriculum Review

- 1999-present Collaborative Graduate Program in Environment and Health. Member of Advisory Committee.
- 1997-2004 Arctic Working Group. Member.
- 1996-2000 Environmental Engineering Faculty Council. Member.
- 1995-2001 Collaborative Graduate Program in Toxicology. Member of Program Committee.
- 1994-1997 Graduate Committee, Dept. of Geography.
- 1994 Ranking NSERC and OGS applications.
- 1994 Mathematics Sciences Review Committee.
- 1994 Ranking NSERC Undergraduate Student Research Awards from "non-NSERC" departments.
- 1992-1993 Undergraduate Committee, Dept. of Geography.

F. OTHER

Co-organizer of the following Conferences, Workshops and Conference Sessions:

- 2013 Co-chair, session at Dioxin 2013 Conference, Daegu, Korea
- 2012 Co-organizer, Discussion of a Chemical Planetary Boundary, Chalmers University, Gotenburg, Sweden, April 18-20, 2012
- 2008-2010 Co-chair of the annual conference of the International Association of Great Lakes Research, held at the University of Toronto, May 2010.
- 2009 Canadian Association for Water Quality, Central Region. 44th Annual conference. Co-chair of special symposium on Bisphenol A.
- 2008 Life Cycle Impact Assessment: The Clearwater Meeting on Developing Characterization Factors for Aquatic Ecotoxicity of Metals.
- 2007 Diversity in POPs, Co-organizer of Special Symposium at Society of Environmental Toxicology & Chemistry annual meeting, Milwaukee.
- 2003 SETAC, Laurentian Chapter Annual Meeting, Toronto.
- 1999 Lake Ontario Research and Management Workshop. Held at University of Toronto. Co-chaired by D. Mackay, Trent University, and J. DePinto, SUNY Buffalo.
- 1996 Life Cycle Assessment of Site Remediation Options - A Review of the Generic Approach and Case Study. Funded by Ministry of Environment and Energy. Held at Dept. of Geography, Toronto.
- 1992 Lake Superior Mass Balance Workshop. Funded by the International Joint Commission and Atmospheric Environment Service of Environment Canada, Toronto.
- 1991 Great Lakes Research Day. Sponsored by the Institute for Environmental Studies, Toronto.
- 1991 Great Lakes Mass Balance Workshop. Funded by the International Joint Commission, Niagara-on-the-Lake.
- 1990 Workshop to develop a regional model of mercury accumulation in sport fish. Held at the Institute for Environmental Studies, Toronto.

Workshop Participant:

- 2013 Blue Mountain Retreat. Assembled 21 experts and industry representatives to advance the agenda of toxic chemical control. June 2013.
- 2011 Advancing exposure science to improve chemical safety. Co-sponsored by American Chemistry Council and Health Canada, Quebec City, June 2011. Rapporteur for poster session.
- 2009 & 2010 SVOCs in Indoor Air, Indoor Air Institute.
- 2009 ScorePP: Workshop on Urban pollution sources and water treatment, Universite de Quebec

- 2009 Canadian Environmental Modelling Centre, Partners' Meeting, "Advances in modelling the aquatic fate and toxicity of metals", Trent University.
- 2009 Indoor contaminants. Workshop sponsored by US EPA, Raleigh, NC.
- 2009 Exposure science in the 21st century. National Research Council, 8th Workshop of the Standing Committee on Risk Analysis Issues and Reviews. Speaker "Predictive Model Frameworks: Physical Models". Washington, DC.
- 2008 Health and indoor environments, sponsored by National Research Council.
- 2008 Health-Environment Linkages, sponsored by Statistics Canada.
- 2007 National Policy Consultation on Children's Health and Environment. Workshop #5, Toxic Substances in Consumer Products. Respondent in discussion.
- 2007 Lake Ontario Lake-wide Management Plan. Annual meeting. Environment Canada and U.S. EPA.
- 2007 Hamilton Harbour Remedial Action Plan. Summary of Results 2007.
- 2007 Roundtable Discussion, Ontario Ministry of Environment, Air Pollution & Climate Change. Opportunity to discuss with Minister Laurel Broten.
- 2007 City of Toronto Workshop on "Community Right to Know", developing a toxic release inventory.
- 2007 "Health and Environmental Tracking and Surveillance in Canada". Health Canada workshop.
- 2007 "Air Pollution and Children's Health" Co-sponsored by Pollution Probe, Children's Health Coalition, Health Canada. Participant.
- 2003 "Hazard Identification Approach for Metals and Inorganic Metal Substances", Pellston Workshop sponsored by SETAC.
- 2003 "Metal Unit World" workshop. Organized by Center for the Study of Metals in the Environment, University of Delaware.
- 2002 Retreat on science in the Meteorologic Service of Canada, Environment Canada. Organized by the Senior Scientists Committee of MSC, Environment Canada.
- 2001 Framework for Modelling Ecological Change in the Detroit River - Lake Erie Corridor. Panelist in a workshop sponsored by the International Joint Commission - Council of Great Lakes Research Managers'.
- 2000 "Northern Contaminants Workshop". Sponsored by Dept. of Indian Affairs and Northern Development.
- 1999 "Lake Ontario Mass Balance Workshop". Sponsored by University of Toronto, Trent University, SUNY Buffalo, Toronto.
- 1999 "Environmental Resource Group Meeting for the PSL2 Assessment of releases from copper and zinc smelters and refineries". Sponsored by Environment Canada, Ottawa.
- 1999 "How Healthy is the Moira?", Sponsored by Trent University and "How Healthy is the Moira" Committee, Peterborough, Ontario.
- 1999 Canadian Network of Toxicology Centres (CNTC), Annual Research Symposium, Ottawa.
- 1998 "Wolf Creek Research Workshop". Sponsored by Environment Canada, Whitehorse.
- 1997 "Environmental Resource Group Meeting for the PSL2 Assessment of releases from copper and zinc smelters and refineries". Sponsored by Environment Canada, Ottawa.
- 1997 "Arctic Archipelago Project Planning Meeting". Sponsored by Dept. Sponsored by Dept. of Indian Affairs and Northern Development, Iqaluit, Nunavik.
- 1997 "Nunavik and Northern Labrador Contaminants Action Plan Meeting". Sponsored by Dept. of Indian Affairs and Northern Development, Kuujuaq, Nunavit.
- 1997 "Northern Contaminants Research Results Workshop". Sponsored by Dept. of Indian Affairs and Northern Development, Victoria 1997, Calgary 1996, Winnipeg 1994, Burlington 1993.
- 1994 Yukon Contaminants Workshop. Organized by Yukon Contaminants Committee.

- Whitehorse, Yukon.
- 1993 "Evaluating the Benefits of Water Quality Improvements". Sponsored by the Ontario Ministry of Environment and Energy.
- 1990 & 1991 "Bay of Quinte Remedial Action Plan Workshop". Two workshops sponsored by the Ontario Ministry of Environment.

Referee for Reports:

- 2003 "Lake Ontario Mass Balance". Member of Scientific Review Panel, U.S. EPA.
- 1998 "Lake Michigan Mass Balance Program". Member of Scientific Review Panel, U.S.EPA.
- 1998 "Hudson River PCB Mass Balance Study". Member of Peer Review Panel, U.S. EPA.
- 1994 "Lower Don Lands Site Characterization and Remedial Options Study". Review for the Waterfront Regeneration Trust.
- 1993 "Niagara River (Ontario) Stage I RAP Report". Review for the Great Lakes Regional Office, International Joint Commission. Review included oral presentation at public information meeting in Niagara Falls, Ontario.
- 1991 "Arsenic and its Compounds, Priority Substances List Assessment Report". Review for Government of Canada, Health and Welfare Canada and Environment Canada under the Canadian Environmental Protection Act (CEPA).

Referee for Journals and Monographs:

Environmental Science and Technology

Environmental Pollution

Atmospheric Environment

Environmental Management

Science of the Total Environment

Journal of Great Lakes Research

Water Environment Federation

Mercury as a Global Pollutant: Towards Integration and Synthesis.

Referee for Grant Proposals:

- 2013 NSERC Discover Grants
- 2012 Israeli Environmental Health Fund
- 2010 NSERC, Swiss Federation of Science
- 2007 NSERC.CRD
- 2006 Large Pelagics Research Centre.
- 2003 NSERC Discovery Grants Program, Canada Foundation for Innovation, Canadian Foundation for Climate and Atmospheric Sciences
- 2001, 2002 NSERC Collaborative Research and Development Grants Program
- 2000 Hudson River Foundation
- 1998 NSERC Strategic Grant.
- 1997 Minnesota Sea Grant College Program
- 1997 Hudson River Foundation
- 1996 National Science Foundation.
- 1993 Great Lakes Research Fund.

Miscellaneous:

Numerous others that I've stopped recording.

- 2011 "Tracking toxins in the city: where are chemicals coming from and what does it mean?" Presentation to UTSS.
- 2008 "What's in the air we breathe?" Presentation at Women's Health conference.
- 2007 "How to stop climate change." Presentation at forum organized by MP Olivia Chow,

- Trinity-Spadina riding.
- 2006 Later Life Learning. "All you want to know about contaminants!"
- 2001 Presentation to the Walkerton Inquiry, Public Hearing 5: Regulatory and Technical Issues for Specific Sources of Contaminants; Water Quality, "Urban development and water quality protection". Toronto, Ontario.
- 1997, 2000 Judge for Chandler-Misener Award, International Association for Great Lakes Research.
- 1997 Co-chair, "Modeling chemicals in the Great Lakes: What have we learned? Where do we go from here?" International Association for Great Lakes Research 1997 Conference, Buffalo, N.Y.

Selected Media interviews*:

- 2014 March 20, 2014. David Fraser, CBC. Discussion about flame retardants. 30 minutes.
- 2013 CTV Newsworld, July 10, 2013. Live to air TV comment on environmental impact of train disaster in Lac Magantic.
- Al Jazeera English, August 14, 2013. Video interview for posting on pay TV channel and website. About stockpile of refinery coking residue in Detroit blowing over to Windsor and broader issue of society's waste.
 - Weather Network. Microplastics. Kasia Bodurka. Phone interview Sept 17, shoot Oct 3, 2013.
 - Toronto Star, Raveena Aulakh. The environmental cost of cheap clothing. Phone interview Oct 8, 2013.
 - CBC Marketplace, Friday Oct 11, 2013. Comment on the finding in tea leaves levels of some pesticides above Health Canada guidelines. About 1.5 hours spent on research and the phone call.
- 2012 Press release from Environmental Defense. "Pre-polluted, A report on toxic substances in the umbilical cord blood of Canadian newborns", June 26, 2013.
- SRC, Radio Canada. Flame retardants. Jan 24, 2012, 30 min interview.
- Global TV. Telephone interview re: health risks to fire fighters. I asked not to be quoted directly since this isn't my area of expertise but I did provide background information. May 8, 2012.
- CBC Market Place, May 11, 2012
- Press release from Canadian Environmental Law Association regarding flammability standards requiring use of flame retardants. May 11, 2012.
- Global News. For on-line news. Interview regarding news of anticipation of extremely hot summer, May 16, 2012
- Global Toronto.com Interview with James Armstrong. The annual "smog" interview. June 11, 2012.
- CBC French. Comment on Peter Kent's announcement of \$16 million to fight algae blooms in Great Lakes (a re-announcement of money already being spent!) Oct 9, 2012
- CBC National News, discussion about a potential story, Thurs November 29, 2012
- Toronto Star, article on flame retardants, Thurs November 29, 2012, for Monday's paper
- CFAX radio in Victoria, ½ live to air interview re: flame retardants, Thurs November 29, 2012
- Interview for magazine, Canadian Chemical News, from Chemical Institute of Canada. Tyler Irving. Monday December 3, 2012. Re: flame retardants.
- CBC TV Marketplace. November 30, 2012. Advice and guidance on program, on camera interviews in lab and on location, experimental work on location and in our lab.
- May 11, 2012. Press release from Canadian Environmental Law Association regarding flammability standards requiring use of flame retardants
- May 8, 2012. Global TV. Telephone interview re: health risks to fire fighters.
- May 11, 2012 CBC Market Place
- 2011 Post Canada Magazine. June 23, 2011

- November 22, 2011. CBC News. Removing BPA from canned soup.
 Flame retardants: are the benefits worth the risk". Participated in film clip to be used as a trailer to get funding for film with that title. Producer – James Redford), March 28, 2012
 November 2011. "A consumer's guide to buying the right mattress: personal health; environmental concerns; comfort". Provided information to free-lance author of this story that was published in
 A few Q&A with CBC researchers
 March 2012. Interview with Stephen Scharper regarding deep cuts to Environment Canada, which he profiled in his column in Toronto Star
- 2010
 CBC's Market Place (feature interview & TV shoot)
<http://www.cbc.ca/marketplace/2011/lousylabels/miriamdiamond.html>
- 2009
 Interview, Zoe Cormier, for New Internationalist
 CBC Radio, Here and Now. Interview on Toronto's garbage strike (July 8)
 CBC Radio, The Current. Interview on "Slow Death by Rubber Duck" (June 18)
 Toronto Sun, beaches water quality (July 24)
 CBC TV special on the future (July 24), 20 minute hour interview
 CBC.ca on-line news article on "back to school" shopping. Phthalates in kids school supplies (August 26), 1/4 hour interview
 Toronto International Film Festival, article connecting "Green Porno" at TIFF with scientific perspective, 1.5 days
 Toronto Sun, phone interview. Sept 18, 15 minutes. Comment on nearshore Lake Ontario water quality
- 2008
 Green Living magazine, interview (March 2009 appeared in April 2009) (interview)
 Toronto Star, Feature article, October 23, 2008.
 Global TV, water pollution. Extended interview broadcast on 19X6 (interview on camera, ~1 hour)
- 2007
 University of Toronto magazine, short & extended interviews on toxic chemicals
 BC Metro Morning. June 7. Live interview, Environ Sci of the Year.
 Toronto Star, June 7. Lead in drinking water.
 Toronto Star, June 7. Smog and health effects (annual interview on the subject that fails to go away).
 Toronto Star, July 9. Air pollution trends.
 Toronto Star, July 11. Release of Stats Can report on Canadian's going "shades" of green.
 Globe & Mail, July 12. Biomagnification of persistent organic pollutants.
 CBC, The Nature of Things, July 16-19. Health effects of climate change and air pollution in cities. Aired November 2007.
 Hamilton Spectator, July 30. Fire at pesticide plant resulting in effluents entering Spencer Creek.
 CTV, Night news. July 31. Ultra fine particles from laser printers. TV shoot.
 Global TV. Consultation on series on pollution. TV interview re: Toronto's major polluters, aired Wed March 7, 2007.
 Radio interview, The Green Majority, CIUT. March 2.
 CBC Radio, Edmonton and Calgary. April 17.
 Canadian Geographic Magazine, 2 weeks, January.

* List starts in 2007

Exhibit C

Statement of David A. Eastmond

Sept. 15, 2014

To whom it may concern:

I, David A. Eastmond, am writing this statement in support of the Petition to the CPSC to ban or significantly restrict the availability of certain household products containing additive non-polymeric organohalogen flame retardants.

1. I am Professor and Chair of the Department of Cell Biology and Neuroscience, and a Research Toxicologist at the University of California, Riverside. I received B.S. and M.S. degrees from Brigham Young University, in Provo, Utah, and a Ph.D. from the University of California, Berkeley. My research focuses on the mechanisms involved in the toxicity and carcinogenicity of environmental and agricultural chemicals, with a goal to more accurately identify the potential adverse health effects associated with chemical exposures. I was a Jefferson Science Fellow at the US Department of State, and have served as President of the Environmental Mutagen Society and as Chair of the Board of Scientific Counselors for the National Toxicology Program, NIEHS. I have also participated on numerous review panels related to chemical mutagenesis, carcinogenesis and risk assessment, including panels for the US EPA, the US Food and Drug Administration, the International Programme for Chemical Safety, the International Agency for Research on Cancer, the Organisation for Economic Cooperation and Development, Health Canada, and the International Working Group for Genotoxicity Testing. In 2011, I was elected a Fellow of the Collegium Ramazzini, an organization of international scholars working towards solutions to occupational and environmental health problems occurring internationally. I am currently a member of the Carcinogen Identification Committee for the California Environmental Protection Agency and of the Chemical Assessment Advisory Committee of the US EPA. I have attached my CV and list of publications.

2. Organohalogens are often used as flame retardants in consumer products, without adequate toxicological information to assess whether or not they may be harmful to human or environmental health. To address this lack of knowledge on health effects, two of my graduate students, Virunya Bhat and Kristi Capsel, performed, under my supervision, a hazard screen of approximately 90 brominated and chlorinated flame retardants, ~85 of which are non-polymeric compounds. The list of studied chemicals includes a large number of organohalogen flame retardants (OFRs) in use or available for potential use in consumer products. The objective of the hazard screen was to determine which of these OFRs should be considered toxic, and therefore used with caution, or not used at all. The results of this study have been presented at several scientific meetings, and we are in the process of preparing a peer-reviewed journal article describing our results.

3. Using the Chemical Abstract Services (CAS) registry numbers as primary identifiers, we performed an extensive search for toxicity information on these 85 non-polymeric OFRs. Whenever possible, we searched for and used, if found, the results of existing hazard screens or

toxicity reviews, such as those from the U.S. EPA Design for the Environment program, the Office of Environmental Health Hazard Assessment of the California Environmental Protection Agency, the World Health Organization/International Programme on Chemical Safety, the Agency for Toxic Substances and Disease Registry, the International Agency for Research on Cancer, Health Canada/Canadian Environmental Protection Agency and/or Clean Production Action. Additionally, we searched for peer-reviewed toxicity data in public databases such as Pubmed and Toxnet. Because often we could not identify peer-reviewed data in these databases, we also used other information sources, which included non-peer reviewed information or unpublished data, such as the U.S. EPA Toxic Substance Control Act Test Submissions, the Registry of Toxic Effects of Chemical Substances, the European Chemicals Agency database, and the U.S. EPA High Production Volume data submissions. We gave preference to *in vivo* data via any exposure route, rather than *in vitro* data, due to the lack of guidelines or current consensus on appropriate method(s) to determine human relevance or to extrapolate the results of *in vitro* assays when characterizing *in vivo* hazard potential. In the cases in which we could not identify any empirical data, we used Structure-Activity Relationship (SAR) models.

4. We used three related hazard screening tools: the U.S. EPA's Design for the Environment (DfE) program, the Clean Production Action's GreenScreen™, and the Washington State Department of Ecology's Quick Chemical Assessment Tool (QCAT®). All three provide a framework for identifying problematic characteristics of chemicals and then grading the chemicals according to the level of concern. Because most OFRs lacked sufficient information to use the DfE tool or run a GreenScreen™, our hazard screening was based mainly on the QCAT® methodology (Stone, 2010, 2012), with some modifications to account for the overall lack of publicly available toxicity information for the majority of chemicals.

5. The QCAT® prioritizes 9 out of the 18 hazard categories included in the more comprehensive GreenScreen™ and US EPA DfE approaches: acute mammalian toxicity, five human health hazards (carcinogenicity, reproductive toxicity, developmental toxicity, mutagenicity/genotoxicity and endocrine disruption) and three environmental hazards (acute aquatic toxicity, persistence, and bioaccumulation). These hazard endpoints are considered to pose significant threats to sensitive populations such as children, and provide a good indication of the risks associated with exposure to chemicals (Stone, 2010). The QCAT® grading process is similar to that established for the GreenScreen™. The main difference is that assigning a QCAT® score requires less information than for a GreenScreen™, meaning that the QCAT® can be performed even on chemicals for which not enough data are available to conduct a GreenScreen™, but it is not as thorough an evaluation of potential hazards posed by chemical alternatives as the GreenScreen™. However, if a chemical is found to be a poor alternative using the QCAT methodology, it will also be a poor candidate using the GreenScreen™ methodology. There remains a chance that a chemical not rejected by QCAT® could still prove to be unsatisfactory if a more complete review is done using methods like the GreenScreen™.

6. To perform our hazard assessment, we assigned concern levels for each hazard category, such as Low, Moderate, or High, based on the available information. Examples are provided below.

- a. Acute Mammalian Toxicity: We assigned the hazard scores based preferentially on the most potent empirical oral, inhalation, and/or dermal LD₅₀ (the dose that is lethal to 50% of a population of test animals) values. When empirical LD₅₀ data were not identified, SAR predictions (rat oral LD₅₀) were used to assign the score.
- b. Carcinogenicity: Cancer bioassays were found for 8 of the studied OFRs, resulting in all of these OFRs being listed as carcinogens by authoritative bodies (i.e. “High” concern). Since most of the screened OFRs did not have empirical carcinogenicity data, the ISS and Oncologic QSAR models (OECD Toolbox, 2012) were used to identify a structural alert for carcinogenicity. If a structural alert was identified, we assigned a hazard score of “Moderate”.
- c. Reproductive toxicity: Two chemicals listed by an authoritative source as reproductive toxicants were rated as “High” concern. For a limited number of OFRs for which a two-generation reproduction study was identified, we assigned concern levels based on NOAEL values identified from these studies. Less than one-third of the OFRs screened had data to assess reproductive toxicity. We did not conduct SAR modeling of reproductive toxicity, due to the lack of guidelines for the use of SAR modeling tools for this hazard category.
- d. Developmental toxicity: The same two chemicals listed by an authoritative source as reproductive toxicants were also listed as developmental toxicants, and thus rated as “High” concern. When developmental toxicity studies were identified, we assigned concern levels based on NOAEL values from these studies. For most of the OFR, we used VEGA Caesar (2012) and/or U.S. EPA (2011) Toxicity Estimation Software Tool (T.E.S.T.) software to predict developmental toxicity potential due to the lack of empirical data. If predicted positive, we assigned a hazard score of “Moderate”.
- e. Mutagenicity/Genetic Toxicity: One OFR, TCEP (tris(2-carboxyethyl) phosphine, CAS#115-96-8), was listed by an authoritative source as a Global Harmonization System (GHS) category 1B germ cell mutagen (i.e. “High” concern). For the other OFRs, the scores were based, when possible, on empirical data, most commonly *Salmonella* reverse mutation assays. A few chemicals were negative in *Salmonella* assays but positive in other assays of genetic toxicity. In this case, we applied a hazard score of “Moderate”. When mutagenicity data were not identified, we used the ISS Quantitative Structure-Activity Relationship (QSAR) model (OECD Toolbox, 2012) to identify molecular functional groups or substructures considered to be structural alerts for *in vivo* or *in vitro* mutagenicity.
- f. Endocrine disruption: A few OFRs were listed as known or suspected endocrine disruptors by authoritative sources. Most of the other OFRs lacked empirical data specifically assessing endocrine disruption. Due to the current lack of SAR models to

predict endocrine disruption, no further modeling was done. This hazard category was the most prevalent one for data gaps.

- g. Acute aquatic toxicity: Those chemicals classified as toxic to aquatic organisms by an authoritative source were designated as “High” concern. For the others, the score was based on empirical LC₅₀ (the lethal concentration to 50% of the organisms tested) or EC₅₀ (the concentration that affects 50% of the organisms) values when identified. When empirical data were not identified, we used the U.S. EPA (2011) ECOSAR software to predict acute aquatic toxicity.
- h. Persistence: OFRs that have been classified as POP (Persistent Organic Pollutants) or PBT (Persistent, Bioaccumulative and Toxic) were designated as “High” concern. Most screened OFRs did not have empirical data available for these parameters. For these, the hazard score for persistence was based on the most conservative EPISuite model estimates for half-life in soil, water and sediment.
- i. Bioaccumulation: For the OFRs that were not listed or classified as a POP or PBT, the hazard score for bioaccumulation was based on octanol-water partition coefficients (K_{ow}) and bioaccumulation or bioconcentration factors, which were predicted using U.S. EPA (2011) EPISuite software when empirical data could not be identified.

7. Data gaps posed the greatest challenge in this study, and as indicated above, we often had to rely on QSAR modeling. It should be noted that QSAR models are often based on SMILES structures, which are sometimes not unique for every chemical, and the models are likely not calibrated specifically for OFRs. Therefore, we interpreted the modeling results with caution and did not rely solely upon them to denote chemicals of “High” concern. I would like to emphasize that the QCAT® methodology we used is generally health-protective. While it may not find all substances of concern, when it does, that result is defined according to independently established criteria and would be sufficient to warrant concern prompting further investigation or a search for a suitable alternative with a lower degree of concern.

8. On the basis of these data and model results, we assigned each chemical both an initial and a final grade based on QCAT® criteria, where:

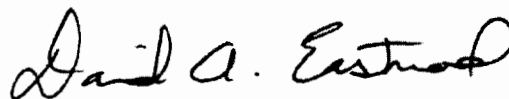
- “A” means few concerns / preferable,
- “B” means the chemical raises slight concerns / improvement possible,
- “C” means the chemical raises moderate concern / use but search for safer alternatives,
- “D” means the chemical is of high concern / avoid
- “F” means the chemical is toxic/do not use.

Chemicals received an automatic F if they were assigned a “High” score for any of the 5 priority human health endpoints. The initial grade considers only the concern levels based on empirical data and model results. The final grade assigned by the QCAT® model includes penalties for excessive data gaps.

9. The results of our on-going hazard screen are presented in draft form in the attached summary table. *Italicized hazard scores denote that QSAR model results and/or low confidence empirical data served as the basis of the score.* As the table shows, the initial grades for all of the evaluated organohalogen flame retardants were C or worse: 9 OFRs received C grades, 26 received D grades, and the remaining 48 received F grades. In the final grading step, 5 OFRs received D grades, and the remaining 78 received F grades. Five polymers and 3 OFRs with inadequate chemical information to allow for scoring were excluded from these tallies. These low grades were due to empirical data suggesting high hazard, SAR model predictions, and/or excessive data gaps. Carcinogenicity was the most prominent potential health hazard identified based on empirical data. Endocrine disruption exhibited the most prevalent data gaps.

10. In conclusion, all of the non-polymeric OFRs that we have screened using the QCAT® and related methodologies were found to be either of high concern or toxic based on the criteria described above. The results of our screening show that critical toxicological data are lacking for many OFRs, and that those for which data are available have the potential to pose significant hazards for human or environmental health.

Sincerely,



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Chemical Name	Abbrev. (Bergman 2012)	CAS #	Initial Grade	Final Predicted Grade (SAR included)	Acute toxicity	Carcinogenicity	Reproduction	Development	Mutagenicity/Genotoxicity	Endocrine Disruption	Acute Aquatic	Persistence	Bioaccumulation
1H-Indene, 4,5,6,7-tetrabromo-2,3-dihydro-1,1,3-trimethyl-3-(2,3,4,5-	OBTMPI	1084889-51-9, 893843-07-7,	F	F		M	dg	M	L	dg	L	vH	L
Benzene, 1,1'-oxybis [2,3,4,5,6-pentabromo- or Decabromodiphenyl ether	DecaBDE	1163-19-5	F	F	L	M			L	dg	L		H
Phenol, 2,4,6-tribromo-	TBP	118-79-6	F	F	H	M	H	M	L	M		vH	M
Phenol, 2,4,6-tribromo-3-	TBPD-TBP	168434-45-5	C	F	M	L	dg	dg	L	dg	L	vH	L
Benzene, 1,2,4,5-tetrabromo-3,6-dimethyl-	TBX	23488-38-2	D	F	L	M	dg	dg	L	dg	M	vH	vH
1,3,5-Triazine, 2,4,6-tris(2,4,6-	TBP-TAZ	25713-60-4	F	F	L	L	L	L	L	dg		vH	H
Benzene, dibromoethenyl-	DBS	31780-26-4	D	F	M	M	dg	M	L	dg	M	vH	L
1,4,-Bis(2,4,6-tribromophenoxy)-2,3-dibromobutene	OBPB	31977-87-4	D	F	M	L	dg	M	L	dg	L	vH	L
Pentabromodiphenyl ether	Penta BDE	32534-81-9	F	F	L	M	M		L				
Octabromodiphenyl ether	Octa BDE	32536-52-0	F	F	L	M			L	M			M
N-N-Ethylene-bis(tetrabromophthalimide	EBTEBPI	32588-76-4	D	F	L	M	L	L	L	dg	L		H
Benzene, 1,3,5-tribromo-2-(2-propen-1-	TBP-AE	3278-89-5	D	F	L	L	dg	M	L	dg	L	vH	H
Phenol, 4,4'-(1-methylethylidene)bis[2,6-dibromo-, 1,1'-diacetate	TBBPA-BOAc	33798-02-6	F	F	M	M	dg	M	M	dg	L	vH	vH
Bicyclo[2.2.1]hept-2-ene, 1,2,3,4,7,7-hexachloro-5-(2,3,4,5-tetrabromophenyl)-	HCTBPH	34571-16-9	C	D	M	M	dg	dg	L	dg	L	vH	L
Benzene, 1,3,5-tribromo-2-(2,3-	TBP-DBPE	35109-60-5	F	F	M	M	dg	M	M	dg	L	vH	vH
Benzene, 1,2,3,4,5-pentabromo-6-(2-propen-1-yloxy)-	PBP-AE	3555-11-1	F	F	M	L	dg	M	L	dg	L	vH	vH
1,2-Bis(2,4,6-tribromophenoxy)ethane	BTBPE	37853-59-1	F	F	L	M	dg	L	L	dg		vH	H
Benzene, 1,2,3,4,5-pentabromo-6-	PBBB	38521-51-6	F	F	L	M	dg	M	M	dg		vH	vH
Benzene, 1,2,3,4-tetrabromo-5-chloro-6-	TBCT	39569-21-6	D	F	M	M	dg	M	L	dg	M	vH	vH
Phenol, 4,4'-sulfonylbis[2,6-dibromo-	TBBPS	39635-79-5	D	F	L	L	dg	M	L	dg	L	vH	H
Benzene, 1,1'-sulfonylbis[3,5-dibromo-4-(2,3-dibromopropoxy)- AKA	TBBPS-BDBPE	42757-55-1	C	F	M	M	dg	M	M	dg	L	vH	M
Benzene, 1,1'-[oxybis(methylene)]bis[2,3,4,5,6-	DBDBE	497107-13-8	C	F	M	L	dg	M	L	dg	L	vH	L

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Chemical Name	Abbrev. (Bergman 2012)	CAS #	Initial Grade	Final Predicted Grade (SAR included)	Acute toxicity	Carcinogenicity	Reproduction	Development	Mutagenicity/Genotoxicity	Endocrine Disruption	Acute Aquatic	Persistence	Bioaccumulation
1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1,3,5-tris(2,3-dibromopropyl)-	TDBP-TAZTO	52434-90-9	F	F	M	M	dg	M	M	dg	L	vH	vH
1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1-(2,3-dibromopropyl)-3,5-di-2-propen-1-yl-	DBP-TAZTO	57829-89-7	D	F	L	M	dg	M	L	dg	M	vH	H
Benzene, 1,2,3,4,5-pentabromo-6-	PBBC	58495-09-3	F	F	H	M	dg	M	M	dg	L	vH	vH
Benzene, 1,2,4,5-tetrabromo-3,6-bis(2,3,4,5,6-pentabromophenoxy)-	4'-PeBPOBDE208	58965-66-5	D	F	L	L	dg	M	M	dg	L	vH	L
2-Propenoic acid, (2,3,4,5,6-pentabromophenyl)methyl ester	PBB-Acr	59447-55-1	F	F	H	M	dg	M	M	M	L	vH	vH
Phenol,2,3,4,5,6-pentabromo-	PBP	608-71-9	F	F		M	dg	dg	L			vH	M
Phenol, 2,4-dibromo-	DBP	615-58-7	F	F		M		M	L		M	vH	L
Phenol, 4,4'-(1-methylethylidene)bis[2,6-dibromo-, polymer with 2,2'-[(1-		68928-70-1	C	F	L	M	L	L	M	dg	L	vH	L
Benzene, 1,1'-sulfonylbis[3,5-dibromo-4-	TBBPS-BME	70156-79-5	F	F	M	L	dg	M	L	dg	L	vH	vH
Tetrabromophthalic anhydride or 4,5,6,7-tetrabromo-2-benzofuran-1,3-dione		72625-95-7	F	F	H	L	dg	dg	M	dg	L	vH	H
Decabromodiphenylethane	DBDPE	84852-53-9	F	F	L	M	dg	L	L	dg	L	vH	H
Benzene, 1,2,3,4,5-pentabromo-6-ethyl-	PBEB	85-22-3	F	F	L	M	dg	M	L	M	L	vH	vH
1,2,3,9-Tetrabromo-1,2,3,4-tetrahydro-1,4-methanonaphthalene	TTMN	855992-98-2			dg		dg	dg	dg	dg			
1,2,3,9-Tetrabromo-1,2,3,4-tetrahydro-1,4-methanonaphthalene	TTMN	855993-01-0	D	F	M	L	dg	M	L	dg	L	vH	M
Benzene, 1,2,3,4,5,6-hexabromo-	HBB	87-82-1	F	F	M	M	dg	L	L	dg		vH	H
Benzene, 1,2,3,4,5-pentabromo-6-methyl-	PBT	87-83-2	F	F	H	M	dg	L	L	M	L	vH	vH
Brominated epoxy resin end-capped with tribromophenol		135229-48-0	C	F	L	L	L	L	L	dg	L	vH	L
Poly(dibromostyrene): Benzene, ethenyl-, ar-bromo derivs., homopolymers	FIREMASTER CP44-HF & PBS-64HW	148993-99-1			dg		dg	dg	dg	dg		dg	dg
Polypentabromobenzyl acrylate PBB-MA Brominated polyacrylate or 2-Propenoic		59447-57-3	C	F	L	M	L	L	M	dg	L	vH	L

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Chemical Name	Abbrev. (Bergman 2012)	CAS #	Initial Grade	Final Predicted Grade (SAR included)	Acute toxicity	Carcinogenicity	Reproduction	Development	Mutagenicity/Genotoxicity	Endocrine Disruption	Acute Aquatic	Persistence	Bioaccumulation
Benzene, ethenyl-, homopolymer, brominated or Brominated polystyrene	na	88497-56-7	C	F	L	L	L	L	L	dg	L	vH	L
1-Propanol, 2,3-dibromo-, 1,1',1''-	TDBPP	126-72-7	F	F	M					dg		M	L
1-Propanol, 3-bromo-2,2-bis(bromomethyl)-, 1,1',1''-phosphate	TTBNPP	19186-97-1	D	F	L	M	H	H	M	dg	L	H	M
Tetrabromophthalic anhydride	TEBP-Anh	632-79-1	D	F	M	L	dg	dg	L	dg	M	vH	H
Bis(pentabromobenzyl)	BPBTB	82001-21-6	D	F	M	M	dg	M	M	dg	L	vH	L
Bis(pentabromobenzyl) terephthalate	BPBTerP	90075-91-5	D	F	H	L	dg	M	M	dg	L	vH	L
Benzoic acid, 2,3,4,5-tetrabromo-, 2-ethylhexyl ester	EH-TBB	183658-27-7	D	D	L	M	M	M	L	dg	L	vH	L
1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, 1-[2-(2-hydroxyethoxy)ethyl] 2-	HEEHP-TEBP	20566-35-2	D	F	L	M	dg	M	L	dg	M	H	L
1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, 1,2-bis(2-ethylhexyl) ester	BEH-TEBP	26040-51-7	F	F	L	M	dg	L	M	dg		vH	L
1,3,5-Triazine-2,4,6-(1H,3H,5H)-trione, 1,3-bis(2,3-dibromopropyl)-5-(2-propen-1-yl)-	BDBP-TAZ	75795-16-3	F	F	M	M	dg	M	M	dg	L	vH	vH
1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, mixed esters with diethylene Ethanol, 2-chloro-, phosphate (3:1)	TCEP	115-96-8	F	F	M	M	dg	M	M	dg	L	vH	L
Tris(1-chloro-2-propyl)phosphate	TCIPP	13674-84-5	C	D	M	M	L	L	L	dg	M	vH	L
2-Propanol, 1,3-dichloro-, phosphate (3:1)	TDCIPP	13674-87-8 (see isomer 78-43-3)	F	F	L		M	M	M	dg	M	vH	L
Tetrakis(2-chloroethyl)dichloroisopentylidiphosphate	BCMP-BBCP	38051-10-4	C	F	L	M	M	M	L	dg	M	vH	L
Tris(2,3-dichloro-1-propyl)phosphate		66108-37-0	D	F	M	L	dg	M	M	dg	M	vH	L
2,3-dichloro-, 1,1,1-phosphate propanol	TDCPP	78-43-3 (see isomer 13674-87-8)	F	F		M	dg	M		dg	M	vH	L
Cyclodecane, hexabromo-	HBCYD	25495-98-1	F	F	L	M	dg	M	M	dg	L		
1,2,5,9,10-Hexabromocyclodecane	unspecified HBCD	25637-99-4	F	F	L	M	H	H	L	H	H		
1,2,5,9,10-Hexabromocyclodecane	HBCDD	3194-55-6	F	F	L	M	H	L	L	M			
Cyclooctane, 1,2,5,6-tetrabromo-	TBCO	3194-57-8	F	F	L	M	dg	dg	L	dg	vH	vH	H
Cyclohexane, 1,2-dibromo-4-(1,2-	DBE-DBCH	3322-93-8	F	F	L	M	dg	M	H		L	vH	L

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Chemical Name	Abbrev. (Bergman 2012)	CAS #	Initial Grade	Final Predicted Grade (SAR included)	Acute toxicity	Carcinogenicity	Reproduction	Development	Mutagenicity/Genotoxicity	Endocrine Disruption	Acute Aquatic	Persistence	Bioaccumulation
Chlorendic anhydride aka 4,7-Methanoisobenzofuran-1,3-dione, 4,5,6,7,8,8-hexachloro-3a,4,7,7a-	HCBCH-DCAh	115-27-5	C	D	L	H	M	L	L	dg	M	vH	L
Chlorendic acid	HCBCH-DCA	115-28-6	F	F	M		M	M	M	dg	M	vH	vL
1,4:7,10-Dimethanodibenzo[a,e]cyclooctene, 1,2,3,4,7,8,9,10,13,13,14,14-dodecachloro-	DDC-CO	13560-89-9	D	F	L	M	L	L	L	dg	L	vH	H
1,3,4-Metheno-1H-cyclobuta[cd]pentalene, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachlorooctahydro-	MIREX	2385-85-5	F	F	vH				L		M		
1,4:6,9-Dimethanodibenzofuran, 1,2,3,4,6,7,8,9,10,10,11,11-dodecachloro-1,4,4a,5a,6,9,9a,9b-octahydro-	DDC-DBF	31107-44-5	F	F		M	dg	dg	M	H	vH		
hexachlorocyclopentadienyl-	DBHCTD	51936-55-1	F	F	L	M	dg	M	L	dg	L	vH	H
1-Propanol, 3-bromo-2,2-bis(bromomethyl)-	TBNPA	1522-92-5	F	F	L	M	dg	dg		dg	M	vH	L
1,3-Propanediol, 2,2-bis(bromomethyl) OR 2,2-Bis(bromomethyl)-1,3-propanediol	DBNPG	3296-90-0	F	F	M		M	M		dg	M	H	L
1-Propanol, 2,2-dimethyl-, tribromo derive. (Tribromoneopentylalcohol)		36483-57-5	D	F	L	M	dg	dg	M	dg	vH	vH	L
Flamestab Nor 116 or 1,3-Propanediamine, N,N'-1,2-ethanediylbis-, Alkanes, C10-13, chloro	SCCP	85535-84-8; 71011-	F	F	L		dg	M	L	M		vH	
Medium chain chlorinated paraffins (more DATA in ECHA)	MCCP	85535-85-9	F	F	L				M	M		vH	H
1,3-Isobenzofurandione, 4,5,6,7-tetrachloro- (TETRACHLOROPHTHALIC	TCP-Anh	117-08-8	C	D	L	M	L	L	L	dg	L	vH	M
1,4:5,8:9,10-Trimethanoanthracene, 1,2,3,4,5,6,7,8,12,12,13,13-dodecachloro-1,4,4a,5,8,8a,9,9a,10,10a-decahydro-	DDC-Ant	13560-92-4	D	F	M	M	dg	dg	L	dg	L	vH	L
Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-(2,3-dibromopropoxy)-	TBBPA-BDBPE	21850-44-2	F	F	L	M	M	M	M	dg	L	vH	H
Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-(2-propen-1-yloxy)-	TBBPA-BAE	25327-89-3	D	F	L	L	dg	M	L	dg		vH	vH

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Chemical Name	Abbrev. (Bergman 2012)	CAS #	Initial Grade	Final Predicted Grade (SAR included)	Acute toxicity	Carcinogenicity	Reproduction	Development	Mutagenicity/Genotoxicity	Endocrine Disruption	Acute Aquatic	Persistence	Bioaccumulation
Oxirane, 2,2'-[(1-methylethylidene)bis[(2,6-dibromo-4,1-phenylene)oxymethylene]]bis-	TBBPA-BGE	3072-84-2	D	F	H	M	dg	M	M	dg	L	vH	M
Phenol, 4,4'-[(1-methylethylidene)bis[2,6-dibromo-, dipropanoate (9CI)]	TBBPA-BP	37419-42-4	D	F	M	M	dg	M	M	dg	L	vH	H
Benzene, 1,1'-[(1-methylethylidene)bis[3,5-dibromo-4-methoxy- AKA TETRABROMOBISPHENOL A BME	TBBPA-BME	37853-61-5	D	F	L	M	dg	H	L	dg	M	vH	H
Ethanol, 2,2'-[(1-methylethylidene)bis[(2,6-dibromo-4,1-phenylene)oxy]]bis-	TBBPA-BHEE	4162-45-2	F	F	H	L	dg	M	M	dg		vH	vH
2-Propenoic acid, 1,1'-[(1-methylethylidene)bis(2,6-dibromo-4,1-	TBBPA-BA	55205-38-4	D	F	M	L	dg	dg	M	dg	L	vH	H
2-Propenoic acid, 1,1'-[(1-methylethylidene)bis(2,6-dibromo-4,1-	TBBPA-BHEEBA	66710-97-2	D	F	M	L	dg	M	M	dg	L	vH	H
Phenol, 4,4'-(-methylethylidene)bis[2,6-	TBBPA	79-94-7	F	F	L	M		H	L			vH	
1,2,5,9,10-Hexabromocyclodecane	γ-HBCD	134237-52-8	F	F	L	M	H	M	L	H	H		
1,2,5,9,10-Hexabromocyclodecane	α-HBCD	34237-50-6	F	F	L	M	H	M	L	H	H		
1,2,5,9,10-Hexabromocyclodecane	β-HBCD	34237-51-7	F	F	L	M	H	M	L	H	H		
2,2',4,4'-Tetrabromodiphenyl ether	BDE-47	5436-43-1	F	F	M	M			M	H	M	vH	vH

CURRICULUM VITAE

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EDUCATION: University of California, Berkeley, California, Ph.D., Environmental Health Sciences (Toxicology), 1987.

Brigham Young University, Provo, Utah, M.S., Entomology, 1983.

Brigham Young University, Provo, Utah, B.S., Zoology, 1980.

PROFESSIONAL EXPERIENCE:

Professor, Environmental Toxicology Graduate Program and Department of Cell Biology & Neuroscience, University of California, Riverside, California; Assistant professor 1990-1996, Associate professor 1996-2000, Professor 2000-present, Graduate Program Chair, 1999-2004, 2005-08, Interim Director, UC Washington Center and UC Sacramento programs at UCR, 2007-08; Department Chair, 2008-present.

Assistant Research Toxicologist, Department of Biomedical and Environmental Health Sciences, University of California, Berkeley, California, 1989.

Alexander Hollaender Distinguished Postdoctoral Fellow in Genetic and Molecular Toxicology, Biomedical Sciences Division, Lawrence Livermore National Laboratory, University of California, Livermore, California, 1987-1989.

Research assistant in biochemical toxicology, University of California, Berkeley, California, 1983-1987.

Intern with the Environmental Effects Branch, Office of Toxic Substances, Environmental Protection Agency, Washington, D.C., 1983.

Research assistant in environmental toxicology, Brigham Young University, Provo, Utah. 1979-1983.

Field supervisor for a seed alfalfa integrated pest management project directed by Utah State University, Delta, Utah, summer 1979.

Field technician conducting environmental impact-related studies directed by BYU for the Department of Energy, Raft River, Idaho, summer 1978.

TEACHING EXPERIENCE:

Instructor for a graduate-level Principles of Toxicology course (ENTX 201) at UC Riverside

Instructor for a graduate-level and an undergraduate level Risk Assessment courses (ENTX 154 & 220) at UC Riverside.

Lead instructor for a graduate-level seminar course (ENTX 270) at UC Riverside

Lead instructor and co-instructor for a graduate-level Mechanisms of Toxicity course (ENTX 202) at UC Riverside

Co-instructor for an undergraduate-level Cancer Biology course (ENTX 150) at UC Riverside

Instructor for freshman-advising seminars (NASC 91 and 93) at UC Riverside

Instructor for an Environmental Toxicology course (Env. Sci. X100) taught through the UC Riverside Extension.

Teaching assistant in the General Biology, Introductory Entomology, Human Physiology, and Comparative Toxicology classes at Brigham Young University.

OTHER PROFESSIONAL EXPERIENCE:

Member, Chemical Assessment Advisory Committee, Science Advisory Board, U.S. Environmental Protection Agency, Nov. 4, 2013 – Sept. 30, 2016

Member, Carcinogen Identification Committee, Science Advisory Board, Office of Environmental Health and Hazard Assessment, State of California, 1999 - 2003, 2005 to present.

Associate Director, NIEHS Training Program in Environmental Toxicology at University of California, Riverside, July 1, 2010 – present.

Member, Genotoxicity Test Guidelines Working Group, Organisation for Economic Cooperation and Development Sept. 2010 – present.

Member, Genetic Toxicology Technical Committee Steering Team, Health and Environmental Sciences Institute, International Life Sciences Institute, Jan. 2013 – present.

Member, Working Group on Quantitative Approaches and Non-Linear Dose-Response Relationships in Genotoxicity Assessment, International Working Group on Genotoxicity Testing, Jan. 2013 – present.

Chair, Board of Scientific Counselors, National Toxicology Program, NIEHS, Member, Jan. 2009 – Dec. 2012, Chair, Feb. 2011 – Dec. 2012.

Participant, Research Participation Program, National Center for Environmental Assessment, Environmental Protection Agency, 2008 – 2011.

Co-chair, Expert Panel on Genotoxicity Testing of Pharmaceuticals, Center for Drug Evaluation and Research, Food and Drug Administration, Jan. 2010.

Member, Risk and Technology Review Panel, Science Advisory Board, Environmental Protection Agency, July 2009 - Jan. 2010.

Council Member, National Council on Radiation Protection and Measurements, 2004 to 2010; consociate member, 2010 - present.

Editorial board member for the journals *Toxicological Sciences* (2007 – present), *Mutation Research*, *Genetic Toxicology and Environmental Mutagenesis* (1994 - present), and *Chemico-Biological Interactions* (1998 - 2001).

Member, Working group, International Agency for Research on Cancer, Working group meeting on pharmaceuticals, Oct. 2008.

Chair, WHO/IPCS international expert meetings to conduct an update of the "IPCS harmonization of methods for the prediction and quantification of human carcinogenic/mutagenic hazard", April 2007 and June 2008.

Working group member, International Agency for Research on Cancer, Working group meeting on ethylene oxide, 1,3-butadiene, vinyl chloride, vinyl bromide, and vinyl fluoride, June 2007.

Advisor to the US Environmental Protection Agency and conducted detailed reviews of the following topics: Chemical and radiation-induced leukemogenesis in humans and rodents and the value of rodent models for assessing risks of lymphohematopoietic cancers, 1995-96; The use of genetically modified animals in the cancer risk assessment process, 2001; Genotoxicity of carbon tetrachloride and its implications for mode-of-action and dose response decisions, 2006; Conducted a review of the literature on "Childhood leukemia: origins and biomarkers" 2005-2006; Conducted a review of the genotoxicity and mode-of-action sections of the draft toxicological review of 1,2,3-trichloropropane (NCEA-S-1669), 2007; Lymphohematopoietic Cancers Induced by Chemicals and Other Agents: Overview and Implications for Risk Assessment, 2012.

Invited expert for the USEPA "Peer Consultation Workshop on Research Needs Related to the IRIS Draft Toxicological Review of Naphthalene", April 2005

Invited specialist, International Agency for Research on Cancer, Working Group meeting on Formaldehyde, 2-butoxyethanol, and propylene glycol mono-t-butyl ether, June 2004.

Program chair, 34th Annual meeting of the Environmental Mutagen Society, Miami Beach, Florida, May 10-14, 2003.

Member, ILSI Risk Science Institute Steering Committee for Screening Tests for Toxic Chemicals, 2002-05.

Reviewer of Public Health Goal Documents, Risk Assessment Documents or Proposed Guidelines for the US Environmental Protection Agency (EPA), 1999, 2004 and the California EPA, Office of Environmental Health Hazard Assessment, 1998, 2001, 2002, 2004, 2005, 2006, 2008.

Invited participant to the ILSI/Health Canada peer consultation panel on "Genotoxicity for Categorisation of "Inherent Toxicity" to Humans under CEPA '99", 2002.

Council member, Environmental Mutagen Society, April 1997-2000.

Panel member, US Environmental Protection Agency's Expert Panel Peer Review of Benzene Risk Assessment Update, June-July 1997.

Research associate, Statewide Air Pollution Research Center, Riverside, California.

Invited participant in the World Health Organization's International Programme on Chemical Safety Task Group to finalize the Environmental Health Criteria for Hydroquinone. Carshalton Surrey, United Kingdom May 1993.

Reviewer of manuscripts for *American Journal of Human Genetics*; *Archives of Biochemistry and Biophysics*; *Archives of Environmental Contamination and Toxicology*; *Biochemie*; *British Journal of Cancer*; *Bulletin of Environmental Contamination and Toxicology*; *Cancer Epidemiology, Biomarkers and Prevention*; *Cancer Letters: Cancer Research*; *Chemico-Biological Interactions*; *Critical Reviews in Toxicology*; *Cytometry*; *Environmental and Molecular Mutagenesis*; *Environmental Health Perspectives*; *Environmental Pollution*; *Environmental Science & Technology*; *Environmental Toxicology & Pharmacology*; *Genes, Chromosomes and Cancer*; *Genetics and Molecular Biology*; *Human Genetics*; *International Journal of Environmental Research and Public Health*; *International Journal of Environmental Research and Public Health*; *International Journal of Radiation Biology*; *Journal of Agriculture and Food Chemistry*; *Journal of Toxicology and Environmental Health*; *Leukemia*; *Mutagenesis*; *Mutation Research*; *Oncology Research*; *Pediatrics*; *Proceedings of the National Academy of Sciences*; *Toxicological Sciences*; *Radiation Research*; *Toxicology Letters*; *Toxicology and Applied Pharmacology*; *Vaccine*. 1987-present.

Member of the Society of Toxicology's ad hoc Tox 90s Educational Issues Task Force 1991-1993.

Reviewer of Grant Proposals, Pre-proposals/Fellowship Applications, or Cooperative Research Agreements for the U.S. Environmental Protection Agency (1989), the Air Force Office of Scientific Research (1990), Center for Indoor Air Research (1995), NIEHS Small Business Grants (1995, 96,

97, 03), Flanders (Belgium) Fund for Scientific Research (1998), UC MEXUS (2003), Health Effects Institute (1994, 2005), University of California Biotechnology Research and Education Program (2005 and 2006), University of California Toxic Substances Research and Teaching Program (1992, 2007 and 2008).

Invited Participant in a peer review session to recommend acceptable levels of polycyclic aromatic hydrocarbons in the Great Lakes for the International Joint Commission, 1982.

Selected Participant in a tropical biology research project on the function of buttressing in tropical trees, Barro Colorado Island, Panama, 1982.

Participant in a marine biology field experience, focusing primarily on intertidal ecology, Friday Harbor, Washington, 1980.

AWARDS AND RECOGNITIONS:

Article by Bhat, Hester, Nesnow and Eastmond was selected as "One of the Best Papers Advancing the Science of Risk Assessment" by the Risk Assessment Specialty Section of the Society of Toxicology at its 2014 annual meeting, March 2014.

Recipient of the Perry J. Gehring Best Graduate Student Abstract Mentor Award by the Risk Assessment Specialty Section of the Society of Toxicology at its 2013 annual meeting, March 2013.

Elected Fellow of the Collegium Ramazzini, Nov. 2011

Jefferson Science Fellow, US Department of State (administered by the National Academy of Sciences), Washington DC, 2004-2005.

President, Environmental Mutagen Society, May 2003-Oct. 2004.

Outstanding Environmental Toxicology Faculty/Mentor award presented by the students of the Environmental Toxicology Graduate Program, University of California, Riverside, 2001, 2007 and 2011.

Alexander Hollaender Distinguished Postdoctoral Fellow, U.S. Dept. of Energy, 1987-1989.

Outstanding Postdoctoral Research Presentation, Genetic and Environmental Toxicology Association of Northern California, 1988.

Selected New Investigator, Society of Toxicology, 1987.

Recipient of the Margaret Beattie Award for Excellence in the Laboratory Sciences, School of Public Health, U.C. Berkeley, 1987.

Honorable Mention, Society of Toxicology Mechanisms Award, 1987.

Outstanding Graduate Student Research Presentation, Genetic and Environmental Toxicology Association of Northern California, 1986.

Thesis selected as the Outstanding Thesis of the College of Biological and Agricultural Sciences at BYU, 1983.

Various Fellowships and Traineeships, U.C. Berkeley, 1983-1987.

Sigma Xi Research Society, 1982.

Phi Kappa Phi Honor Society, 1980.

Alvin S. Barrett Scholarship, Brigham Young Univ., 1974-75, 1977-80.

SOCIETY

MEMBERSHIPS:

Environmental Mutagenesis and Genomics Society

Society of Toxicology (National and Southern California Chapters)

Collegium Ramazzini

American Association for the Advancement of Science

BIBLIOGRAPHY

David A. Eastmond, Ph.D.

PUBLICATIONS

1. Vassilaros, D.L., Eastmond, D.A., West, W.R., Booth, G.M., and Lee, M.L. (1982). Determination and Bioaccumulation of Polycyclic Aromatic Sulfur Heterocycles in Aquatic Biota. In: Polynuclear Aromatic Hydrocarbons: Physical and Biological Chemistry, M. Cooke, A.J. Dennis, and G.L. Fisher (Eds.), Battelle Press, Columbus, pp. 845-857.
2. Porter, S., and Eastmond, D.A. (1982). *Euryopsis coki* (Therididae), A Spider that Preys on *Pogonomyrmex* Ants. *J. Arachnology* 10, 275-277.
3. Eastmond, D.A., Meuhle, C.M., Price, R.L., Hutchens, C.A., Booth, G.M., and Lee, M.L. (1983). Acute Toxicity, Bioconcentration, and Elimination of a Coal Liquid in Freshwater Organisms. In: Polynuclear Aromatic Hydrocarbons: Formation, Metabolism, and Measurement, M. Cooke and A.J. Dennis, (Eds.), Battelle Press, Columbus, pp. 451-469.
4. Eastmond, D.A. (1983). Toxicity, Accumulation, and Elimination of Polycyclic Aromatic Sulfur Heterocycles in *Daphnia magna*. Master's Thesis, Brigham Young University.
5. Fluck, D.S., Rappaport, S.M., Eastmond, D.A., and Smith, M.T. (1984). Conversion of 1-Naphthol to Naphthoquinone Metabolites by Rat Liver Microsomes: Demonstration by HPLC with Reductive Electrochemical Detection. *Arch. Biochem. Biophys.* 235, 351-358.
6. Eastmond, D.A., Booth, G.M., and Lee, M.L. (1984). Toxicity, Accumulation, and Elimination of Polycyclic Aromatic Sulfur Heterocycles in *Daphnia magna*. *Arch. Environ. Contam. Toxicol.* 13, 105-111.
7. Smith, M.T., Fluck, D.S., Eastmond, D.A., and Rappaport, S.M. (1985). Detection of Quinone Metabolites by HPLC with Reductive Electrochemical Detection. *Life Chemistry Reports* 3, 250-258.
8. Lipnick, R.L., Bickings, C.K., Johnson, D.E., and Eastmond, D.A. (1985). Comparison of QSAR Predictions with Fish Toxicity Screening Data for 110 Phenols. In: *Aquatic Toxicology and Hazard Assessment, Eighth Symposium, ASTM STP 891*, R.C. Bahner and D. J. Hensen, (Eds.), American Society for Testing and Materials, Philadelphia, pp. 153-176.
9. Eastmond, D.A., Smith, M.T., Ruzo, L.O., and Ross, D. (1986). Metabolic Activation of Phenol by Human Myeloperoxidase and Horseradish Peroxidase. *Molecular Pharmacology* 30, 674-679.
10. Eastmond, D.A., French, R.C., Ross, D., and Smith, M.T. (1987). Metabolic Activation of Diethylstilbestrol by Human Leukocytes. *Cancer Letters* 35, 79-86.
11. Eastmond, D.A. (1987). Free Radical Mechanisms in Benzene Toxicity. Doctoral Dissertation, University of California, Berkeley.

12. Eastmond, D.A., French, R.C., Ross, D., and Smith, M.T. (1987). Metabolic Activation of Phenol and 1-Naphthol by Human Leukocytes and a Xanthine Oxidase System. *Chemico-Biological Interactions*, 63, 47-62.
13. Smith, M.T., Eastmond, D.A., and Di Monte, D. (1987). The Activation and Detoxication of Quinones by DT-Diaphorase. *Chemica Scripta*, 27A, 105-107.
14. Eastmond, D.A., Smith, M.T., and Irons, R. (1987). An Interaction of Benzene Metabolites Reproduces the Myelotoxicity Observed with Benzene Exposure. *Toxicol. Appl. Pharmacol.*, 91, 85-95.
15. Warren, S.D., Black, H.L., Eastmond, D.A., and Whaley, W.H. (1988). Structural Function of Buttresses of *Tachigalia versicolor*. *Ecology* 69, 532-536.
16. Eastmond, D.A. and Tucker, J.D. (1989). Identification of Aneuploidy-inducing Agents Using Cytokinesis-blocked Human Lymphocytes and an Antikinetochores Antibody. *Environmental and Molecular Mutagenesis* 13, 34-43.
17. Smith, M.T., Yager, J.W., Steinmetz, K.L., and Eastmond, D.A. (1989). Peroxidase-dependent Metabolism of Benzene's Phenolic Metabolites and its Potential Role in Benzene Toxicity and Carcinogenicity. *Environmental Health Perspectives*, 82, 23-29.
18. Eastmond, D.A. and Pinkel, D. (1989). Aneuploidy Detection by Analysis of Interphase Nuclei Using Fluorescence *In Situ* Hybridization with Chromosome-Specific Probes. In: *Mechanisms of Chromosome Distribution and Aneuploidy*, M.A. Resnick and B.K. Vig (Eds.), Alan R. Liss, New York, pp. 277-284.
19. Eastmond, D.A., Tucker, J.D., and Pinkel, D. (1989). The Use of an Antikinetochores Antibody and DNA Probes to Measure Aneuploidy in Interphase Human Lymphocytes. In: *Multilevel Health Effects Research: From Molecules to Man*, J.F. Park and R.A. Pelroy (Eds.), Battelle Press, Richland, WA, pp. 157-165.
20. Eastmond, D.A. and Tucker, J.D. (1989). Kinetochore Localization in Micronucleated Cytokinesis-Blocked Chinese Hamster Ovary Cells: A New and Rapid Assay for Identifying Aneuploidy-Inducing Agents. *Mutation Res.* 224, 517-525.
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22. Tucker, J.D. and Eastmond, D.A. (1990). Use of an Antikinetochores Antibody to Discriminate Between Micronuclei Induced by Aneuploidogens and Clastogens. In: *Mutation and the Environment, Part B: Metabolism, Testing Methods, and Chromosomes*, ML Mendelsohn and RJ Albertini, Wiley-Liss, Inc. pp. 275-284.
23. Smith, M.T., Robertson, M.R., Yager, J.W., and Eastmond, D.A. (1990). Role of Metabolism in Benzene-induced Myelotoxicity and Leukemogenesis. In: *Mutation and the Environment, Part B: Metabolism, Testing Methods, and Chromosomes*, ML Mendelsohn and RJ Albertini, Wiley-Liss, Inc. pp. 125-136.

24. Eastmond, D.A. and Smith, M.T. (1990). Xenobiotic Activation by Stimulated Human Polymorphonuclear Leukocytes and Myeloperoxidase. *Methods in Enzymology* 186:579-585.
25. Eastmond, D.A. and Pinkel, D. (1990). Detection of Aneuploidy and Aneuploidy-inducing Agents in Human Lymphocytes using Fluorescence *In Situ* Hybridization with Chromosome-specific DNA Probes. *Mutation Res.* 234, 303-318.
26. Kolachana, P., Subrahmanyam, V.V., Eastmond, D.A., and Smith, M.T. (1991). Metabolism of Phenylhydroquinone by Prostaglandin (H) Synthase: Possible Implications in *o*-Phenylphenol-induced Bladder and Kidney Carcinogenesis. *Carcinogenesis* 12, 145-149.
27. Robertson, M.L., Eastmond, D.A., and Smith, M.T. (1991). Two Benzene Metabolites, Catechol and Hydroquinone, Produce a Synergistic Genotoxic Response in Cultured Human Lymphocytes. *Mutation Research* 249, 201-209.
28. Subrahmanyam, V.V., Ross, D., Eastmond, D.A., and Smith, M.T. (1991). Potential Role of Free Radicals in Benzene-induced Myelotoxicity and Leukemia. *Free Radical Biology & Medicine* 11, 495-515.
29. Eastmond, D.A. (1993). Induction of Micronuclei and Aneuploidy by the Quinone-forming Agents Benzene and *o*-Phenylphenol. *Toxicology Lett.* 67, 105-118.
30. Eastmond, D.A., Rupa, D.S., Chen, H.W. and Hasegawa, L. (1993). Multicolor Fluorescence *In Situ* Hybridization with Centromeric DNA Probes as a New Approach to Distinguish Chromosome Breakage from Aneuploidy in Interphase Cells and Micronuclei, In: *Chromosome Segregation and Aneuploidy*, BK Vig (Ed.), Springer-Verlag, Berlin, pp. 377-390.
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33. Lambert, A.C. and Eastmond, D.A. (1994). Genotoxic Effects of the *o*-Phenylphenol Metabolites Phenylhydroquinone and Phenylbenzoquinone in V79 Cells. *Mutation Res.* 322, 243-256.
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35. Dobo, K.E. and Eastmond, D.A. (1994). The Role of Oxygen Radicals in the Chromosomal Loss and Breakage Induced by the Quinone-Forming Compounds Hydroquinone and *tert*-Butylhydroquinone. *Environ. Molecul. Mutagen.* 24, 293-300.

36. Dobo, K.L., Giver, C.R., Eastmond, D.A., Rumbos, H.S. and A.J. Grosovsky (1995). Extensive Loss of Heterozygosity Accounts for Differential Mutation Rate on Chromosome 17q in Human Lymphoblasts. *Mutagenesis* 10, 53-58.
37. Rupa, D.S., Hasegawa, L. and D.A. Eastmond (1995). Detection of chromosomal breakage in the 1cen - 1q12 region of interphase human lymphocytes using multicolor fluorescence *in situ* hybridization with tandem DNA probes. *Cancer Res.* 55, 640-645.
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39. Eastmond, D.A. and Rupa, D.S. (1995). Fluorescence *In Situ* Hybridization: Application to Environmental Mutagenesis. In: *Environmental Mutagenesis*, (D.H. Phillips and S. Venitt, eds.), Bios Scientific Publishers, Oxford, United Kingdom. pp. 261-290.
40. Chen, H. and Eastmond, D.A. (1995). Synergistic Increase in Chromosomal Breakage Within the Euchromatin Induced by an Interaction of the Benzene Metabolites Phenol and Hydroquinone in Mice. *Carcinogenesis* 16, 1963-1969.
41. Hasegawa, L.S., Rupa, D.S. and Eastmond, D.A. (1995) A Method for the Rapid Generation Of *Alpha*- And Classical Satellite Probes for Human Chromosome 9 by Polymerase Chain Reaction Using Genomic DNA And their Application To Detect Chromosomal Alterations In Interphase Cells *Mutagenesis* 10, 471-476.
42. Chen, H. and Eastmond, D.A. (1995) Topoisomerase Inhibition By Phenolic Metabolites: A Potential Mechanism For Benzene's Clastogenic Effects. *Carcinogenesis* 16: 2301-2307.
43. Eastmond, D.A., Schuler, M. and Rupa, D.S. (1995) Advantages and Limitations of Interphase Analysis using Fluorescence *in situ* Hybridization for the Detection of Aneuploidy in Human Cells. *Mutation Res.* 348, 153-162.
44. Arey, J., Atkinson, R., Sasaki, J., Gupta, P., Eastmond, D.A. and Grosovsky, A.J. (1995) Atmospheric Transformation Reactions of 2-4 Ring Polycyclic Aromatic Hydrocarbons and the Formation of Mutagenic Products. In: "Ecotoxicology of Air Compartment", Communications of the International Symposium in Rouen, Society of Fundamental and Applied Ecotoxicology Congress, pp. 15-22.
45. Frantz, C.E., Chen, H. and Eastmond, D.A. (1996) "Inhibition of Human Topoisomerase II *in vitro* by Bioactive Benzene Metabolites" *Environ. Health Perspect.* Vol. 104, Suppl. 6, 1319-1323.
46. Cranor, C.F., Fischer, J.G. and Eastmond, D.A. (1996) "Judicial boundary drawing and the need for context-sensitive science in toxic torts after *Daubert v. Merrell-Dow Pharmaceutical*" *Virginia Environmental Law Journal* 16:1-77.
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49. Rupa, D.S., Schuler, M. and Eastmond, D.A. (1997) "Detection of hyperdiploidy and breakage affecting the 1cen-1q12 region of cultured interphase human lymphocytes treated with various genotoxic agents" *Environ. Mol. Mutagen.* 29:161-167.
50. Rupa, D.S., Hasegawa, L.S., and Eastmond, D.A. (1997) "Detection of chromosomal alterations affecting the 1cen-1q12 region in irradiated granulocytes and lymphocytes by multicolor FISH with tandem DNA probes" *Mutagenesis* 12:195-200.
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52. Dopp, E., Schuler, M., Schiffmann, D. and Eastmond, D.A. (1997) Induction of micronuclei, hyperdiploidy and chromosomal breakage affecting the centric/pericentric regions of chromosome 1 and 9 in human amniotic fluid cells after treatment with asbestos and ceramic fibers, *Mutation Res.* 377:77-87.
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54. Kwok, E.S.C. and Eastmond, D.A. (1997) Effects of pH on non-enzymatic oxidation of phenylhydroquinone: Potential role in the urinary bladder carcinogenesis induced by *ortho*-phenylphenol in Fischer 344 Rats, *Chem. Res. Toxicol.* 10:742-749.
55. Dobo, K.L., Eastmond, D.A. and Grosovsky, A.G. (1997) The influence of cellular apoptotic capacity on N-nitrosodimethylamine-induced loss of heterozygosity mutations in human cells. *Carcinogenesis* 18:1701-1707.
56. Frantz, C.E., Smith, H., Eades, D.M., Grosovsky, A.J. and Eastmond, D.A. (1997) Bimolane: *in vitro* inhibitor of human topoisomerase II, *Cancer Letters* 120:135-140.
57. Rupa, D.S. and Eastmond, D.A. (1997) "Chromosomal alterations affecting the 1cen-1q12 region of buccal mucosal cells of betel quid chewers detected using multicolor fluorescence *in situ* hybridization", *Carcinogenesis* 18:2347-2351.
58. Schuler, M., Metzler, M. Parks, R. and Eastmond, D.A. (1998) Dose-response studies of the induction of hyperdiploidy and polyploidy by diethylstilbestrol and 17 β - estradiol in cultured human lymphocytes using multicolor fluorescence *in situ* hybridization. *Environmental and Molecular Mutagenesis* 31:263-273.
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Exhibit D

Statement of David Epel

STANFORD UNIVERSITY
HOPKINS MARINE STATION
PACIFIC GROVE, CA 93950

DAVID EPEL
JANE AND MARSHALL STEEL, JR.
PROFESSOR OF MARINE SCIENCES

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DEPEL@STANFORD.EDU

November 17, 2014

I, David Epel, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, David Epel, am a Jane and Marshall Steel Jr. Professor Emeritus of Biological and Marine Sciences at the Hopkins Marine Station of Stanford University. I have a Ph.D. from the University of California, Berkeley. I have been a Guggenheim Fellow, and am a Fellow of the American Association for the Advancement of Science, a Fellow of the California Academy of Sciences, and a Life Fellow of Clare Hall of the University of Cambridge in the UK. I was awarded the Ed Ricketts Memorial Award for Lifetime Achievement in the Marine Sciences. Please see my CV and list of publications accompanying this statement.

2. One of my areas of research deals with the cellular and molecular mechanisms that allow embryos to resist the effects of environmental stresses such as ultraviolet radiation, pathogens and natural and man-made toxins. My expert opinion below is based on my work on the primary line of defense against toxic substances provided by a large family of efflux transporters known as ABC (ATP-binding cassette) transporters.

3. These ABC transporters are proteins in the plasma membrane of cells that act as “bouncers” to keep toxic substances out of cells, and also as “garbage collectors”, removing chemicals that evaded the original bouncer action. All organisms, from bacteria to plants to humans, employ this defense system. If the transporters can recognize a chemical, they can then prevent its entry into the cell. A well-studied example of this mechanism is resistance to cancer chemotherapy, which can develop during the course of cancer treatment. When cells are exposed to anti-cancer drugs, they often respond by elevating the number of ABC transporters. This keeps the anti-cancer drugs out of the cell and makes the cells resistant to chemotherapy.

4. Some chemicals seem to evade this bouncer defense, for example teratogen thalidomide, neurochemical methyl mercury, and organohalogen compounds such as DDT, PCBs and chlordane. These chemicals are not recognized by the ABC transporters. The cell also has little capacity to metabolize or convert these chemicals to less toxic forms. As a result, these chemicals accumulate in the cell, where they remain for the lifetime of the cell – a legacy of prior exposure.

5. A large group of organohalogen flame-retardants are similar to DDT, PCBs and chlordane in that they have very low water solubility and have carbon-halogen bonds. These chemicals:

- (1) Are not transported out of the cell by the ABC transporters.
- (2) Are fat soluble, so they can permeate the cell membrane and enter the cell.

(3) Are not metabolized by the cell or converted to forms that can be eliminated. Consequently, the organohalogen flame-retardants with low water solubility persist in many organisms including in humans, fish, and marine mammals.

6. A colleague has recently studied the interactions between some PBDE congeners (which are also organohalogen flame retardants with very low water solubility) and the ABC transporters. He found that the studied PBDEs inhibited the ABC transporters, which could explain the inability to transport these chemicals out of the cell. This inhibition would also impair the cell's defenses, altering its ability to keep other toxic compounds out. My colleague is continuing to study other organohalogen flame retardants, but these preliminary results are of concern, as they suggest that organohalogen flame-retardants can not only cause biological harm on their own, but also potentially exacerbate the harmful effects of other chemicals.

7. All organohalogen flame-retardants form a structurally similar chemical class, characterized by one or more halogens (chlorine or bromine) bound to carbon. Those that have very low water solubility can bioaccumulate and have the potential to produce the adverse biological effects described above, as my research on their interactions with the ABC transporters has shown. The more water-soluble organohalogen flame retardants do not tend to bioaccumulate. However, as a result of their carbon-halogen bonds, they are also not natural to mammalian biochemistry and may not be recognized by the ABC transporters. Animal and epidemiological studies have linked exposure to the more water-soluble organohalogen flame retardants (most of which are organophosphates) to adverse health effects. Thus, sufficient evidence from scientific studies shows a substantial potential of harm from the entire class of organohalogen flame-retardants (i.e. both water-soluble and water-insoluble).

8. To conclude, my research, as well as the research of many other colleagues, has shown that properties shared by all organohalogen flame-retardants as a class can lead to adverse effects for human health. This class of chemicals easily enters the cells, may decrease the cells' ability to keep out other toxic compounds, and can cause adverse health effects. Because of these findings, my professional opinion is that consumer products containing non-polymeric organohalogen flame-retardants in additive form (which results in exposure) should be banned, as explained in the accompanying petition.

Yours sincerely,

David Epel, PhD

A handwritten signature in black ink, appearing to read 'Epel', written in a cursive style.

Jane and Marshall Steel Jr. Professor Emeritus of Biological and Marine Sciences
Hopkins Marine Station, Stanford University

CURRICULUM VITAE

David Epel

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Date of Birth: March 26, 1937; Detroit, Michigan
Marital Status: Married 1960 to Lois S. Ambush; 3 children

Education: A.B., Wayne University, 1958
Ph.D., University of California, Berkeley, 1963

PRESENT POSITION

The Jane and Marshall Steel Jr. Professor Emeritus of Marine Sciences (2009-present)
The Jane and Marshall Steel Jr. Professor of Marine Sciences (1999-2009) and Professor
of Biological Sciences (1977-present); Interim Director, 1984-1988; Associate Director
(1988-2007).

PREVIOUS POSITIONS

Post-doctoral fellow, Johnson Research Foundation, Department of Biophysics and
Biophysical Chemistry, University of Pennsylvania Medical School, 1963-1965
Assistant Professor of Biology, Hopkins Marine Station, Department of Biological
Sciences, Stanford University, 1965-1970
Associate Professor of Biology, 1970-1974; then Professor, 1974-1977 - Department of
Scripps Institution of Oceanography, University of California, San Diego

NATIONAL AND INTERNATIONAL TEACHING POSITIONS:

Faculty Member, Fertilization & Gamete Physiology Training Program, Marine
Biological Laboratory, Woods Hole, MA; summer, 1974
Co-Director, Embryology Course, Marine Biological Laboratory, Woods Hole, MA;
summers, 1975-1977; adjunct faculty, summer 1992.
Faculty, International Cell Research Organization/UNESCO Course on Developmental
Biology, Palermo Italy, 1987.
Visiting Professor, Toho University, Japan 1989.
Faculty, NSF Antarctic Biology Course, McMurdo Sound, Antarctica, January 1996.
Faculty, International Cell Research Organization/UNESCO course on Early Embryonic
Development, International Marine Research Centre, Sardinia Italy, October
1997.
Faculty, European Molecular Biology Organization Course on "Reproduction and Early
Development: Marine Molecular Biology Aspects", Bergen Norway, October
1998.
Visiting Professor of Developmental Biology, Plymouth Environmental Research Center
and the University of Plymouth, United Kingdom, 1998-2004.

HONORS

Guggenheim Fellow, 1976-1977

Overseas Fellow of Churchill College, Cambridge University, 1976-1977;

Fellow, AAAS (Elected 1978).

Fellow, California Academy of Sciences, (Elected 2000).

Distinguished Fellow in Science and Technology, California State University, Monterey Bay (Awarded, 2004).

Allan A. Cox Medal for Fostering Excellence in Undergraduate Research at Stanford University, 1995

Ed Ricketts Memorial Lecture Award for Lifetime Achievement in Marine Sciences, 2006

Life Fellow, Clare Hall, University of Cambridge, 2007

PROFESSIONAL SERVICE AND ACTIVITIES:

PROFESSIONAL SOCIETIES:

Member

A.A.A.S.

American Society for Cell Biology

International Cell Research Organization (UNESCO)

Marine Biological Laboratory, Corporation Member

Society for Comparative and Integrative Biology

Society for Developmental Biology

National Association of Biology Teachers

National Marine Educators Association

EDITORIAL ACTIVITIES--

Associate Editor:, Developmental Biology, 1974-1983; Gamete Research, 1977- 1986; Biological Bulletin, 1991-1997

Editorial Board, Cell Differentiation, 1982-1990; Experimental Cell Research, 1984-1989. Zygote, 1993-present; Animal Biology, 1993-present; Biological Bulletin, 1997-2004; Acta Histochemica, 1999-present. Aquatic Biology, 2008-present

Advisory Board, Development, Growth and Differentiation, 1995-present;; Zoological Science (Tokyo), 2002-present.

SERVICE TO PROFESSIONAL ORGANIZATIONS AND GOVERNMENT AGENCIES

Member-at-large, Section G (Biological Sciences) American Association for Advancement of Science (AAAS), 1979-1984;

Chairperson, Section G (Biological Sciences) AAAS, 1997-1998;

Council Member, AAAS, 1998-99.

Member of Council, American Society for Cell Biology (ASCB), 1979-1981. Chairman of Education Policy Committee, (ASCB), 1979-1981; Member, Public Policy Committee 1983-1984, .

Organizing Committee, Xth Congress of the International Society for Developmental Biology, 1984-1985;

Organizing Committee, NATO Advanced Research Workshop on Mechanism of Fertilization; Plants to Humans, 1989;
Organizing Committee, 1st, 2nd and 3rd International Conference on the Cell and Molecular Biology of Egg Coats, 1993, 1997 and 2004.
Chairman, Decennial Review Committee (Representative, National Academy of Sciences), Marine Biological Laboratory, 1984; Member, Decennial Review Committee, 1994.
Member, Visiting Committee, Naval Biological Laboratory, ONR, 1983-1985; Member, ONR Technical Advisory Group - Biological Sciences, 1988
Member, Organizing & Advisory Committee and Director Search Committee, Monterey Bay Aquarium Research Institute, 1986;
Board of Directors, Monterey Bay Aquarium Research Institute, 1987-1989;
Member, NIH Animal Resources Review Committee, 1989-1991
Member, NSF Developmental Biology Panel, 1988-1993
Member, University of California Coastal Toxic Research Advisory Board, 1992-2002
Chairperson, National Cooperative Program on Non-Human *in vitro* Fertilization and Pre-implantation Development (NIH), 1991-1998
Chairperson, Section on Developmental & Cell Biology, American Society of Zoologists, 1991-93. Chairperson, Endowment Committee, 1994-95. Member, Program Committee, 2000-2002.
Organizing Committee, 7th and 9th International Congress of Society for Invertebrate Reproduction, 1995 and 2001.
Organizing Committee, 8th-11th International Conference on Pollution Responses in Marine Organisms, 1997, 1999, 2001, 2003 and 2005.
Member, Monterey County Marine Research Task Force, 2000-present
Scientific Advisory Board, The Environment Agency, United Kingdom, 2003-2004
Founding member and organizer, Ocean Round Table, 2005-2009

RECENT CONGRESS & SYMPOSIA ADDRESSES

American Chemical Society Symposium on "Pharmaceuticals and Personal Care Products in the Environment" (San Francisco)
19th Annual Meeting of the Brazilian Society of Biochemistry and Molecular Biology. Plenary Lecture (Caxambu, Brazil).
International symposium "Molecular Mechanisms of Cell-Cell Interaction" (San Diego, CA).
13th and 14th Meeting on the Developmental Biology of the Sea Urchin (Woods Hole, MA)
XIth International Congress of Histochemistry and Cytochemistry (York, UK).
11th International Conference on Pollution Responses in Marine Organisms (Plymouth UK)
9th International Congress of Society of Invertebrate Reproduction, Plenary Speaker, (Grahamstown, South Africa)
Gordon Conference on Fertilization and Activation of Development (Holderness, NH).
Society for Integrative and Comparative Biology Symposium "Ecological Developmental Biology: Developmental Biology Meets The Real World."
American Society for Cell Biology, Organizer and Speaker, Symposium on "Emerging Environmental Contaminants: A Role for Cell Biology?" (San Francisco)

International Workshop on Sustainable Aquaculture: Animal Welfare, Human Health and Interactions with the Environment (Siena Italy)
4th International Symposium on Molecular and Cell Biology of Egg and Embryo Coats, Ise-Shima Japan
Plenary Speaker, 10th International Congress on Invertebrate Reproduction and Development Newcastle UK.
Aquatic Models of Human Disease, Athens GA
XIIth Pollution Responses in Marine Organisms, Alessandria Italy

RECENT KEYNOTE OR PLENARY ADDRESSES:

Reproductive Strategies, National Institute Basic Biology, Okazaki Japan
Symposium in memory of Alberto Monroy...20 years later, Palermo Italy
European Society of Comparative Biochemistry and Physiology, Antwerp Belgium
Cell Signaling in Gamete Activation, Tokyo, Japan
10th Annual Green Chemistry and Engineering Conference, American Chemical Society, Washington DC
National Association of Biology Teachers, Albuquerque NM
ICCA-LRI workshop on Integrating new advances in exposure science and toxicity testing: next steps

DEPARTMENTAL AND UNIVERSITY COMMITTEES

Hopkins representative, Monterey Bay Sanctuary Research Advisory Panel
Stanford Environmental Initiative Pedagogy Committee

STANFORD ALUMNI ASSOCIATION AND CONTINUING EDUCATION ACTIVITIES

• **Alumni Association:**

Alumni College on "Biology of the Sea", July 1999 and 2000.

Director and 'Dean' of this College for the 2nd year. The course enrolled 30+ alumni in a 4-day series of lectures and labs, which included lecturers from the Marine Station, Department of Engineering and Earth Sciences (on ocean currents), Law School (on environmental policy) and also a lecture on Ed Ricketts and John Steinbeck.

• **Alumni Travel/Study Program (Faculty Lecturer)**

Baja California Whale Watching, 1989

Belize Snorkeling Adventure, 1999

Galapagos Family Adventure, 2001

Alaska Family Adventure, 2002

- **Continuing Education:**

“The Ocean as a Laboratory” Every year since 1998.

STANFORD FUND RAISING ACTIVITIES—Campaign for Undergraduate Education

Participant in the Think Again Series, New York City and Orange County

Speaker at Alumni Re-union College, Fall 2002

COMMUNITY SERVICE

Trustee, Monterey Bay Aquarium, 1985-1988

Board Member, Hatton Canyon Foundation, 1989-present

Board Member, Sierra Club (Ventana Chapter), 1990-1996, 2001-present

Science Mentor, Seaside High School, since 1990

Guest Faculty, Outward Bound Program (UCSC), Stanford Young Medical Scientist

Program, Stanford Young Environmental Scientist Program [These programs promote interest of minority students in environmental science or medicine], 1996-present.

Board Member, Friends of Moss Landing Marine Laboratory, 1994-present.

Recent Research Grants:

- 1). National Science Foundation
“Efflux Transporters in Sea Urchin Development”
\$ 390,000
February 1, 2005-January 31, 2008; no-cost extension through 2008..
- 2).National Science Foundation-Instructional Materials Development
“Inquiry-based high school biology using sea urchin fertilization and development”.
\$574,935; no cost extension through 2008
- 3). Wallenberg Foundation and Stanford University
“Hands-On Possibilities and Experiences in Biology Education (Bio-HOPE)
\$50,000 planning grant in collaboration with Goteborg University 2006
- 4). Wallenberg Foundation and Stanford University
“Hands-On Possibilities and Experiences in Biology Education (Bio-HOPE)
\$250,000 grant in collaboration with Goteborg and Linkoping University 2006-2008
- 5). Wallenberg Foundation and Stanford University
“Inquiry and Insight: Investigating environmental problems”
\$113,00 planning grant in collaboration with the Sven Loven Centre for Marine Studies,
Kristineberg, Sweden 2009
- 6). Wallenberg Foundation and Stanford University
“Inquiry and Insight: Investigating environmental problems”
\$650,000 full grant in collaboration with the Sven Loven Centre for Marine Studies,
Kristineberg, Sweden 2009-2013

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Sea Urchin Embryology. Web site of 275 pages devoted to educational materials for high school and college teachers. Primarily directed toward laboratory exercises.
<http://www.stanford.edu/group/Urchin/index.html>

Virtualurchin.stanford.edu. New web site, funded by the NSF, that provides virtual labs for high school and college students

ESI.stanford.edu. New web site, funded by the Wallenberg Foundation, that explores an unexpected consequence of global warming on salmon migration.

I2i.stanford.edu Current web site that focuses on international dialogue between sisters schools in different countries on shared environmental problems.

Exhibit E
Statement of Rolf Halden

September 26, 2014

I, Rolf Halden, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, Rolf Halden, am Director of the Center for Environmental Security at the Biodesign Institute and Professor in the Ira A. Fulton School for Sustainable Engineering and the Built Environment, Arizona State University. I am also a Senior Sustainability Scientist in the Global Institute of Sustainability at Arizona State University and hold an adjunct faculty appointment at the John Hopkins Bloomberg School of Public Health. I am an environmental scientist and engineer by training, and my research focuses on the movement of chemicals through the environment and their potential health impacts. I received my M.S. (1994) and Ph.D. (1997) in Civil (Environmental) Engineering from the University of Minnesota-Minneapolis. I have authored over 110 peer-reviewed articles, 11 book chapters, 15 patent applications and 160 conference papers. I have also presented over 110 invited lectures and keynote addresses at national and international scientific symposia. I have attached a copy of my *curriculum vitae* and a list of my publications for your reference.

2. I strongly believe that there is a need to regulate hazardous chemicals, such as organohalogen flame retardants, as classes or compound families. Many organohalogen flame retardants have been shown to be persistent, bioaccumulative and/or toxic, and have been detected in the environment, wildlife, and human populations across the globe. Due to these concerns, two major commercial flame retardant formulations, penta- and octa-brominated diphenyl ethers (BDE), were banned by the European Union (EU) in 2004 and voluntarily phased-out in the U.S. in 2005. The fully brominated deca-BDE was banned in electrical and electronic applications within the EU in 2008, while negotiations between the EPA and deca-BDE producers in the U.S. led to an agreement to cease all uses of this product in the U.S. by the end of 2013. Many of the replacement chemicals now finding their way into commerce as substitutes for PBDEs are structurally similar to the original, now banned/phased-out compounds; as a result, they show similar persistence and bioaccumulative characteristics in the environment.^{i,ii}

3. In general, the replacement of hydrogen with halogen atoms positively correlates with problematic characteristics such as hydrophobicity (which facilitates bioaccumulation), environmental persistence and toxicity.ⁱⁱⁱ It is therefore a not surprising, but underappreciated fact, that 74% of harmful organic compounds regulated by the U.S. EPA (U.S. Environmental Protection Agency) under the Safe Drinking Water Act contain at least one halogen atom^{iv}.

4. A recent study by our group featured the use of municipal sewage sludge (a solid byproduct of wastewater treatment) for identifying and prioritizing persistent and bioaccumulative chemicals. We identified eight top priority chemicals with high abundance and bioaccumulative potential, including five organohalogens, three of which were brominated flame retardants.^v The brominated flame retardants were the third most abundant group of chemicals detected in nationally representative U.S. sewage sludges, suggesting their widespread use and ongoing exposures of human populations and wildlife. The study also revealed that, out of 55 potentially bioaccumulative chemicals detectable in sewage sludge, 93% were halogenated.

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5. The mass manufacture of toxic chemicals that lack effective routes of degradation creates unnecessary problems for current and future generations. The substitution of known harmful organohalogen flame retardants with chemicals sharing structural and functional similarity is not an effective solution to this problem⁶. Substitutes are often chemicals that have minor modifications to the carbon backbone (i.e., the length or shape of the carbon chain) or halogen substitution pattern (i.e., the arrangement of halogens in the molecule) of known hazardous chemicals. These minor changes do not result in major changes in the risk profile of the substitutes relative to the compounds targeted for replacement.
6. In particular, because of their bioavailability and potential for bioaccumulation, organohalogen flame retardants of low molecular weight that are not covalently bonded to the consumer product will very likely pose significant environmental and human health risks, irrespective of any minor modifications to their structure.
7. The solution to this problem ultimately depends on curtailing the use and production of chemicals sharing structural and functional similarity to known hazardous compounds, rather than making minor modifications to the carbon backbone or halogen substitution pattern, and then hoping for a different, better outcome. Pragmatic steps for reducing environmental pollution and adverse human health impacts include⁶: (i) avoiding the use of flame retardants in consumer products that do not pose a significant fire risk in the first place, (ii) avoiding the use of flame retardants that resemble their hazardous predecessors in molecular size and structure, and (iii) developing next-generation flame retardants that are covalently bound to the consumer products to minimize release, and have large molecular sizes (e.g., large polymers) to limit uptake by biota.
8. My professional opinion is that organohalogen flame retardants should be regulated as a class, especially the ones used in additive form (i.e., not covalently bound) in consumer products. Instead of regulating individual formulations such as penta- or octa-BDE and replacing them with similar formulations, a more proactive and adequate strategy is required for chemical safety management. Learning from past failures is necessary for an effective regulatory framework, and organohalogen flame retardants should be the starting point for the redesign of safer and greener consumer products. I therefore support the accompanying petition and urge the CPSC to regulate consumer products containing non-polymeric additive organohalogen flame retardants.

Yours sincerely,



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ⁱ Covaci A, Harrad S, Abdallah MA, Ali N, Law RJ, Herzke D et al. 2011. Novel brominated flame retardants: A review of their analysis, environmental fate and behaviour. *Environ Int* 37(2):532-556.

ⁱⁱ Wu J, Guan Y, Zhang Y, Luo X, Zhi H, Chen S et al. 2011. Several current-use, non-PBDE brominated flame retardants are highly bioaccumulative: Evidence from field determined bioaccumulation factors. *Environ Int* 37(1):210-215.

ⁱⁱⁱ Halden RU 2014. On the Need and Speed of Regulating Triclosan and Triclocarban in the United States. *Environ Sci Technol* 48:3603-3611. DOI: 10.1021/es500495p. (Cover & Feature Article, April 1, 2014).

^{iv} Halden RU. Invited Talk: Sustainable Chemistry & Human Health in the 21st Century. U.S. EPA Emerging Chemicals Workgroup. Presented on April 6, 2011.

^v Venkatesan AK, Halden RU. 2014. Wastewater Treatment Plants as Chemical Observatories to Forecast Ecological and Human Health Risks of Manmade Chemicals. *Sci Rep* 4:3731. DOI: 10.1038/srep03731. www.nature.com/srep/2014/140116/srep03731/full/srep03731.html

^{vi} Venkatesan AK and Halden RU. New Strategies for Monitoring and Regulating Chemical Mixtures and Contaminants Sharing Pathways of Toxicity (Internal White Paper, Arizona State University).

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September 28, 2014

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EDUCATION B.S., 1986 (Pre-diploma), Technical University of Braunschweig, Field: Biology
M.S., 1992 (Diploma), Technical University of Braunschweig, Major: Biology; Minors: Microbiology, Biotechnology & Sanitary Engineering
M.S., 1994, (Environmental Engineering) Department of Civil Engineering, University of Minnesota, Minneapolis, MN
Ph.D., 1997, (Environmental Engineering) Department of Civil Engineering, University of Minnesota, Minneapolis, MN

POSTDOCTORAL 1997-1998, University of California, Lawrence Livermore National Laboratory, Environmental Protection Department, Livermore, CA

PROFESSIONAL REGISTRATION & CERTIFICATION Management Certificate, University of the Pacific, 2000
Supervisor Certificate, 40-Hour SARA/OSHA 8CCR5192(e)(4)
Professional Environmental Engineer, Minnesota, 1997 – Present (#25155); Arizona 2010 – Professional Environmental Engineer Lic. (#51849)
Engineer-in-Training, Minnesota, 1996 - 1997

PROFESSIONAL EXPERIENCE Founding Director, Center for Environmental Security (CES), The ASU Biodesign Institute, 6/2012 – Present.
Founding Director, Center for Environmental Security Mass Spectrometry Facility, 7/2013 – Present.
Chair of Admissions for the University-wide Biological Design Program at Arizona State University, 12/2012 – Present.
Leader, Biosecurity Thrust Area, Security and Defense Systems Initiative,

ASU, 6/2012 – Present.
 Barrett Honors Faculty, 2012 – Present.
 Co-Founder and Chief Technical Officer, In Situ Well Technologies (ISW), LLC Startup Company, ASU/AzTE, 2011 – Present.
 Tenured Full Professor, School of Sustainable Engineering and the Built Environment, Arizona State University. 2011 – Present.
 Senior Sustainability Scientist, Global Institute of Sustainability, ASU. 2010 – Present.
 Co-founder of the MapStory Health Initiative, 2014 - Present
 Interim Co-Director, Center for Health Information & Research (CHiR) 2011 – 2012.
 Associate Director, Swette Center for Environmental Biotechnology, ASU Biodesign Institute. 2011 – 2012.
 Assistant Director, Center for Environmental Biotechnology, ASU Biodesign Institute. 2009 – 2011.
 Adjunct Associate Professor. 2008 – Present. Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University
 Special Government Employee, Food and Drug Administration, '05 – Present
 Tenured Associate Professor. 12/2007 – 7/2011. School of Sustainable Engineering and the Built Environment, Arizona State University
 Associate Professor. 2007. Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health
 Joint Appointment in the Department of Geography and Environmental Engineering, Johns Hopkins University
 Assistant Professor. 2001 – 2007. Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University
 Project Engineer & Environmental Scientist. 1998 – 2001. Environmental Protection Department, Lawrence Livermore National Laboratory, Livermore, CA. Principal Responsibilities: Design and Management of Subsurface Remediation Activities with a Cumulative Budget of \$6M. Supervisor: Dr. John Ziagos.
 Research & Teaching Fellow/Assistant. January 1993 – April 1997. Department of Civil Engineering, University of Minnesota, Twin Cities, MN. Supervisor: Dr. Daryl Dwyer
 Research Associate. January 1992 – July 1992. Helmholtz Centre for Infection Research, (formerly German National Institute for Biotechnology (GBF), Braunschweig, Germany. Principal Responsibilities: Microbial Ecology. Supervisor: Dr. Daryl F. Dwyer
 Research Assistant. January 1991 – December 1991. Helmholtz Centre for Infection Research, (formerly German National Institute for Biotechnology (GBF), Braunschweig, Germany. Principal Responsibilities: Bioreactors. Supervisor: Dr. Joachim Klein

PROFESSIONAL ACTIVITIES

Society Memberships

American Public Health Association (APHA)
 American Society for Mass Spectrometry (ASMS)
 American Chemical Society (ACS) – ACS Expert for Media Relations, 2014 - Present
 American Society for Microbiology (ASM)
 American Society of Civil Engineers (ASCE)
 Association of Environmental Engineering and Science Professors (AEESP)
 Environmental and Water Resources Institute (EWRI)
 Society of Environmental Toxicology and Chemistry (SETAC)

Participation on Advisory Panels and Committees

- ACS Expert for Media Relations, American Chemical Society (ACS), 2014 - Present**
Member, NIEHS Fish Advisory Information Network, National Institute of Environmental Health Sciences, June 2014 - Present.
- Center for Transformative Action, Invited Member of the Independent Review Board, August 2014 - Present.**
- Invited Presenter and Panel Member: Discussion Forum Micro-plastics in the Marine Environment & Potential Human Health Risks, National Academies, Washington, DC, 3/3/2014.**
- Community Advisory Board Member, West van Buren Area WQARF Site, Phoenix, AZ, 2013 - Present.**
- Invited Presenter at Congressional Briefing on the Safety of the Antimicrobial Triclosan, Washington, DC, 2/17/2011.**
- Food And Drug Administration, Center For Drug Evaluation And Research (CDER) Nonprescription Drugs Advisory Committee. Special Government Employee (10/2005 – 10/2015)**
- Science Advisor, Johns Hopkins University Center for a Livable Future, 2009 – Present**
Invited Panelist, **National Association of Clean Water Agencies Pretreatment and Pollution Prevention Workshop, St. Louis, MO, 5/19/2011.**
- Invited Panelist, Workshop on Environmental Estrogens and Endocrine Disrupting Compounds, sponsored by the **Johnson Foundation, Wingspread, WI, May 2010.**
- Invited Panelist, Special Symposium on Next Generation Superfund Contaminants sponsored by the **National Institute of Environmental Health Sciences (NIEHS), Tucson, AZ, August 2009.**
- Invited Panelist, **American Academy for Microbiology, "Global Antibiotic Resistance: New Approaches to an Old Problem," Fondation Merieux, Annecy, France, October 2008.**
- National Research Council of the National Academies. NRSB-O-05-04-A. Conduct a Technical Assessment of Ongoing and Planned Environmental Remediation and Monitoring Programs at the Los Alamos National Laboratory (LANL) and Provide Recommendations to Improve Their Technical and Cost Effectiveness and Reduce Worker, Public, and Environmental Risks. Invited NRC Committee Member, Dual Appointment in the Areas of Groundwater Monitoring and Chemistry. 15-Month Term Starting March, 2006.**
- Invited Panelist, **BIO 2006, World's Largest Annual International Convention on Biotechnology. Chicago, IL. Environmental Biotechnology Session. 04/9-12/2006**
- Mid-Atlantic States Section of the Air & Waste Management Association (MASS-A&WMA), Special Symposium on Emerging Environmental Issues and Policies. **Invited Speaker/Panelist. New Brunswick, NJ, April 6, 2006.**
- EPA Office of Inspector General, Office of Program Evaluation, Evaluation of Drinking Water Laboratory Procedures. Invited Expert Consultant. 1/19/2006.
- Food And Drug Administration, Center For Drug Evaluation And Research (CDER) Nonprescription Drugs Advisory Committee. "Benefits and Hazards of Antiseptic Products Marketed for Consumer Use." Invited Panelist/Voting Committee Member. 10/20/2005.**
- National Congress on Assessing and Mitigating Environmental Impacts of Emerging Contaminants – Renewable Natural Resources Foundation. Co-Sponsored by the United States Geological Survey and the Food and Drug Administration. **Invited Delegate. 12/1-2/2005**
- Harvard School of Public Health Risk Assessment Workshop: "Pharmaceuticals and Personal Care Products in the Environment: Emerging Threat or Unwarranted Concern?" **Invited Panelist. 11/10/2005**
- International Conference on Safe Water, Exploring Global Demands and Impacts of Natural Disasters, SAFEWATER 2005. San Diego, CA. Groundwater Remediation Session. **Invited Session Chair. 10/21/2005**

DOE/EPA SERDP and ESTCP Expert Panel Workshop on Research and Development Needs for the Environmental Remediation Application of Molecular Biological Tools. **Invited Speaker and Voting Panel Member.** Specialty: Proteomics. 08/9-10/2005

Governor Ehrlich's Maryland Department of the Environment – Maryland State Water Quality Advisory Committee (SWQAC) Public Interest Member. **Selected by JHSPH Dean Al Sommer to be the Johns Hopkins Representative for this Committee.** 1/1/2003 – 12/31/2005

Governor Ehrlich's Maryland Water Security and Wastewater Systems Advisory Council Alternate Member. 01/2004 – 12/2004

Maryland Water Monitoring Council: "Ecological Restoration Assessment & Monitoring" Linthicum, MD. **Invited Panelist.** 11/18/2004

Water Environment Research Foundation (WERF) Project Advisory Committee. "Fate of Pharmaceuticals and Personal Care Products through Wastewater Treatment Processes." **Invited Committee Member.** 2004-2006

Water Environment Research Foundation (WERF) Project Advisory Committee. "Contributions of Household Chemicals to Sewage and their Relevance to Municipal Wastewater Systems and the Environment." **Invited Committee Member.** 2004-06

DOE Natural and Accelerated Bioremediation Research Program (NABIR) Workshop. Warrenton, VA. **Invited Panelist.** 3/18-20/2002

DOE New Perspectives Council, Lawrence Livermore National Laboratory. **Appointed Chairman** of a 14-Member Task Force Assembled to Provide Recommendations for Managing Environmental Cleanup and Research at two CA Superfund Sites, Livermore CA, 2000.

EDITORIAL ACTIVITIES

Book Editor

Contaminants of Emerging Concern: Ecotoxicological and Human Health Considerations, 2010. American Chemical Society (ACS) Book Series. 606 pp. Oxford University Press, New York, NY. ISBN13: 9780841224964; eISBN: 9780841224971; DOI: 10.1021/bk-2010-1048

Peer Review Activities

1. American Chemical Society (ACS) Books
2. American Chemical Society (ACS) Merits Awards, Env. Chem. Division
3. Analytical Chemistry
4. Archives of Environmental Contamination and Toxicology
5. Archives of Microbiology
6. California Environmental Protection Agency
7. Chemosphere
8. Consumer Reports
9. EcoHealth
10. Ecotoxicology and Environmental Safety
11. Environmental Chemistry
12. Environmental Health Perspectives
13. Environmental Pollution
14. Environmental Research
15. Environmental Science & Technology
16. Environmental Science and Pollution Research
17. Environmental Toxicology & Chemistry
18. Environmental Technology
19. Environment International
20. Expert Review of Proteomics
21. Integrated Environmental Assessment and Management (IEAM)
22. International Journal of Industrial Chemistry

23. Journal of Chromatography A
24. Journal of Chromatographic Science
25. Journal of Environmental Science and Health, Part B
26. Journal of Hazardous Materials
27. Journal of Proteome Research
28. Leaking Underground Storage Tank Line
29. Marine Environmental Research
30. Molecular & Cellular Proteomics
31. Renewable Natural Resources Foundation
32. Science
33. Science of the Total Environment
34. Soil & Sediment Contamination: an International Journal
35. Toxicology
36. United States Environmental Protection Agency
37. Water Research
38. Water Science & Technology

PROPOSAL REVIEW ACTIVITIES

- 2014 Department of Defense, Air Force Ad Hoc Proposal Review
- 2011 EPA Small Business Innovative Research (SBIR) Panel – Drinking Water
- 2011 NIH Study Section Community Level Health Promotion (CLHP) Ad Hoc Member
- 2011 Hudson River Foundation for Science and Environmental Research
- 2010 Water Resources Research Institutes Program, United States Geological Survey
- 2009 NIH Study Section ZRG1 HDM-B 11B, Healthcare Delivery and Methodologies-Occupational Health, Small Business Innovative Research (SBIR) Program
- 2009 NIH Study Section ZRG1 HOP E 11, Health of the Population, Small Business Innovative Research (SBIR) Program
- 2009 Water Resources Research Institutes Program, United States Geological Survey
- 2008 NIH Study Section ZRG1 HOP E 10, Health of the Population, Small Business Innovative Research (SBIR) Program
- 2007 NIH Study Section ZRG1 HOP E 10, Health of the Population, Small Business Innovative Research (SBIR) Program
- 2007 Natural Sciences and Engineering Research Council of Canada, NSERC's Discovery Grant Program
- 2007 Caribbean Coral Reef Institute (CCRI) in Cooperation with the University of Puerto Rico – Mayagüez and the National Atmospheric and Oceanic Administration (NOAA)
- 2006 National Academies, U.S. Agency for International Development (USAID), Middle East Regional Cooperation Program (MERC)
- 2006 U.S. Environmental Protection Agency (EPA), Office of Research, Small Business Innovative Research (SBIR) Program
- 2006 International Science and Technology Center (ISTC); Science Center Programs of the U.S. Department of State
- 2005 Natural Sciences and Engineering Research Council of Canada (NSERC), Collaborative Health Research Project (CHRP) Grant Program
- 2005 Cooperative Grants Program of the U.S. Civilian Research and Development Foundation (CRDF), Co-founded and Sponsored by the National Science Foundation (NSF)
- 2004 National Science Foundation (NSF), Microbial Observatories (MO) and Microbial Interactions and Processes (MIP); RFA: NSF-04-586
- 2004 Water Environment Research Foundation (WERF), Pharmaceuticals and Personal Care Products in the Environment
- 2003 National Science Foundation (NSF), Microbial Observatories (MO) and Microbial Interactions and Processes (MIP); RFA: NSF-03-571

2002 International Science and Technology Center (ISTC); Science Center Programs of the U.S. Department of State

ACADEMIC SERVICE

Nationwide

National Institute of Environmental Health Sciences (NIEHS) Superfund Research Program, R01 Working Group, National Leader. 2012 – Present
Congressional Briefing, Invited Talk at U.S. Congress: Environmental Health Risks of Triclosan. Capitol Hill Congressional Briefing Room, Washington, DC, February 17, 2011

University Wide

ASU Biological Design Graduate Program, Executive Committee Member. 2013 – Present
ASU Biological Design Graduate Program, Chair of Admission. 2013 – Present
Chief Operating Officer of ASU/AzTE Startup Company, ISW, LLC (2012 – Present)
ASU IPIRC Intellectual Property Institutional Review Committee, Member. 2011 – Present
ASU Biodesign/AzTE Intellectual Property Advisory Committee, Member. 2011 – Present

School Wide

ASU Faculty Search Committee (Member; Process Engineering Position) 2013 – 2014
ASU Faculty Search Committee (Member; Water Resources Position) 2013 – 2014
ASU Faculty Search Committee (Chair; CHiR Director) 2011 – 2012
ASU Faculty Search Committee (Chair; Air Toxics) 2011 – 2012
ASU Curriculum Committee, 2009 – 2011
ASU Fulton Undergraduate Research Initiative (FURI) Committee, 2009 – 2013
ASU Grand Challenges Faculty Search Committee, 2009 – 2011
ASU Faculty Search Committee, 2008 – 2009
Johns Hopkins University Faculty Senator, Dept. of Environ. Health Sciences. Elected 09/2003 – 08/2004
Johns Hopkins University Committee on Information Technology (CIT) Member, JHSPH, 9/04 – 12/07
Faculty Representative at the Technology Transfer Retreat, JHSPH, July 23, 2004
JHSPH Faculty Title Task Force. Invited Representative of the Junior Faculty, 2003
Co-organizer of the JHSPH Junior Faculty Meetings, 2003

Division and Department

ASU Biodesign Personnel Committee, 2014 – Present
ASU Intellectual Property Institutional Review Committee, 2011 – 2012
ASU Biodesign Research & Collaboration Advancement Committee, 2011 – Present
ASU Specialty Area Coordinator for Environmental and Water Resource Engineering. 2008 – 2009
JHU Enrichment and Seminars Committee, EHS, Member, 08/2003 – 07/2004
JHU Ad-hoc Committee for Development of a Mission Statement for the Dept. of EHS, 2003
JHU Center for Water and Health Faculty Search Committee, Member, 2002 – 2005
JHU Academic Affairs Committee, Dept. of Environ. Health Sci., Member, 9/2004 – 8/2005
JHU Organizer of the “Exposure Assessment Session” at the EHS Annual Research Day, Mt. Washington Conference Center, Baltimore, MD, Nov. 14, 2003

Communication and Outreach

Conducted 150+ TV/Radio/Newspaper Interviews; Contributions were featured in, e.g., New York Times, Wall Street Journal, Time Magazine, Science News, and the Los Angeles Times

AWARDS & HONORS

- 2014 Invited Expert for Media Relations, Expert Program, American Chemical Society (ACS)
- 2012 Appointed National Leader of R01 Working Group of the NIEHS Superfund Program
- 2011 Leroy E. Burney Lecturer, Johns Hopkins School of Public Health
- 2011 List of 20 Public Health Experts Worth Knowing
- 2010 Senior Sustainability Scientist, Global Institute of Sustainability, ASU. 2010 – Present
- 2010 Award for Research Excellence, Arizona BioIndustry Association's BIOFEST 2010, Nominee and Finalist
- 2010 Biodesign Impact Accelerator Program, Selected Startup Company, ASU
- 2010 Faculty Honoree, School of Sustainable Engineering and the Built Environment, ASU
- 2007 Faculty Research Initiative Award, Johns Hopkins University
- 2005 Faculty Research Initiative Award, Johns Hopkins University
- 2002 Faculty Innovation Award, Johns Hopkins University
- 2000 Two Recognition Awards, Lawrence Livermore National Laboratory
- 1998 American Permanent Residency National Interest Waiver, LLNL
- 1997 American Society for Microbiology, Travel Grant
- 1996 Dissertation Fellowship, Outstanding Ph.D. Student, University of Minnesota

PUBLICATIONS

Peer-reviewed, Archival Journal Articles (* Indicates Corresponding Author)

1. Done, H., and **R. U. Halden.*** 2014. Reconnaissance of 47 Antibiotics and Microbial Risks in Major Seafood and Aquaculture Products Consumed in the United States. *J. Hazardous Materials* (In Press).
2. **Halden, R. U.*** 2014. Epistemology of Contaminants of Emerging Concern and Literature Meta-analysis. *J. Hazardous Materials* (In Press).
3. Geer, L. A., B. F. Pycke, D. M. Sherer, O. Abulafi, and **R. U. Halden.** 2014. Use of Amniotic Fluid for Determining Pregnancies at Risk of Preterm Birth and for Studying Diseases of Potential Environmental Etiology. *Environmental Research* (In Press).
4. Pycke, B. F. G.; L. A. Geer; M. Dalloul; O. Abulafia; A. M. Jenck; **R. U. Halden;** Human Fetal Exposure to Triclosan and Triclocarban in an Urban Population from Brooklyn, New York. *Environmental Science & Technology.* 48(15):8831–8838. DOI: 10.1021/es501100w.
5. Pycke, B. F. G., I. Roll, B. Brownawell, C. Kinney, E. Furlong, D. Kolpin, and **R. U. Halden.*** 2014. Transformation Products and Human Metabolites of Triclocarban and Triclosan in Sewage Sludge across the United States. *Environmental Science & Technology.* 48(14):7881-7890. DOI: 10.1021/es5006362.
6. Bruton, T., A., B. F. G. Pycke, and **R. U. Halden.*** 2014. Effect of Nanoscale Zero-Valent Iron Treatment on Biological Reductive Dechlorination: A Review of Current Understanding and Research Needs. (In Press in *Critical Reviews in Environmental Science & Technology*).
7. Venkatesan A. and **R. U. Halden.*** 2014. Loss and In Situ Production of Perfluoroalkyl Chemicals in Outdoor Biosolids-soil Mesocosms. *Environmental Research* 132:321–327; 10.1016/j.envres.2014.04.024
8. Venkatesan, A, B. F. G. Pycke, and **R. U. Halden.*** 2014. Detection and Occurrence of N Nitrosamines in Archived Biosolids from the Targeted National Sewage Sludge Survey of the

U.S. Environmental Protection Agency. *Environmental Science & Technology* 48(9):5085-5092. doi: 10.1021/es5001352. Epub 2014 Apr 15.

9. Wells, E. M.,* A. Navas-Ancien, B. J. Apelberg, J. B. Herbstman, J. M. Jarrett, Y. H. Lin, C. P. Verdon, C. Ward, K. L. Caldwell, J. R. Hibbeln, **R. U. Halden**, F. R. Witter, and L. R. Goldman. 2014. Association of Selenium and Copper with Lipids in Umbilical Cord Blood. *Journal of Developmental Origins of Health and Disease*. 5(4), 281-287. DOI:10.1017/S2040174414000233.
10. Hesari, N., C. M. Francis, and **R. U. Halden**.* 2014. Evaluation of Glycol Ether as an Alternative to Perchloroethylene in Dry Cleaning. *Toxics* 2:115-133; doi:10.3390/toxics2020115
11. **Halden, R. U.*** 2014. On the Need and Speed of Regulating Triclosan and Triclocarban in the United States. *Environmental Science & Technology* 48:3603–3611. DOI: 10.1021/es500495p. ES&T Cover & Feature. Epub March 3, 2014.
12. Venkatesan, A., H. Done, and **R. U. Halden**.* 2014. United States National Sewage Sludge Repository at Arizona State University – A New Resource and Research Tool for Environmental Scientists, Engineers, and Epidemiologists. *Environmental Science and Pollution Research* (In Press).
13. Venkatesan A. and **R. U. Halden**.* 2014. Brominated flame retardants in U.S. biosolids from the EPA national sewage sludge survey and chemical persistence in outdoor soil mesocosms. *Water Research* 55, 133-142. <http://dx.doi.org/10.1016/j.watres.2014.02.021>
14. Venkatesan A. and **R. U. Halden**.* 2014. Wastewater Treatment Plants as Chemical Observatories to Forecast Ecological and Human Health Risks of Manmade Chemicals. *Scientific Reports*, 4: 3731 | DOI: 10.1038/srep03731. www.nature.com/srep/2014/140116/srep03731/full/srep03731.html
15. Marsalla, J., B-O. Kim. and **R. U. Halden**.* 2013. Analysis of Crop Rotations in the U.S. Breadbasket Using Legumes as an Alternative to Industrially-Produced Fertilizer. *J. Agric. Sci. Appl.* 3(2):169-174. <http://www.j-asa.org/Download.aspx?ID=5141>. PMID TBD.
16. Deo, R. P. and **R. U. Halden**.* 2013. Pharmaceuticals in the Built and Natural Water Environment of the United States. *Water* 5(3):1346-1365. DOI:10.3390/w5031346. PMID TBD.
17. Doudrick, K., N. Corson, G. Oberdorster, A. C. Elder, P. Herckes, **R. U. Halden**, and P. Westerhoff. 2013. Extraction and Quantification of Carbon Nanotubes in Biological Matrices with Application to Rat Lung Tissue. *ACS Nano* (In Press; Article ASAP). DOI: 10.1021/nn403302s
18. Dong, H.-P., Williams, E., Wang, D.-Z., Xie, Z.-X.,³ Hsia, R.-C., Jenck, A., **Halden, R.U.**, Chen, F., Place, A. R. 2013. Responses of *Nannochloropsis oceanica* IMET1 to Long-term Nitrogen Starvation and Recovery. *Plant Physiol.* 162(2):1110-1126. DOI: 10.1104/pp.113.214320
19. Scotch, M, B. Baarson, R. Beard, R. Lauder, A. Varman, and **R. U. Halden**. 2013. Examining the Differences in Format and Characteristics of Zoonotic Virus Surveillance Data on State Agency Websites. *Journal of Medical Internet Research* 15(4):e90. doi:10.2196/jmir.2487.
20. Venkatesan A. and **R. U. Halden**.* 2013. National Inventory of Perfluoroalkyl Substances in Archived U.S. Biosolids from the 2001 EPA National Sewage Sludge Survey. *J. Hazardous Materials* 4:413-418. DOI:10.1016/j.jhazmat.2013.03.016. NIHMS 464002.

21. Ziv-El, M., T. Kalinowski, R. Krajmalnik-Brown and **R. U. Halden**.* 2013. Simultaneous Determination of Chlorinated Ethenes and Ethene in Groundwater using Automated Headspace Solid Phase Microextraction. *Journal of Chromatographic Science* doi 10.1093/chromsci/bms258.
22. North, E. J. and **R. U. Halden**.* 2013. Plastics and Environmental Health: The Road Ahead. Invited paper at *Reviews on Environmental Health* 28(1):1-8. DOI 10.1515/reveh-2012-0030.
23. Venkatesan A. and **R. U. Halden**.* 2013. National Inventory of Alkylphenol Ethoxylate Compounds in U.S. Biosolids and Chemical Fate in Outdoor Soil Mesocosms. *Environmental Pollution* 174:189-193.
24. Love, D. C., **R. U. Halden**, M. F. Davis, and K. E. Nachman. 2012. Response to Comment on Feather Meal: A Previously Unrecognized Route for Reentry into the Food Supply of Multiple Pharmaceuticals and Personal Care Products (PPCPs). *Environ. Sci. Technol.*, 46(24): 13557-13558. DOI: 10.1021/es304181c.
25. Love, D. C., **R. U. Halden**, M. F. Davis, and K. E. Nachman. 2012. Response to Comment on Feather Meal: A Previously Unrecognized Route for Reentry into the Food Supply of Multiple Pharmaceuticals and Personal Care Products (PPCPs). *Environ. Sci. Technol.*, 46(24):13026-13027. DOI: 10.1021/es304180x.
26. Chari, B. P. and **R. U. Halden**.* 2012. Predicting the Concentration Range of Unmonitored Chemicals in Wastewater-dominated Streams and in Run-off from Biosolids-amended soils. *Science of the Total Environment* 440:314-320. doi: 10.1016/j.scitotenv.2012.05.042. PMID 22682556.
27. Kalinowski, T. * and **R. U. Halden**. 2012. Can Stress Enhance Phytoremediation of Polychlorinated Biphenyls? *Environmental Engineering Science* 29(12):1047-1052; DOI: 10.1089/ees.2012.0089.
28. Hartmann, E. M., and **R. U. Halden**.* 2012. Analytical Methods for the Detection of Viruses in Food by Example of CCL-3 Bioagents. *Analytical and Bioanalytical Chemistry* 404(9):2527-2537. PMID 22526652.
29. Pycke, B. F. G., T.-C. Chao, P. Herckes, P. Westerhoff and **R. U. Halden**.* 2012. Beyond nC₆₀: Strategies for Identification of Transformation Products of Fullerene Oxidation in Aquatic and Biological Samples. *Analytical and Bioanalytical Chemistry*, 404(9) (2012):2583-2595. DOI 10.1007/s00216-012-6090-8. PMID 22644149.
30. Chari, B. P. and **R. U. Halden**.* 2012. Validation of Mega Composite Sampling and Nationwide Mass Inventories for 26 Previously Unmonitored Contaminants in Archived Biosolids from the U.S National Biosolids Repository. *Water Research* 36:4814-4824. PMID 22789759.
31. Delgado, A., P. Parameswaran, D. Fajardo-Williams, **R. U. Halden**, and R. Krajmalnik-Brown.* 2012. Role of Bicarbonate as a pH Buffer and Electron Sink in Microbial Dechlorination of Chloroethenes. *Microbial Cell Factories* 1(128):10pp.
32. Ziv-El, M., S. C. Popat, K. Cai, **R. U. Halden**, R. Krajmalnik-Brown, and B. E. Rittmann*. 2012. Managing Methanogens and Homoacetogens to Promote Reductive Dechlorination of Trichloroethene with Direct Delivery of H₂ in a Membrane Biofilm Reactor. *Biotechnol. Bioeng.* 109(9):2200-2210. PMID 22392141.

33. Ziv-El, M., S. C. Papat, P. Parameswaran, D. W. Kang, A. Polasko, **R. U. Halden**, B. E. Rittmann, and R. Krajmalnik-Brown.* 2012. Using Electron Balances and Molecular Techniques to Assess Trichloroethene-induced Shifts to a Dechlorinating Microbial Community. *Biotechnol. Bioeng.* 109(9):2230-2239. PMID 22447387.
34. Venkatesan, A. K., B. F. Pycke, L. B. Barber, K. E. Lee, and **R. U. Halden**.* 2012. Occurrence of Triclosan, Triclocarban, and Its Lesser Chlorinated Congeners in Minnesota Freshwater Sediments Collected Near Wastewater Treatment Plants. *Journal of Hazardous Materials* 229-230:29-35. PMID 22742731.
35. Ziv-El, M., A. G. Delgado, Y. Yao, K. Muto, D.-W. Kang, **R. U. Halden**, R. Krajmalnik-Brown.* 2012. Development and Characterization of DehaloR², a Novel Anaerobic Microbial Consortium Performing Rapid Dechlorination of TCE to Ethene. *Applied Microbiology and Biotechnology* 95(1):273-274. PMID 21667274.
36. Hartmann, E. M., J. P. Badalamenti, R. Krajmalnik-Brown, and **R. U. Halden**.* 2012. Quantitative PCR for Tracking Megaplasmid-borne Biodegradation Potential of a Model *Sphingomonad*. *Appl. Environ. Microbiol.* 78(12):2293-4496. PMID 22492441.
37. Love, D. C., **R. U. Halden**, M. F. Davis, and K. E. Nachman. Response to Comment on Feather Meal: A Previously Unrecognized Route for Reentry into the Food Supply of Multiple Pharmaceuticals and Personal Care Products (PPCPs). *Environ. Sci. Technol.*, 46(10):5631-5631. DOI: 10.1021/es301528a.
38. Hansmeier, N., T.-C. Chao, L. R. Goldman, F. R. Witter, and **R. U. Halden**.* 2012. Prioritization of Biomarker Targets in Human Umbilical Cord Blood: Identification of Proteins in Infant Blood Serving as Validated Biomarkers in Adults. *Environmental Health Perspectives* 120(5):764-769. <http://dx.doi.org/10.1289/ehp.1104190>. PMID 22538116.
39. Love, R. C., **R. U. Halden**, M. F. Davis and K. E. Nachman. 2012. Feather Meal: a Previously Unrecognized Route for Reentry into the Food Supply of Multiple Pharmaceuticals and Personal Care Products (PPCPs). *Environ. Sci. Technol.* 46(7):3795-3802. PMID 22435972.
40. Wells, E. M.,* L.R. Goldman, J. M. Jarrett, B. J. Apelberg, J. B. Herbstman, K. L. Caldwell, **R. U. Halden**, and F. R. Witter. 2012. Selenium and Maternal Blood Pressure During Childbirth. *Journal of Exposure Science and Environmental Epidemiology.* 22(2):191-197. PMID 22108761.
41. Gray, E. P, T. A. Bruton, C. P. Higgins, **R. U. Halden**, P. Westerhoff, and J. F. Ranville. 2012. Analysis of Gold Nanoparticle Mixtures: a Comparison of Hydrodynamic Chromatography (HDC) and Asymmetrical Flow Field-Flow Fractionation (AF4) Coupled to ICP-MS. *J. Analyt. Atomic Spectrometry* 27(9):1532-1539. DOI: 10.1039/c2ja30069a
42. Colquhoun, D., E. M. Hartmann, and **R. U. Halden**.* 2012. Proteomic Profiling of the Dioxin-Degrading Bacterium *Sphingomonas wittichii* RW1. *J. Biomed. Biotech.* Article ID 408690, 9 pages. (In Press). doi:10.1155/2012/408690. PMID 23091346.
43. Ziv-El, M., A. G. Delgado, Y. Yao, K. Muto, D.-W. Kang, **R. U. Halden**, R. Krajmalnik-Brown.* 2011. Development and Characterization of DehaloR², a Novel Anaerobic Microbial Consortium Performing Rapid Dechlorination of TCE to Ethene. *Applied Microbiology and Biotechnology* 92(5):1063-1071. PMID 21667274.

44. Novak, P. J., Arnold, W. A., Blazer, V.S., **Halden, R. U.**, Klaper, R. D., Kolpin, D. W., Kriebel, D., Love, N. G., Martinovic-Weigelt, D., Patisaul, H. B., Snyder, S. A., vom Saal, F. S., Weisbrod, A. V., and D. L. Swackhamer. 2011. On the Need for a National (US) Research Program to Elucidate the Potential Risks to Human Health and the Environment Posed by Contaminants of Emerging Concern. *Environmental Science & Technology* 45(9):3829-3830. DOI: 10.1021/es200744f. PMID 21438522.
45. Novak, P. J. with Contributing Authors: Arnold, W. A., Blazer, V.S., **Halden, R. U.**, Klaper, R. D., Kolpin, D. W., Kriebel, D., Love, N. G., Martinovic-Weigelt, D., Patisaul, H. B., Snyder, S. A., vom Saal, F. S., Weisbrod, A. V., and D. L. Swackhamer. 2011. Unite to Assess Contaminant Risk. *Nature* 471(7340):578-578. (See <http://www.nature.com.ezproxy1.lib.asu.edu/nature/journal/v471/n7340/extref/471578a-s1.pdf> for full list of authors).
46. Chao, T.-C., G. Song, N. Hansmeier, P. Westerhoff, P. Herckes, **R. U. Halden**.* 2011. Characterization and LC-MS/MS based quantification of hydroxylated fullerenes. *Analytical Chemistry* 83(5):1777-1783. PMID 21294534.
47. Wells, E. M.,* B. J. J. M. Jarrett, Y. H. Li, K. L. Caldwell, J. R. Hibbeln, B. J. Apelberg, J. Herbstman, **R. U. Halden**, F. R. Witter and L. R. Goldman. 2011. Body Burdens and Descriptors of Mercury, Lead, Selenium and Copper Among Newborns at an Urban Hospital. *Environ. Res.* 11(3):411-417. doi:10.1016/j.envres.2010.12.009. PMID 21277575.
48. Wells, E. M.,* Navas-Acien, A., Herbstman, J. B., Apelberg, B. J., Silbergeld, E.K., Caldwell, K. L., Jones, R. L., **Halden, R. U.**, Witter, F. R., and L. R. Goldman. 2011. Low level lead exposure and elevated blood pressure during pregnancy. *Environ. Health Perspect.* 119(5):664-669. doi:10.1289/ehp.1002666. PMID 21292600.
49. Neta, G.,* L. R. Goldman, D. Barr, A. Sjödin, N. Fedarko, B. J. Apelberg, F. R. Witter, **R. U. Halden**. 2011. Fetal exposure to chlordane and permethrin mixtures in relation to inflammatory cytokines and birth outcomes. *Environmental Science & Technology* 45(4):1680-1687. PMID 21235202.
50. Benn, T. M.*, B. F. Pycke, P. Herckes, P. Westerhoff, and **R. U. Halden**. 2011. Evaluation of Extraction Methods for the Quantification of Aqueous Fullerenes in Urine. *Anal. Bioanalyt. Chem.* 399(4):1631-1639. PMID 21153587.
51. W. P. Ela,* D. L. Sedlak, M. A. Barlaz, H. F. Henry, D. D. G. Muir, D. L. Swackhamer, E. J. Weber, R. G. Arnold, L. Ferguson, J. A. Field, E. T. Furlong, J. P. Giesy, **R. U. Halden**, T. Henry, R. A. Hites, K. C. Hornbuckle, P. H. Howard, R. G. Luthy, A. K. Meyer, A. E. Sáez, F. S. vom Saal, C. D. Vulpe, and M. R. Wiesner. 2011. Towards Identifying the Next Generation of Superfund and Hazardous Waste Site Contaminants. *Environ. Health Perspect.* 119(1):6-10. PMID 21205582.
52. Higgins, C. P.,* Z. J. Paesani, T. E. A. Chalew, **R. U. Halden**, L. Hundal. 2011. Persistence of Triclocarban and Triclosan in Soils after Land Application of Biosolids and Bioaccumulation in *Eisenia foetida*. *Environ. Toxicol. Chem.* 30(3):556-563. PMID 21128266.
53. Pycke, B. F., T. M. Benn, P. Herckes, P. Westerhoff, and **R. U. Halden***. 2011. Strategies for Quantifying C60 Fullerenes in Environmental and Biological Samples and Implications for

Toxicological Studies in Environmental Health and Ecotoxicology. *Trends in Analytical Chemistry* 30(1):44-57. PMID 21359100.

54. Miller, T. R., A. L. Delcher, S. L. Salzberg, E. Saunders, J. C. Detter, and **R. U. Halden**.* 2010. Genome Sequence of the Dioxin Mineralizing Bacterium *Sphingomonas wittichii* RW1. *J. Bacteriology* 192(22):6101-6102. PMID 20833805.
55. Deo, R. P. and **R. U. Halden**.* 2010. *In Silico* Screening for Unmonitored, Potentially Problematic High Production Volume (HPV) Chemicals Prone to Accumulate in Biosolids. *Journal of Environmental Monitoring* 12(10):1840-8145. DOI:10.1039/c001559h. PMID 20721409.
56. Miller, T. R., D. R. Colquhoun, and **R. U. Halden**.* 2010. Identification of Wastewater Bacteria Involved in the Degradation of Triclocarban and its Non-Chlorinated Congener. *J. Hazard. Mat.* 183(1-3):766-772. PMID 20727675.
57. Walters, E., K. McClellan and **R. U. Halden**.* 2010. Occurrence and loss over three years of 72 pharmaceuticals and personal care products from biosolids-soil mixtures in outdoor mesocosms. *Water Research* 44:6011-6020. PMID 20728197.
58. Neta, G., L. R. Goldman,* D. Barr, A. Sjödin, B. J. Apelberg, J. Herbstman, F. R. Witter and **R. U. Halden**. 2010. Distribution and determinants of pesticide mixtures in cord serum using principal component analysis. *Environ. Sci. Technol.* 44(14):5641–5648. PMID 20550184.
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2. Hartmann, E. M., D. R. Colquhoun, and **R. U. Halden.*** Absolute Quantification of Norovirus in Food, Water and Soil Using Synthetic Peptides with Electrospray and MALDI Mass Spectrometry. (In Review).

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2. Venkatesan, A. and **R. U. Halden**. Occurrence of carcinogenic N-nitrosamines in nationally representative samples of U.S. sewage sludges. 248th American Chemical Society National Meeting and Exposition, San Francisco, August 10-14, 2014.
3. Venkatesan, A. and **R. U. Halden**. Nationwide Occurrence, Release Inventories and Prioritization of Emerging Contaminants in U.S. Sewage Sludges: Results from the National Sewage Sludge Repository of Arizona State University. 248th American Chemical Society National Meeting and Exposition, San Francisco, August 10-14, 2014.

4. Jenck, A. M., D. Lake, and **R. U. Halden**. Development of a proteomic-based analytical method for the isolation and identification of *Coccidioides* spp. proteins detectable in human blood plasma. 248th American Chemical Society National Meeting and Exposition, San Francisco, August 10-14, 2014.
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15. Jenck, A. and **R. U. Halden**. Development of a Proteomic-based Diagnostic Tool for Valley Fever Infection Through the Isolation and Identification of *Coccidioides* Proteins Detectable in Blood Plasma. 58th Annual Coccidioidomycosis Study Group Meeting in Phoenix, AZ April 5, 2014.
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17. Venkatesan, A, and **R. U. Halden**. National Sewage Sludge Repository at Arizona State University: A Chemical Observatory to Identify and Prioritize Chemicals of Concern to Environmental and Human Health. WATERCON IWEA 2014 Joint Conference and Expo, Springfield, IL, March 17-20, 2014.
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32. Kalinowski, T, I. Bennett and R. U. Halden. Facilitating Mutual Understanding Among Diverse Stakeholders Through Participatory Assessment Of An Emerging Technology. DuPont Summit on Science, Technology and Environmental Policy, Washington, DC, December 2012.
33. McClellan, K., T. Kalinowski, T. A. Bruton, I. B. Roll, **R. U. Halden**. Bringing The Lab To The Field - The *In Situ* Microcosm Array. DECHEMA International Environmental Remediation Symposium. Frankfurt am Main, Germany, November 26-27, 2012.

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48. Kalinowski, T., K. McClellan, T. A. Bruton, I. B. Roll, R. Krajmalnik-Brown and **R. U. Halden**. Bioremediation of TCE and Hexavalent Chromium: Comparing Bench-Scale Treatability Studies to the In Situ Microcosm Array. Battelle's 8th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 2012.

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50. Kalinowski, T., K. McClellan, T. A. Bruton, I. B. Roll, R. U. Halden. "In Situ Microcosm Array (ISMA) Vs. Standard Laboratory Assessment Of Candidate Remediation Technologies – A Trichloroethylene And Hexavalent Chromium Case Study" ACS National Meeting, San Diego, CA, March 29-29, 2012.
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55. Venkatesan, A.K., B.F.G. Pycke, T-C Chao, and **R. U. Halden**. Occurrence of triclosan, triclocarban, and their transformation products in sediments up- and downstream of U.S. wastewater treatment plants. Industrial Wastewater Seminar 2011. Atlantic City, NJ, USA. May 10, 2011.
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57. **Halden, R. U.**, A. K. Venkatesan and N. Hansmeier. Mixtures of Manmade Hazardous Compounds in the Anthroposphere and in Humans. International Toxicology of Mixtures Conference, Arlington, VA, October 21-23, 2011.
58. McClellan, K., T. Kalinowski, T. A. Bruton, I. B. Roll, and **R.U. Halden**. In Situ Microcosm Array (ISMA) vs. Standard Laboratory Assessment of Candidate Remediation Technologies – A Perchlorate Case Study Annual Symposium of the NIEHS Superfund Program, October 23-26, 2011, Lexington, KY.
59. Kalinowski, T., K. McClellan, T. A. Bruton, I. B. Roll, R. Krajalnik-Brown and **R.U. Halden**. Evaluating Bioremediation of TCE and Hexavalent Chromium: A Case Study of the *In Situ* Microcosm Array (ISMA). Annual Symposium of the NIEHS Superfund Program, October 23-26, 2011, Lexington, KY.
60. Kalinowski, T., K. McClellan, T. A. Bruton, I. B. Roll and **R.U. Halden**. *In Situ* Microcosm Array (ISMA): A Novel Device for Conducting Treatability Studies. Geological Society of America Annual Meeting, October 9-12, 2011, Minneapolis, MN.
61. McClellan, T. Kalinowski, K. T. A. Bruton, I. B. Roll and **R.U. Halden**. *In Situ* Microcosm Array (ISMA) vs. Standard Laboratory Assessment of Candidate Remediation Technologies – A Perchlorate Case Study. Geological Society of America Annual Meeting, October 9-12, 2011, Minneapolis, MN.
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63. **Halden, R. U.** Biosolids: A Diagnostic Matrix Foretelling Exposures in the Anthroposphere. 3rd International Conference on Occurrence, Fate, Effects, and Analysis of Emerging Contaminants in the Environment, Copenhagen, Denmark, August 23-26, 2011.
64. Hartmann, E. M., M. L. Fisher, and **R. U. Halden**. Site-Directed Mutagenesis of the Dioxin Dioxygenase to Improve Activity Towards 2,3,7,8-Tetrachloro-Dibenzo-*p*-Dioxin. National Science Foundation East Asia and Pacific Summer Institute, Toyama, Japan, August 2011.
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68. Delgado, A. G., M. Ziv-El, **R. U. Halden**, and R. Krajmalnik-Brown. Microbial Trichloroethene Dechlorination by a Novel Enriched Consortium. Science Foundation Arizona Grand Challenges Conference, Flagstaff, AZ. May 22 - 24, 2011.
69. Pycke, B. F. G., T.-C. Chao, T. M. Benn, R. Scholze, P. Herckes, **R. U. Halden**, and P. Westerhoff. 2011. Mass spectrometry-based detection of aqueous and oxidized fullerenes in biological and environmental samples. Nanotechnology GO Meeting, NIEHS, Bethesda, MD, March 4-5, 2011.
70. Wells, E. M., J. Jarrett, C. Verdon, C. D. Ward, K. Caldwell, F. R. Witter, **R. U. Halden**, L. R. and Goldman. Umbilical Cord Blood Methyl and Inorganic Mercury Concentrations and Their Relationship With Ponderal Index. 2011 International Conference on Mercury as a Global Pollutant. Halifax, Nova Scotia, July 24-29, 2011.
71. Seager, T., M. Fraser, M. Holl and **R. U. Halden**. The SUMMIT Approach to Sustainability in Superfund Research Translation. International Conference on Sustainable Remediation. Amherst, MA, June 1-3, 2011.
72. Venkatesan, A. K., B. Pycke, T.-C. Chao and **R. U. Halden**. Occurrence of Triclosan, Triclocarban, and Their Transformation Products in Sediments Up and Downstream of U.S. Wastewater Treatment Plants. Water Environment Federation: Industrial Wastewater Conference. Bally's Hotel, Atlantic City, New Jersey, May 9-10, 2011.
73. Doudrick, K, A. K. Venkatesan, E. M. Hartmann, T. Kalinowski and **R. U. Halden**. Assessment of the Contribution of Triclosan to Dioxin Emissions from Sludge Incineration in the U.S. Using a Mathematical Model. Water Environment Federation: Industrial Wastewater Conference. Bally's Hotel, Atlantic City, New Jersey, May 9-10, 2011.
74. Hartmann, E. M. and **R. U. Halden**. Use of AQUA and MALDI-TOF/TOF MS to Quantify a Dioxin-Degrading Enzyme. 23rd Annual Sanibel Conference on Mass Spectrometry, American Society for Mass Spectrometry (ASMS), St. Pete Beach, FL, January 21-24, 2011.
75. McClellan, K., T. A. Bruton, T. Kalinowski, and **R. U. Halden**. Use of the "In Situ Microcosm Array"(ISMA) Technology for Evaluation of 1,4-Dioxane and Trichloroethene Co-Remediation. Partners in Environmental Technology Technical Symposium & Workshop, Washington, D.C., November 30 - December 2, 2010.
76. Bruton, T. A., K. McClellan, T. Kalinowski, and **R. U. Halden**. Development of Online Sensing Capability for the In Situ Microcosm Array (ISMA) Technology. Partners in Environmental Technology Technical Symposium & Workshop, Washington, D.C., November 30 - December 2, 2010.

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78. Kalinowski, T., K. McClellan, K., T. A. Bruton, and **R. U. Halden**. Capabilities of the In Situ Microcosm Array. Partners in Environmental Technology Technical Symposium & Workshop, Washington, D.C., November 30 - December 2, 2010.
79. **R. U. Halden**, K. McClellan, T. Kalinowski, T. A. Bruton, T. R. Miller, E. M. Hartmann, D. R. Colquhoun, T.-C. Chao, N. Hansmeier, R. P. Deo, A. Sapkota, T. E. A. Chalew, T. A. Young, C. R. Matos-Pérez, E. Walters, R. N. Cole, F. R. Witter and L. R. Goldman. Novel Approaches to Studying the In Situ Bioremediation Potential of Complex Mixtures. Annual Conference of the NIEHS Superfund Program, Portland, OR, November 10 - 12, 2010.
80. McClellan, K., T. Kalinowski, T. A. Bruton, and **R. U. Halden**. Field Application of the *In Situ* Microcosm Array. Annual Conference of the NIEHS Superfund Program, Portland, OR, November 10 - 12, 2010.
81. Westerhoff, P., T. Benn, B. Pycke, T.-C. Chao, K. Doudrick, **R. U. Halden** and P. Herckes. Characterization of Fullerenes and Fullerols in Complex Matrices. SETAC North America 31st Annual Meeting, November 7-11, 2010.
82. Lee, H.-S., A. G. Delgado, C. I. Torres, **R. U. Halden**, B. E. Rittmann and R. Krajmalnik-Brown. Anaerobic Dechlorination of Trichloroethene with Hydrogen Produced from a Microbial Electrolysis Cell. Leading Edge Technologies Conference, Phoenix, AZ, June 1, 2010.
83. Goldman, L. R., G. Neta, J. B. Herbstman, A. Sjödin, F. R. Witter, and **R. U. Halden**. Use of principal component analysis to elucidate independent effects of in utero exposure to PBDE and PCB mixtures on newborn thyroid hormone measures. Dioxin 2010 - 30th International Symposium on Halogenated Persistent Organic Pollutants (POPs), San Antonio, TX, September 12-17, 2010.
84. Ziv-El, M. A. Delgado, **R. U. Halden**, and R. Krajmalnik-Brown. 2010. Molecular-biological characterization of a novel, sediment-free mixed culture showing exceptionally rapid dechlorination of TCE to ethane. 13th International Symposium on Microbial Ecology (ISME), Seattle, WA, August 22-27, 2010.
85. Delgado, A., M. Ziv-El, **R. U. Halden**, and R. Krajmalnik-Brown. 2010. Role of pH Buffering on TCE Reduction and Composition of Dechlorinating Consortia. 13th International Symposium on Microbial Ecology (ISME), Seattle, WA, August 22-27, 2010.
86. **Halden, R. U.** Sustainable Management of Hazardous Mixtures. A Proposal. Arizona Department of Environmental Quality, Phoenix, AZ, August 13, 2010.
87. Wells, E. M., J. M. Jarrett, B. J. Apelberg, J. B. Herbstman, A. Navas-Acien, K. L. Caldwell, **R. U. Halden**, F. R. Witter, and L. R. Goldman. The non-monotonic relationship of selenium exposure with blood pressure and hypertension during late pregnancy. The 23rd Annual Meeting of the Society for Pediatric and Perinatal Epidemiologic Research (SPER), Seattle, WA, June 23-26, 2010.
88. Neta, G., L. R. Goldman, D. Barr, A. Sjödin, B. Apelberg, F. Witter, **R. U. Halden**. Distribution and Determinants of in utero Pesticide Mixtures using Principal Component Analysis. Society for Epidemiologic Research (SER) 43rd Annual Meeting Seattle, WA, June 23-26, 2010.
89. Hartmann, E. M. and **R. U. Halden**. Concept for a Brain Tissue Screening Procedure to Ensure Prion Exclusion. Arizona Alzheimer's Consortium Annual Conference, Glendale, AZ, May 21, 2010.
90. Wells E. M., A. Navas-Acien, B. J. Apelberg, J. B. Herbstman, J. M. Jarrett, K. L. Caldwell, **R. U. Halden**, F. R. Witter, and L. R. Goldman. Association of selenium and copper with triglycerides in umbilical cord blood serum. Research ShowCASE 2010, Case Western Reserve University: Cleveland, Ohio, 15 April 2010.

91. Hartmann, E.M. and **R. U. Halden**. 2010. Discovery and Detection of Biomarkers of Petroleum-degrading Bacteria. Science Foundation Arizona Grand Challenges Conference, Phoenix, Arizona, April 12–13, 2010.
92. **R. U. Halden**. Concluding Remarks on Policies for Promoting Sustainable Chemistry. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
93. **R. U. Halden**. Introduction to Policies for Promoting Sustainable Chemistry. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
94. **R. U. Halden**. Concluding Remarks on Antimicrobial Agents and Sustainability. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
95. **R. U. Halden**. Introduction to Antimicrobial Agents and Sustainability. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
96. **R. U. Halden**. Examining the Sustainability of Persistent Antimicrobial Compounds. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
97. Deo, R. P. and **R. U. Halden**. Impact of Sample Processing Procedures on the Quality of Environmental Monitoring Data Influencing Policy Decisions. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
98. **R. U. Halden**. Toward Sustainable Use of Organohalogenes. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
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100. McClellan, K., T. Kalinowski and **R. U. Halden**. ESTCP Project 200914: A New Technology for Remedial Design. Annual Technical Symposium & Workshop hosted by the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP), Washington, DC, December 1-3, 2009.
101. T. Kalinowski, K. McClellan, and **R. U. Halden**. In Situ Sediment Column Microcosms for Studying Bioremediation. Annual Technical Symposium & Workshop hosted by the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP), Washington, DC, December 1-3, 2009.
102. Guerrero-Preston, R., C. LeBron, J. B. Herbstman, **R. U. Halden**, D. Sidransky, and L. Goldman. Global DNA Hypomethylation in Cord Blood Serum of Babies Exposed to Maternal Smoking *In Utero*. 137th APHA Annual Meeting & Exposition, San Antonio, TX, November 7-11, 2009.
103. T. Kalinowski, McClellan, K., and **R. U. Halden**. Novel Approaches to Studying the In Situ Bioremediation Potential of Complex Mixtures. Superfund Research Program 2009 Annual Conference, Columbia University, New York, NY, November 3, 2009.
104. **R. U. Halden**. *In Situ* Downhole Technology for Commercialization. First ASU Spartan Workshop for Technology Commercialization, Scottsdale, AZ, September 19, 2009.
105. **R. U. Halden**. Toward Sustainable Chemistry and Engineering. ASU School of Sustainability and the Built Environment, Student Organization, Invited Seminar, Tempe, AZ, September 4, 2009.
106. Walters, E. K. McClellan and **R. U. Halden**. Fate of Pharmaceuticals and Personal Care Products in Agricultural Soils Modified With Biosolids. 238th American Chemical Society (ACS) National Meeting, Washington, DC, August 16-20, 2009.

107. McClellan and **R. U. Halden**. Analysis of PPCPs in biosolids originating from the 2001 EPA National Sewage Sludge Survey. 238th American Chemical Society (ACS) National Meeting, Washington, DC, August 16-20, 2009.
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109. Deo, R. P. and **R. U. Halden**. Empirical Model for Predicting Concentrations of Refractory Hydrophobic Organic Compounds in Digested Sludges from Municipal Wastewater Treatment Plants. 238th American Chemical Society (ACS) National Meeting, Washington, DC, August 16-20, 2009.
110. Fox, A. and **R. U. Halden**. Applicability of Passive Sampling Modules for the Determination of Contaminants of Emerging Interest in Digested Municipal Sewage Sludge (Biosolids). 238th American Chemical Society (ACS) National Meeting, Washington, DC, August 16-20, 2009.
111. Higgins, C. P., Z. J. Paesani, T. E. A. Chalew, **R. U. Halden**, and L. S. Hundal. Persistence and Bioaccumulation of Triclocarban and Triclosan in Soils After Land Applications of Municipal Biosolids. EmCon 2009, 2nd International Conference on Occurrence, Fate, Effects, and Analysis of Emerging Contaminants in the Environment, August 4-7, 2009.
112. Walters, E. K. McClellan and **R. U. Halden**. Fate of Pharmaceuticals and Personal Care Products in Agricultural Soils Modified With Biosolids. Micropol/Ecotox, Burlingame, CA, June 8 – 10, 2009.
113. McClellan, K. and **R. U. Halden**. Nationwide Assessment of Pharmaceuticals and Personal Care Products in U.S. Biosolids. Micropol/Ecotox, Burlingame, CA, June 8 – 10, 2009.
114. Doom, T. R. and **Halden, R. U.**: BME Capstone Design Project Presentation. Tempe, May 1, 2009.
115. Doom, T. R. and **Halden, R. U.**: In Situ Remediation of Contaminated Subsurface Environments: Assessing Industry Needs for Technical Innovations. 19th Annual AEHS Meeting and West Coast Conference on Soils, Sediments, and Water. San Diego, CA, March 10, 2009.
116. Geer, L. and **R. U. Halden**. Triclosan and Triclocarban Levels in Urine and Cord Blood of Mother/Infant Pairs. Annual Meeting of the Superfund Basic Research Program of the National Institute of Environmental Health Sciences, Pacific Grove, CA, December 7-9, 2008.
117. Hartmann, E., McClellan, K. and **R. U. Halden**. Toward Proteomics-informed Optimization of In Situ Bioremediation. Annual Meeting of the Superfund Basic Research Program of the National Institute of Environmental Health Sciences, Pacific Grove, CA, December 7-9, 2008.
118. Higgins, C. P., Z. J. Paesani, T. E. A. Chalew, and **R. U. Halden**. Bioaccumulation of Triclocarban in *Lumbricus variegatus*. SETAC Meeting, November 2008.
119. Wells, E. M., A. Navas-Acien, K. L. Caldwell, R. L. Jones, B. J. Apelberg, J. B. Herbstman, **R. U. Halden**, F. R. Witter, and L. R. Goldman. Selenium and lipids in umbilical cord serum. International Society for Environmental Epidemiology Annual Conference, Pasadena, CA, October 12-16, 2008.
120. Hartmann, E. M., D. R. Colquhoun, and **R. U. Halden**. Identification of Pollutant-Degrading Bacteria Using Peptide Mass Fingerprinting and Mass Spectrometry. American Chemical Society Middle Atlantic Regional Meeting, Philadelphia, PA, May 16–18, 2007.
121. DeLaquil, A., T. R. Miller, and **R. U. Halden**. Accumulation of Antimicrobial Chemicals in Sediment. American Chemical Society Middle Atlantic Regional Meeting, Philadelphia, PA, May 16–18, 2007.
122. Wells, E., Goldman, L. R., Jones, R., Caldwell, K., Apelberg, B. J., Herbstman, J., Needham, L., Witter, F. R. and **R. U. Halden**. Modeling low-level cord blood lead exposure and maternal blood pressure. 19th Annual Conference of the International Society for Environmental Epidemiology, Mexico City, Mexico, September 5–7, 2007.
123. Herbstman J. B., Witter F. R., Apelberg B. J., Sjödin A., Patterson D. G., **Halden, R. U.**, Needham, L. L., and Goldman, L. R. Prenatal PCB and PBDE Exposure and Thyroid Hormone

- Levels. 19th Annual Conference of the International Society for Environmental Epidemiology, Mexico City, Mexico, September 5–7, 2007.
124. Wells, E., Goldman, L. R., Jones, R., Caldwell, K., Apelberg, B. J., Herbstman, J., Needham, L., Witter, F. R. and **R. U. Halden**. Public Health Policy Implications of Socioeconomic and Demographic Correlates of Prenatal Lead Exposure. 135th Annual Meeting of the American Public Health Association, Washington, D.C., November 3–7, 2007.
 125. Heidler, J., and **R. U. Halden**. Behavior of Persistent Biocides During Wastewater Treatment: Mass Balances and Meta Analysis. American Water Resources Association (AWRA) Summer Specialty Conference on "Emerging Contaminants of Concern in the Environment," Vail, Colorado, June 25–27, 2007.
 126. Heidler, J., and **Halden, R. U.** Detection of Persistent Biocides in Sewage Sludge and Human Blood Using LC-ESI-MS and LC-ESI-MS/MS. 55th ASMS Conference on Mass Spectrometry, Indianapolis, IN, June 3–7, 2007.
 127. Colquhoun, D. R. and **R. U. Halden**. Comparative Proteomic Analysis of Cells of the Dioxin Degrading Bacterium *Sphingomonas wittichii* RW1 Grown on Various Substrates. 107th ASM General Meeting, Toronto, Ontario, Canada, May 21–25, 2007.
 128. Miller, T. R., Salzberg, S. L., Eisen, J. A., and **R. U. Halden**. Comparative Sequence Analysis of Catabolic Megaplasms from *Sphingomonas wittichii* RW1 and Related Bioremediation Agents. 107th ASM General Meeting, Toronto, Ontario, Canada, May 21–25, 2007.
 129. Miller, T. R., Salzberg, S. L., and **R. U. Halden**. Sequence Analysis of Megaplasms from the Dioxin Mineralizing Bacterium *Sphingomonas wittichii* RW1. Joint Genome Institute User Conference, Walnut Creek, CA, March 28–31, 2007.
 130. Higgins, C. P., J. P. Bressler and **R. U. Halden**. Mechanisms of Perfluorochemical Surfactant Bioaccumulation: The Potential Role of Organic Anion Transporters. 15th Annual Scientific Workshop of the JHU-NIEHS Center In Urban Environmental Health. Baltimore, MD, February 28, 2007.
 131. Goldman, L. R., B. J. Apelberg, J. B. Herbstman, **R. U. Halden**, F. R. Witter, A. M. Calafat, Z. Kuklenyik, L. L. Needham. Possible Etiologies of PFAA-Induced Developmental Effects: Reflections from a Pediatric Perspective. Society of Toxicology Conference: Current Concepts in Toxicology—Perfluorinated Alkyl Acids and Related Chemistries: Toxicokinetics and Mode-of-Action Workshop. Arlington, VA, February 14–16, 2007.
 132. **Halden, R. U.**, and T. R. Miller. In Situ Microcosm Array Technology for Remedial Feasibility Assessment and Design. Partnership in Environmental Technology Technical Symposium & Workshop (ESTCP/SERDP), Washington, D.C., November 28–30, 2006.
 133. Herbstman J. B., Sjödin A., Apelberg B. J., Witter F. R., Patterson D. G., **Halden, R. U.**, Jones, R. S., Park, A., Heidler, J., Needham, L. L., and Goldman, L. R. Determinants of Prenatal Exposure to Polybrominated Diphenyl Ethers (PBDEs) in an Urban Population. International Conference on Environmental Epidemiology & Exposure, Paris, France, September 2–6, 2006.
 134. Apelberg B. J., Calafat, A. M., Herbstman J. B., **Halden, R. U.**, Heidler, J., Witter, F. R., Needham, L. L., and Goldman, L. R. Magnitude and Determinants of Fetal Exposure to Perfluorinated Chemicals. International Conference on Environmental Epidemiology & Exposure, Paris, France, September 2–6, 2006.
 135. **Halden, R. U.**, D. R. Colquhoun, R. N. Cole and K. J. Schwab. Mass Spectrometry Method for the Epidemiological Surveillance of Norovirus. 106th General Meeting of the American Society for Microbiology, Orlando, FL, May 21–25, 2006.
 136. Colquhoun, D. R., T. R. Miller, E. M. Hartmann, and **R. U. Halden**. Rapid Characterization of Pollutant Degrading Bacteria Using Matrix Assisted Laser Desorption Ionization—Time of Flight Mass Spectrometry. 106th General Meeting of the American Society for Microbiology, Orlando, FL, May 21–25, 2006.

137. **Halden, R. U.**, and T. R. Miller. Novel Diagnostic In Situ Monitoring Technology. BIO 2006. Annual International Convention. Environmental Biotechnology Session. Chicago, IL, April 9–12, 2006.
138. Miller, T. R., Colquhoun, D. R., and **R. U. Halden**. Characteristics of a Bacterial Enrichment Culture Utilizing the Antimicrobial Compound Triclocarban as Sole Carbon and Energy Source. 106th General Meeting of the American Society for Microbiology, Orlando, FL, May 21–25, 2006.
139. Heidler, J., and **Halden, R. U.**: Preliminary Assessment of Biocide Inputs to U.S. Water Resources and Soils. 5th International Conference on Pharmaceuticals and Endocrine Disrupting Chemicals in Water, Costa Mesa, California, March 13-15, 2006.
140. Colquhoun, D. R. and **Halden, R. U.**: Phenotypic Characterization of a Dioxin-degrading Bacterium Using MALDI-TOF MS. American Society for Mass Spectrometry, Fall Workshop on Characterization of Microorganisms by Mass Spectrometry, San Diego, CA, December 9, 2005.
141. **Halden, R. U.**: Effect of Lifestyle on Mother/Infant Exposure to Ubiquitous Pollutants. CLF Research Day: Insights Along the Path of Sustainability, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, November 30, 2005.
142. **Halden, R. U.**, A. Sapkota, J. Heidler, J. Keehner, N. Haws, and B. G. Halden: Municipal Sludge Disposal and Sustainable Agriculture: A Pilot Study Showcasing the Challenge of Combining the Two. CLF Research Day: Insights Along the Path of Sustainability, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, November 30, 2005.
143. Naples, J., C. Shiff, C., D. R. Colquhoun, and **Halden, R. U.**: The Use of Cedar Oil Components to Prevent Infection by Schistosome Cercariae. 54th Annual Meeting of the American Society of Tropical Medicine and Hygiene, Washington, DC, December 11-15, 2005.
144. Miller, T. R. and **Halden, R. U.**: Enrichment of Xenobiotic-Degrading Bacteria Using a New In Situ Monitoring Device. SETAC 26th Annual Meeting in North America, Baltimore, MD, November 17, 2005. <http://abstracts.co.allenpress.com/pweb/setac2005/document/?ID=56786>
145. Heidler, J. and **Halden, R. U.**: Tracking the Fate of Triclosan during Activated Sludge Wastewater Treatment. SETAC 26th Annual Meeting in North America, Baltimore, MD, November 14, 2005. <http://abstracts.co.allenpress.com/pweb/setac2005/document/?ID=56429>
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147. Herbstman, J., A. Sjodin, D. Patterson, B. Apelberg, F. Witter, **R. U. Halden**, J. Heidler, L. Needham, and L. Goldman: PCBs and PBDEs and Thyroid Hormone Levels in Umbilical Cord Blood in an Urban U.S. Population: A Feasibility Study. Dioxin 2005, Toronto, Canada, August 21-26, 2005.
148. **Halden, R. U.**: Innovative Method for Environmental Monitoring and Bioprospecting. 8th In Situ and On-Site Bioremediation Symposium, Baltimore, MD, June 6-9, 2005.
149. **Halden, R. U.**: Pharmaceuticals and Personal Care Products in Biosolids. New Jersey Water Environment Association Annual Conference, Tropicana Hotel, Atlantic City, NJ, May 4, 2005.
150. **Halden, R. U.**: Pharmaceuticals and Personal Care Products as Indicators of Sewage Spills. Maryland Water Monitoring Council 10th Annual Conference, Linthicum, MD, November 18, 2004. <http://www.mgs.md.gov/mwmc/conf/2004/>
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152. Heidler, J. and **R. U. Halden**: Mass Balance for Antimicrobial Compounds at a Municipal Wastewater Treatment Plant in Baltimore, MD. Groundwater and Public Health – Making the Connection. Groundwater Foundation Annual Conference and Groundwater Guardian Designation, Washington, D.C., November 4-5, 2004. http://www.groundwater.org/pe/conference/2004conference_agenda.pdf

153. Matos, C. and **R. U. Halden**: Antimicrobial Compounds as Indicators of Sewage Contamination in Surface Waters. Annual Biomedical Research Conference for Minority Students (ABRCMS), Dallas, TX, November 10 – 13, 2004.
154. Heidler, J. and **R. U. Halden**: Fate of antimicrobial compounds during wastewater treatment. Proceedings of the 228th National Meeting of the American Chemistry Society. Presented at the 2nd National Symposium on Environmental Aspects of Pharmaceuticals and Personal Care Products, Philadelphia, PA, August 22 – 26, 2004. <http://www.tntech.edu/wrc/PPCPWebcast/PPCP.htm>
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158. Paull, D.H., and **R. U. Halden**: Monitoring Antimicrobial Compounds as Indicators of Sewerage Problems Impacting Urban Streams. Maryland Water Monitoring Council 9th Annual Conference: Ecological Restoration Assessment and Monitoring, Linthicum, MD, 2003. <http://www.mgs.md.gov/mwmc/conf/abspost03.html#paull>
159. **Halden, R.U.**, R. N. Cole, C. Bradford, D. Chen, and K. J. Schwab. Rapid Detection of Norwalk Virus-like Particles using MALDI-TOF MS and ESI-MS/MS. 51st ASMS Meeting, Montreal, Quebec, Canada, 2003. <http://www.inmerge.com/aspfolder/ASMSSchedule2.asp>
160. Franklin, M. P., Madrid, V., Gregory, S., and **R. U. Halden**: Spatial Analysis of a Microbial Community Mediating Intrinsic Reductive Dechlorination of TCE to *cis*-DCE at a DOE Superfund Site. 103rd General Meeting of the American Society for Microbiology, Washington, D.C., 2003. <http://www.asmta.org/memonly/abstracts/AbstractView.asp?AbstractID=80900>
161. Xie, G., T. Palmateer Oxenberg, W. Dong, A. Kalmykov, M. P. Franklin, E. J. Bouwer, and **R. U. Halden**: Sorption, Bioavailability, and Bioreduction of U(VI) in Sediment from the Aberdeen Proving Ground, MD. 103rd General Meeting of the American Society for Microbiology, Washington, DC, 2003. <http://www.asmta.org/memonly/abstracts/AbstractView.asp?AbstractID=81438>
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164. **Halden, R. U.**: Microarrays for Bioremediation. Presenter and Session Moderator. DOE-NABIR PI Workshop, Warrenton, VA, 2002.
165. Lowe, M., A. Spiro, G. Xie, and **R. U. Halden**: Development of a Multiplexed, Bead-based Assessment Tool for Rapid Identification and Quantitation of Microorganisms in Field Samples. DOE-NABIR PI Workshop, Warrenton, VA, 2002.
166. Madrid, V. M., Z. Demir, **R. U. Halden**, S. D. Gregory and J. E. Valett: New Geospatial Model Tracks Chloroethene Subsurface Contamination. Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, 2002.

167. Madrid, V. M., **R. U. Halden**, Z. Demir, J. E. Valett, and S. D. Gregory: 3-D Geospatial Modeling of a DNAPL Source Area. 97th Annual Meeting of the Geological Society of America, Universal City, CA, 2001.
168. Kane, S. R., H. R. Beller, T. C. Legler, C. J. Koester, **R. U. Halden**, and A. M. Happel: Aerobic Metabolism of Methyl *tert*-Butyl Ether by Aquifer Bacteria. 101st General Meeting of the American Society for Microbiology, Orlando, FL, 2001.
<http://www.asmsusa.org/memonly/abstracts/AbstractView.asp?AbstractID=49632>
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171. **Halden, R. U.**, V. M. Madrid, S. D. Gregory, R. L. Goodrich, and P. F. Daley: Advanced Site Characterization and Data Visualization Using Passive Soil Vapor Surveying, GPS/GIS and 3D-Imaging Tools. 10th West Coast Conference on Contaminated Soil and Groundwater, San Diego, CA, 2000.
172. Semprini, L., S. Vancheeswaran, S. Yu, M.-Y. Chu, and **R. U. Halden**: Tetraalkoxysilanes as Slow-release Substrates to Promote Aerobic and Anaerobic Dehalogenation Reactions in the Subsurface. General Meeting of the American Chemical Society, Washington, D.C., 2000.
173. Happel, A. M., E. H. Beckenbach, B. P. Dooher, K. Emmerson, S. R. Kane, C. Koester, **R. U. Halden**, H. R. Beller, and T. C. Legler: Evaluating Attenuation of MTBE. EPA MTBE Biodegradation Workshop, Cincinnati, OH, 2000.
174. Brown, D., R. Holley-Shanks, D. Maeder, K. Schindler, M. Lowe, F. Brockman, **R. U. Halden**, and F. Robb: Comparison of ISR and 16S-ISR Analysis of VOC Effect on Microbial Communities at Two DOE Sites. 100th General ASM Meeting, Los Angeles, CA, 2000.
<http://www.asmsusa.org/memonly/abstracts/AbstractView.asp?AbstractID=30677>
175. Ziagos, J. P., **R. U. Halden**, P. W. Krauter, and W. D. Daily: The Proposed Application of “Green” Technology to Achieve Cleanup Goals. 11th National DOE Technology Information Exchange Workshop, Las Vegas, NV, 1999.
176. **Halden, R. U.**, A. M. Happel, H. R. Beller, C. Koester, B. G. Halden, S. R. Kane, and T. C. Legler: Evidence for Intrinsic Bioremediation of MTBE at a LUFT Site. In-Situ Alternatives for MTBE Impacted Aquifers, Oxnard, CA, 1999.
177. **Halden, R. U.**, V. Madrid, P. Daley, M. Lima, S. Gregory and J. P. Ziagos: Silicon Lubricants Facilitate Bioattenuation of TCE at LLNL’s Superfund Site 300. 5th In Situ and On-Site Bioremediation Symposium, San Diego, CA, 1999.
178. **Halden, R. U.**, S. R. Schoen, Y. Galperin, I. R. Kaplan, and A. M. Happel: Evaluation of EPA and ASTM Methods for Analysis of Oxygenates in Gasoline-Contaminated Ground Water. 8th Annual AEHS West Coast Conference on Contaminated Soil and Groundwater, Oxnard CA, 1998.
179. **Halden, R. U.**, W. W. McNab Jr., R. Ruiz, and A. M. Happel: Palladium-Catalyzed Transformation of TCE and MTBE in Groundwater, 1st International Symposium on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, 1998.
180. Rhodes, I., J. Milazzo, L. Brzuzy, L. Harvey, A. Verstuyft, **R. U. Halden**, S. Schoen, Y. Galperin, I. R. Kaplan, and A. M. Happel: Analytical Methods for the Determination of Oxygenates in Gasoline-contaminated Groundwater: Modified EPA and ASTM Methods. 21st EPA Conference on Analysis of Pollutants in the Environment, Norfolk, VA, 1998.
181. **Halden, R. U.**, B. G. Halden, and D. F. Dwyer: A Kinetic Analysis of Dioxin Degradation in Bioaugmented Soils. 97th General ASM Meeting, Miami Beach, FL, 1997.
182. **Halden, R. U.**, and D. F. Dwyer: Biodegradation of Dioxins in Soils. 4th International Battelle Bioremediation Symposium, New Orleans, LA, 1997.
183. **Halden, R. U.**: A Kinetic Analysis of Dioxin Degradation in Bioaugmented Soils. 5th Environmental Science & Engineering Conference, Minneapolis, MN, 1997.

184. **Halden, R. U.**, and D. F. Dwyer: Biotransformation of Dioxin-Related Compounds Via Angular Dioxygenation: Bacterial Strains, Degradative Pathways and Their Potential Use for Bioremediation. 3rd International ISEB Symposium, Boston, MA, 1996.
185. **Halden, R. U.**, and D. F. Dwyer: Small Inocula Can Effect In Situ Biodegradation of Carboxydiphenyl Ether in Soil. Proceedings of the North Amer. Water & Environment Congress, ASCE, Somerset, NJ, 1996.
186. **Halden, R. U.**, and D. F. Dwyer: Colonization of Soil by Low Numbers of a Bacterium Constructed to Degrade Dioxin-Related Pollutants. 96th General ASM Meeting, New Orleans, LA, 1996.
187. Raatz, W. A., K. Anderson, **R. U. Halden**, and D. F. Dwyer: Bioremediation of Aquifers Using Introduced Bacteria. 96th General ASM Meeting, New Orleans, LA, 1996.
188. **Halden, R. U.**: Detection and Environmental Fate of Bacteria Able to Degrade Dioxin-Related Compounds. 4th Annual Environmental Science & Engineering Conference, St. Paul, MN, 1996.
189. **Halden, R. U.**, G. W. Mundfrom, E. G. Peters, and D. F. Dwyer: Detection and Environmental Fate of Bacteria Able to Degrade Dioxin-Related Compounds," 55th Annual ASM North Central Branch Meeting, Iowa City, IA, 1995.
190. **Halden, R. U.**, G. W. Mundfrom, E. G. Peters, and D. F. Dwyer: In Situ Bioremediation: Tracking Introduced Diaryl Ether-Degrading Bacteria In Soil. National ASCE Environmental Engineering Conference, Pittsburgh, PA, 1995.
191. **Halden, R. U.**, G. W. Mundfrom, E. G. Peters, and D. F. Dwyer: Bioaugmentation: Monitoring Diaryl Ether-Degrading Bacteria Introduced Into Contaminated Environments Using Molecular-Genetic Methods. 3rd International Bioreclamation Symposium, San Diego, CA, 1995.
192. **Halden, R. U.**: In Situ Biodegradation of Diaryl Ether Compounds in Soil and Sediment. 3rd Annual Environmental Science & Engineering Conference, Minneapolis, MN, 1995.

PUBLICATIONS

Invited Keynotes, Invited Presentations, Invited Webinars, Invited Expert Panel Member & Conference Session Moderation

1. **Halden, R. U.** Analytical Methods for Detecting and Prioritizing Contaminants of Concern. ACS-Invited Symposium Chair. 248th ACS National Meeting & Exposition San Francisco, CA, August 10-14, 2014.
2. **Halden, R. U.** Invited Keynote Address: Sewage Epidemiology - Taking the Chemical Pulse of a Nation at the Sewer. AZ Engineers Club of the West Valley: Sun City West, AZ. March, 7, 2014.
3. **Halden, R. U.** Invited Talk: Sewage Metrology - Taking the Chemical Pulse of our Nation at the Sewer. Johns Hopkins University, School of Public Health. April 24, 2014.
4. **Halden, R. U.** Invited Talk and Nationally Broadcasted Webinar: Chemical Composition of U.S. Sewage Sludges Informed by Analysis of EPA-Collected Biosolids Samples from Across the United States. United States Environmental Protection Agency Headquarter, Washington, DC, April 22, 2014.
5. **Halden, R. U.** Invited Talk and Nationally Broadcasted Webinar: Update on Antimicrobials in the U.S. Environment. United States Food and Drug Administration, Headquarter, Washington, DC, April 22, 2014.
6. **Halden, R. U.** Invited Talk, Panel Member, and Panel Moderator: Potential Human Health Risks of Microplastics. U.S. National Academies, Washington, DC, April 23, 2014.
7. **Halden, R. U.** Fate, Transport, and Toxicity of Wastewater-borne Contaminants by Example of Widely Used Persistent Antimicrobials. SETAC North America 34th Annual Meeting, Nashville, TN, November 17-21, 2013.
8. **Halden, R. U.** Environmental Fate and Human Health Risks of Contaminants of Emerging Concern in the U.S. Environment. Invited Seminar. Distinguished Lecture Series. Simulcast and Taped. <http://icsde.ifas.ufl.edu/Accordent/live/Haden05-21-13/> University of Florida, Gainesville, FL, May 21, 2013.
9. **Halden, R. U.**, K. McClellan and T. Kalinowski. *In Situ* Microcosm Array – A New Decision-Making and Design Tool for In Situ Remediation. Invited Webinar. Technical Practices Network – In Situ Bioremediation Group, AECOM. Presented Online. December 11, 2012.
10. **Halden, R. U.**, S. D. Supowit, I. A. Roll, V. D. Dang, K. J. Kroll and N. D. Denslow. Addressing Risk Assessment Needs for Traditional and Emerging Contaminants Using the Innovative In Situ Sampling/Bioavailability (IS2B) Device. SETAC North America 33rd Annual Meeting, Long Beach, CA, November 11 – 15, 2012. (Invited talk).
11. **Halden, R. U.** Antimicrobials, Antimicrobial Resistance and New Risk Assessment Tools. SETAC North America 33rd Annual Meeting, Long Beach, CA, November 11 – 15, 2012.
12. **Halden, R. U.** Understanding and Minimizing the Health Risks of Plastics. SETAC North America 33rd Annual Meeting, Long Beach, CA, November 11 – 15, 2012.
13. Kalinowski T., K. McClellan and **R. U. Halden**. An Emerging Remediation Technology: The *In Situ* Microcosm Array. Community Informational Group meeting for the Motorola 52nd St. Superfund Site community hosted by the EPA. Sonoran Science Academy-Phoenix K-12 School. Oct. 24, 2012. (Invited talk).
14. **Halden, R. U.**, K. McClellan and T. Kalinowski. *In Situ* Microcosm Array – A New Decision-Making and Design Tool for In Situ Remediation. Invited Interactive Webinar. Remedial Design (In-Situ) Network. Presented Online. September 19, 2012.
15. **Halden, R. U.** and N. Denslow. *In Situ* Sampling Tool for Assessing Bioavailability and Toxicity of Sediments. Invited Webinar Presented Online on May 7, 2012. <http://www.clu-in.org/conf/tio/srpfunding/>

16. **Halden, R. U.**, K. McClellan and T. Kalinowski. *In Situ* Microcosm Array – A New Decision-Making and Design Tool for In Situ Remediation. Invited EPA Clu-in Webinar. Presented Online. August 15, 2012. <http://www.clu-in.org/conf/tio/isma/>
17. **Halden, R. U.** Invited Member of 5-Expert Panel Discussion. *Feed 8 Billion*. Arizona State University, Tempe Campus, AZ, February 2, 2012.
18. **Halden, R. U.** Invited Talk. Polluting While Cleaning: *How Personal Care Products Affect Environmental Quality and Human Health*. Polytechnic Campus, Arizona State University, Mesa, AZ, January 10, 2012.
19. Benny F.G. Pycke, L. A. Geer, A. K. Venkatesan, K. E. Lee, L. B. Barber, A. Crabbé, N. Leys, P. Monsieurs, M. Mergeay, G. Vanermen, H. De Wever, W. Verstraete, and **R. U. Halden**. Invited Talk. Antimicrobial Exposure Assessment From The Cradle To The Grave. *International Conference of the Flemish Centre of Expertise for Environment and Health*. Brussels, Belgium, December 21-22, 2011.
20. **Halden, R. U.** Invited Talk (Webcast). Sustainable Chemistry: Public Health at the Crossroads. Biomedical Informatics Symposium Series, Department of Biomedical Informatics, ASU Mayo Campus, Scottsdale, AZ, November 17, 2011.
21. **Halden, R. U.** Invited Talk. Novel Approaches to Assessing the *In Situ* Treatability and Health Impacts of Toxic Mixtures. Pacific Northwest National Laboratory (PNNL), Richland, WA, November 14, 2011.
22. **Halden, R. U.**, K. McClellan, T. Kalinowski, T. A. Bruton, E. M. Hartmann, T. R. Miller, M. Ziv-El, A. Delgado, D. R. Colquhoun, T.-C. Chao, N. Hansmeier, R. P. Deo, J. Heidler, J. B. Herbstman, B. J. Apelberg, E. M. Wells, G. Neta, F. R. Witter, L. R. Goldman, and R. Krajmalnik-Brown. Novel Approaches to Understanding and Managing Complex Mixtures. Annual Conference of the NIEHS Superfund Program, Lexington, KY, October 23 – 26, 2011.
23. **Halden, R. U.** Invited Talk: Overuse of Antimicrobial Household Products: Environmental and Human Health Effects. American Public Health Association (APHA) Annual Meeting, Washington, DC, October 31, 2011.
24. **Halden, R. U.** Invited Panel Member: Beyond the Hospital: Antibiotic Resistance as a Problem of the Community Environment. American Public Health Association (APHA) Annual Meeting, Washington, DC, October 31, 2011.
25. **Halden, R. U.** Invited Talk: Biosolids: A Diagnostic Matrix Foretelling Exposures in the Anthroposphere. Institute for Food Toxicology and Analytical Chemistry, University of Veterinary Medicine, Hanover, Germany, August 29, 2011.
26. **Halden, R. U.** Invited Talk: Antimicrobial Agents and Sustainable Chemistry, *Science Cafe* Series, hosted by the Center for Nanotechnology in Society, Phoenix, AZ, May 20, 2011.
27. **Halden, R. U.** Invited Talk: Public Health Engineering: From Problem Recognition to Regulation. Presented to the IGERT Program at the University of Minnesota, Minneapolis, MN, May 5, 2011.
28. **Halden, R. U.** Invited Talk: In Situ Microcosm Array and In Situ Sampling Technologies for Technology Transfer. ASU Biodesign Institute, April 21, 2011.
29. **Halden, R. U.** Invited Talk: Sustainable Chemistry & Human Health in the 21st Century. U.S. EPA Emerging Chemicals Workgroup. Presented on April 6, 2011.
30. **Halden, R. U.** Invited Talk at Leroy E. Burney Lecturer Series: Sustainable Chemistry and Human Health in the 21st Century, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, March 7, 2011.
31. **Halden, R. U.** Invited Talk at the U.S. Congress: Environmental Health Risks of Triclosan. Capitol Hill Congressional Briefing Room, Washington, DC, February 17, 2011.
32. **Halden, R. U.** and T. Jones-Lepp. Invited Session Chairs: Contaminants of Emerging Concern in the Natural and Built Environment. 241st American Chemical Society National Meeting & Exposition, Anaheim, California, March 27-31, 2011.
33. **Halden, R. U.** Invited Talk: In Situ Microcosm Array Technology and the SUMMIT Center. Arizona Department of the Environment, Phoenix, AZ, January 31, 2011.

34. **Halden, R. U.** Invited Talk: Sustainable Chemistry and Human Health, *The Wiseguide Seminar Series*, Scottsdale, AZ, November 19, 2010.
35. **Halden, R. U.** Invited Chalk Talk. Sustainable Chemistry for the 21st Century and Beyond. Center for Biological Physics Seminar Series, Arizona State University, Tempe, AZ, October 26, 2010.
36. **Halden, R. U.** Invited Presentation. Antimicrobial Personal Care Products: Are They Good for Us? Science Salon. Spirit of the Senses Seminar Series. Biodesign Institute, Arizona State University, Tempe, AZ, September 30, 2010.
37. **Halden, R. U.** Invited Presentation. The SUMMIT Project. CHiR-Arizona HealthQuery Stakeholder Meeting, ASU Biomedical Campus, Phoenix, AZ, September 20, 2010.
38. **Halden, R. U.:** Invited Seminar. Examining the Sustainability of Persistent Antimicrobial Compounds. Department of Chemical and Environmental Engineering, University of Arizona, Tucson, AZ, April 20, 2010.
39. **Halden, R. U.:** Parallel *In Situ* Screening of Remediation Strategies for Improved Decision Making, Remedial Design, and Cost Savings. Department of Defense, ESTCP Program, Arlington, VA, February 10, 2010.
40. **Halden, R. U.:** Chemicals of Emerging Concern in the U.S. Environment. American Chemical Society Meeting, Las Vegas, November 10, 2009.
41. **Halden, R. U.:** Wastewater Treatment Plants as Chemical Observatories of Persistent and Problematic Contaminants in the Environment. 238th American Chemical Society (ACS) National Meeting, Washington, DC, August 16-20, 2009.
42. **Halden, R. U.** and J. Katz: Occurrence, Fate, and Impact of Triclosan and Other Antimicrobials to Wastewater Treatment Utilities. Microconstituents and Industrial Water Quality, Water Environment Federation (WEF), Baltimore, MD, July 26-29, 2009.
43. **Halden, R. U.:** Invited Panel Member. "Superfund Contaminants: The Next Generation." Invitation-only Special Symposium Tucson, AZ, August 12-14, 2009.
44. **Halden, R. U.:** Invited Speaker. "State of the Science – Antimicrobial Resistance." FDA Discussion: the Problem of Triclosan, Food and Drug Administration, Washington, D.C., July 13, 2009.
45. **Halden, R. U.:** Invited Speaker. "State of the Science – Environmental Fate & Persistence." FDA Discussion: the Problem of Triclosan, Food and Drug Administration, Washington, D.C., July 13, 2009.
46. **Halden, R. U.:** Toward Sustainable Chemistry and Engineering. Invited Seminar presented at the 1st Biological Design Graduate Program Symposium, Tempe, May 6, 2009.
47. **Halden, R. U.** and E. Hartmann. Invited presentation: "Challenges of Detecting Bioterrorism Agents in Complex Matrices." NATO ARW Workshop on "Detection of Biological Agents and Toxins for the Prevention of Bioterrorism in Homeland Security by Advanced Mass Spectrometric Methods," Spezzano Albanese Terme, Italy, June 26-July 2, 2009.
48. **Halden, R. U.:** Invited Speaker. High-throughput Diagnostic Screening and Proteomics in Bioremediation - Opportunities & Challenges. The 19th Annual AEHS Meeting and West Coast Conference on Soils, Sediments, and Water. San Diego, CA, March 10, 2009.
49. **Halden, R. U.:** Invited Speaker. What's in Our Water? National Research Council 6th Workshop of the Standing Committee on Risk Analysis Issues and Reviews. Characterizing the Potential Human Toxicity from Low Doses of Pharmaceuticals in Drinking Water: Are New Risk Assessment Methods or Approaches Required? The National Academies, Washington, D.C., December 11-12, 2008.
50. **Halden, R. U.** and B. Anderson: SBRP Technology Transfer: Statistics & Case Study. Annual Conference of the Superfund Basic Research Program (SBRP) of the National Institute of Environmental Health Sciences. Member of Steering Committee and Invited Speaker of Technology Transfer Session, Pacific Grove, CA, December 7-9, 2008.

51. **Halden, R. U.:** Pharmaceuticals and Personal Care Products in U.S. Water Resources. Invited Keynote at the 2008 Fall Meeting of the Interstate Technology & Regulatory Council (ITRC). Phoenix, AZ, October 21, 2008.
52. **Halden, R. U.:** Invited Panel Member. Antibiotic Resistance: New Approaches to an Old Problem. The American Academy of Microbiology. Invitation-Only International Symposium, Annecy, France, October 12-14, 2008.
53. **Halden, R. U.:** Invited Speaker and Session Chair. Environmental Fate of Antimicrobials: 50 years in 15 minutes. Pacific Southwest Organic Residuals Symposium 2008. Sacramento, October 1-2, 2008.
54. **Halden, R. U.:** Parallel *In Situ* Screening of Remediation Strategies for Improved Decision Making, Remedial Design, and Cost Savings. Department of Defense, ESTCP Program, Arlington, VA, September 16, 2008.
55. **Halden, R. U.:** Occurrence of and Exposure Routes to Triclosan and Triclocarban in the U.S. Environment. State University of New York, Downstate Medical Center, Department of Preventive Medicine and Community Health Seminar, August 28, 2008.
56. **Halden, R. U.:** Work Plan for Field Deployment of the *In Situ* Microcosm Array Technology, Lawrence Livermore National Laboratory, Livermore, CA, July 11, 2008.
57. **Halden, R. U.:** Exposure Sources of Triclosan and Triclocarban in the Environment. Invited Talk at the Food and Drug Administration, Washington, DC, February 27, 2008.
58. **Halden, R. U.:** Field Deployment of the *In Situ* Microcosm Array Technology, Lawrence Livermore National Laboratory, Livermore, CA, February 25, 2008.
59. **Halden, R. U.:** Innovative Technologies. Session Moderator and Planning Committee Member, 20th Anniversary Meeting of the Superfund Basic Research Program, Durham, NC, December 3, 2007.
60. **Halden, R. U.:** Findings from the Johns Hopkins Nationwide Study on the Fate of Pharmaceuticals and Personal Care Products in the Environment. U.S. EPA, Office of Science and Technology, November 28, 2007.
61. **Halden, R. U.:** Forensic Tools for Environmental Assessment and Remediation. University of Delaware, Newark, DE, Department of Civil and Environmental Engineering, October 19, 2007.
62. **Halden, R. U.:** Keynote Speaker. Emerging Knowledge on Emerging Contaminants. New England Interstate Water Pollution Control Commission's (NEIWPCC) 2007 Northeast Water Science Forum – Pharmaceuticals and Personal Care Products: State of the Science Conference, Portland, ME, August 8–9, 2007.
63. **Halden, R. U.:** Guest Speaker. Risks and Benefits of Using Persistent Antimicrobials in Public Health Practice. Public Health Practice Grand Rounds, Live Webcast, MidAtlantic Public Health Training Center (MAPHTC), Baltimore, MD, June 20, 2007.
64. **Halden, R. U.** and K. J. Schwab: Guest Speaker. Environmental Issues Related to Industrial Food Animal Production. National Commission on Industrial Farm Animal Production. Denver, CO, June 5, 2007.
65. **Halden, R. U.:** Keynote Speaker. Antimicrobial Pesticides as Environmental Pollutants. Beyond Pesticides 25th National Pesticide Forum: "*New Opportunities for Protecting Health and the Environment*," Chicago, IL, June 2, 2007.
66. **Halden, R. U.:** Guest Speaker. Antimicrobial Pesticides in Aquatic Environments – Implications for the Great Lakes. Beyond Pesticides 25th National Pesticide Forum: "*New Opportunities for Protecting Health and the Environment*," Chicago, IL, June 3, 2007.
67. **Halden, R. U.:** Guest Speaker. Rachel Carson Open House and Centennial Celebration: "U.S. Environmental Quality 45 Years after the Publication of Silent Spring," Silver Spring, MD, May 19, 2007.
68. **Halden, R. U.:** Guest Speaker. USGS Symposium: Rachel Carson Centennial Celebration: "Considering the Microbial Loop in Wildlife Conservation," USGS Patuxent Wildlife Research Center, Laurel, MD, May 18, 2007.

69. **Halden, R. U.:** Guest Speaker & Session Moderator. Antimicrobial Agents in the Chesapeake Bay Watershed. Pesticides in Chesapeake Waterways: Working Group Meeting, Reisterstown, MD, May 14, 2007.
70. **Halden, R. U.:** Guest Speaker. Emerging Contaminants in U.S. Surface Waters: Challenges and Potential Solutions. Potomac River Basin Drinking Water Source Protection Partnership's Mini-Workshop. Rockville, MD, May 7, 2007.
71. **Halden, R. U.:** Moderator of Film Screening and Invited Discussant. Lifecycle Analysis of Polyvinyl Chloride Products. Chesapeake Sustainable Business Alliance, Visionary Arts Museum, Baltimore, MD, March 19, 2007.
72. **Halden, R. U.:** Keynote Speaker. Antimicrobial Agents in the Environment and Human Exposure Assessment. Chesapeake Potomac Chapter of SETAC Winter Meeting, Washington, DC, February 22, 2007.
73. **Halden, R. U.:** Panel Chair and Keynote Speaker. Reducing Our Ecological Footprint. 10th Anniversary of the Johns Hopkins Center for a Livable Future – Charting A Course To Sustainability Through Research, Education And Service, Baltimore, MD, December 6, 2006.
74. **Halden, R. U.:** Overused Household Biocides Cause Nationwide Pollution. 10th Anniversary of the Johns Hopkins Center for a Livable Future – Charting A Course To Sustainability Through Research, Education And Service, Baltimore, MD, December 6, 2006.
75. **Halden, R. U.:** Persistent Antimicrobials as Emerging Endocrine Disrupting Chemicals in U.S. Water Resources, Biosolids and Sediments. Endocrine Disruptors – What We Know & What We Don't Know. Research Symposium of the Mid-Atlantic Regional Water Program, A Partnership of USDA CSREES & Land Grant Colleges and Universities, Frederick, MD, November 16, 2006.
76. **Halden, R. U.:** Environmental Routes of Human Exposure to Persistent Antimicrobial Compounds – A Human Exposure Assessment. Municipal Institute of Medical Research, Barcelona, Spain, November 3, 2006.
77. **Halden, R. U.:** Environmental Toxins. 44th Annual New Horizons in Science Briefing, sponsored by the Council for the Advancement of Science Writing, hosted by The Johns Hopkins University, Baltimore, MD, October 30, 2006. <http://www.jhu.edu/newhorizons/>
78. **Halden, R. U.:** Persistent Antimicrobial Compounds in the Environment – A Human Health Concern? Christine Mirzayan Science and Technology Policy Graduate Fellowship Program at the National Academies—National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research, Washington, DC, October 25, 2006.
79. **Halden, R. U.:** Contemporary Technologies for Combating Emerging Contaminants. Biodesign Institute, Center for Environmental Biotechnology. Tempe, AZ, October 12, 2006.
80. **Halden, R. U.:** In Situ Microcosm Array (ISMA) Technology for Environmental Monitoring and Toxicity Testing. U.S. Army Invitation-Only Symposium, Massachusetts Institute of Technology. Boston, MA, September 15, 2006.
81. **Halden, R. U.:** Novel Approaches in Environmental Biotechnology. Arizona State University. Tempe, AZ, August 16, 2006.
82. **Halden, R. U.:** Use of Proteomics and In Situ Microcosm Arrays in Environmental Biotechnology. BIO 2006. Annual International Convention. Environmental Biotechnology Session. Chicago, IL, April 9-12, 2006.
83. **Halden, R. U.:** Study on Consumer Products and Pharmaceuticals in the Environment. The Mid-Atlantic States Section of the Air & Waste Management Association (MASS-A&WMA), New Brunswick, NJ, April 6, 2006.
84. **Halden, R. U.:** Environmental Fate of Persistent Antiseptic Compounds. Southern Nevada Water Authority. Las Vegas, NV, February 9, 2006.
85. **Halden, R. U.:** A Novel Tool in Environmental Restoration: Proteomics-enabled In Situ Microcosm Array. Lawrence Livermore National Laboratory, CA, February 6, 2006.
86. **Halden, R. U.:** Fate of Persistent Antimicrobials in the Environment: From Germ Killers to Culinary Curiosities. Colorado School of Mines, Golden, CO, December 14, 2005.

87. **Halden, R. U.:** Environmental Exposure to Persistent Antimicrobial Compounds – A Human Health Concern? Municipal Institute of Medical Research, Barcelona, Spain, November 18, 2005.
88. **Halden, R. U.:** Through a Glass Safely: How Healthy is Our Drinking Water? A Woman's Journey—Johns Hopkins Premier Woman's Health Conference, Baltimore, MD, November 12, 2005.
89. **Halden, R. U.:** Sources, Occurrences, and Fate of Pharmaceuticals and Personal Care Products in the Environment. Public Health Risk Assessment Workshop. Harvard School of Public Health, Boston, MA, November 10, 2005.
90. **Halden, R. U.:** Screening of Groundwater Remediation Technologies Using In Situ Microcosm Arrays. Presenter and Chair of Groundwater Remediation Session. International Conference on Safe Water: Exploring Global Demands and Impact of Natural Disasters, San Diego, CA, October 21, 2005.
91. **Halden, R. U.:** Secondary Routes of Exposure to Biocides. Food And Drug Administration, Center For Drug Evaluation And Research (CDER) Nonprescription Drugs Advisory Committee. "Benefits and Hazards of Antiseptic Products Marketed for Consumer Use." Silver Spring, MD, October 20, 2005.
92. **Halden, R. U.:** Use of Proteomics in Bioremediation. The 21st Annual International Conference on Soils, Sediments, and Water. University of Massachusetts, Amherst, MA, October 18, 2005.
93. **Halden, R. U.:** Measuring Antibacterial Agents in Biosolids and Predicting Their Environmental Fate. Mid-Atlantic Biosolids Association Research Symposium, Washington, DC, September 28, 2005.
94. **Halden, R. U.:** Proteomics in Bioremediation: Opportunities and Challenges. University of Maryland, Department of Chemistry and Biochemistry. College Park, MD, September 9, 2005.
95. **Halden, R. U.:** Potential Application of Proteomics. DoD SERDP/ESTCP Molecular Biological Tools Workshop, Charlottesville, VA, August 9, 2005.
96. **Halden, R. U.:** Fate of Personal Care Products During Wastewater Treatment. 35th Annual Joint Conference and Exhibition. The Chesapeake Water Environment Association and the Waters and Waste Operators Association of Maryland, Delaware and the District of Columbia, Ocean City, MD, July 8, 2005.
97. **Halden, R. U.:** Use of Proteomic Mass Spectrometry and Bioinformatics for the Identification of Environmental Microorganisms. U.S. Department of Agriculture, Beltsville, MD, June 27, 2005.
98. **Halden, R. U.:** ISMA – A Platform Technology with Biomedical Applications. Johns Hopkins University, School of Medicine. Alliance for Science and Technology. Spring 2005 Meeting. April 12, 2005.
99. **Halden, R. U.:** Fate of Polychlorinated Antimicrobial Compounds in the U.S. Environment. U.S. Headquarters of the Soap and Detergent Association (SDA), Washington, D.C., March 29, 2005.
100. **Halden, R. U.:** Polychlorinated Antimicrobials as Indicators of Sewage Spills. Presented at the American Chemical Society Meeting, Maryland Chapter, Baltimore, MD, February 23, 2005.
101. **Halden, R. U.:** Triclocarban: A New Contaminant in Baltimore Streams. Maryland State Water Quality Advisory Committee (SWQAC), Baltimore, MD, December 3, 2004.
102. **Halden, R. U.:** Pharmaceuticals and Personal Care Products as Indicators of Sewage Spills. Presenter and Panelist at the Maryland Water Monitoring Council 10th Annual Conference, Linthicum, MD, November 18, (2004).
<http://mddnr.chesapeakebay.net/MWMC/pub/MWMC10conf.pdf>.
103. **Halden, R. U.:** Antimicrobials Signal High Levels of Pathogens in Baltimore Streams. Herring Run Watershed Association Annual Meeting, Baltimore, MD, November 16, 2004.
104. **Halden, R. U.:** Invited Discussant for Seminar by Dr. Leigh English, Director of the Monsanto Protein Science Team, titled: Genetically Modified Crops: A Jelly Donut of Social Issues Surrounded by Technical Explanations. Institute for Global Studies in Culture, Power and History; Fall Seminar Series: Feeding the World: Ethical, Moral, Legal and Scientific Dimensions, Baltimore, MD, November 11, 2004.

105. **Halden, R. U.:** JHU Center for Water and Health On-going Research. Chesapeake Bay Foundation Research Retreat, Port Isobel, VA, October 3, 2004.
106. **Halden, R. U.:** The Johns Hopkins University Center for Water and Health Nationwide Study on the Fate of Pharmaceuticals and Personal Care Products in the Environment – Preliminary Results for the State of Maryland. Johns Hopkins University, Baltimore, MD, September 21, 2004.
107. **Halden, R. U.:** Pharmaceuticals and Personal Care Products in the Environment. Chesapeake Biological Laboratory, University of Maryland, Solomon, MD, September 9, 2004.
108. **Halden, R. U.:** Leaky Pipes and Cross-Contamination – Is Baltimore’s Aging Sewer System a Threat to Public Health? Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, August 13, 2004.
109. **Halden, R. U.:** Chemical Analysis and Treatment of Perchlorate. Aberdeen Proving Ground, MD, July 23, 2002.
110. **Halden, R. U.:** Aberdeen Proving Grounds Environmental Research. National Defense Industrial Association TACOM – ARDEC Technical Symposium, Rockaway, NJ, April 10, 2002.
111. **Halden, R. U.:** Pharmaceuticals in U.S. Streams – A Public Health Concern? Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, March 27, 2002.
112. **Halden, R. U.:** Microcontaminants in Food and Water. Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, March 12, 2002.
113. **Halden, R. U.:** Toxins as Modifiers of Human Vulnerability to Disease. University of Pennsylvania, 2002 Health-Environment Symposium, Hershey, PA, March 7, 2002.
114. **Halden, R. U.:** Bioremediation: From Pure Culture to the Dirty Reality. Johns Hopkins University, Department of Geography and Environmental Engineering, Baltimore, MD, October 23, 2001.
115. **Halden, R. U.:** From Cloning to Cleaning: Bioremediation in the Real World. University of Maryland Biotechnology Institute – Center of Marine Biotechnology, Baltimore, MD, September 26, 2001.
116. **Halden, R. U.:** Detection and Bioremediation of Fuel Oxygenates, Perchlorate and Trichloroethene. University of Minnesota, School of Public Health, Minneapolis, MN, August 21, 2001.
117. **Halden, R. U.:** Detection and Destruction of Anthropogenic Toxins in Drinking Water Resources. University of California at Berkeley, Center for Environmental Biotechnology Video-taped Lecture Series, Berkeley, CA, March 6, 2001.
118. **Halden, R. U.:** Detection and Destruction of Anthropogenic Toxins in Drinking Water Resources. Johns Hopkins University, Department of Environmental Health Sciences, October 15, 2000.
119. **Halden, R. U.:** Analytical Methods for the Detection of Oxygenates in Ground Water. United States Environmental Protection Agency, MTBE Scientist-to-Scientist Meeting, Argonne National Laboratory, Argonne, IL, June 20, 2000.
120. **Halden, R. U.:** ASTD Deployment of Bioremediation and Natural Attenuation at the Building 834 Complex at Site 300. Lawrence Livermore National Laboratory, Subcon Focus Area Meeting, Livermore, CA, October 9, 2000.
121. **Halden, R. U.:** The Building 834 Study Area at Site 300, CA. Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, September 9, 1999.
122. **Halden, R. U.:** Where Did that TCE End Up? – Refining the Conceptual Model for Contaminant Fate at LLNL’s Site 300, Building 834. Oregon State University, Department of Civil Engineering, Corvallis, OR, February 5, 1999.
123. **Halden, R. U.:** Engineered In Situ Biodegradation of Dioxins – Do Laboratory Bacteria Function in the Real World? University of Florida at Gainesville, Department of Environmental Engineering Sciences, Gainesville, FL, March 4, 1997.
124. **Halden, R. U.:** Engineered In Situ Biodegradation of Dioxins. Lawrence Livermore National Laboratory, Environmental Protection Department, Livermore, CA, January 16, 1997.

SPONSORED RESEARCH

Halden (0% Effort) In Situ Delivery of Remediation Agents Chevron. Role: PI. (60% Recognition)	04/15/2014 – 01/15/2014 \$38,725
Halden (5% Effort) Thermal <i>In Situ</i> Remediation of Weathered Heavy Hydrocarbons Chevron. Role: PI. (100% Recognition)	01/1/2014 – 12/31/2014 \$75,000
Halden (10% Effort) NIEHS-R01 1R01ES020889 In Situ Sampling Tool for Assessing Bioavailability and Toxicity of Sediments This Project Explores the Bioavailability of Traditional and Emerging Contaminants Role: PI. (100% Recognition)	09/20/2011 – 07/31/2014 \$830,943
DoD ESTCP Project 201122 Halden (16.6% Effort) Cost-effective, Ultra-sensitive Groundwater Monitoring for Site Remediation and Management Role: Sole PI. (100% Recognition)	03/01/2011 – 2/28/2014 \$1,151,152
Halden (0% Effort) Arizona Technology Enterprises (AzTE) The ASU Catalyst Fund Role: PI. (100% Recognition)	06/1/2013 – 05/30/2014 \$25,000
Halden (0% Effort) NIEHS-R01 Supplement 3R01ES020889-03S1 <i>In Situ</i> Sampling / Bioavailability Assessment (IS2B) Tool Addressing Remediation Market Needs This Project Supports the Development for Commercial Application of a Small Sampling Device Role: PI. (100% Recognition)	08/1/2013 – 07/31/2014 \$42,597
Salt River Project (SRP) Halden (8.3% Effort) In Situ Bioremediation – An Innovative Approach for Elevated Chlorinated Volatile Organic Compounds in Groundwater Role: Sole PI. (100% Recognition)	01/01/2013 – 06/30/2014 \$60,000
Halden (10% Effort) Piper Charitable Trust Center for Environmental Security/AZ Public Health Observatory Role: PI. (100% Recognition)	06/1/2012 – 05/30/2015 \$450,000
Halden (0% Effort) AZ Board of Regents Planning, Development and Implementation of a State-wide Research Initiative in Environmental Informatics: “Arizona Environmental Grid Infrastructure Service (AEGIS)” Role: ASU-PI. (PD: Petuskey)	5/24/2013 – 11/23/2014 \$40,000 subcontract of \$450K Total
Halden (0% Effort) TRIF Biodesign Mass Spectrometry Recharge Facility Trial Run Role: PI. (0% Recognition)	01/1/2013 – 12/30/2013 \$60,000

Halden (0% Effort) NASA 2012-T72247 Analysis of Hormones, Steroids, Pharmaceuticals, and Personal Care Products in Water, Wastewater and Preserved Urine Samples Role: PI. (100% Recognition)	03/1/2012 – 02/28/2013 \$15,000
WRF Water Research Foundation (PI: Westerhoff, Co-PI: Halden, 8.3% Effort) Constructed Wetlands for Treatment of Organic and Nanomaterial Pollutants. The major goal of this project is to develop design criteria for constructed wetlands for removal of emerging contaminants. Role: Co-PI (30% Recognition or \$100,200)	9/30/2010 – 8/31/2012 \$334,000 (\$84,000 match. funds)
NIH-NIEHS-RC2 1RC2ES018801-01 (PI: Westerhoff; Co-PI: Halden, Herckes, Hristovski) Detection of Engineered Nanomaterials in Drinking Water, Food, Commercial Products and Biological Samples. The major goal of this project is to develop and validate analytical methods for the determination of nanomaterials in environmental and biological samples. Role: Co-PI (28% Recognition or \$355,144; 8.3% Effort)	9/30/2009 – 7/31/2011 \$1,268,370
Halden (0% Effort; PI: B. Bakkaloglu) ASU Grand Challenges Seed Funding Research Center for Integrated Sub-mm Environmental & Molecular Sensors (iSEMS)™ Role: Co-PI. (15% Recognition)	01/01/2011 – 12/31/2011 \$100,000
Halden (16.6% Effort) DoD ESTCP ER-200914 Parallel In Situ Screening of Remediation Strategies for Improved Decision Making, Remedial Design, and Cost Savings. Role: Sole PI. (100% Recognition)	03/01/2009 – 12/31/2013 \$1,060,125
Halden (16.6% Effort) Biocides in the U.S. Environment. Role: Sole PI. (100% Recognition)	02/01/2008 – 12/31/2011 \$373,031
Halden (0% Effort) Anonymous Gift, JHU Hopkins Graduate Student Initiative Role: Sole PI. (100% Recognition)	02/01/2008 – 12/31/2011 \$131,468
Halden (0% Effort) NIEHS-R01 3R01ES015445-04W1 Cooperative Supplement to: Novel Approaches to Studying the In Situ Bioremediation Potential of Complex Mixtures Detection of Triclocarban in Human Specimens. Role: Sole PI at ASU. (100% Recognition)	08/12/2009 – 07/31/2012 \$228,164
Halden (0% Effort) NIEHS-R01 3R01ES015445-04S-TT Technology Transfer Supplement to: Novel Approaches to Studying the In Situ Bioremediation Potential of Complex Mixtures Development of a Nutrient Injection Unit for the In Situ Microcosm Array.	08/12/2009 – 07/21/2012

Role: Sole PI. (100% Recognition)	\$152,843
Halden (0% Effort) NIEHS-R01 1R01ES015445S Supplement to: Novel Approaches to Studying the In Situ Bioremediation Potential of Complex Mixtures Evaluation of In Situ Microcosms Arrays for the Study of Chemical Mixtures in Contaminated Environments.	09/28/2009 – 09/27/2012
Role: Sole PI. (100% Recognition)	\$109,375
Halden (16.6% Effort) NIEHS-R01 1R01ES015445 Novel Approaches to Studying the In Situ Bioremediation Potential of Complex Mixtures Evaluation of In Situ Microcosms Arrays for the Study of Chemical Mixtures in Contaminated Environments.	09/28/2006 – 07/31/2012
Role: Sole PI. (100% Recognition)	\$624,261
Halden (8.3% Effort) Central Arizona Project (PI: Westerhoff, Co-PI: Halden and Herckes) Enhancement Project by Central Arizona Project (CAP): Regional Water Quality Monitoring and Evaluation for the Metropolitan-Phoenix Area Water Supply.	01/01/2008 – 04/30/2009
Role: Co-PI. (25% Recognition or \$7,500)	\$30,000
Halden (0% Effort) City of Phoenix Planning Dept. (PI: Westerhoff, Co-PI: Halden and Herckes) Regional Water Quality Monitoring and Evaluation for the Metropolitan-Phoenix Area Water Supply.	07/01/2007 – 06/30/2010
Role: Co-PI. (0% Recognition)	\$155,250
Salt River Project (SRP) Halden (8.3% Effort) In Situ Bioremediation – An Innovative Approach for Elevated Chlorinated Volatile Organic Compounds in Groundwater	06/01/2011 – 5/30/2012
Role: Sole PI. (100% Recognition)	\$75,000
Halden (0% Effort) DOE BER Genome Sequencing Program Genome Sequencing of the Dioxin-Mineralizing Bacterium <i>Sphingomonas wittichii</i> RW1 Sequencing and Annotation of the Genome of a Dioxin-Metabolizing Bacterium.	01/01/2007 – 12/31/2009 Free Genome Sequencing
Role: Sole PI. (100% Recognition)	~\$100,000
Halden (PI: Ketner) JHSPH-Faculty Research Initiative Proteomic Approach to Understanding Viral Infection and Pathogenesis Elucidation of viral infection mechanisms and identification of intervention strategies.	03/01/2007 – 2/28/2009
Role: Co-PI. (50% Recognition or \$17,500)	\$35,000
Halden (PI: Schwab; Co-PI: Halden, Graczyk) R83300201 U.S. EPA Science to Achieve Results (STAR) Program Quantitative Assessment of Pathogens in Drinking Water Development and Evaluation of Novel Methods for the Detection of Emerging Waterborne Pathogens.	04/01/2006 – 12/31/2008
Role: Co-PI. (30% Recognition or \$180,000)	\$600,000
Halden (PI: Lawrence; Co-PI: Silbergeld, Schwab, Halden)	10/01/2005 - 12/31/2007

The Pew Charitable Trusts
National Commission on Industrial Farm Animal Production
A Collaboration Was Formed Between The Pew Charitable Trusts and the Johns Hopkins Bloomberg School of Public Health to Investigate and Summarize in a Report, Issues of Environmental Quality, Public Health, and Ethics Linked to Concentrated Animal Feeding Operations (CAFOs) in the United States.
Role: Co-I. (20% Recognition or \$84,600) \$423,000 (JHU of \$2.4M total)

Halden 10/01/2005 – 09/30/2006
State of Maryland TEDCO
Supporting Funds for International Patent Rights to a Hopkins' Technology (International Patent Application PCT WO 2004/081530).
Role: Sole PI. (100% Recognition) \$10,000

Halden (PI: Goldman) 10/01/2005 – 09/30/2006
JHU-Center for a Livable Future Pilot Project
Exposures to Persistent Contaminants in Food and Fetal Growth and Development.
Determination of Potential Linkages Between Fetal Exposure to Polybrominated Flame Retardants / Perfluorinated Organic Compounds and Adverse Health Outcomes.
Role: Co-I. (10% Recognition) \$20,000

Halden 01/01/2005 – 06/30/2007
JHSPH-Faculty Research Initiative
Carcinogens in Biosolids as Determinants of Human Morbidity and Mortality
Creation of a Nationwide Repository and Database for Application of Municipal Sludge (Biosolids) in Agriculture.
Role: PI. (100% Recognition) \$50,000

Halden 01/1/2006 – 07/30/2006
JHU-NIOSH ERC Pilot Project
Application of Proteomics for the Development of Biomarkers of Occupational Exposure
Proteomic Analysis of Baltimore Cord Blood Serum Samples for the Discovery of Protein Biomarkers of Exposure to Toxic Occupational Contaminants.
Role: Sole PI and Advisor. (100% Recognition) \$14,995

Halden 9/1/2004 – 8/31/2005
JHU-Center for a Livable Future Pilot Project
Municipal Sludge Disposal and Sustainable Agriculture – A Pilot Study Showcasing the Challenge of Combining the Two
Explore the Fate of Persistent Antimicrobial Compounds in Municipal Sludge and Their Potential Uptake into Agricultural Plants as a Pathway for Human Exposure to Carcinogens. Role: Sole PI. (100% Recognition) \$20,000

Halden 06/01/2004 – 05/30/2005
CRF—Maryland Cigarette Restitution Fund
(Matching Funds by the CDC; PI: Needham)
Human Fetal Exposure to Drinking Water Carcinogens in Maryland
Creation and Analysis of a Cord Blood/Cord Tissue Repository and Determination of Fetal Exposure Levels to Carcinogens in Maryland Drinking Water Resources and Water Supply. Role: Sole PI. (100% Recognition) \$150,000

Halden 06/01/2004 – 05/30/2005

CDC—Centers for Disease Control and Prevention (Matching Funds for CRF Study; PI: Needham) Human Fetal Exposure to Drinking Water Carcinogens in Maryland Creation and Analysis of a Cord Blood/Cord Tissue Repository and Determination of Fetal Exposure Levels to Carcinogens in Maryland Drinking Water Resources and Water Supply. Role: Sole PI of Parent Grant. (10% Recognition)	\$250,000
Halden (PI: Buckley; Co-PI: Halden) CRF—Maryland Cigarette Restitution Fund Statistical Analysis of Drinking Water Quality vis-à-vis Cancer Morbidity and Mortality Geospatial Analysis to Identify Potential Links Between Drinking Water Quality and Cancer Morbidity and Mortality in the State of Maryland. Role: Co-PI. (50% Recognition or \$10,000)	11/1/2004 – 10/30/2005 \$20,000
Halden JHSPH—Technology Transfer Seed Grant Production and Testing of an In Situ Microcosm Array Prototype Design, Construction and Initial Testing of an Innovative Environmental Monitoring Device. Role: Sole PI. (100% Recognition)	11/1/2003 – 10/31/2004 \$25,000
Halden JHU-Center for a Livable Future Pilot Project Mass Spectrometric Determination of Microbial Pathogens in Waste Streams of Explore the Use of Mass Spectrometry for Detecting the Bacteriophage MS2 as an Indicator of Microbial Pathogens Originating from Concentrated Animal Feeding Operations. Role: Sole PI, Advisor. (100% Recognition)	9/1/2003 – 8/31/2004 \$20,000
Halden JHU-Center for a Livable Future Pilot Project Effect of Lifestyle on Mother/Infant Exposure to Ubiquitous Pollutants Determine Whether Exposure to Polyfluorinated Environmental Contaminants is Associated with Lifestyle Choices. (100% Recognition) Role: Sole PI.	10/1/2003 – 9/30/2004 \$20,000
Halden JHU-CLF Pre-doctoral Fellowship/Mentor Award Proteomic Approach to Monitoring Microbes in Waste Streams from Animal Production Facilities Explore the Use of Mass Spectrometry for Detecting Viruses and Bacterial Pathogens in Samples from Concentrated Animal Feeding Operations Using MALDI-TOF MS, Nanospray ESI-MS/MS, and AP-MALDI and ESI-IT-MS Techniques. Role: Sole PI and Advisor. (100% Recognition)	10/1/2003 – 8/31/2005 \$99,000
Halden JHU-CLF Donor's Gift (No Title) Environmental Fate of Persistent Personal Care Products. Role: Sole PI. (100% Recognition)	7/1/2003 – 12/31/2003 \$3,000
Halden JHSPH—Technology Transfer Seed Grant Down-Well Diagnostic Device for Environmental Monitoring and Bioprospecting Conceptually Develop and Refine Plans for a Novel Environmental Monitoring Device Amenable to Automated, High-throughput Analysis Using Genomic and Proteomic Analyses. Role: Sole PI. (100% Recognition)	3/1/2003 – 2/28/2004 \$25,000

Halden JHU-NIOSH Education and Research Center Grant LC-MS Analysis of a Urinary Biomarker of Occupational Exposure to PAHs Detection of a Urinary PAH Biomarker in Human Specimens Targeting the Underivatized Conjugate. Role: Sole PI. (100% Recognition)	10/1/2003 – 9/30/2004 \$9,000
Halden Donor's Gift (No Title) In Support of Technology Transfer Activities Directed Toward a Down-Well Diagnostic Device for Environmental Monitoring and Bioprospecting (International Patent Application PCT WO 2004/081530). Role: Sole PI. (100% Recognition)	06/01/2004 – 05/30/2005 \$20,000
Halden JHU-Center for a Livable Future Pilot Project Bioaccumulation of Methyl Triclosan in Agriculturally Applied Sewage Sludge and in Breast Milk Trace Analysis of Biocides in Municipal Sludge and Human Milk. Role: Sole PI. (100% Recognition)	10/1/2002 – 6/30/2003 \$17,500
Halden JHU-NIEHS Center Pilot Project; P30ES03819 Development of an Exposure Assessment Tool for the Biocide Triclosan Development an LC-MS Technique Suitable for Trace Analysis of the Biocides. Role: Sole PI. (100% Recognition)	6/1/2002 – 5/30/2003 \$15,000
Halden JHU-Center for a Livable Future Internship/Mentoring Award Sponsored Research Internship in Environmental Health Sciences Provide Laboratory Study Opportunities for an Undergraduate Student. Role: Sole PI; Student Advisor. (100% Recognition)	7/1/2002 – 9/30/2002 \$4,000
Halden JHSPH—Faculty Innovation Award Environmental Sources, Occurrence and Biodegradation of the Biocide Triclosan Pilot Study Designed to Explore the Extent of Environmental Contamination with the Biocide Triclosan. Role: Sole PI. (100% Recognition)	5/1/2002 – 6/30/2003 \$30,000
Halden Bechtel BWXT Idaho, LLC, Research Contract Determination of the Microbial Community Structure at a Trichloroethene-Contaminated Area at Site 300, CA, in Support of a Proposed In Situ Bioremediation Deployment Use Non-culture-dependent Techniques to Determine the Impact of Chlororethenes on the Microbial Community of a Polluted Aquifer. Role: Sole PI (100% Recognition)	2/12/2002 – 12/31/2002 \$57,500
Halden Shimadzu Corp. Instrumentation Grant (No Title) Improve Laboratory Instrumentation Infrastructure for Trace Analysis of Environmental Toxicants. Role: Sole PI. (100% Recognition)	7/1/2001 – 6/30/2002 \$56,000
Halden (PI: Naples; Co-PI: Shiff, Halden)	11/1/2003 – 10/31/2004

JHSPH—Technology Transfer Seed Grant

A Product for the Detection and Focal Control of Schistosome Cercariae to Reduce Disease Burden and Cercariae Dermatitis, Both in Endemic Areas, and in U.S. Lacustrine Habitats

Explore the Use of Natural Essential Oils for the Control of Cercariae in Surface Waters. Role: Co-PI. (25% Recognition or \$6,250) \$25,000

Halden (PI: Lowe; Co-PI: Halden) 2/12/2002 – 12/31/2002

DOE—NABIR Research Grant (DE-FG02-01ER63264)

Development of a Multiplexed, Bead-based Assessment Tool for Rapid Identification and Development of Novel Diagnostic Tool for Microbial Community Analysis at Contaminated Subsurface Sites.

Role: Co-PI. (30% Recognition or \$19,444) \$64,812

Halden (Project Director: Rice) 10/1/2000 – 9/30/2001

LLNL Work-In-the-Public-Interest Grant

Dioxins in San Francisco Bay

Determine Potential Avenues for Reducing Environmental Contamination with Dioxin-like Compounds.

Role: PI (20% Recognition or \$26,000) \$130,000

Halden (PI: Happel) 10/1/2000 – 9/30/2001

DOE—Fossil Fuel Research Project

Detection and Biodegradation of MTBE from Leaking Underground Storage Tanks

Determine the Bioremediation Potential of LUFT Sites.

Role: Co-PI. (10% Recognition or \$5,000) \$50,000

TEACHING

Graduate Students Supervised

Ph.D. Students

1. Sung-Roul Kim (Ph.D.) Environmental Health Sciences, Johns Hopkins. “Assessment of Urban Air Pollution Exposure Among New Mothers and Nursing Infants and Internal Dose Measured in Breast Milk” (2006). (Committee member)
2. Tanya Oxenberg (Ph.D.) Environmental Engineering, Hopkins. “Subsurface Transformation of Depleted Uranium at Aberdeen Proving Ground, Maryland” (2006). (Co-Advisor)
3. David R. Colquhoun (Ph.D.) Environmental Health Sciences, Johns Hopkins. “Public Health Applications of Quantitative Protein Biomarkers” (2007). (Chairman)
4. Jochen Heidler (Ph.D.) Environmental Health Sciences, Johns Hopkins. (Chairman) “Environmental Fate of Persistent Biocides and Human Exposure” (2007).
5. Talia E. A. Chalew (Ph.D.) Environmental Health Sciences, Johns Hopkins. (Expected 2011).” (Past Advisor)
6. Kristin McClellan (Ph.D.) Environmental Engineering, ASU. “A New Approach to Groundwater Remediation Treatability Studies – Moving Flow-through Column Experiments from Laboratory to *In Situ* Operation” (8/2008 – 4/3/2013). (Chairman)
7. Erica M. Hartmann (Ph.D.) Biological Design, ASU. “Application of Proteomic Mass Spectrometry in Bioremediation” (8/2008 – 6/2012). (Chairman)
8. Tomasz Kalinowski (Ph.D.) Biological Design, ASU. “Technical, Economical and Social Aspects of Moving Treatability Studies for the *In Situ* Bioremediation of Contaminated Aquifers from the Laboratory to the Field” (8/2008 – 4/4/2013). (Chairman)
9. Thomas Bruton (Ph.D.) Environmental Engineering, ASU. “Use of Nano Zerovalent Iron in Groundwater Remediation” (2009 - 2012). (Transferred to UC Berkeley)

10. Arjun K. Venkatesan (Ph.D.) Environmental Engineering, ASU. "Contaminants of Emerging Concern in U.S. Sewage Sludges and Forecasting of Associated Ecological and Human Health Risks Using Sewage Epidemiology Approaches" (8/1/2010 - 11/14/2013). (Chairman)
11. Isaac Roll (Ph.D.) Environmental Engineering, ASU. "Novel Tools for Environmental Analysis of Trace Contaminants at Ultra-low Detection Limits" (Expected 2014). (Chairman)
12. Samuel Supowit (Ph.D.) Environmental Engineering, ASU. "Application of and Active Sampling Device for Bioavailability Assessment of Contaminants in Sediment." (Expected 2014). (Chairman)
13. Hansa Done (Ph.D.) Biological Design, ASU. "Antibiotics and Antibiotic Resistant Microbes in U.S. Seafood." (Expected 2016). (Chairman)
14. Alizee Jenck (Ph.D.) Environmental Engineering, ASU. "Application of MALDI-TOF/TOF Mass Spectrometry to Environmental Health Monitoring." (Expected 2016). (Chairman)
15. Maurissa Charles (Ph.D.) Environmental Engineering, ASU. "Application of the In Situ Microcosm Array Technology to Environmental Remediation." (Expected 2016). (Chairman)
16. Burcu Yavuz (Ph.D.) Environmental Engineering, ASU. "To Be Determined (Expected 2017). (Chairman)
17. Erin Driver (Ph.D.) Environmental Engineering, ASU. "To Be Determined." (Expected 2017). (Chairman)
18. Jing Chen (Ph.D.) Biological Design, ASU. "To Be Determined." (Expected 2017). (Chairman)
19. Justin Kidd (Ph.D.) ASU "To Be Determined." (Expected 2018). (Chairman)

M.S., M.S.E, and M.P.H. Students

20. Sharri Hollist (M.P.H.) Public Health, Hopkins. "Incidence of Illness Associated with Recreational Water Contact: Determining and Evaluating a Potential Public Health Problem" (2005). (Capstone Advisor)
21. Toni Nunes (M.P.H.) Public Health, Hopkins. "Pesticides in Ground and Surface Waters of the Chesapeake Bay Watershed: Occurrence, Risks and Potential Solutions" (2007). (Capstone Advisor)
22. Christopher von Seggern (M.P.H.) Public Health, Hopkins. "Biodetection Utilizing Matrix-assisted Laser Desorption/Ionization Mass Spectrometry" (2005). (Capstone Advisor)
23. Meredith Lewis (M.S.E.) Environmental Engineering, ASU. (2009).
24. Guozheng Li (M.S.) Biological Design, ASU (2011).
25. Alison D. Fox (M.S.) Technology (Environmental Management), ASU. "Use of Passive Sampling Devices for Determination of Contaminants in Sewage Sludge" (2010 - 2012). (Graduate Advisor)
26. Sara Carey (M.S.) Environmental Engineering, ASU. "Policy Solutions for Limiting Environmental Release of Persistent, Bioaccumulative and Toxic Compounds." (2012). (Temporary Advisor)
27. Bipin Chari (M.S.) Environmental Engineering, ASU. "Analysis and Modeling of Residual Compounds in Process Streams From U.S. Wastewater Treatment Plants" (4/12/2012). (Thesis Advisor)

Other Graduate Students

28. Peter D'Amato (Ph.D.) Environmental Engineering, Hopkins. "Biodegradation of Polycyclic Aromatic Hydrocarbons" (2003). (Committee Member)
29. Denise Taylor (Ph.D.) Environmental Engineering, Hopkins (2003). (Committee Member)
30. Amir Sapkota (Ph.D.) Environmental Health Sciences, Hopkins (2004). (Committee Member)

31. Kristen Malecki Chossek (Ph.D.) Health Policy and Management, Hopkins (2005). (Committee Member)
32. Michelle Hladik (Ph.D.) Environmental Engineering, Hopkins (2005). (Committee Member)
33. Henry Schuver (Dr.P.H.) Epidemiology, Hopkins (2007). (Committee Member)
34. Ying Yao (M.S.) Environmental Engineering, ASU. (2009). "Development of a Novel Dechlorinating Culture" (2009). (Committee Member)
35. Ed Hilyard (Ph.D.) Marine Biotechnology, University of Maryland, (Expected 2010) (Committee Member 2005-2009)
36. Liang Chen (M.S.) Environmental Engineering, ASU. (2009). (Committee Member)
37. John Schloendorn (Ph.D.) Molecular and Cellular Biology, ASU. "Progress Towards Medical Bioremediation by Enzymatic Transformation of 7-Ketocholesterol and the Pyridinium Bisretinoid A2e" (2009). (Committee Member)
38. Katherine Muto (M.S.) Environmental Engineering, ASU. (2010). (Committee Member)
39. Prathap Parameswaran (Ph.D.) Environmental Engineering, ASU. (2010). (Committee Member)
40. Youneng Tang (Ph.D.) Environmental Engineering, ASU. Biofilm Reduction of Oxidized Contaminants" (2/19/2011). (Committee Member)

Postdoctoral Researchers

41. Guibo Xie (10/2001 – 06/2003)
42. Wenming Dong (2002) (Currently: Staff Scientist, U.S. National Laboratory)
43. Mark P. Franklin (04/2002 – 12/2003)
44. Eric S. Wisniewski (06/2003 – 08/2003) (Currently: Staff Scientist, U.S. Government)
45. Amir Sapkota (11/2004 – 10/2005) (Currently: Tenure-track Assistant Professor, University of Maryland)
46. Todd R. Miller (10/2004 – 10/2007) (Currently: Assistant Professor, University of Wisconsin, Milwaukee)
47. Christopher Higgins (11/2006 – 12/2007) (Currently: Tenure-track Assistant Professor, Colorado School of Mines)
48. Jay Graham (02/2008 – 07/2008) (Currently: Assistant Professor, George Washington University, Washington, DC)
49. Randhir Deo (04/2008 – 2012) (Currently: Assistant Professor, Grand Canyon University, Phoenix, AZ)
50. Tzu-Chiao Chao (01/2009 – 01/2011) (Currently: Faculty, University of Regina, Canada)
51. Gopianth Nallani (02/2011 – 06/2011)
52. Nicole Hansmeier (12/2008 – 6/2012) (Currently: Assistant Professor, Osnabrück University, Germany)
53. Benny Pycke (02/2010 – Present)
54. Bhagyashree Manivannan (03/2013 – 04/2014)
55. Manivannan Yegambaram (03/2013 – 04/2014)
56. Arjun Venkatesan (12/2013 – Present)

Graduate Independent Projects Supervised

57. Jacqueline Heilman, Johns Hopkins University Research Intern (2002) "Antimicrobial Compounds and Their Possible Breakdown Products in Biosolids"
58. Edward Kruse (2007). (M.P.H.) Public Health, Hopkins. "Assessing the Impact of Point and Nonpoint Sources of Pollution on Recreational and Drinking Water Quality in the Springfield Watershed in Dominica" (2007). (Capstone Advisor)
59. Katherine Muto (Spring 2010) "Method for Detection of Chlorinated Carbanilides"
60. Chen Zhou (Spring 2010) "Versatile Roles of Sulfate Reducing Bacteria in Contaminant Remediation"
61. Kristin McClellan (Spring 2010) "Demonstration Plan: Parallel In Situ Screening of Remediation Strategies for Improved Decision Making, Remedial Design, and Cost Savings"

62. Isaac Roll (Fall 2010) “Cost-effective, Ultra-sensitive Groundwater Monitoring for Site Remediation and Management”
63. Thomas Bruton (Fall 2010) “Investigation of Fate and Transport of Zero Valent Iron Nanoparticles Using an In-Situ Microcosm Array”
64. Arjun Venkatesan (Fall 2010) “Analysis of compounds of emerging concern in Biosolids by GC/MS”
65. Kristin McClellan (Fall 2010) “Review Paper on Treatability Studies”
66. Jing Chen (Fall 2013) Rotational Student of the Biological Design Graduate Program, “Determination of Contaminants in Autopsy Tissues of Alzheimer’s Disease Fatalities”
67. Stephen Hart (Fall 2013) Rotational Student of the Biological Design Graduate Program, “Application of the In Situ Microcosm Array in a Fractured Bedrock Aquifer Contaminated with Perchlorate”

Undergraduate Students and High School Interns

68. Stephanie Burge (Research Intern, LLNL) “Optimization Study of Nitrate and Perchlorate Removal by Ion Exchange” (1999).
69. Daniel Paull (Undergraduate Research Intern, Johns Hopkins) “Detection of Antimicrobials by Liquid Chromatography/Mass Spectrometry” (2002).
70. Daniel Paull (Undergraduate Research Intern, Johns Hopkins) “Detection of Triclocarban in Environmental Waters by Liquid Chromatography/Mass Spectrometry” (2003).
71. Beth Links (High School Intern, Johns Hopkins) “Uptake into Plants of Contaminants from Biosolids-Amended Soils” (2004).
72. Cristina Matos (Diversity Research Intern, Johns Hopkins) “*Ab Initio* and *In Situ* Comparison of Organic Wastewater Compounds as Indicators of Sewage-derived Microbes in Surface Waters” (2004).
73. Anna Kalmykov (High School Intern, Johns Hopkins) (2004 – 2005).
74. Amelia DeLaquil (Undergraduate Research Intern, Johns Hopkins) “Fate of Triclosan and Triclocarban in Estuarine Sediment” (2006).
75. Jocelyn Keehner (High School Intern, Johns Hopkins) “Uptake into Plants of Contaminants from Biosolids-Amended Soils” (2006).
76. Erica Hartmann (Undergraduate Research Intern, Johns Hopkins) “Detection of Bioremediation Agents by MALDI Mass Spectrometry” (2006 – 2008).
77. Travis Doom. (B.S.E.) Biomedical Engineering, ASU. “Nutrient Injection Unit: Subsurface Environmental Engineering with In Situ Microcosm Array Tool” (2009).
78. Benjamin Duong (High School Intern, ASU) “Development of a Laboratory Web Page” (2008 – 2009).
79. Patrick Trang (High School Intern, ASU) “Development of a Laboratory Web Page” (2008 – 2009).
80. David E. C. Adams (B.S.E.) Environmental Engineering, ASU. (2010). “Fluorinated Chemicals and the Impacts of Anthropogenic Use” (2010) (Honor Thesis Advisor).
81. James Fernandez (Undergraduate Research Intern, ASU) “Policy Analysis for Atrazine” (2011 – 2012).
82. Benjamin Duong (Undergraduate Research Intern, ASU) “Programming of a Bioremediation Device” (2009 – 2012).
83. Patrick Trang (FURI Undergraduate Research Intern, ASU) “Programming the Nutrient Injection Module” (2009 – 2012).
84. Kristen Latta (Undergraduate Research Intern, ASU) “Environmental Research” (2012).
85. Justin Kidd (Undergraduate Research Intern, ASU) “Theoretical Examination of the Bioavailability of Contaminants in Soils” (2012 – 2013).
86. Olga Epshtein (Undergraduate Research Intern, ASU) “Modeling of the Tres Rios Wetland” (2012 – 2013).
87. Amitis Karris (High School Intern, ASU) “Environmental Research” (2013).
88. Cody Moore (Barrett Honors College Intern, ASU) “Environmental Research” (2012 – 2013).

89. Chris Bean (Undergraduate Research Intern, ASU) “Environmental Research” (2013).
90. Emily North (Barrett Honors College Intern, ASU) “Safety of Plastics” (2012 – 2013).
91. Olga Epshtein (B.S.) Civil Engineering, ASU (Expected 5/2014)
92. Justin Kidd (B.S.) Biology, ASU (Expected 5/2014)

Technicians Employed and Co-supervised

93. Tina Legler (1998 – 1999)
94. Thayer Young (01/2005 – 2007)
95. Kristin McClellan (4/2008 – 8/2008)
96. Sara Murch (11/2012 – 5/2014)

Synergistic Activities

- Supervisor Certificate, 40-Hour SARA/OSHA 8CCR5192(e)(4) (1999).
- Management Certificate, University of the Pacific, 2000.
- DOE Natural and Accelerated Bioremediation Research Program (NABIR) Workshop. Warrenton, VA. Invited Panelist. 3/18-20/2002.
- Johns Hopkins School of Public Health Faculty Title Task Force. Invited Representative of the Junior Faculty, 2003
- Co-organizer of the Johns Hopkins School of Public Health Junior Faculty Meetings, 2003.
- Organizer of the “Exposure Assessment Session” at the Environmental Health Sciences Annual Research Day of the Johns Hopkins Bloomberg School of Public Health, Mount Washington Conference Center, Baltimore, MD, November 14, 2003.
- Water Environment Research Foundation (WERF) Project Advisory Committee. “Contributions of Household Chemicals to Sewage and their Relevance to Municipal Wastewater Systems and the Environment.” Invited Committee Member. 2004-06.
- Water Environment Research Foundation (WERF) Project Advisory Committee. “Fate of Pharmaceuticals and Personal Care Products through Wastewater Treatment Processes.” Invited Committee Member. 2004-2006.
- Maryland Water Monitoring Council: “Ecological Restoration Assessment & Monitoring” Linthicum, MD. Invited Panelist. 11/18/2004.
- Governor Ehrlich’s Maryland Water Security and Wastewater Systems Advisory Council Alternate Member. 01/2004 – 12/2004.
- Governor Ehrlich’s Maryland Department of the Environment – Maryland State Water Quality Advisory Committee (SWQAC) Public Interest Member. Selected by JHSPH Dean Al Sommer to be the Johns Hopkins Representative for this Committee. 1/1/2003 – 12/31/2005.
- DOE/EPA SERDP and ESTCP Expert Panel Workshop on Research and Development Needs for the Environmental Remediation Application of Molecular Biological Tools. Invited Speaker and Voting Panel Member. Specialty: Proteomics. 08/9-10/2005.
- International Conference on Safe Water, Exploring Global Demands and Impacts of Natural Disasters, SAFEWATER 2005. San Diego, CA. Groundwater Remediation Session. Invited Session Chair. 10/21/2005.
- Harvard School of Public Health Risk Assessment Workshop: “Pharmaceuticals and Personal Care Products in the Environment: Emerging Threat or Unwarranted Concern?” Invited Panelist. 11/10/2005.
- National Congress on Assessing and Mitigating Environmental Impacts of Emerging Contaminants – Renewable Natural Resources Foundation. Co-Sponsored by the United States Geological Survey and the Food and Drug Administration. Invited Delegate. 12/1-2/2005.
- Food And Drug Administration, Center For Drug Evaluation And Research (CDER) Nonprescription Drugs Advisory Committee. “Benefits and Hazards of Antiseptic Products Marketed for Consumer Use.” Invited Panelist/Voting Committee Member. 10/20/2005.

- EPA Office of Inspector General, Office of Program Evaluation, Evaluation of Drinking Water Laboratory Procedures. Invited Expert Consultant. 1/19/2006.
- Mid-Atlantic States Section of the Air & Waste Management Association (MASS-A&WMA), Special Symposium on Emerging Environmental Issues and Policies. Invited Speaker/Panelist. New Brunswick, NJ, April 6, 2006.
- Invited Panelist, BIO 2006, World's Largest Annual International Convention on Biotechnology. Chicago, IL. Environmental Biotechnology Session. 04/9-12/2006
- National Research Council of the National Academies. NRSB-O-05-04-A. Conduct a Technical Assessment of Ongoing and Planned Environmental Remediation and Monitoring Programs at the Los Alamos National Laboratory (LANL) and Provide Recommendations to Improve Their Technical and Cost Effectiveness and Reduce Worker, Public, and Environmental Risks. Invited NRC Committee Member, Dual Appointment in the Areas of Groundwater Monitoring and Chemistry. 15-Month Term Starting March, 2006.
- Panel Chair and Keynote Speaker. Reducing Our Ecological Footprint. 10th Anniversary of the Johns Hopkins Center for a Livable Future – Charting A Course To Sustainability Through Research, Education And Service, Baltimore, MD, December 6, 2006.
- Co-Organizer, Annual Conference of the Superfund Basic Research Program (SBRP) of the National Institute of Environmental Health Sciences (NIEHS). Innovative Technologies. Session Moderator and Planning Committee Member, 20th Anniversary Meeting of the Superfund Basic Research Program, Durham, NC, December 3, 2007.
- Co-Organizer, Annual Conference of the Superfund Basic Research Program (SBRP) of the National Institute of Environmental Health Sciences (NIEHS). Member of Steering Committee and Invited Speaker of Technology Transfer Session, Pacific Grove, CA, December 7-9, 2008.
- Invited Panelist, American Academy for Microbiology, "Global Antibiotic Resistance: New Approaches to an Old Problem," Fondation Merieux, Annecy, France, October 2008.
- Invited Speaker and Session Chair. Environmental Fate of Antimicrobials. Pacific Southwest Organic Residuals Symposium 2008. Sacramento, October 1-2, 2008.
- Invited Panelist, Special Symposium on Next Generation Superfund Contaminants sponsored by the National Institute of Environmental Health Sciences (NIEHS), Tucson, AZ, August 2009.
- Symposium Chair and Organizer, Pharmaceuticals, Personal Care Products and Organohalogenes in Biosolids, 238th American Chemical Society (ACS) National Meeting, Washington, DC, August 16-20, 2009.
- Symposium Chair and Organizer, Toward Sustainable Use of Organohalogenes. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
- Symposium Chair and Organizer, Policy Options for Sustainability. Spring 2010 National Meeting & Exposition of the American Chemical Society, San Francisco, CA, March 21-25, 2010.
- Invited Panelist, Workshop on Environmental Estrogens and Endocrine Disrupting Compounds, sponsored by the Johnson Foundation, Wingspread, WI, May 2010.
- Co-Organizer, 25th Anniversary Conference of the Superfund Research Program (SRP) of the National Institute of Environmental Health Sciences (NIEHS). Scientific Session 2: Risk Assessment and Remediation. Planning Committee Member, 25th Anniversary Meeting of the Superfund Basic Research Program, Raleigh, NC, October 21-24, 2012.

Classroom Instruction

Principal Instructor

CEE470	Sustainable Environ. Biotechnologies (87936) (3 credits). Fall 2014. Enrollment: 15
CEE570	Sustainable Environ. Biotechnologies (87937) (3 credits). Fall 2014. Enrollment: 7
HON494	Sustainable Environ. Biotechnologies (88753) (3 credits). Fall 2014. Enrollment: 5
HON494	Biological Design Seminar (89949). Lecture (1 credit). Fall 2014. Enrollment: 9
BDE598	Biological Design Seminar (84106). Lecture (1 credit). Fall 2014. Enrollment: 7
BDE598	Biological Design Seminar (89564). Lecture (1 credit). Fall 2013. Enrollment: 8
HON494	Biological Design Seminar (89591). Lecture (1 credit). Fall 2013. Enrollment: 12
CEE361	Introduction to Environmental Engineering, Lecture (3 credits). Spring 2013 Enrollment: 61
CEE361	Introduction to Environmental Engineering, Laboratory (1 credit). Spring 2013 Enrollment: 61
CEE563	Environmental Chemistry Laboratory (3 credits). Fall 2012. Enrollment: 18
ASU101	The ASU Experience (1 credit). Fall 2011. Enrollment: 16
CEE598*	Sustainable Environmental Biotechnologies (3 credits). Fall 2011. Enrollment: 16
CEE494	Sustainable Environmental Biotechnologies (3 credits). Fall 2011. Enrollment: 2
CEE361	Introduction to Environmental Engineering, Lecture (3 credits). Spring 2011. Enrollment: 56
CEE361	Introduction to Environmental Engineering, Laboratory (1 credit). Spring 2011 Enrollment: 56
CEE790	Reading and Conference, Spring 2011 Enrollment: 1
CEE563	Environmental Chemistry Laboratory (3 credits). Fall 2010. Enrollment: 19
ASU101	The ASU Experience (1 credit). Fall 2010. Enrollment: 19
E2 Camp	Taught one module of ASU101 at Fall 2010 Freshman Camp in Prescott, AZ
CEE790	Reading and Conference. Fall 2010. Enrollment: 3
ASU101-1	The ASU Experience (1 credit). Fall 2009. Enrollment: 19
ASU101-2	The ASU Experience (1 credit). Fall 2009. Enrollment: 19
CEE790	Reading and Conference. Fall 2009. Enrollment: 2
CEE563	Environmental Chemistry Laboratory (3 credits). Fall 2009. Enrollment: 17
CEE598*	Sustainable Environmental Biotechnologies (3 credits). Spring 2009. Enrollment: 7
CEE494	Sustainable Environmental Biotechnologies (3 credits). Spring 2009. Enrollment: 33
CEE598	Environmental Engineering Analytical Laboratory (3 credits). Fall 2008. Enrollment: 11
JHU-Spain	Air, Water and Food Toxics (3 credits). Barcelona, Spain. JHU Fall Institute on Health Policy and Management (October 2008). Enrollment: 7.
182.638	Water & Health (4 credits), 4 th Term, 2006/07. Enrollment: 12.
182.852	Air, Water, and Food Toxics (3 credits), 3 rd Annual JHU Fall Institute in Health Policy and Management, Barcelona, Spain, 2006. Enrollment: 14.
182.638	Fundamentals of Water Quality Engineering for Public Health (4 credits), 4 th Term, 2005/06. Enrollment: 13.
182.639	Introductory Principles of Water Quality Engineering for Public Health Water (3 credits). Highest-ranked Course of the 2 nd Annual JHU Fall Institute in Health Policy and Management, Barcelona, Spain, 2005. Enrollment: 6.
183.849	SSR: Water-borne Diseases: Emerging Threats To Potable Water Supplies. 2004. Enrollment: 6.

Online Training Modules for the Center of Public Health Preparedness

(No Code)	Chemical Weapons and Water Safety, 2005. http://www.jhsph.edu/preparedness/training/online/chemagents_water_safety.html .
(No Code)	Water Safety, 2005. http://www.jhsph.edu/preparedness/training/online/water_safety.html

- (No Code) Water Safety—A Case Study, 2005. http://www.jhsph.edu/preparedness/training/online/water_safety_case_study.html
- (No Code) Monitoring Chemical Agents, 2005. http://www.jhsph.edu/preparedness/training/online/monitoring_chem_agents.html
- Guest Lectures**
- MIC445 Molecular Biology & Genetics, Fall 2012. Enrollment: 50
- PFF Preparing Future Faculty, Fall 2012. Enrollment: 32
- BDE 598 Biological Design. Fall 2011. Enrollment: 13.
- BDE 701 Biological Design. Fall 2009. Enrollment: 13.
- CEE 100 Introduction to Civil and Environmental Engineering. Spring 2009. Enrollment: 60.
- BDE 598 Biological Design. Fall 2008. Enrollment: 13.
- 180.609 Principles of Environmental Health I. 2004, 2006. Sources and Types of Water Contamination.
- 180.609 Principles of Environmental Health I. 2004. Water and Wastewater Treatment Systems.
- 182.640 Food and Waterborne Diseases, 3rd Term, 2002, 2004, 2006. Microcontaminants in Water.
- 180.880 Special Studies in Environmental Health Community Outreach. 2004. Sewage Spills: Turning a Community Concern into a Science Project.
- (No Code) Diversity Student Summer Seminar Series. 2004. Pharmaceuticals and Personal Care Products in the Environment.
- (No Code) Maryland Public Television Summer Institute. 2004.
- 550.865 Public Health Perspectives on Research. 2002. Environmental Health Engineering—Making a Career of Protecting the Environment and Human Health.
- AS 020.151 General Biology I. Fall. Bioremediation. Enrollment: 297 (2004), 250 (2005). TBD (2006).
- AS 020.161 Biology Workshop I. Fall. Bioremediation. Enrollment: 48 (2004), 48 (2005), TBD (2006).
- (Taped) Environmental Biotechnology Lecture Series, UC Berkeley, Berkeley, CA. 2001. Detection and Destruction of Anthropogenic Toxins in Drinking Water.

OTHER SIGNIFICANT TEACHING ACTIVITIES AND INSTRUCTIONAL TRAINING

- 2009 Spartan Entrepreneurial Workshop, Crash Course for Faculty Entrepreneurs. ASU Sky Song, Scottsdale, September 17-19.
- 2009 Preparing Future Faculty, Conducted Mock Interviews with Graduate Students, ASU.
- 2007 Teaching Well, Saving Time. A Teaching Workshop, Johns Hopkins University, January 12, 2007.
- 2005 Extreme Course Make-overs: Using Student Evaluations to Improve Your Course. Johns Hopkins University Workshop, Bloomberg School of Public Health, January 19.
- 2004 Creating the Loop: Developing Learning Objectives and Assessment Methods. Johns Hopkins University Workshop, Bloomberg School of Public Health, July 26.
- 2004 Lecturing & Active Learning: Strategies for Excellence Johns Hopkins University Workshop, Bloomberg School of Public Health, January 13-14.
- 1998 – 2001 Mentor, Science & Technology Education Program, Lawrence Livermore National Laboratory. Supervised four undergraduate research semester (URS) and two summer students.
- 1999 – 2001 Supervisor, 40 Hour SARA/OSHA Hazardous Waste Site Operator, 8CCR5192(e)(4), Lawrence Livermore National Laboratory.
- 1996 – 1997 Participant, University of Minnesota, Graduate School. Participated in the Bush Faculty Development Program for Excellence and Diversity in Teaching Program Preparing Doctoral Candidates for Their Role as Future Faculty: Introduction to

Diverse Teaching Methods, Peer-reviewed Practice Teaching, Design of Effective Courses/Exams/Homework Assignments, Acknowledging Students' Diversity and Learning Styles.

1993 – 1997

Teaching Assistant, University of Minnesota, Department of Civil Engineering. Organized and Conducted Laboratory Section of Graduate Courses Titled “Microbiology for Environmental Engineers” and “Groundwater Microbiology.”

Exhibit F

Statement of Kim Harley

I, Kim Harley, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, Kim Harley PhD, am Associate Adjunct Professor in Maternal and Child Health and Associate Director for Health Effects, Center for Environmental Research and Children's Health at UC Berkeley. I am an environmental epidemiologist by training, and my research interests include the reproductive effects of PBDEs, prenatal exposure to environmental contaminants and the effects of endocrine disrupting compounds on birth outcome, fertility and the onset of puberty. I have been working in this field for 14 years and have attached my CV and list of publications.

2. I am one of the researchers running the CHAMACOS Study, a longitudinal birth cohort study investigating the role of chemicals and other environmental factors in the health of low-income, Mexican-American children living in the Salinas Valley of California. In 1999-2000, we enrolled 601 pregnant women living in Salinas and monitored the women and their children's health for the past 14 years. We carried out detailed physical exams and neurodevelopmental tests on the children every 1 to 2 years. At the time the mothers were pregnant, the organohalogen Penta PBDE mixture was the predominant flame retardant used in furniture. We found a strong positive correlation between the levels of flame retardants in pregnant mothers' bodies and the length of time they had lived in California¹. We also found a significant increase of over 26% in total PBDE levels among women who had three or more pieces of upholstered furniture in their homes, suggesting that indoor contamination was contributing to this exposure.² The levels of flame retardants in the blood of these Latino children, who were all born in California, were among the highest levels ever published³, three times higher than their mothers during pregnancy, and seven times higher than children living in Mexico⁴. The PBDE levels in children were positively correlated with the total PBDE levels in maternal serum during pregnancy, duration of exclusive breastfeeding, and absence of a safe place to play in their neighborhood.⁵ In terms of health effects, we found that the women with higher levels of flame retardants in their blood: (i) took significantly longer to get pregnant, i.e. had reduced fecundability⁶; (2) had babies with lower birth weight (over 100 g decrease in birth weight for every 10 fold increase in PBDE levels)⁷; and (iii) had lower thyroid hormone levels during pregnancy⁸, which may have implications for both maternal health and development of the fetus. We also assessed the development of over 300 children and found that, by the time they were 5 to 7 years old, their mother's flame retardant exposure during pregnancy was associated with lower IQ (a decrease by 6 points on average), attention problems, and impaired

fine motor coordination, particularly in the non-dominant hand⁹. Thus, pregnant women's exposure to PBDEs is of concern because it may have long-term adverse effects on the children.


3. Other scientific studies of completely different populations found similar adverse health effects, including alterations in thyroid hormone during pregnancy^{10,11}, decreased birth weight¹², and impaired neurodevelopment, cognitive and behavioral performance in children^{13,14,15,16,17,18,19}. Other studies also found associations between PBDEs and decreased semen quality²⁰, hormonal changes in men^{21,22,23}, cryptorchidism (undescended testicles, which increases the risk of infertility and testicular cancer later in life)^{24,25}, and early puberty in girls²⁶. These human studies are corroborated by several studies on rats and mice showing adverse neurodevelopmental effects^{27,28,29,30,31,32,33,34,35,36,37,38,39,40,41} and adverse reproductive effects, including alterations in sex hormone levels, reduced sperm count and changes in the structure of the ovaries^{42,43,44,45,46,47}.

4. Our published studies on pregnant women and children relate to the Penta BDE mixture, which was the predominant chemical used to meet TB117 in 2000 when the study began. According to the Center for Disease Control biomonitoring studies, 97% of the US population has PBDEs in their blood. This is because additive organohalogen flame retardants such as PBDEs migrate out of consumer products into dust and get into people's bodies.

5. Now Penta BDE has been replaced in upholstered furniture by other organohalogen flame retardant chemicals such as chlorinated Tris and FireMaster 550, both found in 100% of California homes and childcare facilities tested⁴⁸. Chlorinated tris has been listed as a carcinogen by the state of California under Proposition 65⁴⁹ and recently banned in several states⁵⁰, which exemplifies the problem of regrettable substitution. Human studies are also starting to show effects of some of these other organohalogen flame retardants on thyroid hormone levels⁵¹, and animal studies have found adverse reproductive and developmental^{52,53,54,55,56}, neurobehavioral^{57,58,59} and endocrine^{60,61,62,63,64} effects.

6. Based on my research on the impacts of PBDE flame retardants on the health of pregnant women and their children and the increasing evidence of harm from the replacement flame retardants, it is my professional opinion that all organohalogen flame retardants may pose similar risks, especially to fetuses and young children. To protect the health of our population, including the most vulnerable pregnant women and children, I support this petition to ban certain household products containing additive organohalogen flame retardants. This ban is necessary to avoid exposure of pregnant women and children to this class that includes chemicals that I studied and found to be harmful to human health.

Yours sincerely,



Kim Harley, Ph.D.

Associate Adjunct Professor, Maternal & Child Health

Associate Director for Health Effects, Center for Environmental Research & Children's Health

¹ Castorina R., Bradman A., Sjodin A., Fenster L., Jones R. S., Harley K., Eisen E. A., Eskenazi B. (2011) Determinants of serum polybrominated diphenyl ether (PBDE) levels among pregnant women in the CHAMACOS cohort. *Environ Sci Technol.* 45(15):6553-6560

² Castorina R., Bradman A., Sjodin A., Fenster L., Jones R. S., Harley K., Eisen E. A., Eskenazi B. (2011) Determinants of serum polybrominated diphenyl ether (PBDE) levels among pregnant women in the CHAMACOS cohort. *Environ Sci Technol.* 45(15):6553-6560

³ Eskenazi B., Chevrier J., Rauch S. A., Kogut K., Harley K. G., Johnson C., Trujillo C., Sjodin A., Bradman A. (2012) In utero and childhood polybrominated diphenyl ether (PBDE) exposures and neurodevelopment in the CHAMACOS study. *Environ Health Perspect.* 121(2):257-262

⁴ Eskenazi B., Fenster L., Castorina R., Marks A. R., Sjodin A., Rosas L. G., Holland N., Guerra A. G., Lopez-Carillo L., Bradman A. (2011). A comparison of PBDE serum concentrations in Mexican and Mexican-American children living in California. *Environ Health Perspect.* 119(10):1442-1448

⁵ Bradman A., Castorina R., Sjodin A., Fenster L., Jones R. S., Harley K. G., Cevrier J., Holland N. T., Eskenazi B. (2012) Factors associated with serum polybrominated diphenyl ether (PBDE) levels among school-age children in the CHAMACOS cohort. *Environ Sci Technol.* 46(13):7373-7381

⁶ Harley K. G., Marks A. R., Chevrier J., Bradman A., Sjodin, A., Eskenazi B. (2010) PBDE concentrations in women's serum and fecundability. *Environ Health Perspect.* 118(5):699-704

⁷ Harley K. G., Cevrier J., Schall R. A., Sjodin A., Bradman A., Eskenazi B. (2011) Association of prenatal exposure to polybrominated diphenyl ethers and infant birth weight. *Am J Epidemiol.* 174(8):885-892

⁸ Chevrier J., Harley K. G., Bradman A., Gharbi M., Sjodin A., Eskenazi B. (2010) Polybrominated diphenyl ether (PBDE) flame retardants and thyroid hormone during pregnancy. *Environ Health Perspect.* 118(10):1444-1449

⁹ Eskenazi B., Chevrier J., Rauch S. A., Kogut K., Harley K. G., Johnson C., Trujillo C., Sjodin A., Bradman A. (2012) In utero and childhood polybrominated diphenyl ether (PBDE) exposures and neurodevelopment in the CHAMACOS study. *Environ Health Perspect.* 121(2):257-262

¹⁰ Stapleton H. M., Eagle S., Anthonopolos R., Wolkin A., Miranda M. L. (2011) Associations between polybrominated diphenyl ether (PBDE) flame retardants, phenolic metabolites, and thyroid hormones during pregnancy. *Environ Health Perspect.* 119(10):1454-1459

¹¹ Zota A. R., Park J. S., Wang Y., Petreas M., Zoeller R. T., Woodruff T. J. (2011) Polybrominated diphenyl ethers, hydroxylated polybrominated diphenyl ethers, and measures of thyroid

function in second trimester pregnant women in California. *Environ Sci Technol.* 45(18):7896-7905. doi: 10.1021/es200422b

¹² Chao H. R., Wang S. L., Lee W. J., Wang Y. F., Papke O. (2007) Levels of polybrominated diphenyl ethers (PBDEs) in breast milk from central Taiwan and their relation to infant birth outcome and maternal menstruation effects. *Environ Int.* 33(2):239-245

¹³ Herbstman J. B., Sjolín S., Kurzon M., Lederman S. A., Jones R. S., Raugh V., Needham L. L., Tang D., Niedzwiecki M., Wang R. Y., Perera F. (2010) Prenatal exposure to PBDEs and neurodevelopment. *Environ Health Perspect.* 118(5):712-719

¹⁴ Gascon M., Fort M., Martínez D., Carcin A. E., Fornis J., Grimalt J. O., Santa Marina L., Lertxundi N., Sunyer J., Vrijheid M. (2012) Polybrominated diphenyl ethers (PBDEs) in breast milk and neurophysiological development in infants. *Environ Health Perspect.* 120(12):1760-1765

¹⁵ Gascon M., Vrijheid M., Martínez D., Fornis J., Grimalt J. O., Torrent M., Sunyer J. (2011) Effects of pre and postnatal exposure to low levels of polybromodiphenyl ethers on neurodevelopment and thyroid hormone levels at 4 years of age. *Environ Int.* 37(3):605-611

¹⁶ Roze E., Meijer L., Bakker A., Van Braeckel K. N., Sauer P. J., Bos A. F. (2009) Prenatal exposure to organohalogenes, including brominated flame retardants, influences motor, cognitive, and behavioral performance at school age. *Environ Health Perspect.* 117(12):1953-1958. doi: 10.1289/ehp.0901015

¹⁷ Hoffman K., Adgent M., Goldman B. D., Sjödin A., Daniels J. L. (2012) Lactational exposure to polybrominated diphenyl ethers and its relation to social and emotional development among toddlers. *Environ Health Perspect.* 120(10):1438-1442. doi: 10.1289/ehp.1205100

¹⁸ Costa L. G., Giordano G. (2007) Developmental neurotoxicity of polybrominated diphenyl ether (PBDE) flame retardants. *Neurotoxicology.* 28(6):1047-1067

¹⁹ Jurewicz J., Polańska K., Hanke W. (2013) Exposure to widespread environmental toxicants and children's cognitive development and behavioral problems. *Int J Occup Med Environ Health.* 26(2):185-204. doi: 10.2478/s13382-013-0099-x

²⁰ Akutsu K., Takatori S., Nozawa S., Yoshiike M., Nakazawa H., Hayakawa K., Makino T., Iwamoto T. (2008) Polybrominated diphenyl ethers in human serum and sperm quality. *Bull Environ Contam Toxicol.* 80(4):345-350. doi: 10.1007/s00128-008-9370-4

²¹ Johnson P. I., Stapleton H. M., Mukherjee B., Hauser R., Meeker J. D. (2013) Associations between brominated flame retardants in house dust and hormone levels in men. *Sci Total Environ.* 445-446:177-184. doi: 10.1016/j.scitotenv.2012.12.017

²² Meeker J. D., Johnson P. I., Camann D., Hauser R. (2009) Polybrominated diphenyl ether (PBDE) concentrations in house dust are related to hormone levels in men. *Sci Total Environ.* 407(10):3425-3429. doi: 10.1016/j.scitotenv.2009.01.030

²³ Meeker J. D., Stapleton H. M. (2010) House dust concentrations of organophosphate flame retardants in relation to hormone levels and semen quality parameters. *Environ Health Perspect.* 118(3):318-323. doi: 10.1289/ehp.0901332

²⁴ Toppari J. (2012) Male reproductive health as a sentinel for environmental endocrine disruption. *Acta Vet Scand.* 54(Suppl. 1)

²⁵ Krysiak-Baltyn K., Toppari J., Skakkebaek N. E., Jensen T. S., Virtanen H. E., Schramm K. W., Shen H., Vartiainen T., Kiviranta H., Taboureau O., Audouze K., Brunak S., Main K. M. (2012)

Association between chemical pattern in breast milk and congenital cryptorchidism: modeling of complex human exposures. *Int J Androl.* 35(2):294-302. doi: 10.1111/j.1365-2605.2012.01268.x

²⁶ Chen A., Chung E., DeFranco E. A., Pinney S. M., Dietrich K. N. (2011) Serum PBDEs and age at menarche in adolescent girls: analysis of the National Health and Nutrition Examination Survey 2003-2004. *Environ Res.* 111(6):831-837. doi: 10.1016/j.envres.2011.05.016

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hormones and environmental factors. *Environ Pollut.* 184:193-200. doi: 10.1016/j.envpol.2013.08.034

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KIM HARLEY

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Berkeley, CA 94707
(510) 508-6077

CURRENT POSITIONS

Associate Adjunct Professor, Maternal and Child Health Division
School of Public Health, U.C. Berkeley

Associate Director for Health Effects, Center for Environmental Research and Children's Health
School of Public Health, U.C. Berkeley

EDUCATION

Ph.D. **University of California at Berkeley**
Epidemiology, 2004

Dissertation: *Examining an Epidemiologic Paradox: The Role of Acculturation, Nutrition, and Social Support in the Birth Outcomes of Women of Mexican Descent*

M.P.H. **University of California at Berkeley**
Maternal and Child Health, 1998

Thesis: *Maternity Hospital Practices that Affect Breastfeeding at Four Months in Egypt*

B.A. **Vassar College**
Anthropology, 1992

Independent Study Project: *Modern Magic: Medical Care in Rural Bali*

RESEARCH INTERESTS

- Reproductive and perinatal epidemiology
- Endocrine disruptor exposure to adolescent girls and effects on puberty and fertility
- Reproductive and developmental effects of Bisphenol A, PBDEs, pesticides, and other endocrine disruptors

TEACHING EXPERIENCE

Spring 2008 - Present	Instructor, Practical Issues in Maternal and Child Health Data Analysis (PH 293-6)	UC Berkeley
Spring 2007 - Present	Instructor, Reproductive and Perinatal Epidemiology (PH 210D)	UC Berkeley
Spring 2004 Spring 2003	Graduate Student Instructor, Reproductive and Perinatal Epidemiology (PH 210D)	UC Berkeley
Fall 2000	Graduate Student Instructor, Epidemiologic Methods II (PH 250B)	UC Berkeley

MENTORING EXPERIENCE (MASTER'S PROJECT COMMITTEE)

2012-2013	Mariko Sweetnam (Committee Chair) Ayca Erkin-Cakmak Kristina Kastler Emily Murphy
2011-2012	Rasika Behl (Committee Chair) Shayla Livingston (Committee Chair) Brett Augspurger Vidita Chopra Marlowe Dieckmann
2010-2011	Alison Gemmill (Committee Chair) Jocelyn Audelo Dewight Cowley Aarti Kale Hannah Sheehy Emilia Wilkins
2009-2010	Maria Elena Young Hataav Khademi Elizabeth Cretti
2008-2009	Lauren Hubner
2007-2008	Celina Trujillo
2006-2007	Jennifer Wright

RESEARCH EXPERIENCE

1998-present	CENTER FOR CHILDREN'S ENVIRONMENTAL HEALTH RESEARCH U.C. Berkeley Associate Director (2007-present)
	<ul style="list-style-type: none"> • Manage research study investigating the health of pregnant women and children in a farmworker community. (Salinas Valley, CA) • Supervise staff of study coordinator, data analysts, interviewers, graduate students. • Devise research questions, design studies, oversee data collection • Analyze data, author scientific research articles • Present research findings to scientists, public health providers, funders. • Write grant applications and reports to funders.
	Study Coordinator (2004-2007), Researcher/Graduate Student (1998-2004)

OTHER PUBLIC HEALTH EXPERIENCE

2008-2010	ENVIRONMENTAL HEALTH SCIENCES Charlottesville, VA Science Communication Fellow
	<ul style="list-style-type: none"> • Work with media relations and policy experts to advance public understanding of environmental health issues. • Identify scientific studies to be prioritized for media attention. • Translate and explain relevance of findings for journalists.

Summer 1997 **WELLSTART INTERNATIONAL** San Diego, CA
Evaluation and Resource Development Consultant

- Fundraising and grant-writing for public health non-profit organization.
- Evaluated changes in breastfeeding practices over a ten-year international promotion project.
- Conducted cost-benefit analysis of breastfeeding promotion in US hospitals.

1993-1996 **PROJECT CONCERN INTERNATIONAL** San Diego, CA
Grants Coordinator (1996)

- Managed grant proposal submissions, resulting in \$800,000 for international public health programs.
- Monitored progress, ensured grant obligations were met, represented Project Concern to donors.
- Coordinated proposal and report writing process, collaborated with overseas staff and headquarters staff in fundraising, program and finance departments.
- Supervised two full-time employees and one part-time employee.

Foundation Grants Officer (1994 - 1995), Corporate Grants Officer (1993 - 1994)

1992-1993 **JOHN SNOW INC.** Arlington, VA
Staff Associate

- Coordinated USAID-funded shipments of contraceptives to developing nations.
- Responsible for processing USAID missions' contraceptive orders, tracking the progress of shipments and communicating instructions to shipping company.
- Provided headquarters support to overseas advisors.

GRANT SUPPORT

Decreasing Endocrine Disruptor Exposure in Latina Teens (HERMOSA Study)

Principal Investigator: K. Harley

Grant Number: 18BB1800 Funder: CA Breast Cancer Research Amount: \$646,431

Grant Period: 9/30/2009 - 7/31/2011

Role: PI

Bisphenol A and Children's Growth and Development

Principal Investigator: K. Harley and B. Eskenazi (Multiple PIs)

Grant Number: 1RC2ES018792 Funder: NIEHS Amount: \$1,493,880

Grant Period: 9/30/2009 - 7/31/2011

Role: PI

Administrative Supplement to Bisphenol A and Children's Growth and Development

Principal Investigator: K. Harley

Grant Number: 3RC2ES018792-S1 Funder: NIEHS Amount: \$76,620

Grant Period: 5/28/2010 - 7/31/2011

Role: PI

Center for Children's Environmental Health Research

Principal Investigator: B. Eskenazi

Grant Number: PO1 ES009605 Funder: NIEHS/EPA Amount: \$4,160,551

Grant Period: 9/24/2009 - 7/31/2014

Role: Co-investigator

DDT & PBDE Exposure, Puberty Onset, and Neurodevelopment in Mexican-American Girls.

Principal Investigator: B. Eskenazi
Grant Number: RO1 ES017054 Funder: NIEHS Amount: \$3,285,313
Grant Period: 8/1/2009 – 4/30/2014
Role: Co-investigator

PBDEs, DDT and Neurodevelopment in School-Aged Mexican-American Children

Principal Investigator: B. Eskenazi
Grant Number: RO1 ES015572 Funder: NIEHS Amount: \$1,960,631
Grant Period: 8/7/2007 – 4/30/2011
Role: Co-investigator

PON1 and Developmental Sensitivity to OP Pesticides

Principal Investigator: N. Holland
Grant Number: RO1 ES012503 Funder: NIEHS Amount: \$1,748,016
Grant Period: 1/1/2006 – 12/31/2010
Role: Co-investigator

PROFESSIONAL AFFILIATIONS

International Society for Environmental Epidemiology

PROFESSIONAL SERVICE

Reviewer: American Journal of Epidemiology, Environmental Health Perspectives, Environmental Health, Journal of Exposure Science and Environmental Epidemiology.

Publication List – Kim Harley

1. Eskenazi, B. and **Harley, K.** (2001). Commentary: Revisiting the primipaternity theory of pre-eclampsia. *International Journal of Epidemiology*, 30(6): p. 1323-1324.
2. Eskenazi, B., **Harley, K.**, Bradman, A., Weltzien, E., Jewell, N.A., Barr, D.B., Furlong, C.E., and Holland, N.T. (2004). Association of in utero organophosphate pesticide exposure and fetal growth and length of gestation in an agricultural population. *Environmental Health Perspectives*, 112(10): p. 1116-1124.
3. **Harley, K.**, Eskenazi, B., and Block, G. (2005). The association of time in the US and diet during pregnancy in low-income women of Mexican descent. *Paediatric and Perinatal Epidemiology*, 19(2): p. 125-134.
4. Duramad, P., **Harley, K.**, Lipsett, M., Bradman, A., Eskenazi, B., Holland, N.T., and Tager, I.B. (2006). Early environmental exposures and intracellular Th1/Th2 cytokine profiles in 24-month-old children living in an agricultural area. *Environmental Health Perspectives*, 114(12): p. 1916-1922.
5. Fenster, L., Eskenazi, B., Anderson, M., Bradman, A., **Harley, K.**, Hernandez, H., Hubbard, A., and Barr, D.B. (2006). Association of in utero organochlorine pesticide exposure and fetal growth and length of gestation in an agricultural population. *Environmental Health Perspectives*, 114(4): p. 597-602.
6. **Harley, K.** and Eskenazi, B. (2006). Time in the United States, social support and health behaviors during pregnancy among women of Mexican descent. *Social Science & Medicine*, 62(12): p. 3048-3061.
7. Warner, M.L., **Harley, K.**, Bradman, A., Vargas, G., and Eskenazi, B. (2006). Soda consumption and overweight status of 2-year-old Mexican-American children in California. *Obesity*, 14(11): p. 1966-1974.
8. Eskenazi, B., Marks, A.R., Bradman, A., **Harley, K.**, Barr, D.B., Johnson, C., Morga, N., and Jewell, N.A. (2007). Organophosphate pesticide exposure and neurodevelopment in young Mexican-American children. *Environmental Health Perspectives*, 115(5): p. 792-798.
9. **Harley, K.**, Stamm, N.L., and Eskenazi, B. (2007). The effect of time in the US on the duration of breastfeeding in women of Mexican descent. *Maternal and Child Health Journal*, 11(2): p. 119-125.
10. Eskenazi, B., Rosas, L.G., Marks, A.R., Bradman, A., **Harley, K.**, Holland, N., Johnson, C., Fenster, L., and Barr, D.B. (2008). Pesticide toxicity and the developing brain. *Basic & Clinical Pharmacology & Toxicology*, 102(2): p. 228-236.
11. **Harley, K.G.**, Marks, A.R., Bradman, A., Barr, D.B., and Eskenazi, B. (2008). DDT exposure, work in agriculture, and time to pregnancy among farmworkers in California. *J Occup Environ Med*, 50(12): p. 1335-42.

12. **Harley, K.G.**, Macher, J.M., Lipsett, M., Duramad, P., Holland, N.T., Prager, S.S., Ferber, J., Bradman, A., Eskenazi, B., and Tager, I.B. (2009). Fungi and pollen exposure in the first months of life and risk of early childhood wheezing. *Thorax*, 64(4): p. 353-8.
13. Huen, K., **Harley, K.**, Brooks, J., Hubbard, A., Bradman, A., Eskenazi, B., and Holland, N. (2009). Developmental changes in PON1 enzyme activity in young children and effects of PON1 polymorphisms. *Environ Health Perspect*, 117(10): p. 1632-8.
14. Rosas, L.G., **Harley, K.**, Fernald, L.C., Guendelman, S., Mejia, F., Neufeld, L.M., and Eskenazi, B. (2009). Dietary Associations of Household Food Insecurity among Children of Mexican Descent: Results of a Binational Study. *J Am Diet Assoc*, 109(12): p. 2001-9.
15. Chevrier, J., **Harley, K.G.**, Bradman, A., Gharbi, M., Sjodin, A., and Eskenazi, B. (2010). Polybrominated diphenyl ether (PBDE) flame retardants and thyroid hormone during pregnancy. *Environ Health Perspect*, 118(10): p. 1444-9.
16. Eskenazi, B., Huen, K., Marks, A., **Harley, K.G.**, Bradman, A., Barr, D.B., and Holland, N. (2010). PON1 and Neurodevelopment in Children from the CHAMACOS Study Exposed to Organophosphate Pesticides in Utero. *Environ Health Perspect*, 118(12): p. 1775-81.
17. **Harley, K.G.**, Marks, A.R., Chevrier, J., Bradman, A., Sjodin, A., and Eskenazi, B. (2010). PBDE concentrations in women's serum and fecundability. *Environ Health Perspect*, 118(5): p. 699-704.
18. Huen, K., **Harley, K.**, Bradman, A., Eskenazi, B., and Holland, N. (2010). Longitudinal changes in PON1 enzymatic activities in Mexican-American mothers and children with different genotypes and haplotypes. *Toxicol Appl Pharmacol*.
19. Marks, A.R., **Harley, K.**, Bradman, A., Kogut, K., Barr, D.B., Johnson, C., Calderon, N., and Eskenazi, B. (2010). Organophosphate Pesticide Exposure and Attention in Young Mexican-American Children: The CHAMACOS Study. *Environ Health Perspect*, 118(12): p. 1768-74.
20. Rosas, L.G., **Harley, K.G.**, Guendelman, S., Fernald, L.C., Mejia, F., and Eskenazi, B. (2010). Maternal perception of child weight among Mexicans in California and Mexico. *Matern Child Health J*, 14(6): p. 886-94.
21. Weldon, R.H., Webster, M., **Harley, K.G.**, Bradman, A., Fenster, L., Davis, M.D., Hubbard, A., Barr, D.B., Holland, N., and Eskenazi, B. (2010). Serum Persistent Organic Pollutants and Duration of Lactation among Mexican-American Women. *J Environ Public Health*, doi: 10.1155/2010/861757 [Online: July 31, 2010]: p. 861757.
22. Bouchard, M.F., Chevrier, J., **Harley, K.G.**, Kogut, K., Vedar, M., Calderon, N., Trujillo, C., Johnson, C., Bradman, A., Barr, D.B., and Eskenazi, B. (2011). Prenatal exposure to organophosphate pesticides and IQ in 7-year-old children. *Environ Health Perspect*, 119(8): p. 1189-95.
23. Bradman, A., Castorina, R., Barr, D.B., Chevrier, J., Harnly, M.E., Eisen, E.A., McKone, T.E., **Harley, K.**, Holland, N., and Eskenazi, B. (2011). Determinants of

organophosphorus pesticide urinary metabolite levels in young children living in an agricultural community. *Int J Environ Res Public Health*, 8(4): p. 1061-83.

24. Castorina, R., Bradman, A., Sjodin, A., Fenster, L., Jones, R.S., **Harley, K.G.**, Eisen, E.A., and Eskenazi, B. (2011). Determinants of serum polybrominated diphenyl ether (PBDE) levels among pregnant women in the CHAMACOS cohort. *Environ Sci Technol*, 45(15): p. 6553-60.
25. Chevrier, J., **Harley, K.G.**, Bradman, A., Sjodin, A., and Eskenazi, B. (2011). Prenatal exposure to polybrominated diphenyl ether flame retardants and neonatal thyroid-stimulating hormone levels in the CHAMACOS study. *Am J Epidemiol*, 174(10): p. 1166-74.
26. Chevrier, J., **Harley, K.G.**, Kogut, K., Holland, N., Johnson, C., and Eskenazi, B. (2011). Maternal Thyroid Function during the Second Half of Pregnancy and Child Neurodevelopment at 6, 12, 24, and 60 Months of Age. *J Thyroid Res*, 2011: p. 426427.
27. **Harley, K.G.**, Chevrier, J., Schall, R.A., Sjodin, A., Bradman, A., and Eskenazi, B. (2011). Association of prenatal exposure to polybrominated diphenyl ethers and infant birth weight. *Am J Epidemiol*, 174(8): p. 885-92.
28. **Harley, K.G.**, Huen, K., Schall, R.A., Holland, N.T., Bradman, A., Barr, D.B., and Eskenazi, B. (2011). Association of organophosphate pesticide exposure and paraoxonase with birth outcome in Mexican-American women. *PLoS One*, 6(8): p. e23923.
29. Rosas, L.G., Guendelman, S., **Harley, K.**, Fernald, L.C., Neufeld, L., Mejia, F., and Eskenazi, B. (2011). Factors associated with overweight and obesity among children of Mexican descent: results of a binational study. *J Immigr Minor Health*, 13(1): p. 169-80.
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 44. *Volberg, V., **Harley, K.G.**, Aguilar, R.S., Rosas, L.G., Huen, K., Yousefi, P., Dave, V., Phan, N., Lustig, R.H., Eskenazi, B., and Holland, N. (2013). Associations between perinatal factors and adiponectin and leptin in 9-year-old Mexican-American children. *Pediatr Obes*.
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47. Alkon, A., Boyce, W.T., Tran, L., **Harley, K.G.**, Neuhaus, J., and Eskenazi, B. (2014). Prenatal Adversities and Latino Children's Autonomic Nervous System Reactivity Trajectories from 6 Months to 5 Years of Age. *PLoS One*, 9(1): p. e86283.
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54. Eskenazi, B., Kogut, K., Huen, K., **Harley, K.G.**, Bouchard, M., Bradman, A., Boyd-Barr, D., Johnson, C., and Holland, N. (2014). Organophosphate pesticide exposure, PON1, and neurodevelopment in school-age children from the CHAMACOS study. *Environ Res*, 134C: p. 149-157.

* Student paper

Exhibit G

Statement of Julie Herbstman



COLUMBIA CENTER
FOR CHILDREN'S
ENVIRONMENTAL
HEALTH

MAILMAN SCHOOL OF PUBLIC HEALTH
COLUMBIA UNIVERSITY

Statement for Julie Herbstman

June 11, 2014

I, Julie Herbstman, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I am an environmental epidemiologist, currently holding the position of Assistant Professor in the Department of Environmental Health Sciences at the Columbia University Mailman School of Public Health. I completed a master's of science (ScM) and a doctoral degree (PhD) in environmental epidemiology from the Johns Hopkins Bloomberg School of Public Health. I completed a postdoctoral fellowship in environmental health at the Columbia Mailman School of Public Health before joining the faculty. At Columbia, I am affiliated with the Columbia Center for Children's Environmental Health, the Columbia Center for Environmental Health in Northern Manhattan, and the Cancer Epidemiology Program at the Herbert Irving Comprehensive Cancer Center at the Columbia University Medical Center.

2. Since 2002, I have been studying the impact of prenatal exposure to polybrominated diphenyl ethers (PBDE) on children's thyroid hormone levels and neurodevelopment, first at Hopkins and now at Columbia. In my research, I have collected umbilical cord blood and have worked with the Centers for Disease Control and Prevention (CDC) to measure PBDE components (congeners) associated with the penta-brominated diphenyl ether (penta-BDE) mixture. I have found that all the neonates in my research studies in Baltimore and in New York had detectable levels of at least one penta-BDE congener in their cord blood [1,2]. We found evidence suggesting that prenatal exposure to penta-BDE congeners may impact perinatal thyroid hormone levels [3]. We also found that children who were exposed prenatally to higher concentrations of penta-BDE congeners (relative to children in the study with lower exposure) scored significantly lower on cognitive tests, including such tests as full-scale, verbal, and performance intelligence quotient (IQ) at ages 4 and 7 [1].

3. Based on this evidence along with evidence provided by other researchers in the field, I conclude that generally, infants in the US are born with detectable concentrations of penta-BDE in their circulating blood. This occurs because the mothers are exposed to penta-BDE either before or during pregnancy, and these chemicals are then transferred to the neonates while *in utero*. Additional research has shown that children's exposure to penta-BDE continues through the ingestion of penta-BDE-containing breast milk [4] and household dust [5]. Research shows that it is likely that penta-BDE in dust is the result of penta-BDE added to consumer products like furniture, toys, and electronics, which subsequently migrates into the household environment. I can conclude from this that other organohalogen flame retardants found in additive form in household consumer products also have the potential to migrate, leading to human exposure, especially in children.

4. Based on my research and the research of other investigators in the field, there is ample evidence indicating that prenatal exposure to penta-BDEs is associated with lower scores on indices of both cognition (e.g., IQ) and behavior throughout childhood. Since PBDEs have been phased out of use in new consumer products, new

compounds have been used instead. Some of these compounds are also organohalogen flame retardants, meaning they are in the same chemical family as PBDEs and other flame retardants that have been banned or phased out (e.g., brominated tris).

5. I have carefully reviewed the statement from Dr. Terry Collins about the toxicity mechanisms of organohalogen flame retardants, and the hazard screen performed by Dr. David Eastmond's group on 85 non-polymeric organohalogen flame retardants. Based on the information in these statements and my research and experience as an environmental epidemiologist, my professional opinion is that there is reason to be concerned that the entire class of organohalogen flame retardants may cause injury or illness to humans, particularly to fetuses and young children. Therefore, I support regulations designed to prevent human exposure to these chemicals from consumer products.

Sincerely,

Julie Herbstman, Ph.D.

References

1. Herbstman JB, Sjodin A, Kurzon M, Lederman SA, Jones RS, et al. (2010) Prenatal exposure to PBDEs and neurodevelopment. *Environ Health Perspect* 118: 712-719.
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5. Stapleton HM, Eagle S, Sjödin A, Webster TF. (2012) Serum PBDEs in a North Carolina toddler cohort: associations with handwipes, house dust, and socioeconomic variables. *Environ Health Perspect* 120(7): 1049-1054.

Julie Beth Herbstman

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TRAINING:

- Columbia University, Mailman School of Public Health***, New York, NY 2006-2010
Postdoctoral Research Fellow
Columbia Center for Children's Environmental Health
Mentor: Dr. Frederica P. Perera, DrPH
- Johns Hopkins University, Bloomberg School of Public Health***, Baltimore, MD 2007
PhD, Environmental Epidemiology (degree completed: June 2006)
Dissertation: "Prenatal Exposure to Polybrominated Diphenyl Ethers:
Effect on Birth Weight, Gestational Age, and Thyroid
Function"
Advisor: Dr. Lynn R. Goldman, MD MPH
- Johns Hopkins University, School of Public Health***, Baltimore, MD 2002
ScM, Epidemiology
Thesis: "Respiratory Effects of Inhalation Exposure Among Workers
During the Clean-Up Effort at the World Trade Center Disaster
Site"
Advisor: Dr. Margo Schwab, PhD
- Johns Hopkins University, School of Public Health***, Baltimore, MD 2001
Certificate in Risk Sciences and Public Policy
- Tufts University***, Medford, MA 1998
B.A. (*cum laude*), Major: Comparative Religion; Minor: Engineering
Science; Certificate in Community Health

FELLOWSHIPS AND AWARDS:

- Career Development Award*** 2012-2014
*Center for Environmental Health in Northern Manhattan,
Columbia University*
- K99-R00 "Pathway to Independence" Career Development Award (NIEHS)*** 2009-2014
Sponsor (for K99 phase): Dr. Frederica Perera
- National Cancer Institute Postdoctoral Fellowship*** 2006-2009
Principal Investigator: Dr. Alfred Neugut
- Center for a Livable Future Research Award*** 2004, 2005
Principal Investigator: Dr. Lynn Goldman
- Doctoral Fellowship in Environmental Public Health Tracking*** 2004-2005
Principal Investigator: Dr. Thomas Burke
- The Charlotte Ferenze Fellowship*** 2004
Johns Hopkins Department of Epidemiology

Maternal Child Health – Epidemiology Fellowship in Applied Epidemiology	2003-2004
<i>Principal Investigator: Dr. Pat O'Campo</i>	
National Cancer Institute Summer Fellowship	2001
<i>Mentor: Dr. Montserrat Garcia-Closas</i>	
 <u>SCIENCE ADVISORY BOARD/REVIEW PANELS:</u>	
Columbia's Center for Environmental Health in Northern Manhattan, Pilot grant review	2012
Einstein-Montefiore Institute for Clinical and Translational Research, Mentored Clinical and Translational Research Career Development Awards review	2012
University of Michigan Environmental Health Science Core Center, Pilot grant review	2012
Harvard School of Public Health NIEHS Center, Pilot grant review	
NIEHS R13 Peer Review Panel	October 2012
U.S. EPA Science Advisory Board Panel on Perchlorate	2012-2013
NIH, Infectious Disease, Reproductive Health, Asthma and Pulmonary Conditions Study Section (IRAP), Ad Hoc Member	June 2013
New York Academy of Sciences, Scientific conferences review	2013
Canadian Institutes of Health Research, external reviewer.	2013
NIH, Neurological, Aging, Musculoskeleton, and Epidemiology Study Section (NAME), Ad Hoc Member	October 2014
South African Medical Research Council (MRC), external reviewer.	2014
 <u>RESEARCH EXPERIENCE:</u>	
Assistant Professor	2010-present
Research Fellow/Scientist	2006-2010
Columbia Center for Children's Environmental Health	
NIEHS Center for Environmental Health in Northern Manhattan	
Herbert Irving Cancer Center Member	
Department of Environmental Health Sciences	
Columbia Mailman School of Public Health	
New York, NY	
 Research Investigator	 2006-present
Research Assistant	2003-2006
"Tracking Health Related to Environmental Exposures" (THREE) Study	
Department of Environmental Health Sciences	
Johns Hopkins Bloomberg School of Public Health	
Baltimore, MD	
 Research Fellow	 2003-2006
Johns Hopkins Center of Excellence in Environmental Health Tracking	
Department of Health Policy and Management	
Johns Hopkins Bloomberg School of Public Health	
Baltimore, MD	

<i>Research Fellow</i>	2001-2004
Johns Hopkins World Trade Center (WTC) Research Team Department of Environmental Health Sciences Johns Hopkins Bloomberg School of Public Health Baltimore, MD	
<i>Research Intern, Environmental Epidemiology Branch</i>	2001
Department of Cancer Epidemiology and Genetics National Cancer Institute Rockville, MD	
<i>Research Assistant</i>	2000
North Dakota Children's Health Study Department of Epidemiology Johns Hopkins School of Public Health Baltimore, MD	
<i>Research Assistant</i>	1998-2000
Nurses' Health Study Channing Laboratory Brigham and Women's Hospital Boston, MA	
<i>Research Intern</i>	1998
Silent Spring Institute Newton, MA	
<u>TEACHING EXPERIENCE:</u>	
<i>Instructor, Postgraduate Course at the American Thoracic Society Meeting</i>	2012, 2014
• The Epigenetics of Lung Disease (1 day)	
<i>Instructor, Workshop in Risk Assessment and Molecular Epidemiology Shanghai Fudan University</i>	2010
• Molecular Epidemiology (1 week)	
<i>Course Director/Instructor, Department of Environmental Health Sciences</i>	2006-Present
Columbia Mailman School of Public Health	
• Analysis of Environmental Data (2013, 2014), Course Director	
• Molecular Epidemiology (2006-present), Lecturer	
• Journal Club (2011), Lecturer	
<i>Teaching Assistant, Department of Epidemiology</i>	
Johns Hopkins Bloomberg School of Public Health	
• Introduction to Epidemiology (2 years)	2001-2002
• Intermediate Epidemiology (2 years)	2004
• Quantitative Methods (4 years)	2002-2005
• Health Services Research (1 year)	2003
Johns Hopkins Krieger School of Arts and Sciences	
• Introduction to Epidemiology (1 year)	2003

Instructor, Experimental College

Tufts University

- Freshman literature course (1 year) 1998

MENTORING/ADVISING (COLUMBIA UNIVERSITY, UNLESS NOTED):

Jelena Vujcic, MPH, Department of Epidemiology	2009
Susan Edwards, MPH, Department of Environmental Health Sciences	2009
Erin Paxson, MS, Department of Human Nutrition	2009
Jennifer Mall, MPH, Department of Environmental Health Sciences	2010
Steven Cook, MPH, Department of Environmental Health Sciences	2011
Rosie Martinez, MPH, Department of Environmental Health Sciences	2012-2014
Shoko Kubotera, MPH, Department of Environmental Health Sciences	2012-2014
Whitney Cowell, PhD candidate, Department of Environmental Health Sciences	2012-present
Kristin White, MPH, Department of Epidemiology	2012
Zaynah Abid, MPH, Yale School of Public Health	2012
Katherine Schleiss, MPH, Department of Epidemiology	2013
Madeleine Hopson, MPH, Department of Environmental Health Sciences	2013-present
Erin Eimutus, MPH, Department of Environmental Health Sciences	2014-present

SELECTED ORAL PRESENTATIONS:

Prenatal Programming and Toxicity (PPTox) IV: Environmental Stressors in Disease and Implications for Human Health. (2014, Boston, MA)

Title: Cell distribution prediction from DNA methylation data using a reference set derived from umbilical cord blood

Northeast Regional Chapter of the Society of Toxicology Annual Meeting: Toxicological Aspects of Epigenetics (2014, Storrs, CT)

Title: DNA methylation and the challenge of linking prenatal exposures to childhood health outcomes

Duke University Integrated Toxicology and Environmental Health Program Spring Symposium (2013, Durham, NC)

Title: Detecting Methylation Changes Associated with Prenatal Exposure to Air Pollutants

Third Symposium on Anesthesia and Neurodevelopment in Children (2012, New York, NY)

Title: Use of Epigenetic Analyses in Studies of Neurodevelopment

American Academy of Pediatrics Julius B. Richmond Center of Excellence Visiting Lectureship and Grand Rounds (2012, Baton Rouge, LA)

Title: Human Epigenetics of Air Pollution

NIEHS Core Centers Meeting: Young Investigator Presentation (2012, Boston, MA)

Title: Using Sibling Pairs to Identify PAH-related Methylation Differences

International Society for Environmental Epidemiology (2011, Barcelona, Spain)

Title: Prenatal Exposure to PBDEs and Child Behavior at 3-7 Years

12th Annual Brominated and Other Flame Retardants (2011, Boston, MA)

Title: PBDE Levels In Children Determined Longitudinally From Birth To Age 9

Dioxin 2010 (2010, San Antonio, TX)

Title: Prenatal Exposure to PBDEs and Neurodevelopment

Am. Assoc. of Cancer Research, Future of Molecular Epidemiology (2010, Miami, FL)

Title: Using sibling pairs to study the epigenetic effects of prenatal PAH exposure

International Society for Environmental Epidemiology (2009 Dublin, Ireland)

Title: Prenatal exposure to polycyclic aromatic hydrocarbons and CpG methylation

International Society for Environmental Epidemiology (2008 Pasadena, CA)

Title: Prenatal Exposure to PBDEs and Neurodevelopment

International Society for Environmental Epidemiology (2007 Mexico City, MX)

Title: PBDE Exposure, Maternal-Fetal Transfer and Birth Outcomes

American Public Health Association (2005 Philadelphia, PA)

Title: State Capacity to Address Non-Communicable Disease Clusters

Dioxin 2005 (2005 Toronto, ON)

Title: PCBs and PBDEs and Thyroid Hormone Levels in Umbilical Cord Blood in an Urban U.S. population: A Feasibility Study.

Johns Hopkins Center for a Livable Future Research Day (2005 Baltimore, MD)

Title: The Effect of Brominated Flame Retardants (PBDEs) on Thyroid Hormone Status, Birthweight and Gestational Age.

American Industrial Hygiene Association, Chesapeake Section (2002 Baltimore, MD)

Title: Respiratory Health of Rubble Removal Workers at the World Trade Center Disaster Site

International Society of Environmental Epidemiology (2002 Vancouver, BC)

Title: Respiratory Health of Rubble Removal Workers at the World Trade Center Disaster Site

Title: Comparison of Exposure Surrogates for Predicting Health Status among Rubble Removal Workers at the WTC Disaster Site.

RESEARCH INTERESTS:

Perinatal and developmental epidemiology, health effects of endocrine disrupting chemicals, neurodevelopment, environmental public health surveillance, cancer, and children's health

PEER-REVIEWED PUBLICATIONS:

Barr RG, **Herbstman J**, Speizer FE, Camargo CA Jr. Validation of self-reported chronic obstructive pulmonary disease in a cohort study of nurses. *American Journal of Epidemiology*. 2002 May 15;155(10):965-71. [PMID: 11994237]

Garcia-Closas M, **Herbstman J**, Schiffman M, Glass A, Dorgan JF. Relationship between serum hormone concentrations, reproductive history, alcohol consumption and genetic polymorphisms in pre-menopausal women. *International Journal of Cancer*. 2002 Nov 10;102(2):172-8. [PMID: 12385014]

Landrigan PJ, Liroy PJ, Thurston G, Berkowitz G, Chen LC, Chillrud SN, Gavett SH, Georgopoulos PG, Geyh AS, Levin S, Perera F, Rappaport SM, Small C; **NIEHS World Trade Center Working Group**. Health and environmental consequences of the World Trade Center disaster. *Environmental Health Perspectives*. 2004 May;112(6):731-9. [PMID: 15121517]

Herbstman J, Frank R, Schwab M, Williams DL, Samet J, Breyse P and Geyh A Respiratory effects of inhalation exposure among workers during the clean-up effort at the World Trade Center disaster site. *Environmental Research*. 2005 September; 99(1):85-92. [PMID: 16053932]

Geyh AS, Chillrud S, Williams D, **Herbstman JB**, Symons JM, Turpin, BJ, Lim, HJ, Kim, SR, Breyse PN. "Assessing truck driver exposure at the World Trade Center disaster site: personal and area monitoring for particulate matter and volatile organic compounds during October 2001 and April 2002." *Journal of Occupational and Environmental Hygiene*. 2005 March;2(3):179-93. [PMID: 15764541]

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Juzuch NS, Resnick B, Streeter R, **Herbstman J**, Zablotsky J, Fox M, Burke TA. State Capacity to Address Non-Communicable Disease Clusters: Is it Adequate in the Era of Environmental Public Health Tracking. *American Journal of Public Health*. 2007 Apr; 97 Suppl 1: S163-9. [PMID: 17413060]

Apelberg BJ, Goldman LR, Calafat AM, **Herbstman JB**, Kuklennyik Z, Heidler J, Neeham LL, Halden RU, Witter FR. Determinants of Fetal Exposure to Perfluorinated Compounds in Baltimore, Maryland. *Environmental Science and Technology*. 2007 Jun 1; 41(11):3891-7. [PMID: 17612165]

Apelberg BJ, Witter FR, **Herbstman JB**, Calafat AM, Halden RU, Needham LL, Goldman LR. Cord serum concentrations of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in relation to weight and size at birth. *Environmental Health Perspectives*. 2007 Nov; 115(11):1670-6. [PMID: 18008002]

Herbstman JB, Sjödin A, Apelberg BJ, Witter FR, Paterson DG, Halden RU, Jones RS, Park A, Zhang Y, Heidler J, Needham LL, Goldman, LR. Determinants of prenatal exposure to polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) in an urban population. *Environmental Health Perspectives*. 2007 Dec; 115(12):1794-800. [PMID: 18087602]

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- Perera FP and **Herbstman JB**. Emerging technology in molecular epidemiology: what epidemiologists need to know. *Epidemiology*, 2008 Mar;19(2):350-2. [PMID: 18277170]
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- Wells EM, Navas-Acien A, **Herbstman JB**, Apelberg BJ, Silbergeld EK, Caldwell KL, Jones RL, Halden RU, Witter FR, and Goldman LR. Low Level Lead Exposure and Elevations in Blood Pressure During Pregnancy, *Environmental Health Perspectives*. 2011 May;119(5):664-9. [PMID: 21292600]
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- Tang WY, Levin L, Talaska G, Cheung YY, **Herbstman J**, Tang D, Miller RL, Perera F, Ho SM. Maternal Exposure to Polycyclic Aromatic Hydrocarbons and 5'-CpG Methylation of Interferon- γ in Cord White Blood Cells. *Environmental Health Perspectives*. 2012 Aug; 120(8): 1195-200. [PMID: 22562770]
- Herbstman JB**, Wang S, Perera FP, Lederman SA, Vishnevetsky J, Rundle AG, Hoepner LA, Qu L, Tang D. Predictors and consequences of global DNA methylation in cord blood and at three years. *PLoS One*. 2013 Sep 4;8(9). [PMID: 24023780]
- Abid Z, Roy A, **Herbstman JB**, Ettinger AS. Urinary Polycyclic Aromatic Hydrocarbon Metabolites and Attention Deficit/Hyperactivity Disorder, Learning Disability, and Special Education in U.S. children Aged 6-15. *J Environ Public Health*. 2014; 2014:628508. [PMID: 24624143]
- Herbstman JB** and Mall JK. PBDEs and Neurodevelopment, *Current Environmental Health Reports*. (2014), June; 1(2): 101-112.
- Wells EM, Navas-Acien A, Apelberg BJ, **Herbstman JB**, Jarrett JM, Lin YH, Verdon CP, Ward C, Caldwell KL, Hibbeln JR, Halden RU, Witter FR, Goldman LR. Association of selenium and copper with lipids in umbilical cord blood. *Journal of Developmental Origins of Health and Disease*. 2014 Aug; 5(4):281-7.
- Perera FP, Chang HW, Tang D, Roen EL, **Herbstman J**, Margolis A, Huang TJ, Miller RL, Wang S, Rauh V. Early-life exposure to polycyclic aromatic hydrocarbons and ADHD behavior problems. *PLoS One*. 2014 Nov 5;9 (11).
- Hansmeier N, Chao TC, **Herbstman JB**, Goldman LR, Witter FR, Halden RU. Elucidating the Molecular Basis of Adverse Health Effects from Exposure to Anthropogenic Polyfluorinated Compounds Using Toxicoproteomic Approaches. *J Proteome Res*. 2014 Nov 11 (*in press*).
- Kundakovic M, Gudsnuk K, **Herbstman JB**, Tang D, Perera FP, Champagne FA. DNA methylation of BDNF as a biomarker of early-life adversity. *Proc Natl Acad Sci USA*. 2014 Nov 10 (*in press*).

BOOK CHAPTERS:

Miller RL and **Herbstman JB**. Epigenetic mechanisms in asthma, In: Epigenetics Nutrition and Environmental Health. Wiley Publishers, 2009.

PEER-REVIEW ACTIVITIES: MANUSCRIPT REVIEWER

Chemosphere, Environmental Research, Environmental Health Perspectives, Environmental Science and Technology, Ecotoxicology and Environmental Safety, Environment International, Environmental Health, Pediatrics, Journal of Hazardous Materials, Emerging Health Threats, PLoS ONE, American Journal of Epidemiology, Epidemiology, PLoS Genetics, New England Journal of Medicine, Environmental and Molecular Mutagenesis, Epigenetics, Nature Communications.

Exhibit H

Statement of Susan Kasper



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University of Cincinnati
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Cincinnati, OH 45267-0056

Kettering
160 Panzeca Way
Cincinnati, OH 45267-0056
513-558-5701

October 7, 2014

I, Susan Kasper, am writing this statement in support of the Petition to the CPSC to ban certain household products containing additive monomer organohalogen flame retardants.

1. I, Susan Kasper PhD, am an Associate Professor in the Department of Environmental Health at the University of Cincinnati, College of Medicine. I have a Ph.D. and a M.Sc. in Physiology/Endocrinology from the University of Manitoba, Canada. Please see my CV and list of publications attached.

2. Research in my laboratory has focused on the mechanisms by which cancers develop and progress to become therapy resistant. This includes the role of chemicals such as organohalogen flame retardants on cancer progression. Many organohalogen flame retardants are Persistent Organic Pollutants (POPs), indicating that they are resistant to degradation and capable of remaining in the environment for many years. Furthermore, they are readily absorbed in the food chain and stored in fatty tissues¹. Most Americans, when tested, were found to have trace levels of flame retardants in multiple tissues, including adipose, liver, muscle, skin and blood². Importantly, organohalogen flame retardants can interfere with normal hormonal function in that they act as "endocrine disrupting chemicals" (EDCs) to either mimic or inhibit the action of naturally occurring hormones^{3,4}. Exposure to organohalogen flame retardants has been linked to developmental defects, altered neurologic function, infertility, and cancer (reviewed in Koprass et al., 2014)⁵. Indeed, exposures to EDCs during the critical time of growth and development can result in genetic modifications that are passed down to subsequent generations⁶.

3. For the past few years, we have studied the endocrine disrupting activities of Firemaster® 550 (FM 550), a new-generation flame-retardant mixture and previously the second most commonly detected flame retardant in polyurethane foam in the United States⁷. FM 550 might now be the most commonly used flame retardant in polyurethane foam since the previously most common compound, TDCPP, has been listed as a carcinogen under California Proposition 65 and is therefore slowly being phased out.

4. FM 550 is a mixture of two organohalogens (2-ethylhexyl-2,3,4,5-tetrabromobenzoate or TBB and bis(2-ethylhexyl)-2,3,4,5-tetrabromophthalate or TBPH) and organophosphates (isopropylated triphenylphosphate isomers or ITPs, and triphenyl phosphate or TPP). The organohalogen components TBB and TBPH have been found in indoor dust, outdoor air, marine mammal tissues, wastewater and sewage sludge^{8,9,10,11,12,13,14}. Stapleton and coworkers determined that exposure to FM 550 components could be measured in tissues of pregnant rat dams and offspring. In pregnant dams, TBB increased serum thyroxine levels and reduced

hepatic carboxylesterase activity; in offspring, exposure to FM 550 in the mother's milk resulted in male cardiac hypertrophy, advanced female puberty, significant weight gain in both males and females, and altered exploratory behaviors^{15,16}. These results demonstrate for the first time that at environmentally relevant levels, FM 550 affects multiple biological processes, including organ development and function, weight gain, and behavior.

5. In our lab we are studying the effects of FM 550 on prostate cancer stem cells (CSC). Prostate CSCs comprise less than 0.1% of the total number of tumor cells, but they are central to promoting tumor growth, metastasis, and the emergence of treatment-resistant disease^{17,18}. Using prostate CSC-like cells derived from human patient biopsy specimens, our initial findings imply that three FM 550 components, namely ITP, TBPH and TBB, are capable of stimulating the rapid expansion of prostate cancer stem cells. Moreover, this response is similar to that observed in CSC-like cells treated with the antiandrogens Casodex and hydroxyflutamide. Therefore, FM 550 could act as an endocrine disrupting chemical to promote the expansion of CSCs. Since prostate CSCs are thought to be resistant to androgen deprivation therapy, expansion of this cell type by FM 550 activity could promote resistance to clinical treatment.

6. The observation that FM 550 exerts anti-androgenic-like activity in prostate cancer implies a high probability that FM 550 will also exert its anti-androgenic effects on non-cancerous processes. These include the development and function of the male reproductive system (prostate, seminal vesicles, penis, testes, epididymis), spermatogenesis, and male fertility¹⁹ as well as normal ovary development in females²⁰.

7. The available data on organohalogen flame retardants indicates a high likelihood that other yet unstudied members of this class of chemicals are also endocrine disruptors, which means they can impair normal cell development, and thus cause substantial personal injury or substantial illness. Therefore, I support this petition to the CPSC to ban consumer products containing organohalogen flame retardants in additive form, where there is a high risk of human exposure.

Yours sincerely,



Susan Kasper, Ph.D.
Associate Professor,
Environmental Health,
University of Cincinnati College of Medicine

¹ Bartrons M, Grimalt JO, de Mendoza G, Catalan J. Pollutant dehalogenation capability may depend on the trophic evolutionary history of the organism: PBDEs in freshwater food webs. *PLoS One*. 2012;7(7):e41829.

² Szabo DT, Diliberto JJ, Hakk H, Huwe JK, Birnbaum LS. Toxicokinetics of the flame retardant hexabromocyclododecane alpha: effect of dose, timing, route, repeated exposure, and metabolism. *Toxicol Sci*. 2011;121(2):234-44.

³ Stapleton HM, Sharma S, Getzinger G, Ferguson PL, Gabriel M, Webster TF, Blum A. Novel and high volume use flame retardants in US couches reflective of the 2005 PentaBDE phase out. *Environ Sci Technol*. 2012;46:13432-39.

⁴ Birnbaum LS. When environmental chemicals act like uncontrolled medicine. *Trends Endocrin Met*. 2013;24:321-3.

⁵ Kopras E, Potluri V, Bermudez ML, Williams K, Belcher S, Kasper S. Actions of endocrine-disrupting chemicals on stem/progenitor cells during development and disease. *Endocr Relat Cancer*. 2014;21(2):T1-12.

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- ⁸ Ma Y, Venier M, Hites RA. 2-Ethylhexyl tetrabromobenzoate and bis(2-ethylhexyl) tetrabromophthalate flame retardants in the Great Lakes atmosphere. *Environ Sci Technol*. 2012;46:204-8.
- ⁹ Lam JC, Lau RK, Murphy MB, Lam PK. Temporal trends of hexabromocyclododecanes (HBCDs) and polybrominated diphenyl ethers (PBDEs) and detection of two novel flame retardants in marine mammals from Hong Kong, South China. *Environ Sci Technol*. 2009;43:6944-9.
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- ¹¹ Klosterhaus SL, Stapleton HM, La Guardia MJ, Greig DJ. Brominated and chlorinated flame retardants in San Francisco Bay sediments and wildlife. *Environ Int*. 2012;47:56-65.
- ¹² Davis EF, Klosterhaus SL, Stapleton HM. Measurement of flame retardants and triclosan in municipal sewage sludge and biosolids. *Environ Int*. 2012;40:1-7.
- ¹³ Ali N, Harrad S, Goosey E, Neels H, Covaci A. "Novel" brominated flame retardants in Belgian and UK indoor dust: implications for human exposure. *Chemosphere* 2011;83:1360-1365.
- ¹⁴ Ali N, Harrad S, Goosey E, Neels H, Covaci A. "Novel" brominated flame retardants in Belgian and UK indoor dust: implications for human exposure. *Chemosphere* 2012;83:1360-5.
- ¹⁵ Springer C, Dere E, Hall SJ, McDonnell EV, Roberts SC, Butt CM, Stapleton HM, Watkins DJ, McClean MD, Webster TF, Schlezinger JJ, Beekelheide K. Rodent thyroid, liver, and fetal testis toxicity of the monoester metabolite of bis-(2-ethylhexyl) tetrabromophthalate (TBPH), a novel brominated flame retardant present in indoor dust. *Environ Health Perspect*. 2012;120:1711-9.
- ¹⁶ Patisaul HB, Roberts SC, Mabrey N, McCaffrey KA, Gear RB, Braun J, Belcher SM, Stapleton HM. Accumulation and endocrine disrupting effects of the flame retardant mixture Firemaster® 550 in rats: an exploratory assessment. *J Biochem Mol Toxicol*. 2013;27(2):124-36.
- ¹⁷ Gu G, Yuan J, Wills M, Kasper S. Prostate cancer cells with stem cell characteristics reconstitute the original human tumor in vivo. *Cancer Res*. 2007;67(10):4807-15.
- ¹⁸ Chaffer CL, Weinberg RA. A perspective on cancer cell metastasis. *Science*. 2011;331(6024):1559-64.
- ¹⁹ Kopras E, Potluri V, Bermudez ML, Williams K, Belcher S, Kasper S. Actions of endocrine-disrupting chemicals on stem/progenitor cells during development and disease. *Endocr Relat Cancer*. 2014;21(2):T1-12.
- ²⁰ Prizant H, Gleicher N, Sen A. Androgen actions in the ovary: balance is key. *J Endocrinol*. 2014. pii: JOE-14-0296.

CURRICULUM VITAE

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BIRTH PLACE: Winnipeg, MB, Canada

EDUCATIONAL BACKGROUND:

1972-74; 1976-78 B. Sc. Honours in Zoology
 University of Manitoba, Winnipeg, Manitoba, Canada

1974 – 75 Department of Forestry
 University of British Columbia, Vancouver, BC, Canada

1975 – 76 Bodenseehof School, Friedrichshafen, Germany

1978 – 81 M. Sc. in Physiology/Endocrinology
 Department of Physiology, Faculty of Medicine
 University of Manitoba, Winnipeg, Manitoba, Canada

1981 – 84 Ph.D. in Physiology/Endocrinology
 Department of Physiology, Faculty of Medicine
 University of Manitoba, Winnipeg, Manitoba, Canada

1984 – 86 Ph.D. Fellow
 Department of Physiology, Faculty of Medicine
 University of Manitoba, Winnipeg, Manitoba, Canada

1986-87 Postgraduate: Medical Research Council of Canada Postdoctoral Fellow Dana
 Farber Cancer Institute, Harvard Medical School, Boston, MA.

1987-89 Postgraduate: Medical Research Council of Canada Postdoctoral Fellow
 Department of Molecular Medicine, New England Medical Center Hospitals, Boston,
 MA.

ACADEMIC AND PROFESSIONAL POSITIONS:

2008-present Associate Professor (tenured), Department of Environmental Health, College of
 Medicine, University of Cincinnati, Cincinnati, OH.

2001-08 Assistant Professor (tenure track), Department of Urologic Surgery, Vanderbilt
 University Medical Center, Nashville, TN.

2001-08 Assistant Professor, cross-appointment in the Department of Cancer Biology.

- 2001-08 Assistant Professor, cross-appointment in the Department of Cell and Developmental Biology
- 2001-08 Member, Vanderbilt Ingram Cancer Center
- 1996-01 Research Assistant Professor (non-tenured), Department of Urologic Surgery, Vanderbilt University Medical Center, Nashville, TN.
- 1989-96 Research Associate, Department of Physiology, University of Manitoba, Winnipeg, MB, Canada.

AWARDS:

- 2014 *Endocrinology* Outstanding Reviewer Award
- 2000 American Urological Association Gallery Best Poster Award
- 1998 Society for Basic Urologic Research Travel Award
- 1997 Society for Basic Urologic Research Travel Award
- 1997 Stowell-Orbison Award, USCAP Best Poster
- 1996 CaP CURE Award, *Co-Investigator* (PI: RJ Matusik RJ), "Progression of Prostate Cancer to Androgen Dependence: The Role of the Androgen Receptor and Tumour-Derived Transcription Factors." [1 of only 2 awarded in Canada]
- 1996 American Urological Association Gallery Best Poster Award
- 1995 American Urological Association Gallery Best Poster Award
- 1993 Society for Basic Urologic Research Award (for Outstanding Science)
- 1986-88 Medical Research Council of Canada Postdoctoral Fellowship Award
- 1985 Drewry Memorial Scholarship and Medal for best Ph.D. dissertation in the Academic Year of 1985, Faculty of Medicine, Univ. of Manitoba

PATENTS/LICENSES:

- 2007 HPET cancer stem cell lines (licensed to Pfizer Global Research and Development, La Jolla laboratories, San Diego, CA).

GRANTS:**Active:**

- 2013-2018 National Institutes of Health, NCI, *Co-Investigator* (PI: Gail Prins) "Estrogen Receptors in Human Prostate Stem-Progenitor Cells", R01 CA172220
- 2014-2015 CEG Pilot Projects Program 2014, *Principal Investigator*, "Exposure to Flame Retardants and Prostate Cancer".

Pending Support

- 2014-2019 National Institutes of Health, *Co-Investigator* (PI: Susan Waltz), "The HGGL:Ron receptor tandem in prostate cancer".
- 2015-2020 National Institutes of Health, *Principal Investigator*, "Inertial Microfluidics for Isolating Clinically Predictive Circulating Tumor Cells".
- 2015-2020 Department of Defense, Synergistic Idea Development Award application, *Principle Investigator*, "Circulating tumor cell subpopulations in early stages of prostate cancer progression".

Completed:

- 2009-13 Department of Defense Prostate Cancer Research Program, *Principal Investigator*, "DJ-1 in the Development of Hormone Refractory Prostate Cancer", W81XWH-08-1-0370.
- 2009-13 Department of Defense Prostate Cancer Research Program, *Principal Investigator*, "The Function of AR-Negative Cancer Stem Cells in Prostate Cancer", W81XWH-08-1-0662.
- 2003-11 National Institutes of Health, NIDDK, *Principal Investigator*, "Development of Androgen-Independent Prostate Cancer", DK060957
- 2004-09 National Institutes of Health, NCI, *Co-Investigator* (PI: RJ Matusik), "A Transgenic Mouse Model for Prostate Cancer", CA076142-08
- 2003-08 National Institutes of Health, NIDDK, *Co-Investigator* (PI: RJ Matusik), "Control of Prostate-Specific Gene Expression DK055748-06
- 2003- 04 Vanderbilt Ingram Cancer Center, *Co-Investigator* (PI: RJ Matusik), "PPG Pilot Project on Prostate Cancer"
- 2002-07 National Institutes of Health, NIDDK, *Principal Investigator*, "Developmental Biology of the Normal Mouse Prostate", DK059142
- 2000-03 Department of Defense, *Co-Investigator* (PI: RJ Matusik RJ), "Growth Inhibitory and Stimulatory Signals in Prostate Cancer", DAMD 17-00-1-0105
- 1999-04 National Institutes of Health, NCI, *Co-Investigator* (PI: RJ Coffey), "Mouse Cancer Models Via TGF β RII Loss", 5U01 CA84239
- 1997-98 NCI Cancer Center Support Grant, *Principal Investigator*, "Progression of Prostate Cancer to Androgen Independence: a Role for the Androgen Receptor, IP30 CA68485
- 1996-97 National Institutes of Health, NIDDK, *Principal Investigator* (Director: MC Orgebin-Crist), "Peptide Growth Factors in Male Genitourinary Development", HD05797-25

PROFESSIONAL SOCIETY MEMBERSHIPS:

American Association for the Advancement of the Sciences, American Society of Cell Biology, American Urological Association, the Endocrine Society, Society for Basic Urologic Research, Vanderbilt Urology Society.

COMMITTEE SERVICE:**EXTRAMURAL (National and International):**

- 2014-present Member, Planning Committee, Fall 2015 meeting, Society for Basic Urologic Research
- 2014 *Chair*, Abstract Committee, 2014 Fall Meeting, Society for Basic Urologic Research
- 2014-present Member, Planning Committee, Spring 2015 meeting, Society for Basic Urologic Research
- 2010-11 Organizing Committee, World Congress Urological Research, Innsbruck, Austria, September 15-17, 2011
- 2010-11 Advisory Board, Gordon Research Conference on Hormone Action in Development and Cancer, Bryant University, Smithfield, RI, July 31-August 5, 2011
- 2011 Endocrine Society, Annual Meeting 2011, Abstracts Review Committee

- 2009-10 Organizing Committee, Fall Meeting, Society for Basic Urologic Research, Atlanta, GE, November 11-14, 2010
- 2008-09 Advisory Board, Gordon Research Conference on Hormone Action in Development and Cancer, Holderness School, Holderness, NH, July 26-31, 2009 2008 American Urology Association Conference, Abstracts Review Committee
- 2007-09 *Chair*, ByLaws Committee, Society for Basic Urologic Research
- 2004-07 *Chair*, Membership Committee, Society for Basic Urologic Research
- 2001-03 Executive Board, Society for Basic Urologic Research
- 1997-2008 Nashville Symphony Chorus, Soprano II
- 1995-96 *Chair*, Eden Health Care Services
- 1994 Vice Chair, Eden Health Care Services
- 1993 Secretary, Eden Mental Health Centre Hospital Board
- 1990-96 Board of Directors, Eden Health Care Services including Eden Mental Health Centre Hospital, Linden Place, Recovery of Hope counseling services, Enns Court Supported Housing Apartments, Segue Vocational Program.

INTRAMURAL:

- 2014-15 *Coordinator*, Department of Environmental Health Wednesday Seminar Series; Fall and Spring series.
- 2012-present Appointment, Reappointment, Promotion, and Tenure (ARPT) committee, Dept. of Environmental Health, UC
- 2012 Department of Environmental Health Wednesday Seminar spring series; co-organizer
- 2011-present Institutional Biosafety Committee, University of Cincinnati
- 2005-08 Executive Committee, HBCU Partnership grant, Department of Defense, Prostate Cancer Research Grant, Vanderbilt and Meharry Universities
- 2005-08 Institutional Biosafety Committee, Vanderbilt University
- 2004-08 American Cancer Society Pilot Project Review Committee, Vanderbilt Ingram Cancer Center
- 2003 The Pilot and Feasibility Committee of the Vanderbilt Diabetes Center
- 2000-08 The Vanderbilt Prostate Cancer Center, Member
- 1998-01 Institutional Animal Care and Use Committee, Vanderbilt University

PROFESSIONAL SERVICE and ACTIVITIES:

Journal Reviewer (ad Hoc): *American Journal of Pathology; Cancer; Cancer Letters; Cancer Research; Cancer Epidemiology Biomarkers and Prevention; Carcinogenesis; Cell Death and Differentiation; Clinical Cancer Research; Current Gene Therapy; Developmental Biology; Differentiation; Endocrine-Related Cancer, Endocrinology; Endocrine-Related Cancer; Future Oncology; Gynecologic Oncology; Histology and Histopathology; International Journal of Cancer; Investigative Urology; Journal of Biological Chemistry; Journal of Mass Spectrometry; The Journal of Steroid Biochemistry and Molecular Biology; Journal of Urology; Molecular Biology of the Cell; Molecular Cancer, Molecular Cancer Therapeutics; Molecular Carcinogenesis; Molecular and Cellular Biology; Molecular Endocrinology; Nature; Nature Communications; Nature Medicine; Nature Reviews Urology; Oncogene; PLOS ONE; Reproductive Toxicology; Science; Stem Cells; Stem Cell Reviews; Steroid Biochemistry & Molecular Biology; The Prostate; Translational Andrology and Urology; Transgenic Research; Urology; Urologic Oncology: Seminars and Original Investigations*

Editorial Boards:

- 2012-present *Endocrinology*
- 2012-present *The Prostate*

Grant Review Panels and Study Sections:

2014	NCI Omnibus (R03 and R21) SEP ZCA1 SRB-V(O1) (June 26-27)
2013	Prostate Cancer UK, Pilot Award, PA13-028 (August 27; external reviewer)
2013	Innovative Molecular Analysis Technologies, IMAT (August, <i>ad hoc</i>)
2013	NCI Review Meeting, Molecular Analysis Technologies, RFA-CA-13-002 (July, <i>ad hoc</i>)
2013	Prostate Cancer UK (Spring; external reviewer)
2013	Innovative Molecular Analysis Technologies, IMAT (February, <i>ad hoc</i>)
2012	Austrian Science Fund, Vienna, Austria, Biological and Medical Sciences (October)
2011	NCI, RFA-CA-11-010, "Cancer Target Discovery and Development (CTDD) Network (U01) (November, <i>ad hoc</i>)
2011	Innovative Molecular Analysis Technologies, IMAT (March, <i>ad hoc</i>)
2010	Department of Defense, PCRP PRE-END peer review panel (April 8)
2009	Innovative Molecular Analysis Technologies, IMAT (November, <i>ad hoc</i>)
2009	ARRA Grand Opportunities Grant Review, NCI Molecular Target Discovery and Development Centers Pilot Program (August, <i>ad hoc</i>)
2009	Innovative Molecular Analysis Technologies, IMAT (June, <i>ad hoc</i>)
2009	American Cancer Society Ohio Division Supported Research (May, <i>ad hoc</i>)
2009	Innovative Molecular Analysis Technologies, IMAT (March, <i>ad hoc</i>)
2009	British Prostate Cancer Charity (January)
2008	British Prostate Cancer Charity (January)
2007	Department of Defense, Prostate Cancer Research Program PCT-1
2007	Israel Science Foundation, Life Sciences & Medicine
2006	Molecular Oncogenesis Study Section (<i>ad hoc</i>)
2006	North Carolina Biotechnology Center Multidisciplinary Research Grants Program
2005-07	Molecular, Cellular, and Developmental Neuroscience Study Section
2005	NIH Special Emphasis Panel: Cell Selective Research Tools and Methods for Studies of the Genitourinary Tract (June)
2005	Australian NHMRC Grant Review Panel 3A, Endocrinology and Reproduction
2004	NIH Special Emphasis Panel: Cell Selective Research Tools and Methods for Studies of the Genitourinary Tract (October).
2004	Urologic and Kidney Development and Genitourinary Disease Study Section (October, <i>ad hoc</i>)
2004	Renal and Urological Sciences Integrated Review Group, (October, <i>ad hoc</i>)
2004	NIH Special Emphasis Panel: Cell Selective Research Tools and Methods for Studies of the Genitourinary Tract (June)
2004	Urologic and Kidney Development and Genitourinary Disease Study Section (June, <i>ad hoc</i>)
2004	Renal and Urological Sciences Integrated Review Group (June, <i>ad hoc</i>)
2004	Department of Defense, Clinical and Experimental Therapeutics # 3
2004	Urologic and Kidney Development and Genitourinary Disease Study Section (March, <i>ad hoc</i>)
2004	Renal and Urological Sciences Integrated Review Group (March, <i>ad hoc</i>)
2003	Endocrinology Study Section (<i>ad hoc</i>)
2003	Reproductive Endocrinology Study Section (October, <i>ad hoc</i>)
2003	Reproductive Endocrinology Study Section (June, <i>ad hoc</i>)
2003	NIDDK Special Emphasis Panel: Androgen Receptor and Prostate Cancer
2003	Department of Defense, Clinical and Experimental Therapeutics # 3.
2002	Urologic and Kidney Development and Genitourinary Disease Study Section (<i>ad hoc</i>)
2002	Renal and Urological Sciences Integrated Review Group (<i>ad hoc</i>)
2001	Department of Defense, Cell Biology # 3

- 1999 Department of Defense, External Reviewer
 1998 Fonds pour la Formation de Chercheurs et l'Aide à la Recherche, Canada

Scientific Session/Symposium Moderator:

- 2011 GRC Hormone Action in Development & Cancer, Hormonal Regulation Of Development & Cancer, Bryant University, Smithfield, RI, July 31, 2011: Keynote Lectures: Hormonal and Dietary Control of Metabolism
 2010 Society for Basic Urological Research, Atlanta GA, November 12, 2010: Aging, Obesity, and Co-Morbidities: Immunologic Impacts on Urologic Function
 2010 Annual Endocrine Meeting, San Diego CA, June 21, 2010: Tumor and Normal Stem Cells in Breast and Prostate
 2010 6th Annual National Symposium on Prostate Cancer, Clark Atlanta University, Atlanta GA, March 16, 2010: Steroid Receptors in Prostate Cancer
 2009 GRC Hormone Action in Development & Cancer, Hormonal Regulation Of Development & Cancer, Holderness NH, July 29, 2009: Common Signaling Pathways: Development Pathways Gone Awry in Cancer
 2008 Society for Basic Urological Research: Epigenetics and Genitourinary Disorders
 2007 DOD Innovative Minds in Prostate Cancer Today (IMPACT) conference: Stem Cells

TEACHING:

- 2014 CCHMC/UC: Introduction to Functional Genomics (GNTD8001C and CS7097C in CoM and CEAS; Course Directors: Jarek Meller and Robert Brackenbury). Lecturer – “AR: a key regulator of normal and abnormal prostate growth”.
 2013 CCHMC/UC: Introduction to Functional Genomics Introduction to Functional Genomics (GNTD8001C and CS7097C in CoM and CEAS; Course Directors: Jarek Meller and Robert Brackenbury). Lecturer – “Estrogen Receptor – Structure and Function”.
 2013 UC: Environmental Genetics & Molecular Toxicology(EGMT)Course: Lecturer For 2 Courses Sections - Stem cells; Male and Female Reproductive Toxicology.
 2011 UC: Environmental Genetics & Molecular Toxicology (EGMT) Course: Course Coordinator
 2010 UC: Environmental Genetics & Molecular Toxicology (EGMT) Course: Lecturer- Stem cells.
 2009 UC: Environmental Genetics & Molecular Toxicology (EGMT) Course: Lecturer - Stem cells.
 2007 VU: Current Topics in Cancer Biology: Cancer and Metastasis: Course Coordinator and Lecturer
 1995-96 UM Faculty of Medicine: Medicine I Endocrinology and Metabolism:Lecturer/tutorials
 1990-96 UM Course in Medical Physiology: Endocrinology: Lecturer
 1979-81 University of Manitoba Special Pre-medical Studies Program: Tutor

LABORATORY TRAINEES AND STUDENT PROGRAMS:

PhD Thesis Supervisor:

- 2002-07 Jennifer Erin Tillman (Advisor: Susan Kasper, PhD, Dept. of Urologic Surgery, VUMC)
 2002-07 Ritwik Ghosh (DOD Predoctoral Training Award recipient) (Advisor: Susan Kasper, PhD, Dept. of Urologic Surgery, VUMC)

Doctoral Dissertation Committee:

- 2014-present Nicholas Brown (Advisor: Susan Waltz, PhD, Dept of Cancer and Cell Biology, UC)
 2013-present Logan Fulford (Advisor: Tanya Kalin, MD, PhD, Department of Pediatrics, UC)
 2013-present Evan Frank (Advisor: Jagjit Yadav, PhD, EH Division of Environmental Genetics and Molecular Toxicology, UC)
 2013-present Abby Johnson (Advisor: Susan Waltz, PhD, Dept of Cancer and Cell Biology, UC)
 2012-present Qin Wang (Advisor: Alvaro Puga, PhD, EH Division of Environmental Genetics and Molecular Toxicology, UC)
 2011-present Andrew Paluch (Advisor: Susan Waltz, PhD, Dept of Cancer and Cell Biology, UC)

- 2010-present Eunice Varughese (Advisor: Jagjit Yadav, PhD, EH Division of Environmental Genetics and Molecular Toxicology, UC)
- 2010-present Nivedita Nivedita (Advisor: Ian Papautsky, PhD, BioMicroSystems Lab, School of Electronic and Computing Systems, UC)
- 2010-2012 Jian Zhou (Advisor: Ian Papautsky, PhD, BioMicroSystems Lab, School of Electronic and Computing Systems, UC)
- 2007-09 Maria Abreu, Department of Cancer Biology, VU
- 2007-09 Jie Wang, Department of Pathology, VU
- 2005-08 Ashwath Jayagopal, Department of Biomedical Engineering, VU

UC Training Grants/graduate student mentor:

- 2009-2012 Brian Wortham (graduate student, EH Gene-Environment Interactions Training Program, UC)
- 2009-2011 Marina Galvez, Ph.D. (EH T32 training program, UC)
- 2009-2011 Rebekah Karns (graduate student, EH Division of Epidemiology/Biostatistics, UC)

UC Young Faculty Mentor:

- 2009-present Tianying Wu, MD, PhD, ScM (Assistant Professor, EH Division of Epidemiology and Biostatistics, UC)

Vanderbilt Integrated Graduate Program Qualifying Exam Committee (IGP):

- 2008 Carrie Whiting (PhD)
- 2007 Maria Abreu (PhD)
- 2006 Jie Wang (PhD)
- 2004 Yue He (PhD)
- 2003 Mingfang Ao (PhD)
- 2002 Ildiko Csiki (MD, PhD)
- 2002 Li Yang (PhD)

Vanderbilt Initiative for Maximizing Student Diversity (IMSD) Program (Faculty Advisor/Mentor):

- 2005-2006 Gerren Ector
- 2002-2006 Tamela Hunt

Vanderbilt Introduction to Biomedical Research Program (Faculty Advisor/Mentor):

- 2003 Julia Kristina Wood (medical student)

Undergraduate courses/summer training:

- 2014 Emma Eschker (Niles North High School, Chicago, IL, Susie Posnock, teacher)
- 2013 Sloane Harris and Meghan Cholak (Walnut Hills High School, Science Project Competition, Renee Mahaffey Harris, Correspondent)
- 2011-12 Preetom Borah (Sycamore High School, Capstone Project research project, Beth Quinones, Science Teacher)
- 2011-12 Nicholas Aube (Sycamore High School, Capstone Project research project, Beth Quinones, Science Teacher)
- 2010 William Hunt (Biology, Summer Undergraduate Research Fellow (SURF), Office of Research and Graduate Education, UC)
- 2010 James Cross (B. Sc Biology undergraduate student/technician, UC)
- 2009 James Cross (B. Sc Biology Summer Undergraduate Research Fellow (SURF), Office of Research and Graduate Education, UC)
- 2009 John Hegman (Biomedical Engineering undergraduate student/technician, UC)
- 2006 Carrie Johnson (Summer Internship, Belmont University, Nashville, TN)

2005	Carrie Johnson (Summer Internship, Belmont University, Nashville, TN)
2005-2006	Carrie Johnson (Biology Course Project, Belmont University, Nashville, TN)
2004	Sheree Carney (Vanderbilt Minority Summer Research Program)
2003	Ashwin Sastry (Undergraduate summer student)
2002	Yash A. Choksi (Undergraduate summer student)

Postdoctoral Fellows:

2010-12	Premkumar Vummidi Giridhar, PhD
2007-08	Seungchan Yang, PhD
2006-08	Mohammed Atiqur Rahman, PhD
2005	Shwetank Sharma, PhD
2004	Zhang Han PhD
2003-07	Guangyu Gu, MD
2001-03	Tiina Pikänen-Arsiola, PhD

Research Scientists:

2009-2013	Karin Williams, PhD
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Other Trainees:

2013	Veena Potluri, MD
2013-2014	Mei-Ling Bermudez (PhD rotation student)
2014	Andrew Vonhandorf (PhD rotation student)

Research Residents:

2008	Michelle E. Koski, MD
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Medical Students:

2013	Karan Motiani, Department of Urology, UC. Research rotation. [Dr. Motiani's abstract was the only submissions from the UC Departments of Urology and Environmental Health accepted. Importantly, it was selected for a prestigious podium presentation for research excellence.]
2007-2011	Thesis Advisor, Thomas Reinhold MD, Universität Witten/Herdecke Witten, Germany [Dr. Reinhold's thesis earned him a <i>cum laude</i> degree]
2006-07	Thomas Reinhold (Universität Witten / Herdecke Witten, Germany: Medical Student rotation)

Research Awards to Trainees:

2011-2012	I served as project director and mentor to a team of two Sycamore High School students, Preetom (Ruku) Borah and Nicholas Aube, on their Capstone research Project research. - Ruku and Nick won a "Superior" rating for their Capstone Research Project, "IGF-1 and its Effects on Human Breast Cancer Cells" at Sycamore High School. - They were winners in the Southwest Ohio District Science & Engineering Expo competition held at UC on Saturday, March 10, 2012. - At the OH State Science Fair on Saturday, May 5, 2012, they won a "Superior" rating with a perfect score of 50/50 from both judges. They also won the following awards for their research on: "IGF-1 and its Effects on Human Breast Cancer Cells": 1) Interdisciplinary Research Award, sponsored by Sigma Xi Scientific Research Society, 2) Veterinary Medicine Award, sponsored by the Ohio Veterinary Medical Association, 3) University of Akron Scholarship.
2006	Jennifer Erin Tillman, PhD student, Travel Award, Society for Basic Urologic Research
2006	Ritwik Ghosh, PhD student, DOD Predoctoral Training Award

2005 Guangyu Gu, MD, Travel Award, Society for Basic Urologic Research
 2003 Tiina Pikänen-Arsiola, PhD, Travel Award, Society for Basic Urologic Research

INVITED LECTURES:

National and International Meetings:

Clark Atlanta University 10th Annual National Symposium on Prostate Cancer, Atlanta GA, March 17, 2014: "Inhibition of Stathmin1 Accelerates the Metastatic Process".

The 10th World Congress on Urological Research, Society for Basic Urologic Research Fall Symposium, Nashville TN, November 21-24, 2013 (substitute speaker for Dr. Gail Prins who could not attend), Plenary Session IV: Stem Cells are Part of the Urologic Tissue Heterogeneity and Therapeutic Solutions: "Cancer Stem Cell Self-renewal and Differentiation".

Underwriters Laboratories – Flame Retardants and Health Summit/Furniture Flammability and Human Health, Atlanta GA, April 16, 2013: "Flame Retardants as Endocrine Disrupting Chemicals that Promote Prostate Cancer".

Clark Atlanta University 9th Annual National Symposium on Prostate Cancer, Atlanta, GA, March 19, 2013: "Mechanisms Which Preserve the Prostate Cancer Stem Cell Phenotype".

Endocrine Society Annual Meeting, Houston, TX, June 23, 2012: "Notch-Androgen Receptor Axis in Prostate Cancer Stem Cells".

Clark Atlanta University 8th Annual National Symposium on Prostate Cancer, Atlanta, GA, March 19, 2012: "Cancer Stem Cell Strategies for Promoting Androgen Resistance".

Society for Basic Urologic Research Fall Symposium, Las Vegas, NE, November 10-13, 2011, Session: Genetic, Epigenetic and Stem Cell Determinants of Development and Disease. "Stem Cell Strategies for Escaping Differentiation".

American Society of Andrology 34th Annual Meeting, Philadelphia, PA, April 5, 2009: "Prostate Stem Cells: Friend or Foe".

Clark Atlanta University 5th Annual National Symposium on Prostate Cancer, Atlanta, GA, March 17, 2009: "Androgen Receptor Function in Hormone-Sensitive and Castrate-Resistant Prostate Cancer

Reproductive Tract Biology Gordon Research Conference (GRC), Andover, NH, August 3-8, 2008: "Regeneration of Human Prostate Tumors from Prostate Cells with Cancer Stem Cell Characteristics".

Endocrine Society Annual Meeting, San Francisco, CA, June 16, 2008: "Stem Cells in Prostate Cancer Initiation & Progression".

Prostate Cancer Research Foundation Forum (United Kingdom), Toronto, Ontario, Canada, June 13, 2008: "Isolation and characterization of cancer stem cells from human prostate tissues".

Society for Basic Urological Research Spring Session, Orlando, FL, May 17, 2008: "Prostate Cancer and Cancer Stem Cells".

Gordon Research Conference on Hormone Action in Development & Cancer, New London, NH, July 15-20, 2007: "Regeneration of Human Prostate Tumors from Prostate Cells with Cancer Stem Cell Characteristics".

Clark Atlanta University 2nd Annual National Symposium on Prostate Cancer, Atlanta, GA, March 31, 2006: "Cancer Stem Cells and the Androgen Receptor in Prostate Cancer".

American Urological Association, Research Conference, Houston, TX, August 1, 1999: "BPH Animal Models - An Overview".

Roswell Park Cancer Institute Workshop: Prostate Cancer, Prouts Neck, ME, October 24, 1999.

Society for Basic Urologic Research/ European Society for Urologic Oncology and Endocrinology Joint Symposium, The Second World Congress on Urological Research, Pacific Grove, CA, December 10-14, 1997: "Gene Therapy Vectors for Prostate Cancer."

Visiting Professor Lectureships:

Green Science Policy Flame Retardant Dilemma Symposium, San Francisco CA, February 14, 2014: "Do Flame Retardants Impact Men's Hormones?"

Prostate Cancer Foundation, 1250 Fourth Street Santa Monica, CA 90401, August 31, 2012. "Inhibition of Stathmin1 Accelerates the Metastatic Process"

Clark Atlanta University CCRTD/RCMI Program, November 10, 2010: "Mechanisms Required to Maintain Epithelial Cell Architecture and Function."

East Tennessee State University, Department of Biochemistry, Johnson City, TN, October 20, 2009: "Beating the Androgen Receptor at Its Own Game".

University of Illinois at Chicago Cancer Center, Chicago, IL, June 17, 2009: "Cancer Stem Cells – Disrupting the Status Quo".

University of Manitoba, Department of Physiology, Winnipeg, MB, Canada, May 7, 2009: "The Androgen Receptor, Cancer Stem Cells and Prostate Tumorigenesis".

Kimmel Cancer Center, Department of Cancer Biology, Philadelphia, PA, October 23, 2008: "In search of the Prostate Stem Cell".

University of Rochester, Department of Pathology, Rochester, NY, August 27, 2008: "Dissecting Androgen Receptor Function in the Prostate".

University of Cincinnati, Department of Environmental Health, Kettering Lab Complex, Cincinnati, OH, July 10, 2008: "Ideas Stemming from Primary Prostate Cell Culture".

Pfizer Global Research and Development, La Jolla laboratories, San Diego, CA, June 18, 2008: "Ideas Stemming from Primary Cell Culture".

University of Cincinnati, Department of Environmental Health, Kettering Lab Complex, Cincinnati, OH, April 23, 2008: "Stem Cells – the Root of Prostate Cancer?"

Boston Medical Center, Section of Endocrinology, Diabetes & Nutrition, Boston, MA, February 12, 2008: "Androgen Receptor Functions in Prostate Development and Disease."

John Hopkins University, Department of Urology, Baltimore, MD, January 17, 2008: "Stem Cells: the Key to Prostate Cancer?"

University of Miami Seminar Series, Miami, FL, December 1, 2005: "Mechanisms Leading to the Development of Hormone Resistant Prostate Cancer".

Wake Forest University Medical Center, Department of Cancer Biology, Winston-Salem, NC, August 15, 2005: "Prostate Tumorigenesis: Insights from Androgen Receptor Studies and Primary Cell Culture Models".

University of Massachusetts Medical School, Department of Surgery/Urology Research, Worcester MA, May 10, 2005: "Development of Androgen-Independent Prostate Cancer".

The University of Texas Health Science Center at San Antonio, Institute of Biotechnology, Department of Molecular Medicine, San Antonio, TX, September 7, 2004: "Prostate Cancer Progression: Escaping Androgen Control".

University of South Florida, College of Medicine, Department of Pathology, Tampa, FL, June 1, 2001: "Modeling Prostate Cancer in LPB-Tag mice: a Lady's Perspective".

University of Massachusetts Medical School, Department of Surgery, Worcester, MA, November 8, 1999.

Tufts University, Department of Biology, Boston, MA, November 9, 1998.

Eastern Virginia Medical School, Department of Microbiology and Immunology, Norfolk, VA, June 19, 1998.

New England Medical Center and Tufts University School of Medicine, Division of Endocrinology, Diabetes, Metabolism and Molecular Medicine, Boston, MA, November 3, 1998.

UC Lectureships:

Cincinnati Prostate Cancer Information Group, Feb 27, 2013: "How do prostate cancer cells become metastatic and why do they migrate to bone?"

GEITP Seminar Series, Jan 15, 2013: "Inhibition of Stathmin1 Accelerates the Metastatic Process".

UC Chemical Engineering Program, Graduate Seminar Series, October 12, 2013: "Separating Fragile Prostate Cancer Stem Cells and Circulating Tumor Cells".

Division of Urology, Urology Oncology Meeting, May 11, 2012: "Stem Cell/CSC Strategies for Promoting Androgen Resistance".

GEITP Seminar Series, February 7, 2012: "Confocal Microscopy".

Division of Urology, Urology Oncology Meeting, April 15, 2011: "Cancer stem cells: Why are they clinically important?"

Cincinnati Children's Hospital Medical Center, Endoderm Club, April 5, 2011: "Using Cancer Stem Cells to Map Normal Prostate Development".

Division of Urology, Urology Oncology Meeting, April 14, 2009: "Androgen Receptor and Prostate Cancer Stem Cells".

Department of Cancer Cell Biology Seminar Series, March 26, 2009: "The Androgen Receptor, Stem Cells and Prostate Tumorigenesis".

Cincinnati Cancer Consortium Leaders Meeting, March 3, 2009: "Androgen Receptor, Stem Cells and Prostate Cancer".

GEITP Seminar Series, February 24, 2009: "In Search of the Prostate Stem Cell".

Vanderbilt Lectureships:

Center for Stem Cell Biology Seminar, September 11, 2008: "Prostate Stem Cell Models".

Surgical Oncology Research Seminar, April 18, 2008: "Cancer Stem Cells: the Key to Prostate Cancer?"

Signal Transduction and Cell Proliferation Program Seminar, November 15, 2005: "Development of hormonal resistance in prostate cancer: Insights from androgen receptor and primary cell culture studies".

32th Annual Vanderbilt Urology Society Visiting Professorship and Rhamy-Shelley Lecture, November 13, 2003: "Update in Prostate Cancer Research".

Surgical Research Conference, September 13, 2002: "Prostate Cancer Progression: Schemes for Escaping Androgen Control".

Vanderbilt Ingram Cancer Center Cancer, Biology Seminar Series, September 11, 2002: "Molecular Mechanisms of Prostate Cancer Progression."

28th Annual Vanderbilt Urology Society Visiting Professorship and Rhamy-Shelley Lecture, November 11, 1999: "BPH Animal Models: An Overview".

Surgical Research Conference, April 18, 1997.

Center for Reproductive Biology Research, April 8, 1997.

PUBLICATIONS:

Total Publications: 66; h-Index: 27; Total Citations: 2171; Research Gate (RG) score: 36.54

PEER-REVIEWED JOURNAL ARTICLES:

1. **Kasper S**, Worsley IG, Rowe JM, Shiu RPC, and Friesen HG, 1982. Chondrocyte growth factor from the human pituitary gland. *J Biol Chem* 257:5226-5230.
2. Rowe JM, **Kasper S**, and Shiu RPC, 1986. Purification and characterization of a human mammary tumor-derived growth factor. *Cancer Res* 46:1408-1412.
3. **Kasper S**, and Friesen HG, 1986. Human pituitary tissue secretes a potent growth factor for chondrocyte proliferation. *J Clin Endocrinol Metab* 62:70-76.
4. Fink JS, Verhave M, **Kasper S**, Tsukada T, Mandel G, and Goodman RH, 1989. The CGTCA sequence motif is essential for biological activity of the vasoactive intestinal peptide gene cAMP regulated enhancer. *Proc Natl Acad Sci USA* 85:6662-6666.

5. **Kasper S**, Popescu RA, Torsello A, Vrontakis ME, Ikejiani C, and Friesen HG, 1992. Tissue-specific regulation of vasoactive intestinal peptide messenger ribonucleic acid levels by estrogen in the rat. *Endocrinology* 130:1796-1801
6. Leite V, Vrontakis ME, **Kasper S**, and Friesen HG, 1993. Bromocriptine inhibits galanin gene expression in the rat pituitary gland. *Mol Cell Neuroscience* 4:418-423.
7. **Kasper S**, Rennie PS, Bruchofsky N, Sheppard PC, Cheng H, Lin L, Snoek R, and Matusik RJ, 1994. Cooperative binding of the androgen receptor to two DNA sequences is required for androgen induction of the probasin gene. *J Biol Chem* 269:31763-31769.
8. Snoek R, Rennie PS, **Kasper S**, Matusik RJ and Bruchofsky N, 1996. Induction of cell-free, *in vitro* transcription by recombinant androgen receptor peptides. *J Steroid Biochem Mol Biol* 59 (3-4): 243-250.
9. Yan Y, Sheppard PC, **Kasper S**, Lin L, Hoare S, Kapoor A, Dodd JG, Duckworth ML, and Matusik RJ, 1997. Large fragment of the probasin promoter targets high levels of transgene expression to the prostate of transgenic mice. *The Prostate* 32(2):129-139.
10. Metts JC, Kotkin L, **Kasper S**, Shyr Y, Adams MC, and Brock JW, 1997. Genital malformations and coexistent urinary tract or spinal anomalies in patients with imperforate anus. *J Urology* 158:1298-1300.
11. Bai G, **Kasper S**, Matusik RJ, Rennie PS, Moshier JA, and Krongrad A, 1998. Androgen regulation of the human ornithine decarboxylase promoter in prostate cancer cells. *J of Androl*, 19(2): 127-135.
12. Lareyre JJ, Mattei M-G, **Kasper S**, Ong DE, Matusik RJ and Orgebin-Crist M-C, 1998. Genomic organization and chromosomal localization of the murine epididymal retinoic acid binding protein (mE-RABP) gene. *Mol Reprod Dev*, 50, 387-395.
13. **Kasper S**, Sheppard PC, Yan Y, Pettigrew N, Borowsky AD, Prins GS, Dodd JG, Duckworth ML and Matusik RJ, 1998. Development, progression, and androgen-dependence of prostate tumors in probasin-large T antigen transgenic mice: A model for prostate cancer. *Lab Invest* 78:i-xv (Erratum, June 1998).
14. Lareyre JJ, Zheng WL, Zhao GQ, **Kasper S**, Newcomer ME, Matusik RJ, Ong DE and Orgebin-Crist MC, 1998. Molecular cloning and hormonal regulation of a murine epididymal retinoic acid-binding protein messenger ribonucleic acid. *Endocrinology*, 139 (6), 2971-2981.
15. Snoek R, Bruchofsky N, **Kasper S**, Matusik RJ, Gleave M, Sato N, Mawji NR, Rennie PS, 1998. Differential transactivation by the androgen receptor in prostate cancer cells. *The Prostate*, 36, 256-263.
16. Lareyre JJ, Mattei M-G, **Kasper S**, Newcomer ME, Ong DE, Matusik RJ and Orgebin-Crist M-C, 1998. Structure and putative function of a murine epididymal retinoic acid-binding protein (mE-RABP). *J of Reprod Fertil Suppl* 53:59-65.
17. Lareyre JJ, Thomas TZ, Zheng W-L, **Kasper S**, Ong DE, Matusik RJ, and Orgebin-Crist M-C, 1999. A 5 kilobase pair promoter fragment of the murine epididymal retinoic acid-binding protein gene drives the tissue-specific, cell-specific, and androgen-regulated expression of a foreign gene in the epididymis of transgenic mice. *J Biol Chem* 274(12): 8282-8290.
18. **Kasper S**, Rennie PS, Bruchofsky, Lin L, Cheng H, Snoek R, Dahlman-Wright K, Gustafsson J-A, Shiu, RPC, Sheppard PC, Matusik RJ, 1999. Selective activation of the probasin androgen-responsive region by steroid hormones. *J Mol Endocrinology* 22:313-325.
19. Shappell SB, Boeglin WE, Olson SJ, **Kasper S**, Brash AR, 1999. 15-Lipoxygenase-2 (15-LOX-2) is expressed in benign prostatic epithelium and reduced in prostate adenocarcinoma. *Am J Pathol* 155(1):235-245.
20. Brash AR, Jisaka M, Boeglin WE, Chang MS, Keeney DS, Nanney LB, **Kasper S**, Matusik RJ, Olson SJ, Shappell S.B, 1999. Investigation of a second 15S-lipoxygenase in humans and its expression in epithelial tissues. *Adv Exp Med Biol* 469:83-89.
21. Zhang J-F, Thomas TZ, **Kasper S**, Matusik RJ, 2000. A small composite probasin promoter confers high levels of prostate-specific gene expression through regulation by androgens and glucocorticoids *in vitro* and *in vivo*. *Endocrinology* 141(12):4698-4710.

22. Lareyre J-J, Reid K, Nelson C, **Kasper S**, Rennie PS, Orgebin-Crist M-C, Matusik RJ, 2000. Characterization of an androgen-specific response region within the 5' flanking region of the murine epididymal retinoic acid binding protein gene. *Biol Reprod* 63:1881-1892.
23. Lareyre J-J, Winfrey VP, **Kasper S**, Ong DE, Matusik RJ, Olson GE, and Orgebin-Crist M-C, 2001. Gene duplication gives rise to a new 17 kDa lipocalin that shows epididymal region-specific expression and testicular factors(s) regulation. *Endocrinology* 142:1296-1308.
24. Masumori N, Thomas TZ, Chaurand P, Case T, Paul M, **Kasper S**, Caprioli R, Tsukamoto T, Shappell S, Matusik RJ, 2001. A probasin-large T antigen transgenic mouse line develops prostate adenoand neuroendocrine-carcinoma having metastatic potential. *Cancer Res* 61:2239-2249.
25. Andriani F, Nan B, Ju Y, Li X, Weigel NL, McPhaul MJ, **Kasper S**, Kagawa S, Fang B, Matusik RJ, Denner L, Marcelli M, 2001. The third generation probasin promoter ARR₂PB drives bax overexpression and apoptosis in androgen receptor positive prostate cancer cells in a dihydrotestosterone-dependent way. *J Natl Cancer Inst* 93:1314-24.
26. Chaurand P, DaGue BB, Ma S, **Kasper S**, Caprioli RM, 2001. Strain-based sequence variations and structure analysis of murine prostate specific spermine binding protein using mass spectrometry. *Biochem* 40:9725-33.
27. Zhang Y, Yu J, Unni E, Shao TC, Nan B, Snaboon T, **Kasper S**, Andriani F, Denner L, Marcelli M, 2002. Monoand poly-gene therapy for the treatment of experimental prostate cancers by use of apoptotic genes Bax and Bad driven by the prostate-specific promoter ARR2PB. *Human Gene Therapy* 13:2051-64.
28. Tu WH, Thomas TZ, Masumori N, Bhowmick NA, Gorska AE, Shyr Y, **Kasper S**, Case T, Roberts RL, Shappell SB, Moses HL and Matusik RL, 2003. The loss of TGF-beta signaling promotes prostate cancer metastasis. *Neoplasia* 5:267-77.
29. Zhang J, Gao N, **Kasper S**, Reid K, Nelson C, Matusik RJ, 2004. An androgen dependent upstream enhancer is essential for high levels of probasin gene expression. *Endocrinology* 145:134-48.
30. Masumori N, Tsuchiya K, Tu W, Lee C, **Kasper S**, Tsukamoto T, Shappell S, Matusik RJ, 2004. An allograft model of androgen independent prostatic neuroendocrine carcinoma derived from a large probasin promoter-T antigen transgenic mouse line. *J Urol* 171:439-442.
31. Jin RJ, Wang Y, Masumori N, Ishii K, Tsukamoto T, Shappell SB, Hayward SW, **Kasper S**, Matusik RJ, 2004. NE-10 neuroendocrine cancer promotes the LNCaP xenograft growth in castrated mice. *Cancer Res* 64:5489-5495.
32. Shao TC, Li H, **Kasper S**, Matusik RJ, Ittmann M, Cunningham GR, 2006. Comparison of the Growth-Promoting Effects of Testosterone and 7- α -Methyl-19-Nor-Testosterone (MENT) on the Prostate and Levator Ani Muscle of LPB-Tag Transgenic Mice. *The Prostate*, 66(4):369-76.
33. Pitkänen-Arsiola T, Tillman JE, Gu G, Yuan JL, Roberts RL, Wantroba M, Coetzee GA, Cookson MS, and **Kasper S**, 2006. Androgen and Antiandrogen Treatment Modulate Androgen Receptor Activity and DJ-1 Stability. *The Prostate* 66:1177-93.
34. Wang Y, **Kasper S**, Yuan J, Jin RJ, Zhang J, Ishii K, Wills ML, Hayward SW, Matusik RJ, 2006. Androgen-dependent prostate epithelial cell selection by targeting ARR(2)PBneo to the LPB-Tag model of prostate cancer. *Lab Invest*. 2006 Oct;86(10):1074-88.
35. Gipp J, Gu G, Crylen C, **Kasper S**, Bushman W, 2007. Hedgehog Pathway Activity in the LADY Prostate Tumor Model. *Molecular Cancer* 6:19-26.
36. Tillman EJ, Yuan J, Gu G, Fazli L, Ghosh R, Flynt AS, Gleave M, Rennie PS, and **Kasper S**, 2007. DJ-1 binds androgen receptor directly and mediates its activity in hormonally treated prostate cancer cells. *Cancer Res* 67:4630-4637.
37. Gu G, Yuan J, Wills ML and **Kasper S**, 2007. Prostate cancer cells with stem cell characteristics reconstitute the original human tumor in vivo. *Cancer Res*, 67:4807-4815.
38. Ghosh R, Gu G, Tillman EJ, Yuan J, Wang YQ, Friedman D, Fazli L, Rennie PS, and **Kasper S**, 2007. Increased expression and differential phosphorylation of stathmin may promote prostate cancer progression. *The Prostate* 67:1038-1052.

39. Chaurand P, Rahman MA, Hunt T, Mobley JA, Gu G, Caprioli RM and **Kasper S**, 2008. Monitoring mouse prostate development by profiling and imaging mass spectrometry. *Mol Cell Proteomics* 7:411-23.
40. Zhang J-F, Gao N, DeGraff D, Yu X, Sun Q, Case T, **Kasper S**, Matusik, RJ, 2010. Characterization of cis elements of the probasin promoter necessary for prostate-specific expression. *Prostate* 70:934-51.
41. Liu J, Pascal LE, Isharwal S, Metzger D, Ramos Garcia R, Pilch J, Kasper S, Williams K, Basse PH, Nelson JB, Chambon P, Wang Z, 2011. Regenerated luminal epithelial cells are derived from preexisting luminal epithelial cells in adult mouse prostate. *Mol Endocrinol.* 25:1849-57.
42. Williams K, Ghosh R, Vummidi Giridhar P, Gu G, Case T, Belcher SM and **Kasper S**, 2012. Inhibition of Stathmin1 Accelerates the Metastatic Process. *Cancer Res*:72:5407-17. PMID: 22915755
43. Kendig EL, Buesing DR, Christie SM, Cookman CJ, Gear RB, Hugo ER, **Kasper S**, Kendzioriski JA, Ungi KR, Williams K, Belcher SM. 2012. Estrogen-like disruptive effects of dietary exposure to bisphenol A or 17 α -ethinyl estradiol in CD1 mice. *Int J Toxicol* 31:537-50. PMID: 23160314
44. Zhou J, Giridhar PV, **Kasper S**, Papautsky I, 2013. Modulation of aspect ratio for complete separation in an inertial microfluidic channel. *Lab Chip* 13:1919-29. PMID: 23529341
45. Cai Y, Balli D, Ustiyani V, Fulford L, Hiller A, Miseti V, Zhang Y, Paluch AM, Waltz SE, **Kasper S**, Kalin TV, 2013. Foxm1 expression in prostate epithelial cells is essential for prostate carcinogenesis. *J Biol Chem.* 288:22527-41. PMID: 23775078
46. Zhou J, **Kasper S**, Papautsky I, 2013. Enhanced size-dependent trapping of particles using microvortices. *Microfluid Nanofluid* 1007/s10404-013-1176-y. PMID: 24187531
47. Zhou J, Vummidi Giridhar P, **Kasper S**, Papautsky I, 2014. Modulation of rotation-induced lift for cell filtration in a low aspect ratio microchannel. *Biomicrofluidics* 8, 044112; doi: 10.1063/1.4891599.

INVITED REVIEWS/EDITORIALS:

1. **Kasper S**, Matusik RJ: Rat Probasin, 2000. Structure and function of an outlier lipocalin. (Review) *Biochim Biophys Acta* 18(1-2):249-258.
2. **Kasper S**, Tu W, Roberts RL, Shappell SB, 2003. Transgenic mouse models for prostate cancer: Identification of an androgen-dependent promoter and creation and characterization of the LPB-tag model. *Methods Mol Med* 81:113-47.
3. **Kasper S** and Smith JA, 2004. Genetically Modified Mice and Their Use in Developing Therapeutic Strategies. *J Urol* 172:12-19.
4. **Kasper S**, 2005. Survey of Genetically Engineered Mouse Models for Prostate Cancer: Analyzing the Molecular Basis of Prostate Cancer Development, Progression and Metastasis. *J Cell Biochem* 94:279-297.
5. **Kasper S** and Cookson MS, 2006. Mechanisms leading to the development of hormone resistant prostate cancer. *Urologic Clinics of North America* 33:201-210.
6. **Kasper S**, 2007. Characterizing the Prostate Stem Cell. *J Urol* 178:375.
7. **Kasper S**, 2007. Mechanisms that Promote Androgen Receptor-mediated Recurrence of Prostate Cancer. *J Urol* 178:1288.
8. **Kasper S**, 2008. Stem cells: The Root of Prostate Cancer? *J Cell Physiol* 216:332-336.
9. **Kasper S**, 2008. Exploring the Origins of the Normal Prostate and Prostate Cancer Stem Cell. *Stem Cell Rev* 4:193-201.

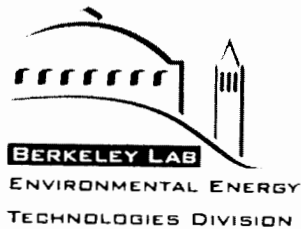
10. **Kasper S**, 2009. Identification, characterization, and biological relevance of prostate cancer stem cells from clinical specimens. *Urol Oncol* 27:301-3.
PMID: 19414117
11. Williams K, Motiani K, Vummidi Giridhar P, **Kasper S**, 2013. CD44 integrates signaling in normal stem cell, cancer stem cell and (pre)metastatic niches. *Exp Biol Med* 238:324-38.
PMID: 23598979
12. Koprás E, Potluri V, Bermudez M-L, Williams K, Belcher S, **Kasper S**, 2014. Actions of endocrine disrupting chemicals on stem/progenitor cells during development and disease. *Endocrine Related Cancer*, 21:T1-T12. doi: 10.1530/ERC-13-0360.

BOOK CHAPTERS:

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2. **Kasper S**, and Friesen HG, 1986. Growth factors: a selected review. In: *Growth Hormone* (Tolis G., and Ludecke, D.K. eds) Raven Press, NY.
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Exhibit I

Statement of Donald Lucas



Sept. 11, 2014

I, Donald Lucas, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I am a scientist at the Lawrence Berkeley National Laboratory (LBNL) and a Professional Researcher in the School of Public Health at the University of California, Berkeley (UCB). I officially retired in 2011, but I continue to perform research in the areas of combustion byproducts at LBNL, UCB, and the Energy and Resources Group at UCB. Before retiring I was a Principal Investigator in the Combustion Group of the Environmental Energy Technologies Division (EETD), and was a Deputy Director for EETD and the Environment, Health, and Safety Division. I am on the Executive Committee for the International Congress on Toxic Combustion Byproducts and their Health Effects, and received their Adel Sarofim Award in 2013. I also serve as a consultant to the Green Science Policy Institute. I received a B.S. in Chemistry from the Illinois Institute of Technology in 1972 and a Ph.D. in Physical Chemistry from the University of California, Berkeley in 1977. I have attached a copy of my curriculum vitae and a list of my scientific publications.

2. Based on my expertise, it is my opinion that, in the case of fires, organohalogen flame retardants used in plastic, foam, fabrics, and other products in residences can lead to the formation of increased amounts of toxic combustion byproducts. It is also my opinion that, as currently used, organohalogen flame retardants do not provide fire safety benefits that justify their use (Talley, 1995; Mehta, 2012; Blais and Carpenter, 2013; Tao, 2005; BEARHFTI, 2002; Babrauskas, 1983; Schuman and Hartzell, 1987). Other experts I collaborate with have described the human and environmental health effects associated with organohalogen flame retardants and their combustion byproducts, so my statements below will be limited to the formation of products of combustion.

3. Organohalogen flame retardants are used in products and assemblies such as electronic enclosures, furniture foam, building insulation, and other items, but they do not make the products flameproof. If a large enough ignition source is involved, flaming combustion of fire-retarded items can occur; for smaller ignition sources, smoldering combustion may happen.

4. Most fire deaths and injuries result from inhalation of smoke containing narcotic/asphyxiant and/or irritant combustion byproducts such as toxic gases and particulates (Hall 2011; Stec and Hull, 2010). These combustion byproducts may be directly toxic or cause such irritation that they impair vision and breathing, ultimately resulting in incapacitation. In addition to the combustion products of immediate concern for survival in a fire, other harmful by-products including halogenated dioxins and furans (generally referred to as dioxins) can cause chronic health effects in those exposed to the fires, contaminate the air, soil, and water long-term, and spread from the

fire site when burned materials are removed.

5. Though in some sense every fire is different, a few factors most strongly influence toxic product yield. These factors include material composition, such as the presence or absence of organohalogen flame retardants (Stec and Hull, 2010). The incorporation of organohalogen flame retardants into the material composition can increase the generation of combustion byproducts of concern for both acute and chronic fire toxicity, for reasons described in detail below.

6. Fire effluents from the combustion of materials containing organohalogen flame retardants can be **more acutely toxic** for the following reasons:

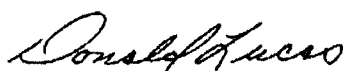
- i. Greater amounts of irritant gases, such as hydrogen chloride (HCl) or hydrogen bromide (HBr) combustion products, and particulate matter of varying size and toxicity can be produced (Stec and Hull, 2010). In fact, these irritant gases are the active fire retardant species, which act by preventing the complete oxidation of the fuel to carbon dioxide and water. HCl and HBr can cause incapacitation, reducing ability to escape a fire. If inhaled, these can also penetrate deep into the lung and injure tissue. If a fire occurs where large amounts of materials with added organohalogen flame retardants burn, significant amount of HCl or HBr will be produced, since HCl and HBr are the thermodynamically favored products for organohalogen flame retardants. For example, furniture foam with chlorinated flame retardants can produce 10 grams of HCl per kg of foam burned for every 1% by mass of chlorine it contains (the amount of halogenated fire retardants in foam varies, but it is commonly used at levels up to 5% (Allen et al., 2008). While the actual concentration depends on the room size and ventilation rate, it should be noted that the American Conference of Governmental Industrial Hygienists (ACGIH) ceiling limit for HCl is 2 ppm, and that in a small room (50 m³) with little ventilation, 100 ppm of HCl can be produced by 1 kg of burning foam.
- ii. Greater amounts of asphyxiant/narcotic gases that are combustion byproducts, such as carbon monoxide and hydrogen cyanide, can be produced, leading to loss of consciousness and ultimately death if people are exposed to high levels or for long amounts of time (Braun et al., 1987; Levin et al., 1985; Purser, 1990, Krasny et al., 2001).
- iii. Greater amount of soot and smoke can be produced, which obscures visibility and impedes escape. The action of chlorine and bromine radicals from organohalogen flame retardants can prevent the complete oxidation of the hydrocarbons present in most fires, resulting in higher yields of partial combustion products, which are apparent as greater amounts of soot and smoke (Stec and Hull, 2010).

7. In addition to increasing the amount of acutely toxic gases and particles produced, the presence of organohalogen flame retardants in products during fires can increase the amounts of persistent organic pollutants produced by combustion processes, thus **increasing the chronic toxicity of fires**.

8. In particular, incomplete combustion of products containing organohalogen flame retardants leads to the formation of halogenated dioxins and furans, substances that are considered amongst

the most toxic chemicals known (Ebert and Bahadir, 2003; Babrauskas et al., 1988; Weber and Kuch, 2003).

9. Based on my research and knowledge of fire toxicity, I support regulations that prevent the use of organohalogen flame retardants in the four categories of consumer products covered in this petition.



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Education:

UC, Berkeley	Ph.D. 1977 Chemistry
Illinois Institute of Technology	B.S. 1972 Chemistry (with Honors)

Professional Experience

Management

2007- 2011	Deputy Director, Environmental, Health and Safety Division, LBNL
2005- 2007	Assistant Division Director, Environmental Energy Technologies Division Member, EET Division Council
2000- 2009	Safety Review Committee, LBNL (Chair 2005 – 2009)
2003- 2007	Program Director, High Performance Commercial Building Systems
2002- 2004	Deputy Director, Berkeley Superfund Basic Research Program
2000- 2007	Chair, Safety Committee, Environmental Energy Technologies Division
2003 -2005	Chair, Laser Safety Committee, LBNL
2000- 2005	Safety Manager, Environmental Energy Technologies Division

Research and Teaching

1980- present	Scientist, Lawrence Berkeley National Laboratory (Environmental Energy Technologies Division – rehired retiree)
1982 – present	Professional Researcher and Visiting Scholar, University of California, Berkeley (Environmental Health Sciences, Mechanical Engineering)
1994 - present	Affiliate, Energy and Resources Group, UC Berkeley
2011 – 2014	Visiting Lecturer, East China University of Science and Technology, Shanghai, China
1988, 1990	Lecturer, University of California, Berkeley (Chemistry) Instructor, University of California, Berkeley (Mechanical Engineering) Visiting Professor, Indiana University (Chemistry) Research Associate, Indiana University (Chemistry) Teaching and Research Assistant, University of California, Berkeley (Chemistry)

Recent Committees and Activities

Finance Committee Chair, The Combustion Institute
35th International Symposium on Combustion, Local Organizing Committee Member
External Advisor, LSU Superfund Program
California AB 127 Working Group
LBNL HSS Steering Committee
LBNL DOE 142.3 Implementation Plan Project Director
LBNL EHS Training Group Head
Idaho National Laboratory Review Committee for Laser Safety (2006)
LBNL Ergonomics Pilot Program Committee (2003-2005)
Scientific Peer Reviewer, California EPA

Multimedia Working Group, California EPA
DOE Laser Program Review Panel (2003)
Executive Board and Treasurer of the US Sections of the Combustion Institute
Executive Committee and Treasurer, Western States Section/Combustion Institute
International Congress on Toxic Combustion Byproducts: Executive Committee and Awards
Committee Chair
Organizing Committee, Quad Universities Superfund – EPA Conference
Publications Committee, The Combustion Institute
Organizing Committee, 2nd Joint Meeting of the U.S. Sections of the Combustion Institute
EPA Peer Review Panels Reviewer
Health Effects Institute Advisory Panel
Technical Advisor, California Institute for Energy Efficiency
Member: American Chemical Society, Sigma Xi, The Combustion Institute
Volunteer for various LBNL CSEE programs.

Service as Reviewer:

U.S. DOE
Environmental Science and Technology
Combustion Science and Technology
California EPA
International Journal of Chemical Kinetics
National Science Foundation
California Air Resources Board
Combustion and Flame
Applied Optics
U.S. EPA
Health Effects Institute
The Combustion Institute
Applied Spectroscopy
Universitywide Energy Research Group
California Energy Commission
California Institute for Energy Efficiency
Journal of Physical Chemistry

Service as Consultant:

ChevronTexaco
Texaco
Western Independent Refiners Association
UC Riverside
WESTAR
Aarons Air Services
Expert witness in legal proceedings
Green Science Policy Institute

Extramural Funding:

U.S. EPA
DOE
California Air Resources Board
NIEHS
UERG
Western States Petroleum Association

Awards

Dr. Donald Lucas and Dr. Catherine P. Koshland shared the Adel Sarofim Award in May, 2013, presented by the International Congress on Toxic Combustion Byproducts and their Health Effects.

Invited Talks (2003 – present):

Lucas, D. (2014). The complex role of chlorinated hydrocarbons in combustion. ACS National Meeting, Dallas, TX, Mar. 18, 2014.

Lucas, D (2011) Measuring combustion products: Plumbing parts to engineered nanoparticles. LSU Chemistry Dept., Baton Rouge, LA, Feb. 2, 2011.

Lucas, D (2011). Toxic combustion emissions: Measuring them and determining their health effects. East China University of Science & Technology (ECUST), June 2, 2011.

Lucas, D (2011) Combustion and health effects: Basic research to public policy. Chinese University of Hong Kong, Hong Kong, China, June 13, 2011.

Lucas, D (2011) Nanomaterials as environmental sensors. EPA Region 9, Sept. 21, 2011, San Francisco, CA

Lucas, D (2011) Nanomaterials as environmental sensors. SRP/EPA Region 9 seminar series. Oct. 3, 2011 (web presentation)

UC Riverside, Department of Mechanical Engineering, Riverside, CA Nov., 2009.

Renewable Energy Sources – New Fuels, New Issues. California Industrial Hygiene Council, San Diego, CA, Dec., 2008; San Francisco, CA, Dec., 2009

Berkeley Nanotechnology Forum, UC Berkeley, CA, April, 2008.

Environmental Health, Energy, and Transportation: Bringing Health to the Fuel Mixture. Institute of Medicine, The National Academies, Washington, DC, Dec., 2007.

Nanoparticles from Combustion Sources and their Toxicity. 38th Environmental Mutagen Society, Atlanta, Ga. Oct., 2007.

“Non-Burning Issues” of Combustion Fundamentals. 5th Meeting of the U.S. Sections of the Combustion Institute, San Diego, CA, Mar., 2007.

Moving Forward in Partnership to Protect Health. Superfund Basic Research Program, Berkeley, CA, May 5, 2006.

ERG100 Lectures, 2004, 2005, 2008 UC Berkeley

Excimer Laser Fragmentation Fluorescence Spectroscopy. Gordon Research Conference on Laser Diagnostics in Combustion, Oxford, England, August, 2003.

Patents

James JZ, Crosby, JS, Lucas D, Koshland CP. Localized Surface Plasmon Resonance Mercury Detection System and Methods. U.S. Application Nos. 61/585,542 and 61/587,546. January 10, 2013 (filed). The International Patent Application has been accorded serial number PCT/US2013/021066.

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3. D. Lucas (1977). Fast Reactions, Free Radicals, and Molecular Complexes Studied by the Matrix Isolation Technique. Ph.D. Thesis, University of California, Berkeley.

4. L. J. Allamandola, D. Lucas, and G. C. Pimentel (1978). Synchronized Flash Photolysis and Pulse Deposition in Matrix Isolation Experiments. *Rev. Sci. Instrum.* **49** (7), 913.
5. D. Lucas and G. C. Pimentel (1979). Reaction Between NO and O₃ in Solid Nitrogen. *J. Phys. Chem.* **83** (18), 2311.
6. D. Lucas and G. E. Ewing (1981). Spontaneous Desorption of Vibrationally Excited Molecules Physically Adsorbed on Surfaces. *Chem. Phys.* **58**, 385.
7. D. Lucas and N. J. Brown (1982). Characterization of the Selective Reduction of NO by NH₃ Addition. *Combust. Flame* **47**, 219.
8. D. Lucas, L. J. Allamandola, and G. C. Pimentel (1982). Matrix Isolation Infrared Spectra of Hydrogen Halide and Halogen Complexes with Nitrosyl Halides. *Croat. Chem. Acta* **55**, 121.
9. D. Lucas, A. S. Newton, and N. J. Brown (1982). The Measurement of Ammonia in Lean Combustion Exhausts. *Combust. Sci. Technol.* **29**, 309.
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Exhibit J

Statement of Sharyle Patton

Commonweal Biomonitoring Resource Center
CBRC, 451 Mesa Road, PO Box 316, Bolinas, CA 94924
PH: 415.779-1010, FAX: 415 868.2230, www.commonweal.org

September 17, 2014

I, Sharyle Patton, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I am the director of the Commonweal Environmental Health Program in Bolinas, California, which takes a science-based approach to the challenge of reducing anthropogenic environmental contaminants. I also direct the Commonweal Biomonitoring Resource Center, and have worked with government agencies and community groups nationally and internationally to design and implement biomonitoring projects to inform improved chemicals regulation, focus chemicals research, and raise public awareness. Additionally, I am director of special projects for the Collaborative on Health and Environment (CHE), a Commonweal-sponsored network that seeks to raise the level of awareness about possible linkages between environmental threat and health outcomes. I was previously the northern co-chair of the International Persistent Organic Pollutants (POPs) Elimination Network, a network of over 350 international non-governmental organizations that worked successfully towards the UN Treaty on POPs, signed in May 2001. Please see my biographical sketch attached.

2. For the past 8 years, I have been involved with numerous biomonitoring studies, including a study in collaboration with the Center for Disease Control (CDC) and California Public Health Department to measure levels of perchlorate in humans, water and produce in Southern California, a study that measured levels of neurotoxins in a group of individuals heading up national groups concerned with learning and developmental disabilities, and a methods development study in collaboration with the International Association of Firefighters that tested 35 firefighters in 15 states for levels of combustion bioproducts and flame retardants. I am currently a founding member of the Women Firefighter Biomonitoring Collaborative, (WFBC), a team of scientists and firefighter groups and advocacy groups which has been awarded a three year grant from the California Breast Cancer Research Foundation to assess women firefighters' exposure to chemicals linked to breast cancer, including carcinogens and endocrine disruptors such as combustion products and diesel exhaust, flame retardants, and perfluorinated chemicals. I am Co-chair of the Women Firefighter Biomonitoring Collaborative's communication, education, and policy team, and have recently co-written a paper discussing effecting biomonitoring study results communication¹.

3. Firefighters are exposed on the job, particularly during fire cleanup and overhaul, to organohalogen flame retardants contained in consumer products, and to their toxic

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combustion products. The latter include dioxins and furans², which are likely contributors to the observed high levels of cancer (such as myeloma, lymphoma, and testicular and bladder cancers) in acting and retired firefighters³.

4. Several studies have found that firefighters have higher levels of organohalogen flame retardants and dioxins and furans than the average population. In collaboration with the University of California Irvine's Center for Occupational and Environmental Health and a Southern California fire department, Biomonitoring California carried out a study of environmental chemical exposures in 101 firefighters in Southern California in 2010-2011, known as the Firefighter Occupational Exposures (FOX) Project⁴. The study detected five PBDE (polybrominated diphenyl ether) congeners in over 90% of the study population, indicating widespread exposure. Two of these highly detected congeners, BDE-47 and BDE-99, are the most abundant congeners used in the commercial flame retardant mixture pentaBDE, which was added to foam inside upholstered furniture in California for many years. A 2013 study by Shaw *et al.*⁵ also measured the blood levels of several flame retardants, including the organohalogen flame retardants PBDEs, in 12 firefighters following a fire event. Study participants had elevated concentrations of PBDEs, particularly the PBDE-209 congener. The authors suggested that this high concentration of PBDE-209 may be due to inhalation of deca-BDE-containing particulate in smoke and dust that is released from burning consumer products such as televisions. Shaw *et al.*⁶ also found distinctive patterns of dioxin and furan congeners in the blood of these 12 firefighters, suggesting occupational exposure.

5. Since 2002, 56 percent of firefighters in the International Association of Fire Fighters Cancer and Occupational Disease Database who have died in the line of duty have died of occupation cancers (unpublished confidential data). This is the largest health-related issue facing the fire fighting profession. Firefighters have higher incidence of several forms of cancer, which may be at least in part related to their exposure to organohalogen flame retardants and their combustion products such as halogenated dioxins and furans⁷. A recent NIOSH study⁸, in collaboration with the National Cancer Institute and the Department of Public Health Sciences at the University of California at Davis, analyzed cancers and cancer deaths through 2009 among 29,993 firefighters from the Chicago, Philadelphia and San Francisco fire departments who were employed since 1950, and found higher rates of respiratory, digestive and urinary systems cancers compared to the general population. Bates *et al.*⁹ found that California firefighters are disproportionately susceptible to testicular cancer, melanoma, brain cancer, or esophageal cancer. Ma *et al.*¹⁰ found that Florida firefighters may get bladder, testicular, or thyroid cancer. Baris *et al.*¹¹ found that Philadelphia firefighters had increased mortality from colon cancer, kidney cancer, non-Hodgkin's lymphoma, or multiple myeloma. A 2006 study by Youakim¹² found firefighters with long-term service had an increased risk for colon cancer, kidney cancer, brain cancer, leukemia, and bladder

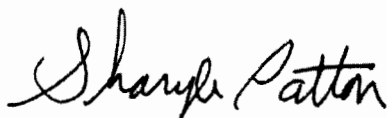
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cancer. Kang *et al.*¹³ found increased incidence of colon and brain cancer in Massachusetts firefighters. LeMasters *et al.*¹⁴ reviewed 32 published studies and concluded that, overall, the risk of multiple myelomas, non-Hodgkin's lymphoma, testicular cancer, and prostate cancer for firefighters was notable. As firefighters are not required to regularly handle industrial chemicals, a probable reason for elevated incidences of such cancers is due to occupational exposure of firefighters to carcinogens such as certain organohalogen flame retardants, dioxins and furans, polycyclic aromatic hydrocarbons (PAHs) and others.

6. Firefighters save lives, but they are more likely to get sick or be killed on the job than the average Americans¹⁵. Organohalogen flame retardants and their combustion products are some of the potentially carcinogenic compounds that firefighters become exposed to on the job at higher levels than the general population. As such, deaths could potentially be avoided by banning, or at least restricting, the use of the entire class of organohalogen flame retardants in household products. Given that organohalogen flame retardants in furniture, mattresses, children's products and electronics casings as currently used do not stop fires, but increase the risk of cancer for firefighters, I see no justification for their use, and fully support the accompanying petition.

Yours sincerely,

Sharyle Patton



¹ Brody JG, Dunagan SC, Morello-Frosch R, Brown P, Patton S, Rudel RA. Reporting individual results for biomonitoring and environmental exposures: lessons learned from environmental communication case studies. *Environ Health* 13(40). doi: 10.1186/1476-069X-13-40.

² Shin-ichi Sakai S, Watanab J, Honda Y, Takatsuki H, Aoki I, Futamatsu M, Shiozaki K. Combustion of brominated flame retardants and behavior of its products. *Chemosphere* 42(5-7), 519-31 (2001).

³ LeMasters GK, Genaidy AM, Succop P, Deddens J, Sobeih T, Barriera-Viruet H, Dunning K, Lockey J. Cancer Risk Among Firefighters: A Review and Meta-Analysis of 32 Studies, *J Occup Environ Med* 48, 1189-202 (2006).

⁴ <http://biomonitoring.ca.gov/projects/firefighter-occupational-exposures-fox-project>

⁵ Shaw SD, Berger ML, Harris JH, Yun SH, Wu Q, Liao C, Blum A, Stefani A, Kannan K. Persistent organic pollutants including polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans in firefighters from Northern California. *Chemosphere* 91(10), 1386-94 (2013). doi: 10.1016/j.chemosphere.2012.12.070.

⁶ Shaw SD, Berger ML, Harris JH, Yun SH, Wu Q, Liao C, Blum A, Stefani A, Kannan K. Persistent organic pollutants including polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans in firefighters from Northern California. *Chemosphere* 91(10), 1386-94 (2013). doi: 10.1016/j.chemosphere.2012.12.070.

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- ¹⁰ Ma F, Fleming LE, Lee DJ, Trapido E, Gerace TA. Cancer Incidence in Florida Professional Firefighters, 1981 to 1999, *J Occup Environ Med* **48**, 883-8 (2006).
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- ¹² Youakim S. Risk of Cancer Among Firefighters: A Quantitative Review of Selected Malignancies, *Arch Environ Occup Health* **61**(5), 223-31 (2006).
- ¹³ Kang D, Davis LK, Hunt P, Kriebel D. Cancer Incidence Among Male Massachusetts Firefighters, 1987-2003, *Am J Ind Med* **51**, 329-35 (2008).
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Sharyle Patton is director of the Commonweal Biomonitoring Resource Center, a program that helps communities of concern learn more about the public health tool of biomonitoring. She also is director of Special Projects for the Collaborative on Health and Environment, a Commonweal-sponsored network that seeks to raise the level of awareness about possible linkages between environmental threat and health outcomes.

Patton was a co-founder and served as the Northern Co-Chair of the International Persistent Organic Pollutants (POPs) Network, a network of over 500 public-interest groups around the globe who are active in UN negotiations dealing with toxic chemical regulation. Working closely with governments, this network participated in creating the Stockholm Convention, a legally binding UN treaty that bans or severely restricts the use of POPs chemicals. The Convention entered into force in May 2004.

Patton serves as advisor for the California Health Tracking Program, a CDC-funded project to develop infrastructure and processes for tracking chemical hazards, pathways of exposure and health outcomes in California.

In 1995, 1996, and 1997, Patton was the public sector representative on the United States Delegation to the UN Commission on Sustainable Development. Patton was also a public sector representative on the United States Delegation to the UN Summit, Habitat II, as well as on the US Delegation to Rio Plus Five. Patton was active as an NGO representative at the UN summits on women's issues in Cairo and Beijing, supporting women's reproductive rights and the right of women to live in environments conducive to the highest possible standard of good health.

Patton currently serves on the Advisory Group for human milk monitoring, World Health Organization, and the steering group for the World Alliance for Breastfeeding Advocacy. Patton is also a board member of the Barbara Smith Fund and The Endocrine Disrupter Exchange (TEDX).

Exhibit K

Statement of Ruthann Rudel



I, Ruthann Rudel, am writing this statement to provide information relevant to the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, Ruthann Rudel, am Director of Research at the Silent Spring Institute, and Adjunct Research Associate in the Brown University Department of Pathology and Laboratory Medicine. I have a B.A. in chemistry and neuroscience from Oberlin College, and an M.S. in environmental management and policy from Tufts University. I have served on the US National Toxicology Program Board of Scientific Counselors and the Regulatory Affairs and Legislative Assistance Committee of the Society of Toxicology, and have participated in numerous environmental regulatory reviews for the US EPA, Health Canada, Toxicology Excellence for Risk Assessment, and others. I have attached my CV and list of publications.

2. For almost 20 years, I have been co-leading Silent Spring Institute's exposure and toxicology research programs focusing on endocrine active chemicals and on the mechanisms by which chemicals may influence breast cancer risk. I also direct Silent Spring Institute's Household Exposure Study, which was described by Environmental Science & Technology as the "most comprehensive analysis to date" of exposures in homes. I have expanded the initial study to include indoor and outdoor air, house dust, urine, blood, and self-reported exposure data from 170 participants in California and Massachusetts, leading to over 30 highly-cited peer-reviewed exposure-related papers.

3. Our 2003 Household Exposure Study was the first to test US homes for the flame retardant PentaBDE (a commercial mixture of polybrominated diphenyl ethers (PBDE)), which was then used as flame retardant in furniture foam. We found that levels of PBDEs in US homes were ten times higher than in Europe. In 2006, we discovered that, due to unique furniture flammability standards, exposures to PentaBDE congeners (BDE 47, 99 and 100) were 4 to 10 times higher in California than in the rest of the US, and two orders of magnitude higher than in Germany and the UK. Californians also had nearly twice as high blood levels of PBDEs (sum of BDE-28, -47, -99, -100, -153, and -154 congeners) compared to other US residents¹. These results show that flammability standards influence exposures and risks².

5. In 2011, we tested again the same 16 California homes from the 2006 study, to understand exposure to a wider range of flame retardants. This time we screened for 49 flame retardants (organohalogens and organophosphates), chosen due to evidence for their widespread use and potential harmful health effects.

6. We found that the current levels of exposure to the organohalogen flame retardants are often above health based guidelines³. House dust concentrations of six chemicals, including the carcinogens TCEP (Tris (2-chloroethyl) phosphate) and TDCPP (chlorinated "Tris"), were higher than EPA health risk guidelines in at least one home, and levels in 13 of 16 homes exceeded at least one health guideline level. TCEP and TDCPP (both listed as carcinogens under California's Proposition 65) were found at levels of up to 0.01% in dust, higher than previously reported in the US. Our study was also the first to detect TDBPP (brominated "Tris") in house dust, in 75% of the homes studied.

7. Our 2011 study also showed that exposure to flame retardants from house dust had changed since 2006, after the phase out of PentaBDE and OctaBDE. PentaBDE levels decreased in homes that added new furniture, electronics, and flooring. Similarly, households that reported purchasing new electronics had lower levels of TBBPA in 2011 compared to 2006. Instead, households that added new furniture and other flame retardant products between 2006 and 2011 had higher levels of tris(1-chloro-2-propyl) phosphate (TDCPP), suggesting its use as PentaBDE replacement⁴.

8. Our 2003, 2006 and 2011 study results prove that, if added to consumer products in additive form (i.e. not chemically-bound to the material), organohalogen flame retardant chemicals migrate out of products and get into dust. This house dust is thought to be a major source of flame retardants in people's bodies, especially in children⁵.

9. In particular, I wish to point out that our 2011 study indicated that banning individual flame retardants is ineffective because manufacturers tend to replace them with other chemicals with similar structures and hazards, including chemicals with uncharacterized toxicity. Some of the chemicals found in homes at the highest levels are carcinogenic, and are structurally similar to banned chemicals. Many of the chemicals detected in households show evidence of hormone disruption. The attached table from the Silent Spring study by Dodson et al. (2012)⁶ summarizes the known health concerns and the data gaps for some of the high production volume flame retardants we found in homes.

10. Based on these findings, my professional opinion is that, in order to reduce people's exposure to hazardous chemicals in homes, it is best to use inherently non-flammable materials or smolder-resistant flammable materials. Continued use of non-polymeric additive organohalogen flame retardants would lead to continued exposure and may cause adverse health effects, particularly to vulnerable populations.

Sincerely,



Ruthann Rudel, MS
Director of Research, Silent Spring Institute

-
- ¹ Zota A.R., Rudel R.A., Morello-Frosch, R.A., Brody, J.G. (2008). Elevated house dust and serum concentrations of PBDEs in California: Unintended consequences of furniture flammability standards? *Environ. Sci. Technol. Lett.* 42(21):8158-64. doi: 10.1021/es801792z.
- ² Dodson R.E., Perovich L.J., Covaci A., den Eede N.V., Ionas A.C., Dirtu A.C., Brody J.G., Rudel R.A. (2012). After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environ. Sci. Technol.* 46(24):13056-66. doi: 10.1021/es303879n.
- ³ Dodson R.E., BFR 2013.
- ⁴ Dodson R.E., Perovich L.J., Covaci A., den Eede N.V., Ionas A.C., Dirtu A.C., Brody J.G., Rudel R.A. (2012). After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environ. Sci. Technol.* 46(24):13056-66. doi: 10.1021/es303879n.
- ⁵ Lorber M. (2008). Exposure of Americans to polybrominated diphenyl ethers. *J Expos Sci Environ Epidem* 18(1):2–19. doi: 10.1038/sj.jes.7500572.
- ⁶ Dodson R.E., Perovich L.J., Covaci A., den Eede N.V., Ionas A.C., Dirtu A.C., Brody J.G., Rudel R.A. Supporting Information for: After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environ. Sci. Technol.* 46(24):13056-66. doi: 10.1021/es303879n.

Table S14. Summary of flame retardant uses and health effects

Flame Retardant Class	Uses	Health Concerns ^a
Polybrominated diphenyl ethers (PBDEs)		
PentaBDE	Additive flame retardant in polyurethane foams ⁷	EPA Action Plan Chemical
CAS 32534-81-9	Phased out in US in 2004	Dose-dependent decrease of T4, increased liver weight and P450 induction after 4 days of oral administration of DE-71 to 28 d.o. female rats. ⁸ Decrease of T4 and T3, increase of TSH, hypothyroid indicators, increased liver to body weight ratio, increased P450 induction, decrease in seminal vesicle and ventral prostate weights and delayed preputial separation in males, delayed vaginal opening in females; males more sensitive in this screening battery for EPA ED Screening Program using gavage of DE-71 on young Wistar rats ⁹
<i>Includes congeners BDE 28, BDE 47, BDE 66, BDE 85, BDE 99, BDE 100, BDE 153, and BDE 154</i>	10-50 million pounds produced in 2002 in US	BDE-99: gestational exposure associated with hyperactivity and permanently impaired spermatogenesis in male rats ¹⁰
		Decreased birth weight and birth length in humans associated with BDE 47, BDE 99, and BDE 100 levels in mothers' breast milk ¹¹
		Children with higher concentrations of BDE 47, BDE 99, and BDE 100 in cord blood scored lower on tests of mental and physical development at 12-48 and 72 months ¹²
		In adult male sport fish consumers, serum levels of BDE 47, BDE 99, BDE 100, and BDE 153 were positively related to T4 and inversely related to T3 and TSH. Men over the 95 th percentile of PBDE levels were more likely to have thyroglobulin antibodies ¹³
		Serum concentrations of BDE 28, BDE 47, BDE 99, BDE 100, and BDE 153 in pregnant women were inversely associated with TSH levels; no relationship was found with T4. ¹⁴ Serum levels of BDE 47, BDE 99, and BDE 100 were positively associated with T4 in pregnant women in their third trimester ¹⁵
		Endocrine disruption through androgen, progesterone, estrogen, T4 receptor agonism and antagonism in vitro ¹⁶
		Decreased attention, motor skills, and IQ in children associated with mothers' PBDE blood serum concentrations during pregnancy; decreased attention and IQ in children (age 7) associated with PBDE serum concentrations ¹⁷
OctaBDE	Additive flame retardant in polymers for plastic housings and office equipment ⁷	EPA Action Plan Chemical
CAS 32536-52-0	Phased out in US in 2004	Dose-dependent decrease of T4, increased liver weight and P450 induction after 4 days of oral administration of DE-79 to 28 d.o. female rats ⁸
<i>Includes congeners BDE 183,</i>		

Flame Retardant Class	Uses	Health Concerns ^a
<i>BDE196, BDE 197, and BDE 203</i>	1-10 million pounds produced in 2002 in US	Neonatal mice gavaged BDE 203 resulted in increased CaMKII and synaptophysin in the hippocampus ¹⁸
DecaBDE CAS 1163-19-5 <i>Includes congener BDE 209</i>	Additive flame retardant in electrical and electronic equipment, textiles and fabric backings; accounts for 80% of total PBDE production ⁷ Volunteer phase-out in US by 2014 50-100 million pounds produced in 2006 in US	EPA Action Plan Chemical Impaired reproductive function to male mice exposed in utero ¹⁹ Neonatal exposure to mice effects neurobehavioral effects, including locomotion, rearing, and habituation activity; effects worsened with age. ²⁰ Neonatal exposure to mice effects sensorimotor responses and locomotor activity, and reduction of thyroxine levels ²¹ Decreased birth weight and birth length in humans associated with BDE 209 levels in mothers' breast milk ¹¹ Leukemia and liver, spleen, and thyroid tumors and cancers in oral high doses over 2 years to male rats ²²
Firemaster® 550 <i>2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EH-TBB)</i> CAS 183658-27-7 <i>bis(2-ethylhexyl)-3,4,5,6-tetrabromophthalate (BEH-TBEP)</i> CAS 26040-51-7 <i>tri-phenyl phosphate (TPHP)</i> CAS 115-86-6	Replacement for PentaBDE in foams BEH-TBEP: 1-10 million pounds produced in 2006 in US TPHP: 10-50 million pounds produced in 2006 in US	FM® 550: DNA damage in liver tissue of fathead minnows after oral exposure. ²³ Increased thyroxine, body weight in offspring, early puberty in female offspring, difficulty in glucose regulation in female offspring and thickened walls in the left ventricle in male offspring. ²⁴ BEH-TBEP structurally similar to DEHP, a reproductive and developmental toxicant and listed carcinogen on CA's Proposition 65 List ^{25,26} Hypothyroidism, decrease T3, hepatotoxicity in pregnant rats, and increased multinucleated germ cells in fetal testis following two days of oral dosing of TBMEHP, a metabolite of TBPH ²⁷ TPHP: increased prolactin levels, reduced sperm concentration in men ²⁸ <i>Lack of cancer, and 2 generation reproductive, and developmental studies</i> ²⁹
hexabromocyclododecanes (HBCYDs) CAS: 3194-55-6 <i>Includes alpha, beta, and gamma-hexabromocyclododecane</i>	Additive flame retardant in thermoplastic (moldable) polymers and styrene resins ⁷ Used in building insulation, upholstery textiles and electrical equipment housing ³⁰ 10-50 million pounds produced in 2006 in US	EPA 2010 Action Plan to review potential reproductive, developmental and neurological effects ³¹ Listed as Substance of Very High Concern (SVHC) under REACH Hyperactive activity, reduced habituation, learning and memory impairment in neonatal mice with oral exposures ³² Non-monotonic dose response curve observed for TSH levels in adult mice and their offspring, decreased ovarian follicles in second generation female mice, decreases in the

Flame Retardant Class	Uses	Health Concerns ^a
		viability index of F2 pups ³³
		Thyroid hormone disruption in animals and in vitro models ³⁴
		Endocrine disruption through androgen, progesterone, estrogen, T4 receptor agonism and antagonism in vitro ¹⁶
		Dopamine and GABA uptake inhibition due to effects on membrane potential in rat brain cells ³⁵
tetrabromobisphenol A (TBBPA) CAS: 79-94-7	Most widely used flame retardant; reactive in circuit boards; additive flame retardant in polymers ⁷ 100-500 million pounds produced in 2006 in US	Endocrine disruption through T3, T4 agonism and estradiol inhibition in vitro. ¹⁶ Strong T4 agonism. ³⁶ CD25 inhibition in female mice. ³⁷ Decreased T4, increased testis and pituitary weight in orally exposed rats, increased testis weight, testosterone, female gonadal weight in second generation ³⁸ Dopamine and GABA uptake inhibition due to effects on membrane potential in rat brain cells ³⁵
<i>Lack of health studies</i>		
Other brominated flame retardants (BFRs)		
tetrabromobisphenol A-bis(2,3-dibromopropylether) (TBBPA-BDBPE) CAS: 21850-44-2	Additive flame retardant in plastics, including pipes, water barriers, kitchen hoods and electronics ³⁹ 1-10 million pounds produced in 2006 in US	Endocrine disruption through T4 agonism and estradiol inhibition in vitro ¹⁶ Mutagenic in salmonella; structural similarities to TDBPP, a classified carcinogen ⁴⁰ <i>Lack of health studies</i>
hexabromobenzene (HBB) CAS: 87-82-1	Additive flame retardant in paper, wood, textiles, electronic and plastics; not used in Europe ³⁹	Disruption of heme formation in female rats following gavaged HBB over 28 days ⁴¹ Increased liver:body ratio and increased carboxylesterase in rats subchronically fed HBB ⁴² <i>Lack of health studies</i>
1,2-bis(2,4,6-tribromophenoxy)ethane (BTBPE) CAS: 37853-59-1	Replacement for OctaBDE ³⁹ 1-10 million pounds produced in 2006 in US	Its metabolite is an endocrine disruptor through androgen, progesterone, estrogen, T4 receptor agonism and antagonism in vitro ¹⁶ Behavioral, gastrointestinal, and respiratory changes, and dermatitis following high dose inhalation in rats. Dermal exposure to rabbits led to metabolic changes ⁴³

Flame Retardant Class	Uses	Health Concerns ^a
		<i>No chronic animal studies</i> ⁴³
decabromodiphenylethane (DBDPE) CAS: 84852-53-9	Alternative to DecaBDE ³⁹ 10-50 million pounds produced in 2006 in US	Reduced EROD activity in fish hepatocytes; acutely toxic to water fleas; reduced hatching rates of zebra fish eggs and increased mortality of hatched larvae ⁴⁴ Structurally similar to BDE 209 ³⁹
		<i>Lack of health studies</i>
Halogenated organophosphate flame retardants (OPFRs)		
tris(2-chloroethyl)phosphate (TCEP) CAS: 115-96-8	Used in polyurethane foams, plastics, polyester resins, and textiles ^{45, 46} Banned from children's products in NY in 2011 ⁴⁷ Up to 1 million pounds produced in 2006 in US	Listed as carcinogen on CA's Proposition 65 List in 1992 Listed as Substance of Very High Concern (SVHC) and persistent, bioaccumulative, and toxic (PBT) as a reproductive toxicant under REACH ⁴⁸ Impaired memory in rats, cholinesterase inhibition in hen brains. ⁴⁹ Neurotoxicity due to altered cellular neurodifferentiation in vitro. ⁵⁰ Decreased cognitive function correlated with TCEP in house dust in boys and girls age 5-9 ⁴⁸
tris(1-chloro-2-propyl)phosphate (TCIPP) CAS: 13674-84-5	Used in polyurethane foams ⁴⁵ 10-50 million pounds produced in 2006 in US	Structurally similar to TCEP ⁵¹ <i>Lack of health studies</i>
tris(1,3-dichloro-isopropyl)phosphate (TDCIPP) CAS: 13674-87-8	Used in polyurethane foams, plastics, and textiles ^{45, 46} Removed from children's clothing in the late 1970s in the US ⁵² 10-50 million pounds produced in 2006 in US	Listed as carcinogen on CA's Proposition 65 List in 2011 Increased liver carcinomas and kidney, testicular, and brain tumors in male and female rats ⁴⁹ Associated with Sick Building Syndrome in men and women ⁵³ Endocrine disruption through decrease in thyroxine, increase in prolactin, and decrease in androgens in men ²⁸ Neurotoxicity due to altered cellular neurodifferentiation and inhibited DNA synthesis in vitro ⁵⁰
tris-(2,3-dibromopropyl)phosphate (TDBPP)	Used in polyurethane foams ⁴⁵ Banned in 1977 for use in children's clothing ⁵⁴	Listed as carcinogen on CA's Proposition 65 List in 1988; classified as IARC 2A carcinogen

Flame Retardant Class	Uses	Health Concerns ^a
CAS: 126-72-7 Non-halogenated OPFRs tri-ethyl-phosphate (TEP)	Used for plasticizing properties and in antifoam agents and lacquers ^{45, 46}	Brain colinesterase inhibition and reduced righting reflex in rats following injection of TEP ⁵⁵
CAS: 78-40-0	1-10 million pounds produced in 2006 in US	<i>Lack of health studies</i>
tri-iso-butyl-phosphate (TIBP)	Used for plasticizing properties and in antifoam agents and lacquers ^{45, 46}	<i>Lack of health studies</i>
CAS: 126-71-6		
Tri-n-butyl-phosphate (TNBP)	Used for plasticizing properties and as lubricants in hydraulic fluids ⁴⁵	A dose-related increase in the incidence and severity of urinary bladder tumors was found in male and female rats receiving TnBP in the diet for 2 years ⁵⁶
CAS: 126-73-8	1-10 million pounds produced in 2006 in US	Associated with Sick Building Syndrome in men and women ⁵³ <i>Lack of health studies</i>
tri-(2-butoxyethyl)-phosphate (TBOEP)	Also used in floor wax, lacquers, and rubber and plastic stoppers ^{45, 46}	Decreased red cell acetylcholinesterase, ataxia, tremors, and increased liver weight in rats gavaged TBEP for 18 weeks ⁵⁷
CAS: 78-51-3	1-10 million pounds produced in 2006 in US	<i>Lack of health studies</i>
tri-(2-ethylhexyl)-phosphate (TEHP)	Used in clothing, as a plasticizer, and as a solvent ⁵⁸	Increase in lymphomas, liver, pituitary tumors in mice orally exposed to high doses of TEHP in diet for 2 years ⁵⁹
CAS: 78-42-2		<i>Lack of health studies</i>
tri-cresyl-phosphate (TMPP)	Used as flame retardant plasticizers and as lubricants in hydraulic fluid ⁴⁵	Reproductive and developmental toxicity due to dose-dependent increase in abnormal sperm morphology in male rats and increased pup mortality following in utero exposure ⁶⁰
CAS: 1330-78-5	1-10 million pounds produced in 2006 in US	Toxicity to central nervous system due to neuropathy of the sciatic nerve ⁶⁰ <i>Lack of health studies</i>
Dechlorane-plus (DDC-CO)	• Flame retardant in electronics ⁶¹	Increased liver weight, increased lung weight and macrophages in alveoli in rats, decreased liver and ovarian weight in rabbits ⁶²
CAS: 13560-89-9	1-10 million pounds produced in 2006 in US	Shares structural similarities with dieldrin, chlordane, heptachlor, endrin, and endosulfan ⁶³

Flame Retardant Class	Uses	Health Concerns^a
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Lack of health studies

^a From laboratory or animal studies unless otherwise indicated

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EDUCATION

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Summer Research Fellowships, Rockefeller University, National Institute of Health, 1984-1986

Tufts University, Department of Civil Engineering, 1989-1991, M.S., Hazardous Materials Management, 1991

Harvard Extension School and New England Epidemiology Institute, 1993-1995, graduate courses in epidemiology, statistics

ACADEMIC APPOINTMENTS

Research Associate, Department of Pathology and Laboratory Medicine, The Warren Alpert Medical School of Brown University, 2007-present

PRIMARY CAREER APPOINTMENTS

Senior Research Assistant, Neuroscience Laboratories, Tufts University Medical School, Boston, MA, 1986-1989

Editor, World Information Systems, Cambridge, MA, 1989-1990

Environmental Toxicologist, Gradient Corporation, Cambridge, MA, 1990-1995

Director of Research, Senior Scientist, Toxicology and Environmental Health Risk Assessment, Silent Spring Institute, 1995-present (Silent Spring Institute is a nonprofit research organization dedicated to studying the environment and women's health.)

OTHER APPOINTMENTS

Ad hoc Manuscript Reviewer, *Environmental Science & Technology*, *Toxicological Sciences*, *Environmental Health Perspectives*, *Environmental Research*, and others, 1997-present

Invited Reviewer, Toxicology Excellence for Risk Assessment, Cincinnati, OH, 1998-present

Reviewer, US EPA/NIEHS STAR grants, 1999

Invited Reviewer, Cornell University Program on Breast Cancer and Environmental Risk Factors, 1999-2002

Advisor, Breast Cancer Fund, Breast Cancer Action, Massachusetts Breast Cancer Coalition, Massachusetts Alliance for a Healthy Tomorrow, California Breast Cancer Research Program, and others, 1999-present
Consultant, risk assessment reviewer, Health Canada, 1997-2009
Science Advisory Board Member, Massachusetts Toxics Use Reduction Act implementation, 2000-2001
Developer, Co-Chair, Society of Toxicology annual meeting symposium, *Breast Cancer: Issues in Screening and Testing of Potential Human Carcinogens*, 2001
Chair, Member, Society of Toxicology Regulatory Affairs and Legislative Assistance Committee, 2004-2006
Expert Panelist, California Breast Cancer and Chemicals Policy Project, 2009
Board of Scientific Counselors, US National Toxicology Program, 2009-2011

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Guest lecturer at Tufts University, Harvard School of Public Health, and Suffolk University, 2005-present

PUBLICATIONS LIST

ORIGINAL PUBLICATIONS IN PEER-REVIEWED JOURNALS

1. Talamo, B.R., **R.A. Rudel**, K.S. Kosik, V.M. Lee, S. Neff, L. Adelman, and J.S. Kauer. 1989. Pathological changes in olfactory neurons in patients with Alzheimer's disease. *Nature* 337:736-739.
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2. **Rudel R.A.** 1997. Predicting health effects of exposures to compounds with estrogenic activity: Methodological issues. *Environmental Health Perspectives* 105 (Suppl 3):655-663.
3. Brody, J.G., R.A. **Rudel**, S.J. Melly, and N.I. Maxwell. 1998. Endocrine disruptors and breast cancer. *Forum for Applied Research and Public Policy* 13(3):24-31.
4. Kriebel, D., J. Tickner, P. Epstein, J. Lemons, R. Levins, E.L. Loechler, M. Quinn, R.A. **Rudel**, R. Schettler, and M. Stoto. 2001. The precautionary principle in environmental science. *Environmental Health Perspectives* 109(9):871-875.
5. Brody, J.G., and R.A. **Rudel**. 2003. Environmental pollutants and breast cancer. *Environmental Health Perspectives* 111(8):1007-1019.
6. Brody, J.G., J. Tickner, and R.A. **Rudel**. 2005. Community-initiated breast cancer and environment studies and the precautionary principle. *Environmental Health Perspectives* 113(8):920-925.
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10. Brody, J.G., R.A. **Rudel**, M. Kavanaugh-Lynch. 2011. Testing Chemicals for Effects on Breast Development, Lactation, and Cancer. *Environmental Health Perspectives*, 119(8).
11. Adams, C., P. Brown, R. Morello-Frosch, J. G. Brody, R. **Rudel**, A. Zota, S. Dunagan, J. Tovar, and S. Patton. June 2011. Disentangling the exposure experience: the roles of

community experience: the roles of community context and report-back of environmental exposure data. *Journal of Health and Social Behavior*, 52(2): 180-196.

12. Osborne G, **Rudel** R, Schwarzman M. 2014. Evaluating chemical effects on mammary gland development: A critical need in disease prevention. *Reprod Toxicol*. doi: 10.1016/j.reprotox.2014.07.077
13. Brody JG, Dunagan SC, Morello-Frosch R, Brown P, Patton S, **Rudel RA**. 2014. Reporting individual results for biomonitoring and environmental exposures: lessons learned from environmental communication case studies. *Environ Health*. 13: 40. doi: 10.1186/1476-069X-13-40

BOOKS AND BOOK CHAPTERS

Rudel, R.A., and B.D. Beck. 1993. Risk assessment for indoor air: Evaluating risks to susceptible populations. In *NATO/CCMS Pilot Study on Indoor Air Quality: Methods of Risk Assessment for the Indoor Environment*. Ed. B. Seifert. Institute for Water, Soil, and Air Hygiene of the Federal Health Office, Berlin.

Beck, B.D., R.A. **Rudel**, and E.J. Calabrese. 1994. The use of toxicology in the regulatory processes. In *Principles and Methods of Toxicology, Third Edition*. Ed. A. Wallace Hayes. New York: Raven Press.

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Rudel, R.A. 2000. Polycyclic aromatic hydrocarbons, phthalates, and phenols. In *Indoor Air Quality Handbook*, Eds. J. Spengler, J. Samet, and J. McCarthy. New York: McGraw-Hill.

Beck, B.D., T.M. Slayton, E.J. Calabrese, L. Baldwin, and R.A. **Rudel**. 2001. The use of toxicology in the regulatory process. In *Principles and Methods of Toxicology*, Ed. A. Wallace Hayes. Philadelphia, PA: Taylor & Francis.

Brody, J.G., R. Morello-Frosch, P. Brown, R.A. **Rudel**, R.G. Altman, M. Frye, C.A. Osimo, C. Perez, and L.M. Seryak. 2008. Improving disclosure and consent: "Is it safe?": New ethics for reporting personal exposures to environmental chemicals. In *Perspectives in Medical Sociology, Fourth Edition*, Ed. Phil Brown. Long Grove, IL: Waveland Press, Inc.

Morello-Frosch, R., P. Brown, J.G. Brody, R.G. Altman, R.A. **Rudel**, A. Zota, and C. Perez. 2011. Experts, ethics, and environmental justice: Communicating and contesting results from personal exposure science. In *Technoscience and Environmental Justice: Expert Cultures in a Grassroots Movement*, eds. G. Ottinger and B.R. Cohen. Cambridge, MA: MIT Press.

Rudel RA, Rodgers KM, Just AC. 2014. Phthalates in Food Packaging, Consumer Products, and Indoor Environments. In: *Toxicants in Food Packaging and Household Plastics: Exposure and Health Risks to Consumers*. London:Springer.

OTHER NON-PEER-REVIEWED PUBLICATIONS

Letters

Rudel, R.A., J.G. Brody, and J.D. Spengler. 2001. Identification of selected hormonally active agents and animal mammary carcinogens in commercial and residential air and dust samples [Response]. *Journal of Air and Waste Management Association* 51:1388-90.

Rudel, R.A., and E. Newton. 2004. Letter to the Editor: Exposure assessment for decabromodiphenyl ether (decaBDE) is likely to underestimate general U.S. population exposure. *Journal of Children's Health* 2(2):171-173.

Zota, A.R., R.A. **Rudel, R.A.** Morello-Frosch and J.G. Brody. 2009. Response to comment on "Elevated house dust and serum concentrations of PBDEs in California: Unintended consequences of furniture flammability standards?" *Environmental Science & Technology* 43(7):2661-2662.

Brody, J.G., R. Morello-Frosch, P. Brown and R.A. **Rudel.** 2009. Letter to the Editor: Reporting individual results for environmental chemicals in breastmilk in a context that supports breastfeeding. *Breastfeeding Medicine* 4(2):121.

Schaider, L.A., R.A. **Rudel, J.M. Ackerman, and J.G. Brody.** (2010) Correspondence re: Using residential history and groundwater modeling to examine drinking water exposure and breast cancer by Lisa Gallagher et al., *Environmental Health Perspectives*, published online 1 September 2010.

Rudel, R.A, J.M. Ackerman, and R.E. Dodson. 2011. Dietary intervention and DEHP reduction: Rudel et al. respond. *Environmental Health Perspectives* 119:a380-a381. doi:10.1289/ehp.1103852R

Rudel, R.A. and L.J. Perovich. 2012. Accurate risk-based chemical screening relies on robust exposure estimates. *Toxicological Sciences*, doi:10.1093/toxsci/kfs143.

PUBLICATIONS SUBMITTED

Dodson, R.E., Van den Eede, N, Covaci, A, Perovich,LJ, Brody, JG., **Rudel, RA.** (Under review) Urinary biomonitoring of phosphate flame retardants: Levels in California adults and recommendations for future studies

INVITED PRESENTATIONS

1. **Rudel, R.A.** 1995. Modeling *in vivo* estrogenic potency. Invited talk. Workshop on hormones, hormone metabolism, and breast cancer. National Cancer Institute's National Action Plan on Breast Cancer, September, New Orleans, LA.
2. **Rudel, R.A.** 2001. Residential exposure to EDCs in the context of a breast cancer study. e.hormone 2001, October 18-20, Tulane University, New Orleans, LA.
3. Brody, JG, RA **Rudel.** 2002. Environmental pollutants and breast cancer: using GIS and environmental sampling in the Cape Cod Breast Cancer and Environment Study. Presented at the

National Institute of Environmental Health Sciences (NIEHS), June 10, 2002, Research Triangle Park, North Carolina.

4. **Rudel, R.A.** 2002. Household exposure to hormonally active agents and animal mammary carcinogens in indoor air, dust, and residents' urine on Cape Cod, MA. Invited talk sponsored by the EPA conference Risk Management for Endocrine Disrupting Compounds, January, Cincinnati, OH.
5. **Rudel, R.A.** 2003. Air, dust, and urinary markers of phthalates. NIEHS Workshop on Human Health Effects of Phthalate Exposure. March 26-27, Research Triangle Park, NC.
6. Brody, JG, RA **Rudel**. 2005. Community-initiated breast cancer and environment studies and the Precautionary Principle. Presented to the Collaborative on Health and the Environment Cancer Working Group, June 1.
7. Brody, JG, RA **Rudel**. 2007. Endocrine disruptors and breast cancer: The Cape Cod Study and beyond. Presented at the Superfund Basic Research Program Seminar, Brown University, April 20, Providence, Rhode Island.
8. Brody, JG, RA **Rudel**. 2007. Breast cancer and the environment: Science review with Silent Spring Institute. Presented to the Collaborative on Health and the Environment Partnership Call, June 19.
9. **Rudel, RA.** 2009. Key issues and data needs for considering mammary gland effects in chemical risk assessment. Presented at the Mammary Gland Evaluation and Risk Assessment Workshop, November 16-17, Oakland, CA.
10. Brody, J.G., R. Morello-Frosch, P. Brown, R.A. **Rudel**, S. Dunagan. Is It Safe? Reporting Personal Exposures When Health Effects are Uncertain. Presented at the Keystone Science Lecture Series sponsored by the NIEHS Division of Extramural Research and Training (DERT), December 1, 2009, Research Triangle Park, North Carolina.
11. **Rudel, R.A.** 2010. Toxicology Can Advance Breast Cancer Prevention by Informing Chemicals Policies and Epidemiologic Study Design. Institute of Medicine Committee on Breast Cancer and the Environment. July 7, 2010, San Francisco, CA
12. **Rudel, RA., R. Dodson.** 2011. SVOCs in indoor air, dust, and personal care products. Presented at the SVOCs in the Indoor Environment: Mechanistic Insights to Support Sustainable Product Design, Safe Use and Improved Public Health Workshop sponsored by the Indoor Air Institute, January 5-7, 2011, EPA, Research Triangle Park, North Carolina.
13. **Rudel, RA.** 2011. "Is It Safe?": New Ethics for Reporting Personal Exposures to Environmental Chemicals. Presented at the Biomonitoring California Workshop: Understanding and Interpreting Biomonitoring Results, March 17, 2011, Oakland, California.
14. Brody, J.G., **R. Rudel**. Household Cancer Hazards Interview. Julie and Ruthann interviewed with Dr. Lynn Goldman on NPR's On Point (Tom Ashbrook) regarding the Product Testing Study, March 13, 2012.

15. **Rudel, RA.** 2013. Chemicals and Breast Cancer: Building on National Initiatives for Chemical Safety Screening. Presented at Chemical Testing in the 21st Century: Opportunities and Challenges, January 24, 2013, Environmental Defense Fund, Washington DC.
16. **Rudel, RA.** 2013. Chemicals Testing Workgroup Panel. California Breast Cancer Research Program's "From Research to Action: Two Decades of Change" symposium, May 17-18, 2013, Costa Mesa, CA.
17. **Rudel, R.A.** 2013. How are the critical relationships between chemical bioavailability, activity, and adversity established within an AOP in a way that protects the most sensitive subpopulations? Panel speaker at Adverse Outcome Pathways: From Research to Regulation. September 3-4, 2014, Bethesda, MD.
18. **Rudel, R.A.** Toxicology for Breast Cancer Prevention. Risk Assessment Specialty Section (RASS) and Mixtures Specialty Section (MSS) Webinar. September 10, 2014.

SELECTED ABSTRACTS

1. **Rudel, R.A.,** and B.D. Beck. 1993. Risk assessment for indoor air: Evaluating risks to susceptible populations. *Methods of Risk Assessment for Indoor Environment*. B. Seifert, ed. NATO/CCMS Pilot Study of Indoor Air Quality and European Collaborative Action. "Indoor Air Quality and its Impact on Man (Formerly Cost Project613)." Report on a joint workshop, held October 15-17, 1991 in Kloster Banz, Federal Republic of Germany.
2. **Rudel, R.A.,** and B.D. Beck. 1994. Variability in international criteria for chemical toxicity: Comparison of the methods and criteria developed by the U.S. EPA, the WHO, and the RIVM. Presented at the Society for Risk Analysis Annual Meeting, December, Baltimore, MD.
3. Melly, S.J., S.R. Swedis, R.A. **Rudel,** Y.T. Joyce, and J.G. Brody. 1996. Environmental factors in breast cancer: Enhancing an ecological epidemiology study through the use of a geographic information system. Joint Annual Meeting of the Society for Risk Analysis and the International Society for Exposure Assessment. New Orleans, LA.
4. Melly, S.J., R.A. **Rudel,** A.M. Soto, C. Sonnenschein, M. Fernandez, and J.G. Brody. 1996. Potential exposure to estrogenic chemicals via drinking water from a vulnerable aquifer: Pairing chemical analysis with a bioassay. Joint Annual Meeting of the Society for Risk Analysis and the International Society for Exposure Assessment. New Orleans, LA.
5. Brody, J.G., A. Aschengrau, and R.A. **Rudel.** 1997. Occupational history module of the breast cancer core questionnaire. American Public Health Association Annual Meeting. Indianapolis, IN.
6. **Rudel, R.A.** 1998. Estrogenic components in wastewater, septage, and groundwater: A comparison between chemical analysis and results from an MCF-7 cell proliferation bioassay. Presented at the NIEHS/EPA Endocrine Disruptor Grantees Annual Meeting, October, Research Triangle Park, NC.

7. **Rudel, R.A., A.M. Soto, C. Sonnenschein, M. Luizzi, B. Weill, S.J. Melly, P.W. Geno, and J.G. Brody.** 1998. Estrogenic components in wastewater, septage, and groundwater: A comparison between chemical analysis and results from an MCF-7 cell proliferation bioassay. NIEHS/US EPA Endocrine Disruptor Investigators Meeting. Research Triangle Park, NC.
8. Camann, D.E., J.S. Colt, S.L. Teitelbaum, R.A. **Rudel**, R.M. Hart, and M.D. Gammon. 2000. Pesticide and PAH distributions in house dust from seven areas of USA. Society of Environmental Toxicology and Chemistry 21st Annual Meeting, Nashville, TN.
9. **Rudel, R.A., D. Camann, P.W. Geno, N. Ho, M. Ortiz, A. Yau, J.D. Spengler, J. Vallarino, and J.G. Brody.** 2000. Identification of animal mammary carcinogens and hormonally active chemicals in residential air and dust samples. International Society for Exposure Analysis Meeting. Monterey, CA.
10. Brody, JG, SJ Melly, RA **Rudel**, NI Maxwell. 2000. GIS exposure assessment for pesticides and drinking water in the Cape Cod Breast Cancer and Environment Study. Annual Conference of International Society for Environmental Epidemiology (ISEE)/International Society of Exposure Analysis (ISEA). *Epidemiology* 11(4):S102.
11. **Rudel, R.A.** and B. Davis. 2001. Breast cancer: Issues in screening and testing of potential human carcinogens. Symposium for 2001 Society of Toxicology Annual Meeting, March 29, San Francisco, CA.
12. O'Leary, ES, CH Swartz, JG Brody, RA **Rudel**. 2001. GIS in exposure assessment for pesticides in the Cape Cod Breast Cancer and Environment Study and the Long Island Breast Cancer Study Project. Presented at the American Public Health Association Meeting. October 24, Atlanta, Georgia.
13. **Rudel, RA, D Barr, JG Brody.** 2001. Characterizing exposure to a wide range of chemicals of interest for breast cancer research: Indoor air and dust and urinary measure for pesticides, endocrine disruptors, and animal mammary carcinogens. Presented at the American Public Health Association Meeting, October 24, Atlanta, Georgia.
14. **Rudel, RA, JG Brody, D Camann, A Yau, JD Spengler, J Vallarino.** 2001. Characterization of residential exposures to a wide range of endocrine-active compounds in the context of a breast cancer epidemiologic study. Presented at e.hormone 2001: The Cutting Edge of Endocrine Disruptor Research, Tulane University. October 20, New Orleans, Louisiana.
15. **Rudel, RA.** 2002. Residential indoor air and dust measurements of phthalates and other EDCs. Effective Risk Management of Endocrine Disrupting Chemicals, U.S. Environmental Protection Agency. January 29–30, Cincinnati, Ohio.
16. Brody, JG, RA **Rudel**. 2002. Environmental pollutants and breast cancer: using GIS and environmental sampling in the Cape Cod Breast Cancer and Environment Study. Presented at National Institute's Environmental Health Sciences meeting. June 10, Research Triangle Park, North Carolina.

17. Brody, JG, CH Swartz, T Kennedy, RA **Rudel**. 2002. Historical pesticide exposure assessment using a geographic information system and self-report in a breast cancer study. Annual Conference of International Society for Environmental Epidemiology (ISEE)/International Society of Exposure Analysis (ISEA). *Epidemiology* 13(4):S209.
18. **Rudel**, RA, CH Swartz, JG Brody, DM Camann, A Yau, M Zuniga, JD Spengler. 2002. Residential indoor air and dust measures for pesticides, alkylphenols, phthalates, and other endocrine disruptors. Annual Conference of International Society for Environmental Epidemiology (ISEE)/International Society of Exposure Analysis (ISEA). *Epidemiology* 13(4):S198.
19. Brody, JG, R Polk, AM Menting, CH Swartz, RA **Rudel**. 2002. Beyond “I don’t know”: responsible and effective strategies to communicate results of exposure assessment for endocrine disruptors to study participants and communities in a breast cancer study. Annual Conference of International Society for Environmental Epidemiology (ISEE)/ International Society of Exposure Analysis (ISEA). *Epidemiology* 13(4):S253.
20. Swartz, CH, RA **Rudel**, JR Kachajian, JG Brody. 2002. Indicators of wastewater and land use impacts on public drinking water: Historical reconstruction of exposure on Cape Cod, MA. Annual Conference of International Society for Environmental Epidemiology (ISEE)/ International Society of Exposure Analysis (ISEA). *Epidemiology* 13(4):S191.
21. **Rudel**, R.A. 2003. Phthalates in indoor air, housedust, and urine. Invited talk. NIEHS Workshop on Human Health Effects of Phthalate Exposure. March 26-27, 2003, Research Triangle Park, NC.
22. McKelvey, W, RA **Rudel**, V Cortessis, JG Brody. 2003. Is there an association between cryptorchidism or hypospadias in a son and a mother’s risk of breast cancer? Presented at the 36th Annual Meeting of the Society for Epidemiologic Research; June 11–14, Atlanta, Georgia. *American Journal of Epidemiology* 157(suppl 11): S39.
23. Brody, JG, RA **Rudel**, R Morello-Frosch, P Brown, A Napolis, RG Altman, C Osimo, C Perez, L Seryak, A Just. 2006 Environmental justice and breast cancer advocacy: Household exposure to endocrine disrupting compounds. 134th Annual Meeting of the American Public Health Association, November, Boston, Massachusetts.
24. Attfield, K, T Kennedy, A Just, S Gray, R **Rudel**, JG Brody. 2006. Developing computer mapping tools for public access to environmental health information. 134th Annual Meeting of the American Public Health Association, November, Boston, Massachusetts.
25. Morello-Frosch, R, JG Brody, M Frye, P Brown, RG Altman, RA **Rudel**, C Perez. 2006. Right-to-know, the right-to-act, and the right not-to-know: Ethical and scientific dilemmas of reporting data in biomonitoring and environmental exposure studies. 134th Annual Meeting of the American Public Health Association, November, Boston, Massachusetts.
26. Standley, LJ, RA **Rudel**, CH Swartz, KR Attfield, JG Brody. 2006. Contamination of surface ponds on Cape Cod, MA, by EDCs and pharmaceuticals from septic-contaminated groundwater. North

American Meeting of the Society for Environmental Toxicology and Chemistry, November, Montreal, Canada.

27. Zota, AR, RA **Rudel**, RA Morello-Frosch, DE Camann, JG Brody. 2007. Regional variation in levels of indoor polybrominated diphenyl ethers may reflect differences in fire safety regulations for consumer products. 17th Annual Conference of the International Society of Exposure Analysis. Research Triangle Park, North Carolina.
28. Zota, AR, RA **Rudel**, RA Morello-Frosch, JG Brody. 2008. Elevated house dust and serum concentrations of PBDEs in California: Unintended consequences of furniture flammability standards? ISEE-ISES Joint Annual Conference on Exposure and Health in a Global Environment. Pasadena, California.
29. Morello-Frosch, RA, AR Zota, RA **Rudel**, C Perez, J Tovar, P Brown, R Dodson, JG Brody. 2008. Community-based participatory exposure assessment in an environmental justice community: preliminary results and communication. ISEE-ISES Joint Annual Conference on Exposure and Health in a Global Environment. Pasadena, California.
30. **Rudel** RA, RE Dodson, E Newton, AR Zota, JG Brody. 2008. Correlations between urinary phthalate metabolites and phthalates, estrogenic compounds 4-Butyl phenol, and some pesticides in home indoor air and house dust. ISEE-ISES Joint Annual Conference on Exposure and Health in a Global Environment. Pasadena, California.
31. Dodson RE, RA **Rudel**, E Newton, JG Brody. 2008. Urinary Pesticide Concentrations and Their Relationship to Air and Dust Concentrations and Household Predictors. ISEE-ISES Joint Annual Conference on Exposure and Health in a Global Environment. Pasadena, California.
32. Dodson RE, LJ Standley, JG Brody, RA **Rudel**. 2008. Development of an Evidence-based Intervention Study to Reduce Exposures to Contaminants in Consumer Products. ISEE-ISES Joint Annual Conference on Exposure and Health in a Global Environment. Pasadena, California.
33. Brody JG, RG Altman, R Morello-Frosch, P Brown, C Adams, RA **Rudel**. 2008. Reporting Individual-level Exposure Measurements to Participants in Intervention Studies for Emerging Contaminants. ISEE-ISES Joint Annual Conference on Exposure and Health in a Global Environment. Pasadena, California.
34. Dodson RE, KR Attfield, RA **Rudel**. 2009. Green buildings and indoor air quality: Lessons learned from household exposure studies. Healthy Buildings 2009 Conference and Exhibition. Syracuse, New York.
35. Zota AR, G Adamkiewicz, JD Spengler, R Morello-Frosch, JG Brody, RA **Rudel**. 2009. Cumulative Exposures to Thyroid Hormone Disrupting Compounds (PCBs and PBDEs) in Residential House Dust. Annual Conference of the International Society of Exposure Science (ISES). Minneapolis, Minnesota.

36. Dodson RE, JG Brody, RA **Rudel**. 2009. Endocrine Disrupting Compounds in Paired Residential Indoor and Outdoor Air Samples from Two Northern California Communities: Comparisons and Relationships. Annual Conference of the International Society of Exposure Science (ISES). Minneapolis, Minnesota.
37. **Rudel**, RA. 2009. Residential exposures to endocrine disrupting compounds from consumer products and building materials: recent findings and future directions. Annual Conference of the International Society of Exposure Science (ISES). Minneapolis, Minnesota.
38. Chan E, S Dairkee, S Janssen, J Latimer, RA **Rudel**, M Schwarzman, A Wlassowsky, L Zeise, DE Johnson. 2009. Chemical Exposure and Breast Cancer: identifying compounds of concern. Society of Toxicology Annual Meeting. March 5-12, 2010. Salt Lake City, UT.
39. Schaidler LA, JM Ackerman, SC Dunagan, JG Brody, RA **Rudel**. 2010. Organic Wastewater Compounds in Drinking Water Wells Impacted by Septic Systems. Annual North America Meeting of the Society of Environmental Toxicology and Chemistry (SETAC). Portland, Oregon.
40. **Rudel** RA, SY Euling, SL Makris, SE Fenton. Mammary Gland Development as a Sensitive Indicator of Early Life Exposures: Recommendations from an Interdisciplinary Workshop. Society of Toxicology Annual Meeting, Salt Lake City, UT March 2010.
41. Dodson, R.E., J.G. Brody, R.A. **Rudel**. Household Exposures in an Urban Environmental Justice Community. Urban Environmental Pollution Conference 2010. Boston, Massachusetts.
42. Dodson, R.E., L.J. Perovich, M. Nishioka, J.D. Spengler, J. Vallarino, R.A. **Rudel**. Long-term integrated sampling of SVOCs in indoor air: Measurement of emerging compounds using novel active and passive sampling methods. International Society of Exposure Science/International Society of Environmental Epidemiology (ISES/ISEE) 2010. Seoul, South Korea.
43. Dodson, R.E., R.A. **Rudel**, L.J. Perovich, D.E. Camann, J.G. Brody. Partitioning theory applied to paired indoor air and house dust SVOC measurements: Implications for residential exposure measurements in epidemiology studies. ISES/ISEE 2010. Seoul, South Korea.
44. Adamkiewicz, G, R Dodson, A Zota, L Perovich, J Brody, R **Rudel**, J Spengler. 2010. Semi-volatile Organic Compounds Distributions in Residential Dust Samples From 5 US Communities: Key Lessons for Improving Residential Exposure Assessment. Joint Conference of International Society of Exposure Science & International Society for Environmental Epidemiology. Seoul, Korea. *Epidemiology*. 22(1):S160-S161, January 2011. doi: 10.1097/01.ede.0000392166.33641.22.
45. Dodson, R.E., M.G. Nishioka, L.J. Standley, L.J. Perovich, J.G. Brody, R.A. **Rudel**. Chemical analysis of household and personal care products for endocrine disrupting compounds and other chemicals of emerging concern. ISES/ISEE 2010. Seoul, South Korea.
46. **Rudel** RA, Ackerman JA, Euling S, Makris S, Fenton S. 2010. Chemical Perturbation of Mammary Gland Development and Function: current initiatives to strengthen mammary gland assessment in

guideline studies and risk assessment. Society of Toxicology Annual Meeting 2011. March 6-10, 2011. Washington, D.C.

47. Schaidler, L.A., R.A. **Rudel**, J.M. Ackerman, S.C. Dunagan, J.G. Brody. 2011. Pharmaceuticals, Perfluorinated Compounds and Other Organic Wastewater Compounds in Private Drinking Water Wells on Cape Cod, Massachusetts. 32nd Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC) North America. November 13-17, 2011, Boston, Massachusetts.
48. Dodson, R., M. Nishioka, L. Standley, L. Perovich, J. Brody, R. **Rudel**. 2011. What Do We Know About What Is in Personal Care Products?. 32nd Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC) North America. November 13-17, 2011, Boston, Massachusetts.
49. Dodson, R., L. Perovich, J. Brody, R. **Rudel**. 2011. Relationship Between House Dust and Indoor Air Concentrations: Applying Partitioning Theory to Empirical Data. 32nd Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC) North America. November 13-17, 2011, Boston, Massachusetts.
50. **Rudel** RA, J. Ackerman, K. Attfield, R. Dodson, JG Brody. New exposure biomarkers for breast cancer epidemiology. ISES 2012. Seattle, WA.
51. Dodson R.E., K. Rodgers, A. Covaci, N. Van den Eede, A. Ionas, A. Dirtu, L. Perovich, J. Brody, R. **Rudel**. 2012. Health Risks from Flame Retardants in California House Dust. Environment and Health-Bridging South, North, East and West Conference of ISEE, ISES, and ISIAQ. August 19-23, 2013, Basel, Switzerland.
52. **Rudel** RA, JA Ackerman, C Vulpe. 2013. *In Vitro* Predictive Toxicology for Breast Cancer. Society of Toxicology Annual Meeting 2013. March 10-14, 2013. San Antonio, Texas.
53. Van den Eede N, RE Dodson, RA **Rudel**, LJ Perovich, H Neels, A Covaci. Urinary Concentration of Phosphate Flame Retardants and Plasticiser Metabolites and Relationships with Indoor Dust Levels. Brominated Flame Retardants Conference. 2013.
54. Pan, S., C. Yuan, A. Tagmount, R. **Rudel**, C. Vulpe, D. Leitman. 2013. Cross-Talk Between HER2 Agonists and Xenoestrogens Lead to a Synergistic Proliferation of Breast Cancer Cells. California Breast Cancer Research Symposium. May 17-18, 2013, Costa Mesa, California.
55. Dodson, RE, KM Rodgers, A Covaci, N Van den Eede, AC Ionas, AC Dirtu, LJ Perovich, JG Brody, RA **Rudel**. 2013. Health Risks From Flame Retardants In California Homes. Sixth International Symposium On Flame Retardants. April 7-10, 2013, San Francisco, California.
56. **Rudel**, R., J. Ackerman, C. Vulpe. 2013. Chemical Screening to Identify Potential Breast Carcinogens Using Human Breast Cell Cultures: Genotoxicity. California Breast Cancer Research Symposium. May 17-18, 2013, Costa Mesa, California.

57. Zarate, O, J Brody, P Brown, L Sweeney, M Ramirez-Andreotta R. **Rudel**. 2013. "Open Data" Practices for Environmental Health Studies. Environmental Health Disparities and Environmental Justice Meeting. July 29-31, 2013, Research Triangle Park, North Carolina.
58. Dodson, RE, RA **Rudel**. 2013. Indoor exposure to SVOCs from consumer products and building materials: Empirical data validates air-dust partitioning models and informs measurement strategies. 2013 Conference of the International Society of Environmental Epidemiology (ISEE), the International Society of Exposure Science (ISES), and the International Society of Indoor Air Quality and Climate (ISIAQ). August 19–23, 2013, Basel, Switzerland.
59. Dodson, RE, K Rodgers, A Covaci, N Van den Eede, A Ionas, A Dirtu, L Perovich, J Brody, RA **Rudel**. 2013. Health Risks of Flame Retardants in California House Dust. 2013 Conference of the International Society of Environmental Epidemiology (ISEE), the International Society of Exposure Science (ISES), and the International Society of Indoor Air Quality and Climate (ISIAQ). August 19–23, 2013, Basel, Switzerland.
60. Ackerman J., R **Rudel**, C. Vulpe. 2014. High-Content Screening of Genotoxicity in Breast and Liver Cells. FutureTox II: In Vitro Data and In Silico Models for Predictive Toxicology. January 16-17, 2014, Chapel Hill, North Carolina

GRANTS

1. California Breast Cancer Research Program Women Firefighters Biomonitoring Collaborative	2013 - 2016	\$833,945
2. National Institutes of Health: 1R01ES021726-01 Data Sharing and Privacy Protection in Digital-Age Environmental Health Studies	2012 - 2017	\$1,785,672
3. US Department of Housing and Urban Development: MAHH000512 (PI) Impact of Green Renovations on asthma and IEQ in public housing: The role of phthalates, glycol ethers, flame retardants, perfluorinated compounds and PCBs	2012 - 2015	\$699,786
4. California Breast Cancer Research Program Chemicals and Breast Cancer: Building on National Initiatives for Chemical Safety Screening	2011 - 2014	\$256,194
5. Avon Foundation Methods and resources for cohort studies of breast cancer and environmental chemicals;	2011 - 2014	\$175,000
6. American Chemistry Council Interpretation of Biomonitoring Data from a Dietary Intervention Study	2011 – 2012	\$120,000
7. Mount Desert Island Biological Laboratory Exposure Ontology and HES data on the Web	2010 – 2011	
8. Avon Foundation (Co-I)	2010 - 2011	\$150,000

Methods and resources for cohort studies of breast cancer and environmental chemicals;
Massachusetts Health and Environment Information System

9.	National Institute of Environmental Health Sciences: 1R01ES017514-01A1	2009 - 2014	\$2,830,157
	Ethical and Legal Challenges in Communicating Individual Biomonitoring and Personal Exposure Results to Study Participants: Guidance for Researchers and Institutional Review Boards (5 years)		
10.	MA Environmental Trust (Co-I)	2009-2010	\$45,000
	Emerging Contaminants in Public and Private Drinking Water Wells		
11.	Centers for Disease Control: 1R01EH000632-01 (Co-I)	2009 - 2010	\$333,000
	Women's Health and the Environment: Breast Cancer Prevention Research		
1.	Passport Foundation/Breast Cancer Fund (Co-I)	2009 – 2010	\$10,000
	BPA Migration and Consumption in a Pilot Sample of US Families		
13.	Brown University/NIEHS (Co-I)	2009 – 2010	\$10,000
	Brominated Flame Retardants		
14.	Avon Foundation (Co-I)	2009 - 2010	\$200,000
	Methods and resources for cohort studies of breast cancer and environmental chemicals; Massachusetts Health and Environment Information System		
15.	Barnstable Assembly of Delegates (Co-I)	2009 – 2010	\$24,000
	EDC's in Public Drinking Water on Cape Cod		
16.	New York Community Trust (Co-I)	2009 - 2010	\$75,000
	Pollution at Home: Exposures in a Fence-line Environmental Justice Community		
17.	California Breast Cancer Research Program (PI)	2009	\$25,000
	Conference on the Effects of Chemicals on Mammary Glands		
18.	National Institute of Environmental Health Sciences (PI)	2009	\$32,000
	Conference on the Effects of Chemicals on Mammary Glands		
19.	US Environmental Protection Agency (PI)	2009	\$17,354
	Conference on the Effects of Chemicals on Mammary Glands		
20.	NSF/University of California – Berkeley: SES-0822724 (Co-I)	2008 - 2011	\$94,395.66
	Toxic Ignorance and the New Right-to-Know: The Implications of Biomonitoring for Regulatory Science		
21.	Centers for Disease Control: 1H75EH000377-01 (Co-I)	2008 - 2009	\$118,886

Women's Health and the Environment: Breast Cancer Prevention Research

22. National Institute of Environmental Health Sciences: 3R25ES013258-04S2 (Co-I)	2008 - 2009	\$139,805
Linking Breast Cancer Advocacy and Environmental Justice Supplement 2		
23. Avon Foundation (Co-I)	2008 - 2009	\$175,000
Breast Cancer and Environmental Chemicals		
24. Commonwealth of Massachusetts	2008 - 2009	\$20,000
Breast Cancer Prevention Research: Household Exposure		
25. New York Community Trust (Co-I)	2007 - 2008	\$75,000
California Household Exposure Study Data Analysis		
26. Commonwealth of Massachusetts	2007 - 2008	\$107,500
Breast Cancer and the Environment on Cape Cod		
27. Commonwealth of Massachusetts (UMASS Lowell) (Co-I)	2007 - 2008	\$175,000
Breast Cancer Prevention Research: Household Exposure		
28. MA Environmental Trust (Co-I)	2007 - 2008	\$25,000
EDC's in Ponds on Cape Cod (FY2008 grant)		
29. Avon Foundation (Co-I)	2007 - 2008	\$175,000
Breast Cancer and Environmental Chemicals		
30. HES Goldman (Co-I)	2006 – 2009	\$400,000
Exposure Reduction for Endocrine Disruptors in Homes		
31. Department of Defense (Co-I)	2006 – 2008	\$93,108
Nanotech Method to Identify EDC's in Septic Waste		
32. Babylon Breast Cancer Coalition (Co-I)	2006 – 2007	\$7,500
EDC's in Cape Cod Groundwater and Drinking Water		
33. MA Environmental Trust (Co-I)	2006 - 2007	\$25,000
Groundwater and Drinking Water		
34. Hurricane Voices (Co-I)	2006 - 2007	\$45,000
Household Exposure Study		
35. Jane's Trust	2006 - 2007	\$100,000
Environmental Factors in Breast Cancer		
36. Avon Foundation (Co-I)	2006 - 2007	\$100,000

Breast Cancer and Environmental Chemicals

37. Commonwealth of Massachusetts Cape Cod Household Exposure Study	2006 - 2007	\$107,500
38. National Science Foundation: SES-0450837 (Co-I) "Research Right-to-Know": Ethics and Values in Communicating Environmental Health Study Results to Individuals and Communities	2005 - 2008	\$299,999
39. Beldon Fund Environmental factors and women's health	2005 - 2007	\$150,000
40. Centers for Disease Control: R01DP000218-01 (Co-I) Impact of Environmental Pollutants on Breast Cancer and Women's Health	2005 - 2006	\$347,200
41. Avon Foundation Environmental factors and breast cancer	2005 - 2006	\$75,000
42. MA Department of Public Health (Co-I) Cape Household Exposure Study follow-up	2005 - 2006	\$107,500
43. MA Environmental Trust (Co-I) Groundwater and Drinking Water	2005 - 2006	\$25,000
44. National Institute of Environmental Health Sciences: 1R25ES013258 (Co-I) Linking Breast Cancer Advocacy and Env. Justice (4 yrs)	2004 - 2008	\$932,104
45. Susan G. Komen for the Cure (Co-I) Breast Cancer and the Environment Science Review	2004 - 2008	\$611,273
46. Agua Fund (Co-I) EDCs in Cape Cod Groundwater and Drinking Water	2004 - 2006	\$25,000
47. National Cancer Institute: 5R03CA103478-2 Risk Factors for Ductal Carcinoma In Situ (DCIS)	2004 - 2006	\$140,000
48. National Library of Medicine: 1G08LM008415 Public Access to Environmental Health Information	2004 - 2006	\$130,199
49. Hurricane Voices (Co-I) Household Exposure Study of EDCs	2004 - 2005	\$60,000
50. Avon Foundation Environmental factors and breast cancer	2004 - 2005	\$50,000

51. MA Environmental Trust (FY05 grant) (Co-I) Groundwater and Drinking Water	2004 - 2005	\$25,000
52. Heinz Endowments Environmental factors and breast cancer	2004 - 2004	\$50,000
53. Jane's Trust Environmental factors and women's health	2003 - 2004	\$281,980
54. Beldon Fund Environmental factors and women's health	2003	\$75,000
55. MA Environmental Trust 2003 grant – Wells (Co-I) EDCs in Cape Cod Water	2003	\$25,000
56. MA Environmental Trust 2002 grant (Co-I) EDCs in Cape Cod Water	2002	\$25,000
57. Susan G. Komen Breast Cancer Foundation Cape Cod Breast Cancer and Environment Study data analysis	2001 - 2002	\$160,000
58. Anonymous foundation Environmental factors and women's health	2000-2005	\$606,072
59. Tides Foundation (Co-I) EDCs in Cape Cod Groundwater and Drinking Water	2000 - 2001	\$115,000
60. Jessie B. Cox Charitable Trust Environmental factors and women's health	1998-2002	\$194,000
61. Dolphin Trust (Soil, Atlas, Wells, and Septic) (Co-I) EDCs in Cape Cod Groundwater and Drinking Water	1998 - 2001	\$86,700
62. Komen Massachusetts Affiliate Outreach and education	1996 - 2003	\$312,000
63. Massachusetts Department of Public Health (Co-I) Cape Cod Breast Cancer and Environment Study	1994 - 2003	\$7,300,000

Exhibit L

Statement of Ted Schettler



October 14, 2014

I, Ted Schettler, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I, Ted Schettler MD, MPH am a physician and the Science Director of the Science and Environmental Health Network. I also serve as Science Director of the Collaborative on Health and Environment (CHE) and am a science advisor to the Health Care Without Harm (HCWH) campaign. I have a medical degree from Case Western Reserve University and a Masters in Public Health from Harvard University. I am co-author of "Generations at Risk: Reproductive Health and the Environment"; "In Harm's Way: Toxic Threats to Child Development"; and "Environmental Threats to Healthy Aging." I am also the author of "The Ecology of Breast Cancer: The Promise of Prevention and the Hope for Healing". I have published a number of articles in peer-reviewed scientific journals. I served on the U. S. Environmental Protection Agency's (EPA) Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC) and the National Academy of Sciences' committee on defining concerns associated with products of animal biotechnology.

2. In collaboration with organizations in the US and internationally, I have addressed many aspects of the relationship between environmental exposures and human health. I am an active contributor to HCWH's international campaign on improving the environmental performance of healthcare institutions. HCWH has had great success in helping to reduce the emissions of dioxin and mercury from health care institutional materials management practices, and we are working to reduce the use of organohalogen flame retardants in materials and products purchased by those institutions.

3. Organohalogen flame retardants are of considerable concern because of their persistence, toxicity, tendency of many to bioaccumulate, and long-range transport. Many of these chemicals have been incorporated into consumer products and are being released from them into indoor and outdoor environments, resulting in exposures to humans and wildlife.¹ In general, halogenated organic molecules (i) are more resistant to metabolic break down, (ii) cross biologic membranes more readily, and (iii) gain access to cells and tissues more readily than non-halogenated compounds. Because of this, virtually all halogenated flame retardants have adverse impacts when they interact with cells and

tissues of living organisms. Virtually all organohalogen flame retardants studied for their toxic properties have health effects at varying levels of exposure, including adverse impacts on brain development in children,² adverse impacts on reproduction,³ endocrine disruption,⁴ immune suppression,^{5,6} and/or cancer.

4. Widespread human and wildlife exposures to flame retardants are well documented. Humans are exposed to organohalogen flame retardants mainly through inhalation or ingestion of dust particles containing these chemicals⁷ and ingestion of food that has been contaminated with these chemicals⁸. Fetuses are exposed to these chemicals by transplacental transport, and infants are also exposed through ingestion of contaminated breast milk.

5. As a physician, I am particularly concerned about the health effects of organohalogen flame retardants on developing children. In 2010, in invited testimony before the U.S. Senate Committee on Environment and Public Works⁹, I described windows of vulnerability and unique susceptibility to hazardous environmental exposures during *in utero* development, infancy, and childhood. Those exposures may result in adverse health outcomes with lifelong consequences. For example, ample scientific evidence confirms the unique susceptibility of the developing brain to chemical exposures that can disrupt one or more of a number of biologic processes that must proceed in an orderly fashion as brain architecture and chemistry are established throughout pregnancy, infancy, and childhood.¹⁰ Studies have shown that exposure to polybrominated diphenyl ethers during critical windows of brain development can result in adverse impacts on multiple measures of brain function in childhood, including impaired learning and memory.^{11,12} As replacement organohalogen flame retardants are slowly tested, their toxicity, too, becomes increasingly clear.

6. This combination of circumstances – biologically active compounds, increased resistance to biologic degradation, ready access to biologic tissues, and widespread exposure – justifies evaluation of organohalogen flame retardants as a class and replacement with safer alternatives.

Yours sincerely,



Ted Schettler, MD MPH

¹ Lorber M. Exposure of Americans to polybrominated diphenyl ethers. *J Expo Sci Environ Epidemiol*. 2008 Jan;18(1):2-19.

² Herbstman JB, Sjödin A, Kurzon M, Lederman SA, Jones RS, Rauh V, Needham LL, Tang D, Niedzwiecki M, Wang RY, Perera F. Prenatal exposure to PBDEs and neurodevelopment. *Environ Health Perspect*. 2010 May;118(5):712-9. doi: 10.1289/ehp.0901340.

³ Birnbaum LS, Staskal DF. Brominated flame retardants: cause for concern? *Environ Health Perspect*. 2004 Jan;112(1):9-17.

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- ⁴ Legler J, Brouwer A. Are brominated flame retardants endocrine disruptors? *Environ Int.* 2003 Sep;29(6):879-85.
- ⁵ Darnerud PO, Eriksen GS, Jóhannesson T, Larsen PB, Viluksela M. Polybrominated diphenyl ethers: occurrence, dietary exposure, and toxicology. *Environ Health Perspect.* 2001 Mar;109 Suppl 1:49-68.
- ⁶ Birnbaum LS, Staskal DF. Brominated flame retardants: cause for concern? *Environ Health Perspect.* 2004 Jan;112(1):9-17
- ⁷ Lorber M. Exposure of Americans to polybrominated diphenyl ethers. *J Expo Sci Environ Epidemiol.* 2008 Jan;18(1):2-19.
- ⁸ Schecter A, Harris TR, Shah N, Musumba A, Päpke O. Brominated flame retardants in US food. *Mol Nutr Food Res.* 2008 Feb;52(2):266-72.
- ⁹ Hearing on EPA's Efforts to Protect Children's Health. Testimony of Ted Schettler MD, MPH. March 17, 2010
http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=b1cf9367-64b7-4884-b06a-2719c2709f2c
- ¹⁰ Ibid
- ¹¹ Eriksson P, Jakobsson E, Fredriksson A. Brominated flame retardants: a novel class of developmental neurotoxicants in our environment? *Environ Health Perspect.* 2001 Sep;109(9):903-8.
- ¹² Viberg H, Fredriksson A, Jakobsson E, Orn U, Eriksson P. Neurobehavioral derangements in adult mice receiving decabrominated diphenyl ether (PBDE 209) during a defined period of neonatal brain development. *Toxicol Sci.* 2003 Nov;76(1):112-20. Epub 2003 Aug 12.

CURRICULUM VITAE

Theodore H. Schettler, M.D., M.P.H.

Education:

Carleton College - B.A., 1963
University of Minnesota
Case-Western Reserve University - M.D., 1968
Internship - Internal Medicine - University Hospitals - Cleveland, Ohio
Harvard School of Public Health - MPH, 1994
Occupational and environmental health

Clinical Medical Practice:

1969-71 - U.S. Navy / 3rd Marine Division - Viet Nam, Okinawa, Japan, San Francisco
1971-79 - Emergency Medicine - Dept. of Emergency Medicine; Windham
Community Memorial Hospital; Willimantic, Ct.
1979-90 - Chief of Emergency Services; Penobscot Bay Medical Center; Rockland, Me.
Established and directed the department of emergency medicine.
Provided both clinical and administrative services as department director
1987-93 - Medical Director; Health Connections – an occupational health program
established in 1987 as a subsidiary of its parent corporation, Northeast Health.
1994 – June, 2006 – Dept. of Internal Medicine; Boston Medical Center. Staff physician -
East Boston Neighborhood Health Center; E. Boston, MA

Non-clinical positions:

1999 – present - Science director, Science and Environmental Health Network
2008—present—Science director. Collaborative on Health and Environment
Science advisor—Health Care Without Harm
Physicians For Social Responsibility (PSR)
- Steering Committee - Greater Boston PSR (co-chair, 2000, 2001)
- Environment Committee - National PSR (1995, 1996)
2000- 2006—Co-Chair - Committee on Human Health and the Environment - New
England

Administrative:

- 1979-89 - Medical Director - Mid-Coast Emergency Medical Services, Inc.
- 1979-90 - Chief of Emergency Services - Penobscot Bay Medical Center (PBMC)
- 1982-85 - Secretary of Medical Staff (PBMC)
- 1986 - Vice President of Medical Staff (PBMC)
- 1986 - Chairman, Credentials and Peer Review Committee (PBMC)
- 1982-86 - Member, Executive Committee of Medical Staff (PBMC)

Boards and committees:

- 1987-90 - Member, Medical Staff Development Plan Committee (PBMC)
- 1989-90 - Member, Board of Trustees, Northeast Health
- 1989 - Member of Subcommittee on Emergency Medicine - Maine Medical Mutual Insurance Co. - charged with developing standards for medical management of selected clinical conditions in emergency medicine
- 1995 -96 - Member of the Federal Facility Environmental Restoration Dialogue Committee - (US EPA)
- 1996-1998 - Endocrine Disruptor Screening and Testing Advisory Committee (US EPA)
- 1997 - 2003 - Special committee on occupational and environmental health. Massachusetts Medical Society; member and consultant
- 1997-2000 – Advisory Board – Women's Cancer Resource Center; Minneapolis, MN
- 1999-2000 - Board of Directors – Clean Water Action; Boston, MA
- 1999-2000 - Member – Environmental Leadership Committee – American Hospital Association and US EPA
- 2001- 2003: Professional Advisory Board – Learning Disabilities Association of America
- 2001 – National Academy of Sciences Sub-Committee on Defining Science-based Concerns Associated with Animal Biotechnology

2001, 2002, 2003 – Endocrine Disruptor Methods Validation Subcommittee (US EPA)

2008-present—Science Advisory Board; Environmental Health Initiative; American Association of Intellectual and Developmental Disabilities (formerly American Association for the Mentally Retarded)

2009-2013—Board of directors. Pesticide Action Network North America

2010-present—Science Advisory Panel. The Breast Cancer Fund.

2012-present—Advisory council; California Breast Cancer Research Program

2014—Science advisory board. Women’s Voices for the Earth

Select Publications

Schettler, T.H. Reverberations of Militarism: Toxic Contamination, the Environment, and Health. *Medicine and Global Survival*, 2(1), 7-18, (1995).

Co-author: *An Environmental and Health Impact Report on Known and Potentially Contaminated Sites at Former U.S. Military Bases in the Philippines*. 1995.

Schettler T, Solomon G, Burns P, Valenti M. Generations at Risk: How Environmental Toxins May Affect Reproductive Health in Massachusetts. August, 1996.

Schettler T, Solomon G, Valenti M, Huddle A. Generations at Risk: Reproductive Health and the Environment. MIT Press, Cambridge, MA, (June 1999).

Schettler T. Manganese in gasoline: A case study of the need for precautionary action. In: *Protecting Public Health and the Environment: Implementing the Precautionary Principle*. Ed: Raffensperger C, Tickner J. Island Press Washington DC. July, 1999.

Schettler T, Stein J, Reich F, Valenti M. In Harm's Way: Toxic Threats to Child Development. Greater Boston Physicians for Social Responsibility; May, 2000.

Raffensperger C, Schettler T, Myers N. Precaution: A Belief, Regulatory System, and Overarching Principle. *Intl J Occ Env Health* 6(4): Oct-Dec, 2000.

Solomon G, Schettler T. Environment and Health: 6. Endocrine disruption and potential human health implications. *Can Med Assoc J* 163(11):1471-6, 2000.

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Honors and Awards

1968—Alpha Omega Alpha - Case-Western Reserve University

1990—Presidential Leadership Award - 1990 - Mid-Coast Emergency Services Council, Inc.

1998—Broad Street Pump Award - 1998 - Physicians for Social Responsibility

2000 - Will Solimene Award for Excellence in Medical Writing, American Medical Writers Association

2009—Science hero award. The Breast Cancer Fund.

2011—Environmental Health Hero Award; CleanMed

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thscv

Exhibit M
Statement of Roland Weber

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24.09.2014

Schwäbisch Gmünd, den

To Whom It May Concern:

I, Roland Weber, am writing this statement in support of the Petition to the CPSC to regulate four categories of household products containing non-polymeric additive organohalogen flame retardants.

1. I am an independent consultant working mainly for UN Organizations for the implementation of the Stockholm Convention on global elimination of persistent organic pollutants (POPs). I am also a visiting Professor at Tsinghua University, China. I received my Masters in Chemistry (1993) and my Ph.D. (1996) from the University of Tuebingen, Germany. My Ph.D. thesis was entitled "Synthesis, Analysis, Toxicology and Occurrence of fluorinated and chlorinated-fluorinated Dioxins, Dibenzofurans and Biphenyls". Since then I have carried out research, and since 2003 also consulting, in the field of dioxins/furans and other unintentionally and intentionally produced POPs. I have attached a copy of my curriculum vitae and a list of my scientific publications on halogenated dioxins, furans and other unintentionally formed POPs.

2. Polyhalogenated dibenzo-p-dioxins und dibenzofurans (dioxins and furans) are structurally-similar groups of chemicals containing benzene rings and halogens (chlorine or bromine). They have no industrial use, but are unintentional by-products of incomplete combustion and of various industrial processes, including the manufacture of some chemicals.

3. Dioxins and furans are likely human carcinogens and have been linked - at very low doses - to a wide range of other adverse health effects, including immune suppression, enzyme induction, thyroid hormone and vitamin A perturbations, antiestrogenicity, teratogenicity, and neurobehavioral deficits (US EPA, Van den Berg et al. 2013, WHO 1998). Additionally, they are highly persistent and bioaccumulative. They all have similar structures and a common mechanism of action, which accounts for their similar biological effects. The harmful effects of chlorinated dioxins and furans have been recognized by the Stockholm Convention, which recommends reducing and/or eliminating the unintentional releases of these chemicals. Brominated dioxins and furans are not currently regulated by any international authority, but have similar toxicities to their chlorinated counterparts (Van den Berg et al. 2013).

4. Dioxins and furans are unintentional byproducts of the production of halogenated aromatic compounds (i.e. compounds containing halogens and benzene rings), a group that includes many of the commonly used organohalogen flame retardants. As a result, they occur as impurities in commercial organohalogen flame retardants. For instance, brominated dioxins and furans have been found as contaminants in commercial brominated flame retardants, such as polybrominated diphenyl ethers (PBDEs),

decabromobiphenyl, 1,2-bis(tribromophenoxy)ethane, tetrabromobisphenol A (TBBPA), and bromophenols (WHO 1998, Ren et al. 2011).

5. Levels of dioxin and furan contamination in some organohalogen flame retardants increase during a product's life span, suggesting that dioxins and furans can form during the normal use of products containing these organohalogen flame retardants. For instance, additive organohalogenated flame retardant decaBDE in plastics such as those used in TV casings have been shown to form brominated furans when exposed to sunlight during normal use (Kajiwara et al. 2008). Similarly, polybrominated dibenzofurans (PBDFs) can be formed in treated textiles (Kajiwara et al. 2013). Thus, normal usage of household products containing organohalogen flame retardants that are dioxin precursors is potentially a major source of dioxins and furans found in indoor air and dust (Suzuki et al. 2010; Tue et al. 2013).

6. House and office dust originating from normal wear and tear of common household products such as polyurethane foam, TV sets, computers and other electronic and electrical equipment or textiles containing organohalogen flame retardants that are dioxin precursors is a source of direct human exposure to polybrominated dibenzodioxins (PBDDs) and PBDFs (Brorstrom-Lunden et al. 2010; Suzuki et al. 2010; Tue et al. 2013). Levels measured in Japanese house dust were sufficient to contribute to a major share of daily dioxin toxic equivalencies (TEQ)-exposure for toddlers (Suzuki et al. 2007).

7. All chlorinated and brominated aromatic compounds (i.e. compounds containing benzene rings) are dioxin/furan precursors

under thermal treatments below 850°C, which includes accidental household fires (Weber & Kuch 2003, Weber 2007). Furthermore, any chlorine/bromine present in consumer products during their low temperature combustion can lead to the formation of dioxin and furans (McKay 2002, Ikeguchi & Tanaka 2001; Weber et al. 2002, Weber & Kuch 2003). Thus, the presence of any organohalogen flame retardants in consumer products during accidental household fires can lead to the formation of dioxins and furans (Weber & Kuch 2003). This increases the risk of harm to humans, particularly to firefighters who are exposed to these chemicals on the job.

8. In summary, dioxins and furans (i) have been found as impurities in organohalogen flame retardants in consumer products, (ii) can form from certain aromatic organohalogen flame retardants during the normal use of household products containing them, and (iii) can form from all organohalogen flame retardants when products containing them burn during household fires. The EPA, the WHO and Stockholm Convention have determined that some of these dioxins and furans present serious health risks.

9. Therefore, my professional opinion is that the use of organohalogen flame retardant chemicals in the four categories of household products covered by this petition should be stopped, as the human health risks associated with dioxin and furan impurities or their unintentional formation due to organohalogen flame retardants are severe. I am happy to answer any questions, and provide further documentation as needed.

Yours sincerely,

Roland E. Weber, Ph.D.



International Consultant for Persistent Organic Pollutants

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Curriculum Vitae Dr. Roland E. Weber

Family Name: Weber, Dr.
Given Names: Roland Erich
Profession: Chemist; Environmental consultant
Nationality: German
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Key expertise and interests

- Persistent Organic Pollutants (POPs) including newly listed POPs under the Stockholm Convention and related national implementation plans.
- Research and research strategies on chlorinated, brominated and fluorinated POPs/PTS
- Inventories and action plans for PCDD/PCDF (Dioxins) and other unintentionally produced POPs (Stockholm Convention implementation).
- Best Available Technologies (BAT) and Best Environmental Practice (BEP) for reduction of PCDD/PCDF and other unintentionally produced Persistent Organic Pollutants (UPOPs).
- Chemicals and Sustainable Production & Consumption. Substitution of critical chemicals.
- Destruction of POPs (combustion and non-combustion technologies) and formation of Dioxins (PCDD/PCDF) and other pollutants.
- POPs contaminated sites (Editor POPs contaminated site series in ESPR)

Education:

03/1994 - 03/1996 PhD, Thesis "Synthesis, Analysis, Toxicology and Occurrence of fluorinated and chlorinated-fluorinated Dioxins, Dibenzofurans and Biphenyls" (University Tübingen; Institute of Organic Chemistry, Supervisor Prof. Dr. H. Hagenmaier)
10/1993 - 05/1996 Study of "Public law for scientists and engineers" at the University of Hagen. (Equivalent to bachelor degree)
10/1988 - 01/1994 Master (diploma) in chemistry (University of Tübingen/Germany)

Employment career:

Since 01/2003 Independent international consultant (POPs Environmental Consulting)
Since 01/2010 Visiting Professor; Department of Environmental Engineering, POPs Center, Tsinghua University, China (Stockholm Convention Center)
Since 07/2006 Visiting Professor at the MTM Research Center, University Örebro/Sweden
05/97-12/2002 Employee in IHI Co. Ltd. (Yokohama, Japan, www.ihico.jp/index-e.html) (Management dioxin laboratory, R & D Dioxin reduction and POPs destruction)
03/96-04/1997 Post doc at the University Tübingen (Formation mechanisms of PCDD/PCDF)

Consultancies for governmental bodies and UN organisations:

Since 08/2013	Publication “Alternatives to POPs chemicals” (for SC Secretariat)
Since 03/2013	Member of the SwitchMed Expert Group for “Switching to more sustainable consumption and production in the Mediterranean” (for CP/RAC Spain)
Since 02/2013	IPOP Project Dioxin reduction from open burning in the Philippines (for World Bank; Subcontract to Witteveenbos)
Since 11/2012	Updating SC National Implementation Plans (Mongolia, Turkey, Philippines, Indonesia, Sudan, Tanzania) (for UNIDO)
Since 10/2012	R&D project “Environmental contamination of Dioxin and PCB and interlink to food contamination” (for German Environmental Ministry/ Agency)
Since 09/2011	Consultancy on international chemical management (for GIZ)
04/2012 – 04/2013	Monitoring of new listed POPs in articles and products. Support for the Basel and Stockholm Convention Centre China (for BRS Conv. Secretariat and GIZ)
12/2011 – 07/2012	Pilot country workshops for updating Stockholm Convention NIPs for newly listed POPs (Algeria, China, India, Nigeria, Serbia) (for SC Secretariat)
12/2011-12/2012	Consultancy for updating the SC Dioxin Toolkit (for SC Secretariat)
07/2011-08/2012	Lead author/co-author of Guidelines for supporting the implementation of newly listed POPs in the Stockholm Convention (for UNITAR & UNIDO)
07/2011-03/2012	Developing chemical criteria for Ecolabel and Green Public Procurement (For the European Commission Joint Research Center IPTS Seville)
07/2011-10/2011	FSP development for POPs management in Egypt (for WB; with Tauw)
05/2011-12/2011	1 st pilot project on inventory of newly listed POPs Nigeria (for SC Secretariat)
04/2011-01/2013	Dioxin/Furan inventory and NIP development Zimbabwe (for UNEP)
11/2010	Invited expert at POPs Reviewing Committee meeting (for SC Secretariat)
01/2010-10/2010	Technical paper on PBDEs newly listed in the Convention (for SC Secretariat with Alan Watson; UNEP/POPS/POPRC.6-2, UNEP/POPS/POPRC.6/INF/6)
09/2010	Summary report on the questionnaire survey on new POPs PBDE and PFOS from parties and observers (for Stockholm Convention Secretariat & POPRC)
03/2009-04/2011	Hazardous chemical/waste management Egypt (EU Twinning project, for GIZ)
03/2009 – 06/2011	Dioxin/Furan inventory and NIP development Suriname (for UNDP)
10/2009-12/2009	Integrating Pollution Prev. and Control and Stockholm Convention (UNIDO)
02/2009	Refining of National Implementation Plan for UPOPs Serbia (for UNEP)
09/2008 – 03/2009	EU Life project on hazardous waste management Turkey (for GTZ)
10/2008	Refining of National Implementation Plan for UPOPs Montenegro (for UNEP)
2007/2008	Dioxin/Furan Inventory Turkey; support finalising the NIP (for UNIDO)
2007/2008	Dioxin/Furan Inventory Vietnam; BAT/BEP project development for UPOPs reduction Vietnam (MSP for UNIDO)
08/2005 - 02/2006	Stockholm Convention BAT/BEP and NIP consultancy Sudan (for UNDP)
Since 2004	Dioxin/Furan Inventories and NIP support for Montenegro, Serbia, Sudan, Suriname, Turkey, Uganda, Vietnam & Zimbabwe (Stockholm Convention consultancy UNDP, UNEP, UNIDO for respective environmental ministries).
2003	Minimisation strategies for PCDD/PCDF emission from waste incineration. Chemical Risk Assessment (Risk Management Handbook, AIST, Japan)
2002	Regulations and status of hospital waste management in Germany (For Japan Waste Management Experts; Co-operation with German Env. Agency (UBA))
1997-1998	Evaluation historical input of PCDD/F in Japan (Prof. Sakai, NIES, Japan)

Research and Research Cooperations:

- Since 2011 (ongoing) Formation of dioxin-like compounds from Chlorpyrifos (Osaka University).
- Since 2009 (ongoing) PBDE, other BFRs and PBDD/F in E-waste (cooperation Basel Convention Center Nigeria; Fraunhofer Institute Germany; Umea University/Sweden).
- Since 2005 (ongoing) Research/documentation of global POPs contaminated sites (selected partners)
- 2000-2012 Historical PCDD/F inputs and their source implication in Queensland, Australia (National Centre for Environmental Toxicology, Queensland, Australia).
- 2008/2009 Assessment of chlorinated and brominated Dioxin pollution of an e-waste village in Guiyu/China (with Prof. Ming Wong, Baptist University, Honkong).
- 2007/2008 Assessment of PFOS/PFOA sources for contamination of a German river system and drinking water reservoir (BUND, Germany).
- 2004-2007 Research on PCDD/PCDF formation in thermal processes in dependence on inorganic matrices (Czech Academy of Science, Prague, Czech Republic).
- 2002 – 2003 Forest fires as a potential PCDD/F source in Queensland, Australia (National Research Centre for Environmental Toxicology, Queensland, Australia).
- 1997-1999 Evaluation historical input of PCDD/F in Japan (Kyoto University; Japan).
- 1993-1996 Evaluation of the relevance of fluorinated and fluorinated-chlorinated dibenzodioxins and dibenzofurans in technical processes and assessment of their toxicity (with Institute of Toxicology, Univ. Tübingen; Prof. Schrenk).
- 1993-1994 Development of the trace analysis for fluorinated Dioxin and Furans.

Further Activities in the international community of POPs/PTS research

- Member of the UNEP PCDD/PCDF Toolkit group (since 2006) and now BAT/BEP (since 2012).
- Chair of the session “Remediation Methods and Control Techniques” DIOXIN 2004.
- Chair of session “Contaminated sites – cases, remediation, risk and policy” & related at DIOXIN Conference Series 2006 - 2013 (26th to 33th International Symposium on Halogenated POPs).
- International advisory board ISWA final sink Conference (2013); ISWA World 2016
- Editor Board Environmental Science Pollution Research (ESPR)
- Member of the ISO Group analysis brominated flame retardants (ISO/TC 146/SC 6/WG 22)
- Member VDI (Community of German Engineers) development analytical standard for POPs.
- Reviewer for scientific journals: ES&T, ESPR, Chemosphere, Environmental Pollution, Environmental International, Hazardous Materials, Waste Management and others.

Experience in industry and co-operation with industry (including R&D):

- Since 2004 Consulting on long term monitoring of PCDD/PCDF and other UPOPs with AMESA System (Environnement SA, Germany)
- 2004/2005 Consulting on destruction of POPs (Prantner GmbH Verfahrenstechnik, Reutlingen, Germany) <http://www.prantner.de/index.html>
- 1997-2006 BAT/BEP strategies for municipal waste incinerators and hazardous waste incinerators in respect to PCDD/PCDF and other UPOPs emission reduction (IHI Co., Ltd. Yokohama and Tokyo, Japan) <http://www.ihico.jp/en/index.html>
- 1999-2003 Research & development work on formation and destruction of POPs (PCB, PCDD/F, PCP, PCBz) in technical processes (IHI Co., Ltd. Yokohama, Japan).

1998-2002	Development and improvement of catalytic filters (REMEDIA) for PCDD/PCDF destruction (W.L. Gore & Associates, Inc., Elkton, USA)
2001-2003	Formation of brominated and brominated-chlorinated PXDD/PXDF in thermal processes. (IHI Co., Ltd. Yokohama, Japan)
1999-2002	Research and development of catalytic destruction of PCDD/PCDF and PCB on fly ashes (Hitachi Zoosen, Osaka & IHI Co. Ltd., Tokyo Japan,).
1997-2005	BAT implementation in approx. 20 municipal waste incinerators and hazardous waste incinerators reduction of PCDD/PCDF emission (IHI Co., Ltd. Yokohama and Tokyo, Japan).
1999 - 2003	Research and development on reduction and destruction of POPs in technical processes (IHI Co., Ltd. Yokohama, Japan).
1997-2003	Establishment/management of a dioxin research laboratory (IHI Co., Ltd.)
1996-1999	Formation mechanisms of PCDD/PCDF in thermal and industrial processes (IHI Co., Ltd. Yokohama/Japan, University Tübingen/Germany).
1995-1996	Evaluation of potential release of fluorinated and chlorinated-fluorinated PXDD/PXDF from Aluminium industry (facilities in Germany and Norway).

Civil society activities

Ambassador of the International HCH & Pesticides Association (IHPA) (www.iHPA.info).

Member of the International Panel on Chemical Pollution (IPCP) (<http://www.ipcp.ch>)

Board member of the NGO "SOL" (People for Solidarity, Ecology & Lifestyles) (www.nachhaltig.at/) member of the Norther Alliance .

Board member of the NGOs Aufbruch (Germany) for "sustainable lifestyle" (www.anders-besser-leben.de), awarded UNESCO project UN Decade for "Education for Sustainable Development".

Guidelines/Guidances and reports for UN agencies and POP Reviewing Committee

1. Stockholm Convention (2013) Guidance on Sampling, Screening and Analysis of Persistent Organic Pollutants in Products and Articles; Draft; (Lead Author)
2. Stockholm Convention (2012) Guidelines on Best Available Techniques and Best Environmental Practice for the Recycling and Disposal of Articles containing Polybrominated Diphenyl Ethers (PBDEs) under the Stockholm Convention on POPs (Lead author)
3. Stockholm Convention (2012) Guidance for strengthening regulatory framework/voluntary agreements for monitoring of products/articles that may contain new POPs (Lead author).
4. Stockholm Convention (2012) Guidance for the Inventory of commercial Pentabromodiphenyl ether (c-PentaBDE), commercial Octabromodiphenyl ether (c-OctaBDE) and Hexabromobiphenyls (HBB) under the Stockholm Convention on Persistent Organic Pollutants (co-author)
5. UNEP (2010) Technical review of the implications of recycling commercial penta and octabromodiphenyl ethers. Stockholm Convention document for 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/2) Geneva 11-15. October 2010.
6. UNEP (2010) Supporting Document for Technical review of the implications of recycling commercial penta and octabromodiphenyl ethers. Stockholm Convention document 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/6) Geneva 11-15. Oct. 2010.
7. UNEP (2010) Debromination of brominated flame retardants. Stockholm Convention document for 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/20) Geneva 11-15. October 2010
8. UNEP (2010) Additional consideration of new persistent organic pollutants: pentachlorobenzene. Stockholm Convention document for 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/21) Geneva 11-15. October 2010.

Selected Publications (from ca. 140 reviewed papers):

In Book

1. R. Weber. Minimisation strategies for PCDD/PCDF emission in waste incineration. Chemical Risk Assessment Handbook, Asakura publisher, 2003 (In Japanese).

Review Articles and editorials

2. Weber R, Aliyeva G, Vijgen J. (2013) The need for an integrated approach to the global challenge of POPs management. *Environ Sci Pollut Res Int*. DOI 10.1007/s11356-012-1247-8
<http://link.springer.com/article/10.1007%2Fs11356-012-1247-8?LI=true>
3. R. Weber, A. Watson, M. Forter, F. Oliaei. (2011) Persistent Organic Pollutants and Landfills - A Review of Past Experiences and Future Challenges. *Waste Management & Research* 29 (1) 107-121
4. J. Vijgen, P.C. Abhilash, Y-F Li, R. Lal, M. Forter, J. Torres, N. Singh, M. Yunus, C. Tian, A. Schäffer, R. Weber* (2011) HCH as new Stockholm Convention POPs – a global perspective on the management of Lindane and its waste isomers. *Environ Sci Pollut Res*. DOI: 10.1007/s11356-010-0417-9.
5. Klánová J, Diamond M, Jones K, Lammel G, Lohmann R, Pirrone N, Scheringer M, Balducci C, Bidleman T, Bláha K, Bláha L, Booi K, Bouwman H, Breivik K, Eckhardt S, Fiedler H, Garriques P, Harner T, Holoubek I, Hung H, MacLeod M, Magulova K, Mosca S, Pistocchi A, Simonich S, Smedes F, Stephanou E G, Sweetman A, Šebková K, Venier M, Vighi M, Vrana B, Wania F, Weber R, Weiss P (2011) Identifying the research and infrastructure needs for the global assessment of hazardous chemicals 10 years after establishing the Stockholm Convention. *Environ. Sci. Technol.* 45, 7617–7619.
6. S.D. Shaw, A. Blum, R. Weber, K. Kannan, D. Rich, D. Lucas, C. P. Koshland, D. Dobraca, S. Hanson, L. S. Birnbaum Halogenated Flame Retardants: Do the Fire Safety Benefits Justify the Risks? *Reviews on Environmental Health* (2010) 25(4) 261-305.
7. R. Weber, M. Tysklind, C. Gaus, P. Johnston, M. Forter, H. Hollert, H. Heinisch, I. Holoubek, M. Lloyd-Smith, S. Masunaga, P. Moccarelli, D. Santillo, N. Seike, R. Symons, J.P.M. Torres, M. Verta, G. Varbelow, J. Vijgen, A. Watson, P. Costner, J. Woelz, P. Wycisk, M. Zennegg. Dioxin- and POP-contaminated sites—contemporary and future relevance and challenges. *Environ Sci Pollut Res* 15, 363-393 (2008).
8. R. Weber. Relevance of PCDD/PCDF Formation for the Evaluation of POPs Destruction Technologies – Review on Current Status and Assessment Gaps. *Chemosphere* 67, 109-117 (2007).
9. R. Weber and B. Kuch. Relevance of BFRs and thermal conditions on the formation pathways of brominated and brominated-chlorinated dibenzodioxins and dibenzofurans. *Environment International* 29, 699-710 (2003).

Other publications in Scientific Journals

10. Sindiku O, Orata F, Osibanjo O, Weber R (2013) Per- and Polyfluoroalkyl Substances in selected Sewage Sludge in Nigeria. *Chemosphere* 92, 329-335.
11. Wagner BO, Aziz ER, Schwetje A, Shouk FA, Koch-Jugl J, Braedt M, Choudhury K, Weber R* (2013) Recommendations on chemicals management policy and legislation in the framework of the Egyptian-German twinning project on hazardous substances and waste management. *Environ Sci Pollut Res Int*. DOI 10.1007/s11356-013-1523-2
12. Vijgen J, Aliyeva G, Weber R (2012) The Forum of the International HCH and Pesticides Association—a platform for international cooperation. *Environ Sci Pollut Res*. DOI: 10.1007/s11356-012-1170-z
13. Weber R., Varbelow G (2012) The Dioxin/POPs legacy of pesticide production in Hamburg: Part 1 Securing of the production area. *Environ Sci Pollut Res*. DOI: 10.1007/s11356-012-1011-0
14. Götz R, Sokollek V, Weber R* (2012). The Dioxin/POPs legacy of pesticide production in Hamburg: Part 2: Waste deposits and remediation of Georgswerder landfill. *Environ Sci Pollut Res*. DOI: 10.1007/s11356-012-0986-x..
15. Holt E, Weber R, Stevenson G, Gaus C* (2012) Formation of dioxins during exposure of pesticide formulations to sunlight. *Chemosphere*, Epub ahead of print 17. Apr 2012.
16. Huang J, Matsumura T, Yu G, Deng S, Yamauchi M, Yamazaki N, Weber R (2011) Determination of PCBs, PCDDs and PCDFs in insulating oil samples from stored Chinese electrical capacitors. *Chemosphere* 85, 239-246.
17. Holt E, R Weber, G Stevenson, C Gaus. Polychlorinated Dibenzo-*p*-Dioxins and Dibenzofurans Impurities in Pesticides: A Neglected Source of Contemporary Relevance, *Environ. Sci. Technol* 44, 5409–5415 (2010).
18. S Jit, M Dadhwal, H, Kumari S Jindal, Kaur J, Lata P, Niharika N, Lal D, Garg N, Gupta SK, Sharma P, Bala K, Singh A, Vijgen J, Weber R, Lal R Evaluation of hexachlorocyclohexane contamination from the last Lindane production plant operating in India. *Environ Sci Pollut Res* (2010) *Environ Sci Pollut Res* 18(4), 586-597.
19. Reinmann J., Weber R., Haag R.. Long-term monitoring of PCDD/PCDF and other unintentionally produced POPs – Concepts and case studies from Europe. *Science in China -Chemistry* 53, 1017-1024 (2010).
20. R. Weber, A. Watson, T. Webster. PBDEs as “New POPs” – Challenges and knowledge gaps of controlling PBDEs under the Stockholm Convention. *Organohalogen Compd.* 72 1493-1496, 2010.
21. Adu-Kumi S, Malisch R, Alexander Kotz, Kypke K, Asante KA, Takahashi S, Tanabe S Takasuga T, Clarke E, Weber R Levels of POPs in human breast milk samples from Ghana. *Organohalogen Compounds* 72, 1046-1049 (2010)
22. R Weber, I Bantz, M Klumbies, I Valentin, P Fantke. PFOS/PFC pollution from use of fire fighting foam in a major fire in Düsseldorf/Germany – human exposure and regulatory actions. *Organohalogen Compd* 72, 1005-1008).
23. M. Zennegg, X. Yu, M. H. Wong, R. Weber. Fingerprints of chlorinated, brominated and mixed halogenated dioxins at two e-waste recycling sites in Guiyu/China. *Organohalogen Compounds* 71 2263-2267 (2009).

24. E. Holt, R. von der Recke, W. Vetter, D. Hawker, V. Alberts, B. Kuch, R. Weber, C. Gaus. Assessing dioxin precursors in pesticide formulations as a source of OCDD in soil. *Environ. Sci. Technol.* 42, 1472–1478 (2008).
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26. P. Kröfges, D. Skutlarek, H. Färber, C. Baitinger, I. Gödeke, R. Weber. PFOS/PFOA Contaminated Megasites in Germany Polluting the Drinkingwater Supply of Millions of People. *Organohalogen Compd.* 69, 877-880 (2007).
27. V. Pekárek, R. Weber, R. Grabic, O. Šolcová, E. Fišerová, M. Šyc, J. Karban, Matrix Effect on the De Novo Synthesis of Polychlorinated Dibenzo-p-dioxins, Dibenzofurans, Biphenyls and Benzenes. *Chemosphere* 68, 51-61 (2007).
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30. W. Otto, H. Schönberger, D. Burger, R. Weber. Case study on remediation of a German city contaminated by a chloralkali plant and PCP production. *Organohalogen Compd.*, 68, 880-885 (2006).
31. B. Kuch, C. Schneider, J. W. Metzger, R. Weber. Hexabromobenzene and Pentabromophenol in German Sewage Sludge – Indication of Significant Commercial Use. *Organohalogen Compd.*, 67, 434-437 (2005).
32. R. Weber. On-line PCDD/F and PCDD/F surrogate monitoring – basic difficulties due to formation characteristics, memory effects and removal efficiency of air pollution control devices. *Organohalogen Compd.*, 67, 321-325 (2005).
33. T. Sakurai, R. Weber, S. Ueno, J. Nishino, M. Tanaka. Relevance of Coplanar-PCBs for TEQ Emission of Fluidized Bed Incineration and Impact of Emission Control Devices. *Chemosphere*, 53, 619-625 (2003).
34. J. A. Prange, C. Gaus, R. Weber, O. Pöpke, J. F. Müller. Assessing forest fires as a potential PCDD/F source in Queensland, Australia. *Environ. Sci. Technol.*, 37, 4329-4329 (2003).
35. T. Nakano, C. Matsumura, R. Weber. Analysis of low brominated PBDD/F - Analysis of MBDD/MBDF to T₃BDD/T₃BDF on a SP2331 – column. *Organohalogen Compd.* 60, 379-382 (2003).
36. R. Weber, S. Yoshida, K. Miwa. PCB destruction in subcritical and supercritical water - evaluation of PCDF formation and initial steps of degradation mechanism. *Environ. Sci. Technol.* 36 (8), 1833-1838 (2002).
37. R. Weber, K. Nagai, J. Nishino, H. Shiraishi, M. Ishida, T. Takasuga, K. Kondo and M. Hiraoka. Effect of selected metal oxides on dechlorination and destruction of PCDD and PCDF. *Chemosphere*, 46, 1255-1262 (2002).
38. R. Weber, T. Sakurai, S. Ueno, J. Nishino. Correlation of PCDD/F and CO values in MSW Incinerator - indication of memory effects in the high temperature/cooling section. *Chemosphere* 49, 127-134 (2002).
39. C. Gaus, G.J. Brunskill, D. W. Connell, J. Prange, J. F. Mueller, O. Paepke and R. Weber. Transformation processes, pathways, and possible sources of distinctive polychlorinated dibenzo-p-dioxin signatures in sink environments. *Environ. Sci. Technol.* 36 3542-3549 (2002).
40. R. Weber, B. Kuch, T. Ohno, T. Sakurai. De novo synthesis of mixed brominated-chlorinated PXDD/PXDF. *Organohalogen Compd.* 56, 181-184 (2002).
41. R. Weber, T. Sakurai. Low temperature decomposition of PCBs by TiO₂-based V₂O₅-WO₃ catalyst. *Applied Catalysis* 34 (2), 113-127 (2001).
42. C. Gaus, G. J. Brunskill, R. Weber, O. Pöpke, J. F. Müller. Historical PCDD inputs and their source implication from dated sediment cores in Queensland (Australia). *Environ. Sci. Technol.* 35, 4597-4603 (2001).
43. R. Weber, M. Plinke, Z. Xu, M. Wilken. Destruction Efficiency of Catalytic Filters for Polychlorinated Dibenzo-p-dioxin and Dibenzofurans in Laboratory Test and Field Operation - Insight into Destruction and Adsorption Behavior of Semivolatile Compounds. *Applied Catalysis B: Environmental* 31 (3), 195-207 (2001).
44. R. Weber, T. Sakurai. PCDD/F formation characteristics during pyrolysis processes. *Chemosphere* 45, 1111-1117 (2001).
45. R. Weber, F. Iino, T. Imagawa, M. Takeuchi, T. Sakurai and M. Sadakata. Formation of PCDF, PCDD, PCB, and PCN in *de novo* synthesis from PAH: mechanisms & correlation to fluidized bed incinerators. *Chemosphere* 44, 1429-1438 (2001).
46. R. Weber, H. Hagenmaier. PCDD/PCDF Formation in Fluidized Bed Incineration. *Chemosphere* 38, 2643-2654 (1999).
47. R. Weber, S. Sakurai, and H. Hagenmaier. Low temperature decomposition of PCDD/PCDF, chlorobenzenes and PAHs by TiO₂-based V₂O₅-WO₃ catalysts. *Applied Catalysis B: Environmental* 20, 249-256 (1999).
48. K. Nakamura, H. Minami, R. Weber, T. Takasuga and S. Sakai. Destruction of Chlorofluorocarbons (CFCs) in municipal waste incineration plants and behavior of organohalogen compounds. *Organohalogen Compd.*, 40, 559-562 (1999).
49. R. Weber and H. Hagenmaier. Mechanism of the Formation of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Chlorophenols in Gas Phase Reactions. *Chemosphere*, 38, 529-549 (1999).
50. R. Weber and H. Hagenmaier. Synthesis and Analysis of Mixed Chlorinated-Fluorinated Dibenzo-p-dioxins and Dibenzofurans and Assessment of Formation and Occurrence of the Fluorinated and Chlorinated-Fluorinated Dibenzo-p-dioxins and Dibenzofurans. *Chemosphere*, 34, 13-29 (1997).
51. R. Weber, H.-J. Schmitz, D. Schrenk and H. Hagenmaier. Metabolic Degradation, Inducing Potency, and Metabolites of Fluorinated and Chlorinated-Fluorinated Dibenzodioxins and Dibenzofurans. *Chemosphere*, 34, 29-41 (1997).

List of Publications Dr. Roland Weber

In Book

1. Weber R. Minimisation strategies for PCDD/PCDF emission in waste incineration. Chemical Risk Assessment Handbook, Asakura publisher, 2003 (In Japanese).

Review Articles

2. Weber R, Watson A, Forter M, Oliaei F. (2011) Persistent Organic Pollutants and Landfills - A Review of Past Experiences and Future Challenges. Waste Management & Research 29 (1) 107-121.
<http://wmr.sagepub.com/content/29/1/107.full.pdf>
3. Shaw SD, Blum A, Weber R, Kannan K, Rich D, Lucas D, Koshland CP, Dobraca D, Hanson S, Birnbaum LS. (2010) Halogenated Flame Retardants: Do the Fire Safety Benefits Justify the Risks? Reviews on Environmental Health 25(4) 261-305.
<http://www.meriresearch.org/Portals/0/Documents/01-REH%2025%284%292010%20SHAW%20FINAL%20printed.pdf>
4. Vijgen J, Abhilash PC, Li Y-F, Lal R, Forter M, Torres J, Singh N, Yunus M, Tian C, Schäffer A, Weber R* (2011) HCH as new Stockholm Convention POPs – a global perspective on the management of Lindane and its waste isomers. Env Sci Pollut Res. 18, 152-162.
<http://link.springer.com/article/10.1007%2Fs11356-010-0417-9#page-1>
5. Weber R, Gaus C, Tysklind M, Johnston P, Forter M, Hollert H, Heinisch H, Holoubek I, Lloyd-Smith M, Masunaga S, Moccarelli P, Santillo D, Seike N, Symons R, Torres JPM, Verta M, Varbelow G, Vijgen J, Watson A, Costner P, Wölz J, Wycisk P, Zennegg M. (2008) Dioxin- and POP-contaminated sites—contemporary and future relevance and challenges. Env Sci Pollut Res 15, 363-393.
<http://rd.springer.com/content/pdf/10.1007%2Fs11356-008-0024-1.pdf>
<http://link.springer.com/article/10.1007%2Fs11356-008-0024-1#page-1>
6. Weber R. Relevance of PCDD/PCDF Formation for the Evaluation of POPs Destruction Technologies – Review on Current Status and Assessment Gaps. Chemosphere, 67, 109-117 (2007).
7. Weber R, Kuch B. (2003) Relevance of BFRs and thermal conditions on the formation pathways of brominated and brominated-chlorinated dibenzodioxins and dibenzofurans. Environment International 29, 699-710.

Editorials

8. Weber R, Aliyeva G, Vijgen J. (2013) The need for an integrated approach to the global challenge of POPs management. Environ Sci Pollut Res Int. 20, 1901-1906. DOI 10.1007/s11356-012-1247-8
<http://link.springer.com/content/pdf/10.1007%2Fs11356-012-1247-8.pdf>
9. Weber R, Tysklind M, Gaus C. (2008) Dioxin – Contemporary and Future Challenges of Historical Legacies. Env Sci Pollut Res 15 (2) 96–100.
<http://link.springer.com/article/10.1065%2Fespr2008.01.473?LI=true#page-1>

Guidelines/Guidance Documents for UN, POP Reviewing Committee and reports for UN agencies

10. Stockholm Convention (2014) POPs in Articles and Phasing-Out Opportunities (Draft). June 2014 (Author)
11. SWITCH-Med (2014) SWITCH-Med SCP Policy Toolkit: mainstreaming Sustainable Consumption and Production into key economic sectors in the Mediterranean.
12. UNEP (2013) Toolkit for Identification and Quantification Releases of Dioxins, Furans and Other Unintentional POPs. <http://toolkit.pops.int/> (drafting team).
13. Stockholm Convention (2013) Guidance on Sampling, Screening and Analysis of Persistent Organic

Pollutants in Products and Articles; Draft; (Lead Author).

14. Stockholm Convention (2012) Guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants; Draft July 2012; (Lead author).
15. Stockholm Convention (2012) Guidance for strengthening regulatory framework/voluntary agreements for monitoring of products/articles that may contain new POPs; Draft; (Author; for UNITAR).
16. Stockholm Convention (2012) Guidance for the Inventory of commercial Pentabromodiphenyl ether (c-PentaBDE), commercial Octabromodiphenyl ether (c-OctaBDE) and Hexabromobiphenyls (HBB) under the Stockholm Convention on Persistent Organic Pollutants; Draft; (Co-author)
17. UNEP (2010). Technical Review of the Implications of Recycling Commercial Pentabromodiphenyl Ether and Commercial Octabromodiphenyl Ether. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/2)
18. UNEP (2010) Supporting Document for Technical review of the implications of recycling commercial penta and octabromodiphenyl ethers. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/INF/6).
19. UNEP (2010) Debromination of brominated flame retardants. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/INF/20).
20. UNEP (2010) Additional consideration of new persistent organic pollutants: pentachlorobenzene. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/INF/21).

Reviewed publications (including reviewed Conference papers)

21. Huang J, Gao J, Yu G, Yamazaki N, Deng S, Wang B, Weber R (2014) Unintentional formed PCDDs, PCDFs, and DL-PCBs as impurities in Chinese pentachloronitrobenzene products. *Environ Sci Pollut Res Int.* 2014 Aug 30. DOI 10.1007/s11356-014-3507-2
22. Sindiku O, Babayemi J, Osibanjo O, Schlummer M, Schlupe M, Watson A, Weber R (2014) Polybrominated diphenyl ethers listed as Stockholm Convention POPs, other brominated flame retardants and heavy metals in E-waste polymers in Nigeria. *Env Sci Pollut Res.* DOI: 10.1007/s11356-014-3266-0
23. Babayemi J, Sindiku O, Osibanjo O, Weber R (2014) Substance flow analysis of polybrominated diphenyl ethers in plastic from EEE/WEEE in Nigeria in the frame of Stockholm Convention as a basis for policy advice. *Env Sci Pollut Res.* DOI: 10.1007/s11356-014-3228-6
24. Babayemi JO, Osibanjo O, Weber R (2014) Assessment of Use, Reuse, and End-of-Life Disposal and X-Ray Fluorescence Analysis Screening of Waste Mobile Phones in Nigeria. *Environmental Quality Management* DOI: 10.1002/tqem/Summer2014/1
25. Moriwaki H, Sakyama T, Yamamoto Y, Weber R, Peter Behnisch, Arakawa R; Nakano T (2013) Analysis of Thermal Reaction Products of Chlorpyrifos Using LC/MS and GC/MS *Bunseki Kagaku* 62, 855-863, ISSN:0525-1931.
26. Sindiku O, Orata F, Osibanjo O, Weber R (2013) Per- and Polyfluoroalkyl Substances in selected Sewage Sludge in Nigeria. *Chemosphere* 92, 329-335.
27. Sindiku O, Tysklind M, Osibanjo O, Babayemi JO, Schlummer M, Weber R, Lundstedt S (2013) Polybrominated dioxins and furans (PBDD/PBDF) in e-waste plastic in Nigeria. Abstract 6th International Symposium on Flame Retardants, April 7-10, 2013, San Francisco.
28. Weber R, Varbelow G (2013) The Dioxin/POPs legacy of pesticide production in Hamburg: Part 1 Securing of the production area. *Env Sci Pollut Res.* 20, 1918-1924, DOI: 10.1007/s11356-012-1011-0 <http://rd.springer.com/content/pdf/10.1007%2Fs11356-012-1011-0.pdf>
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- Recommendations on chemicals management policy and legislation in the framework of the Egyptian-German twinning project on hazardous substances and waste management. *Environ Sci Pollut Res Int.* 20, 2087-2097. DOI 10.1007/s11356-013-1523-2
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31. Vijgen J, Aliyeva G, Weber R (2013) The Forum of the International HCH and Pesticides Association—a platform for international cooperation. *Env Sci Pollut Res.* 20, 2081-2086. DOI: 10.1007/s11356-012-1170-z <http://rd.springer.com/content/pdf/10.1007%2Fs11356-012-1170-z.pdf>
 32. Oliaei F, Kriens D, Weber R, Watson A. (2013) PFOS and PFC releases and associated pollution from a PFC production plant in Minnesota (USA). *Environ Sci Pollut Res Int.* 20, 1977-1992. DOI 10.1007/s11356-012-1275-4
<http://rd.springer.com/content/pdf/10.1007%2Fs11356-012-1275-4.pdf>
 33. Torres JPM, Fróes-Asmus CIR, Weber R, Vijgen JMH (2013) Status of HCH contamination from former pesticide production and formulation in Brazil – A task for Stockholm Convention Implementation. *Environ Sci Pollut Res* 20, 1951 – 1957. DOI 10.1007/s11356-012-1089-4
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 34. Torres JPM, Leite C, Krauss T, Weber R (2013) Landfill mining from a deposit of the chlorine/ organochlorine industry as source of dioxin contamination of animal feed and assessment of the responsible processes. *Env Sci Pollut Res.* 20, 1958-1965.
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 35. Wycisk P, Stollberg R, Neumann C, Gossel W, Weiss H, Weber R (2013) Integrated Methodology for Assessing the HCH Groundwater Pollution at the Multi-Source Contaminated Mega-Site Bitterfeld/Wolfen. *Env Sci Pollut Res.* 20, 1907-1917. DOI: 10.1007/s11356-012-0963-4
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 39. Sindiku O, Babayemi JO, Osibanjo O, Schlummer M, Schlupe M, Weber R (2012) Assessing POP-PBDEs and BFRs in E-waste polymers in Nigeria. *Organohalogen Compounds* 74, 1320-1223
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