Letter Health Consultation

King County Alder Tower Polychlorinated Biphenyls (PCBs) Caulking
Seattle, King County, Washington

July 22, 2011

Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

DOH 334-274 July 2011

Letter Health Consultation

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in accordance with methodologies and guidelines developed by the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste sites and releases.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation and should not necessarily be relied upon if site conditions or land use changes in the future.

This report was supported by funds from a cooperative agreement with ATSDR. However, it has not been reviewed and cleared by ATSDR.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor:

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Letter Health Consultation

July 22, 2011

TO: Joe Hicker
King County Facilities Management Division
Bill Lawrence
Public Health Seattle King County

FROM: Lenford O'Garro
Washington State Department of Health (DOH)

SUBJECT: King County Alder Tower
Polychlorinated Biphenyls (PCBs) Caulking Contamination

Statement of Issues:

The Washington State Department of Health (DOH) prepared this Letter Health Consultation (LHC) at the request of King County Facilities Management Division (King County) and Public Health Seattle King County (PHSKC). The purpose is to evaluate whether PCBs found in exterior caulk, interior dust, and air samples from the Alder Tower building, owned by King County, pose a potential health hazard to people. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background:

Alder Tower is located on 12th Avenue and East Alder Street in Seattle's Central District, King County, Washington. Alder Tower was built in 1971 and is the administrative center for the Youth Service Center. Other tenants include the King County Prosecutor's Office and Superior Courts. Alder Tower is scheduled for demolition in 2011 pending the outcome of an upcoming bond measure.

In anticipation of redeveloping the property, King County did a pre-design assessment for hazardous materials. Analysis of environmental samples collected during the assessment identified PCBs in the exterior window caulking. PCBs are present in caulking on the top three floors of the five-story building but not in the lower two floors because the first two floors had been extensively renovated in previous years. Ballasts in fluorescent lights are another potential

source of PCBs since the Alder Tower was built in 1971 before PCBs were banned in the United States (U.S.) in 1977.

King County collected additional samples, including wipe samples, from exterior and interior windows and from hard indoor surfaces. Dust samples were collected from carpets near windows, and one exterior and five interior air samples were also collected. Additionally, bulk dust samples were collected from the air handling system.

Discussion:

King County obtained indoor and outdoor PCB data during their assessment of hazardous materials in the Alder Tower building. In order for any contaminant to be a health concern, the contaminant must be present at a high enough concentration to cause potential harm, and there must be a completed route of exposure. DOH has evaluated pathways for exposure and available data to determine whether the PCBs found at Alder Tower pose a health concern. Table 1, shows the concentration range of PCBs found in Alder Tower.

Table 1. Concentration range of PCBs detected in interior samples at the Alder Tower in Seattle, King County, Washington.

Indoor Sample Type	Compound	Concentration Range	Comparison Value	Comparison Value Reference	Contaminant of Concern (COC)
Air	PCB	<0.97- <1.3 (ug/m^3)	0.01(ug/m^3)	CREG (Air)	Yes
Surface Wipes – Desktop, file cabinets, heater, refrigerator		ND	10 ($ug/100cm^2$)	EPA - Spill Clean-up Criteria [1]	No
Surface Wipes – Door trims, Vinyl floors		ND			No
Surface Wipes – Window sills		ND – 9.6 ($ug/100cm^2$)			No
Air handling system (bulk dust)		0.46 – 8.1 ppm	1 ppm	EMEG (Soil)	Yes
Carpet vacuum dust		0.98 – 9.7 ppm	0.4 ppm	CREG (Soil)	

CREG - ATSDR's Cancer Risk Evaluation Guide (chronic child)
EMEG - ATSDR's Environmental Media Evaluation Guide (chronic child)
ppm – parts per million
ND – Non Detected
ug/m^3 - micrograms per cubic meter
ug/100 cm^2 - micrograms per one hundred square centimeter

Exterior Surfaces:
The exterior window glass, caulking, and nearby concrete from the upper floors of Alder Tower contained high levels of PCBs (up to 150,000 parts per million (ppm) in the exterior caulk). However, exposures to workers, youth, or visitors from PCBs on the exterior areas of the building on the higher floors are not likely. Therefore, no completed pathway for exposure exists. As a result, no further evaluation is necessary for the exterior of the building.

Interior Surfaces:
Interior surfaces such as desktops, file cabinets, heater, refrigerator, door trims, and vinyl floors of Alder Tower contained dust with non-detectable levels of PCBs. Window sills of Alder Tower contained dust ranging from non-detectable to 9.6 ug/100cm^2 of PCBs. Carpet and air handling system contained bulk dust ranging from 0.46 to 9.7 ppm of PCBs. Workers, youth, and visitor exposures to PCBs are possible through interior surface dust and indoor air. This could occur via incidental ingestion (swallowing/eating), inhalation (breathing in), and/or dermal (skin) contact with dust.

Interior Surface Dust
ATSDR has no standards with which to evaluate data from surface wipe sampling. However, the U.S. Environmental Protection Agency (EPA) has a regulatory clean-up standard or spill cleanup criteria for PCBs of 10 micrograms per one hundred square centimeters (ug/100cm^2) on wipes collected from indoor surfaces [1]. EPA estimated that inhalation cancer risk from exposure to PCBs at 10 ug/100cm^2 would be at 1 excess cancer case per 1,000,000 exposed (1x 10^{-6}) [1]. Similarly, EPA estimated that cancer risk from dermal contact with PCBs at 10 ug/100cm^2 would be at 1 excess cancer case per 100,000 exposed [1].

Surface wipe samples were taken from a variety of interior surfaces. PCB (Aroclor 1254) was found on three window sills. However, all indoor surface wipe samples tested are below the EPA spill cleanup criteria of 10 ug/100cm^2 for PCBs. This represents a slight to very low increased risk for cancer. In addition, the standard acceptable for exposure at residences and risk would be less for people exposed for less time as in an occupational setting.

Indoor Air
All air samples were below the analytical detection limit at concentrations ranging from less than 0.97 microgram per cubic meter (ug/m^3) to less than 1.3ug/m^3 for PCBs. The analytical method detection limit was above the ATSDR air health comparison value (Cancer Risk Evaluation Guideline, CREG). Therefore, DOH will further evaluate the indoor air pathway by evaluating the movement of indoor carpet dust into the air. PCB air concentrations were estimated using the EPA Particulate Emission Factor (PEF) approach using inhalation of dust particulates (Appendix A).

Air Handling System Bulk Dust
Bulk dust samples were collected in the air handling system and Aroclor 1254 was found at concentrations ranging from 0.46 parts per million (ppm) to 8.1ppm. Pre-filter and lining bulk dust samples concentrations ranging from 6.2ppm to 8.1ppm and post-filter bulk dust samples concentrations ranging from 0.46ppm to 1.8ppm. Since, the maximum bulk dust sample concentration (8.1 ppm) is lower than maximum indoor carpet dust sample concentration (9.7

ppm); further evaluation will proceed using the maximum indoor carpet dust sample concentration.

Indoor Carpet Dust

Indoor carpet dust samples were collected using a specialized vacuum sampling device. Aroclor 1254 was found at concentrations ranging from 0.98 ppm to 9.7ppm. To be protective, DOH compared the results to ATSDR's Aroclor 1254 soil comparison value (Environmental Media Evaluation Guideline, EMEG) for children to assess possible non-cancer health concerns. The ATSDR soil comparison value is a generic, non-site specific guideline. For Arochlor 1254, the guidelines are 1 ppm for children and 10 ppm for adults.

No cancer ATSDR soil comparison value (Cancer Risk Evaluation Guideline, CREG) is available specifically for the Aroclor 1254. However, an ATSDR cancer soil comparison value of 0.04 ppm is available for the most toxic PCBs. Therefore, DOH compared the results to ATSDR's CREG soil comparison value for children to assess possible cancer health concerns.

Chemical Specific Toxicity

PCBs are a mixture of man-made organic chemicals. There are no known natural sources of PCBs in the environment. The manufacture of PCBs stopped in the U.S. in 1977, because evidence showed that they could build up in the environment and harm people's health. Although no longer manufactured, PCBs can still be found in certain products such as old fluorescent lighting fixtures, electrical devices or appliances containing capacitors that were made before the use of PCBs was banned, old microscope oil, and old hydraulic oil. Prior to 1977, PCBs entered the environment (soil, water, air) during the manufacture and use of PCBs. Today, PCBs can still enter the environment from illegal or improper dumping of PCB wastes, such as old hydraulic oil; leaks from electrical transformers that contain PCB oils; and disposal of old consumer products that contain PCBs [2]. Some hazardous waste sites also contribute PCBs to the environment.

PCBs enter the environment as mixtures. There are 209 structural variations of PCBs, referred to as congeners, which differ in the number and location of chlorine atoms in the chemical structure. Most PCBs commercially produced in the U.S. were standard mixtures called Aroclors. The conditions for producing each Aroclor favor the synthesis of certain congeners, giving each Aroclor a unique pattern based on its congener composition. No Aroclor contains all 209 congeners.

Once in the environment, PCBs do not breakdown easily and may stay in the soil for months or years. PCBs stick to soil and do not usually move deep into the soil with rainfall. In air, PCBs can be carried long distances. Although levels of PCBS in the environment are decreasing, small amounts of PCBs can be found in almost all outdoor and indoor air, sediments, surface water, and animals. PCBs build up in the food chain and are stored in the fatty parts of the body. People get most of their exposure to PCBs in the food they eat. The major dietary source of PCBs is fish. PCBs are also found in meats and dairy products [2]. Since the 1980's, levels of PCBs in people have followed a downward trend [3, 4].

In general, direct exposure to contaminants can occur by ingestion, inhalation, and dermal contact. Some of the PCBs that enter the body are metabolized (chemically altered by the body) and excreted within a few days; others stay in the body fat and liver for months and even years. PCBs collect in milk fat and can enter the bodies of infants through breast-feeding [2]. Most of what is known about possible human health risks of PCBs comes from animal studies and accidental human exposures to high levels of these chemicals in the workplace [5]. Chronic (long-term) and acute (short-term) exposures to PCBs have been shown to produce a wide array of toxic effects in animals including neurobehavioral, immunological, and developmental deficits in newborns exposed to PCBs through their mothers while in the womb [2]. Health problems seen in humans include skin irritation, vomiting, nausea, diarrhea, abdominal pain, eye irritation, and liver damage [2]. PCB levels found indoors at Alder Tower are not likely to produce these health effects because levels are well below health guidelines for chronic or acute exposures (see analysis below).

Evaluating Non-cancer Hazards

In order to evaluate the potential for adverse health effects from exposure to a contaminant (PCBs in dust), a dose that a person may receive is estimated. Doses are calculated for situations (scenarios) in which a person might be exposed to the contaminated media. The estimated dose for PCBs under each scenario is then compared to ATSDR's health guideline for PCB exposure Minimal Risk Level, (MRL) (an average daily dose that is not expected to harm people's health). MRLs are derived from toxic effect levels in human populations and laboratory animal studies. If the exposure dose exceeds the MRL, further evaluation is needed. If the exposure dose is lower than the MRL, no health effects are expected.

There is no MRL or oral reference dose (RfD) (RfDs are similar to MRL but derived by the EPA) for all PCBs mixtures. However, ATSDR has derived a chronic MRL for Aroclor 1254 of 0.00002 mg/kg/day for exposure for one year or longer. The MRL is based on the lowest observed adverse effect level (LOAEL) of 0.005 mg/kg/day for immunological effects in monkeys. Similarly, the EPA has an established RfD of 0.00002 mg/kg/day [2]. Because of data uncertainty, the LOAEL is divided by "uncertainty/safety factors" to produce the lower and more protective MRL. If a dose exceeds the MRL, there is the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. If the estimated exposure dose is only slightly above the MRL, that dose will fall well below the observed toxic effect level. The higher the estimated dose is above the MRL, the closer it will be to the actual observed toxic effect level. This comparison is called a hazard quotient (HQ) Appendix A.

As indicated in Table 1, Arochlor 1254 levels in dust exceed the screening value for a child's exposure. It is important to note that the exceedance of a soil comparison value does not mean that people will become ill. It does, however, indicate that further evaluation of the chemical is necessary. Therefore DOH calculated exposure doses based on site-specific exposure scenarios and compared the results to ATSDR's minimal risk level. See Appendix A for details of these calculations.

In evaluating the indoor dust data further, DOH used a scenario of a worker being exposed for 250 days per year for 25 years to the maximum PCB concentration detected in carpet dust.

Similarly, DOH assumed an older child (6-18 years old) being exposed 60 days per year for 10 years to the maximum PCB concentration detected in carpet dust. However, youths and children are not housed in the Alder Tower and would be present only for court proceedings or as visitors. Therefore, assuming exposure for 60 days per year for 10 years is a very protective exposure timeframe. Details of assumptions and calculations are presented in Appendix A.

Based on DOH's site-specific exposure estimates (Appendix A), workers and children are not likely to experience adverse non-cancer health effects from exposure to PCB dust since the estimated exposure dose does not exceed the MRL.

Evaluating Cancer Risk

Some chemicals can cause cancer. Theoretical cancer risk is estimated by calculating a dose similar to that described above and multiplying it by a chemical-specific cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than those encountered in the environment. The use of animal data requires extrapolation (estimating of values by projecting known data) of the cancer potency obtained from these high dose studies down to real-world exposures or environmental exposure levels. This process involves much uncertainty.

Current regulatory practice assumes there is no "safe dose" of a carcinogen, which means that any exposure to a dose of a carcinogen will result in some additional cancer risk. Consequently, theoretical cancer risk estimates are measures of chance (probability), rather than yes/no answers. Such measures, however uncertain, are useful in determining the magnitude of a cancer threat because exposure to any level of a carcinogenic contaminant carries an associated risk. The validity of the "no safe dose" assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered to be carcinogenic must exceed a threshold of tolerance before initiating cancer. EPA still assumes no threshold exists for cancer risk unless sufficient data indicate otherwise. The recent EPA guidelines on cancer risk also reflect the potential that thresholds for some carcinogenesis exist [6].

This health consultation letter describes theoretical cancer risk that is attributable to site-related contaminants in qualitative terms like "low", "very low", "slight", and "insignificant" increase in theoretical cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a "low" increase in cancer risk indicates an estimate in the range of one cancer case per ten thousand persons exposed over a lifetime. A "very low" estimate might result in one cancer case per several tens of thousands exposed over a lifetime, and a "slight" estimate would require an exposed population of several hundreds of thousands to result

Theoretical Cancer Risk

Theoretical Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:

Term		# of Excess Cancers
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

in a single case. DOH considers theoretical cancer risk "insignificant" when the estimate results in less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population.

Cancer is a common illness and its occurrence in a population increases with the age of the population. There are many different forms of cancer resulting from a variety of causes; not all are fatal. Approximately 1-in-2 to 1-in-3 of people living in the U.S. will develop cancer at some point in their lives [7].

DOH also calculated theoretical cancer risk estimates based on site-specific exposure doses (Appendix A). The cancer risk estimate for adults was 7 excess cancers per 10,000,000 adults exposed. Similarly, the cancer risk estimate for older children exposed to dust is 1 excess cancer per 10,000,000 children exposed. Both exposure scenarios fall within an acceptable cancer risk range (1 cancer estimated per 10,000 exposed ($1x\ 10^{-4}$) to1 cancer estimated per 1,000,000 exposed ($1x\ 10^{-6}$)). DOH considers the calculated theoretical risks for adult and children to be insignificant.

Summary of the Indoor PCB evaluation

- EPA spill cleanup criteria for PCBs is 10 ug/100cm^2
- Maximum indoor surface wipe concentration was 9.6 ug/100cm^2
- EPA's acceptable cancer risk range $1x\ 10^{-4}$ to $1x\ 10^{-6}$
- Theoretical cancer risk estimates for potential exposure to PCBs in indoor dust ranged from $1x\ 10^{-7}$ to $7\ x\ 10^{-7}$

Conclusions

DOH concludes that touching, breathing or accidentally ingesting PCBs dust from the interior of the King County Alder Tower is not expected to harm people's health.

DOH concludes that breathing air inside the King County Alder Tower is not expected to harm people's health.

DOH concludes that touching caulk contaminated with PCBs on the exterior of the King County Alder Tower is not expected to harm people's health because people cannot access the caulk.

Recommendations

The Alder Tower is scheduled for PCB abatement in fall 2010 and, pending the outcome of an upcoming bond measure, demolition in 2011. The building will be partially occupied and some floors maybe vacant during the renovation. DOH recommends some simple steps people can take to lower their risk of exposure to PCBs prior to and during the building renovation.

Building Cleaning Staff

- Clean surfaces frequently to reduce dust and residue inside buildings.

- Use a wet or damp cloth (micro fiber) or mop to clean surfaces.
- Use vacuums with high-efficiency particulate air (HEPA) filters.
- Do not sweep with dry brooms; avoid using dusters.
- Wash hands with soap and water after cleaning, and before eating or drinking.

Workers, Youth, and Visitors

- Wash children's hands with soap and water often, particularly before eating.
- Wash hands with soap and water after cleaning, and before eating or drinking.

Public Health Action Plan

Actions Planned

1. DOH will provide copies of this letter health consultation to the EPA, Ecology, Public Health-Seattle and King County, and King County Facilities Management Division of the Alder Tower.
2. If needed, DOH will evaluate any additional data that becomes available.

Please feel free to contact Lenford O'Garro at (360) 236-3376 or 1-877-485-7316 if you have any questions about this letter.

References

1. Part III, Environmental Protection Agency: Polychlorinated Biphenyls Spill Cleanup Policy, Final Rule, 52 Federal Register. 10688-10710 (April 2, 1987) (40 C.F.R. pt.761).

2. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for Polychlorinated Biphenyls (PCBs) (update) PB/2000/108027. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. November 2000. Available at: http://www.atsdr.cdc.gov/toxprofiles/tp17.html.http://www.atsdr.cdc.gov/toxprofiles/tp17.pdf

3. Patterson DG Jr, Wong LY, Turner WE, Caudill SP, DiPietro E, McClure C, Cash TP, Osterloh JD, Pirkle JL, Sampson EJ, Needham LL. Levels in the U.S. Population of those Persistent Organic Pollutants (2003-2004) Included in the Stockholm Convention or in other Long-Range Transboundary Air Pollution Agreements. Environ. Sci. Technol., 2009, 43 (4), 1211-1218.

4. Centers for Disease Control and Prevention. *Fourth National Report on Human Exposure to Environmental Chemicals*. http://www.cdc.gov/exposurereport/. December 2009.

5. Zook D.R. and Rappe, C. Environmental sources, distribution and fate of polychlorinated dibenzodioxins, dibenzofurans, and related organochlorines. 1994.

6. U.S. Environmental Protection Agency. Guidelines for Carcinogen Risk Assessment (Review Draft). NCEA-F-0644 July 1999. Available at: http://www.epa.gov/NCEA/raf/cancer.htm.

7. American Cancer Society. Cancer Facts & Figures 2010. Atlanta: American Cancer Society; 2010.

8. U.S. Environmental Protection Agency. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites: Office of Emergency and Remedial Response, Washington, DC. OSWER 9355.4-24, December 2002.

9. National Center for Environmental Assessment. Exposure Factors Handbook Volume 1 – General Factors EPA/600/P-95/002Fa: U.S. Environmental Protection Agency; August 1997.

10. Cowherd, C., G. Muleski, P. Engelhart, and D. Gillete. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. EPA/600/8-85/002. Prepared for EPA Office of Health and Environmental Assessment, Washington, D.C.

Appendix A

This section provides calculated exposure dose and assumptions used for analysis of exposure to PCBs in indoor dust from the King County Alder Tower in Seattle, Washington. This exposure scenario was developed to model exposures that might occur to an adult worker or an older child. The following exposure parameters and dose equations were used to estimate exposure dose from inhalation, ingestion, and dermal of PCBs.

Exposure to PCBs in dust via ingestion, inhalation, and dermal absorption

Total dose $_{\text{(non-cancer)}}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{C \times CF \times IR \times EF \times ED}{BW \times AT_{\text{non-cancer}}} \quad [8]$$

$$\text{Cancer Risk} = \frac{C \times CF \times IR \times EF \times CPF \times ED}{BW \times AT_{\text{cancer}}} \quad [8]$$

Dermal Route

$$\text{Dermal Transfer (DT)} = \frac{C \times AF \times ABS \times AD \times CF}{ORAF} \quad [8]$$

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{DT \times SA \times EF \times ED}{BW \times AT_{\text{non-cancer}}} \quad [8]$$

$$\text{Cancer Risk} = \frac{DT \times SA \times EF \times CSF \times ED}{BW \times AT_{\text{cancer}}} \quad [8]$$

For inhalation of dust particulates, air concentrations were estimated using the EPA Particulate Emission Factor (PEF) approach, as documented in EPA's Soil Screening Guidance [6].

Inhalation Route

$$\text{Dose}_{\text{non-cancer (mg/kg-day)}} = \frac{C \times SMF \times IHR \times EF \times ED \times 1/PEF}{BW \times AT_{\text{non-cancer}}} \quad [8]$$

$$\text{Cancer Risk} = \frac{C \times SMF \times IHR \times EF \times ED \times CSF \times 1/PEF}{BW \times AT_{\text{cancer}}} \quad [8]$$

Table A1. Exposure assumptions used for exposure to PCBs in indoor dust from the King County Alder Tower in Seattle, Washington.

Parameter	Value	Unit	Comments
Concentration (C)	9.7	mg/kg	Maximum detected value
Conversion factor (CF)	0.000001	kg/mg	Converts contaminant concentration from milligrams (mg) to kilograms (kg)
Ingestion rate (IR) – Older child	3.1*	mg/day	Exposure Factors Handbook [9]
Ingestion rate (IR) – adult	3.1*		
Exposure frequency (EF)	60	Days/year	Older child - Estimated days per year
	250		Adult worker - Average working days per year
Exposure duration (ED)	10	years	Older child - Maximum number of years
	25		Adult worker - Number of years at work
Body weight (BW) – Older child	41	kg	Older child mean body weight
Body weight (BW) - adult	72		Adult mean body weight
Surface area (SA) – child hand	400	cm^2	Exposure Factors Handbook [9]
Surface area (SA) – adult hand	840		
Averaging time $_{non\text{-}cancer}$ (AT)	1825	days	5 years
Averaging time $_{cancer}$ (AT)	27375	days	75 years
Cancer slope factor (CSF)	2	$mg/kg\text{-}day^{-1}$	Source: EPA
24 hr. absorption factor (ABS)	0.14	unitless	Source: EPA (Chemical Specific) PCB
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Adherence duration (AD)	1	days	Source: EPA
Adherence factor (AF)	0.2	mg/cm^2	Older child
	0.07		Adult
Inhalation rate (IHR) – Older child	14	m^3/day	Exposure Factors Handbook [9]
Inhalation rate (IHR) - adult	15.2		
Soil matrix factor (SMF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Particulate emission factor (PEF)	6.00E+8	m^3/kg	Model parameters (no grass coverage) [10]

*assumes 31 mg of dust adhering to the hands (based on average soil adherence to palm [9]) and 10 percent of the total adherence of soil is ingested.

Hazard Quotient formula:

$$HQ = \frac{\text{Estimated Dose (mg/kg-day)}}{\text{MRL (mg/kg-day)}}$$

Chemicals with an HQ less than 1 are not considered a health concern.

Table A2. Non-cancer hazard calculations resulting from exposure to PCBs in indoor dust from the King County Alder Tower in Seattle, Washington.

Contaminant	Maximum Concentration (ppm)	Scenarios	Estimated Dose (mg/kg/day)			RfD (mg/kg/day)	Hazard Quotient
			Ingestion	Dermal	Inhalation of Particulates		
PCB	9.7	Older Child	1.21E-7	4.36E-7	9.08E-10	2.0E-5	0.028
		Adult	2.86E-7	7.87E-7	3.90E-9		0.013

RfD – EPA oral reference dose
ppm – parts per million
mg/kg/day - milligrams per kilogram body-weight per day

Table A3. Cancer hazard calculations resulting from exposure to PCBs in indoor dust from the King County Alder Tower in Seattle, Washington.

Contaminant	Maximum Concentration (ppm)	Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Scenario	Increased Cancer Risk			Total Cancer Risk
				Ingestion	Dermal	Inhalation of Particulates	
PCB	9.7	2	Older Child	3.21E-8	1.16E-7	2.42E-10	1.48E-7
			Adult	1.91E-7	5.24E-7	1.56E-9	7.17E-7

ppm – parts per million
mg/kg/day - milligrams per kilogram body-weight per day

Glossary

Absorption	The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.
Acute	Occurring over a short time [compare with chronic]
Acute exposure	Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].
Adverse health effect	A change in body functions or cell structure that might lead to disease or health problems.
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Animal study	Laboratory experiments are conducted using animals to provide scientific information that may be useful in estimating how humans might respond to similar exposures or conditions.
Cancer	Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.
Cancer Risk	A theoretical risk for developing cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor (CSF)	A number assigned to a cancer-causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with acute].

Chronic exposure	Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure].
Comparison value (CV)	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Concentration	The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal	Referring to the skin. For example, dermal absorption means passing through the skin.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Detection limit	The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on ATSDR's *minimal risk level* (MRL).
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].
Hazard	A source of potential harm from past, current, or future exposures.

Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Minimal Risk Level (MRL)	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see oral **reference dose**].
No threshold	The premise that there is no level below which exposure to radiation or chemicals does not increase the risk of disease; for cancer from chemical or radiation exposure, the hypothesis that any dose of ionizing radiation or a specific chemical carcinogen may increase the risk of developing cancer in organs or tissues of the body.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Risk	The probability that something will cause injury or harm.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Safety factor	see uncertainty factor
Sample	A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.
Toxic	Harmful. Almost any substance, even pure water, can be *toxic* at a certain *dose* (amount). The *dose* is what determines the potential harm of a substance and whether it would cause someone to get sick.
Uncertainty factor	Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effectlevel (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].