Letter Health Consultation

Frank Wear Cleaners Site
Evaluation of October 2014 – September 2015 and October 2015 – May 2017 Indoor Air Results
Former Buckle My Shoe Early Learning Center and Former Learning Tree Early Learning Center

Yakima, Yakima County, Washington

June 15, 2023

Prepared by

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

DOH 334-512 June 2023

Foreword

Report Preparation

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June 15, 2023

Rachel Caron
Washington Department of Ecology
Toxics Cleanup Program
Central Region Office

Re: Letter Health Consultation
Frank Wear Cleaners Site
Evaluation of October 2014 to September 2015 and October 2015 and May 2017 Indoor Air Results
Former's Buckle my Shoe and Learning Tree Early Learning Centers
Yakima, Yakima County, Washington

Dear Mrs. Caron:

At the request of the Washington Department of Ecology (Ecology), the Washington Department of Health (DOH) reviewed indoor air contaminant data from the former's Buckle my Shoe and Learning Tree Early Learning Center in Yakima, Yakima County, Washington. The data were collected by Ecology between October 2014 to September 2015 and October 2015 and May 2017. The formers childcare centers were located adjacent to the former Frank Wear Cleaners property where a release of dry-cleaning chemicals to soil and groundwater occurred sometime in the past. Children from 1 to 5 years old and childcare workers occupied the former's child care centers 5 days a week.

Indoor air contaminants were detected during the testing at the childcare center. In 2014, DOH evaluated indoor air data (July 12 and December 2013) from Buckle My Shoe ECE. DOH concluded that breathing the contaminants is not expected to cause harmful health effects. Although the contaminants found in indoor air during that time were not expected to cause harmful health effects, DOH recommended that Ecology continue monitoring indoor air at the childcare center to ensure that the contaminants associated with the Frank Wear site do not increase in the future. The occurrence and frequency of the testing and type of analysis should be based on site specific conditions.

Ecology continued performing system operation, maintenance, and monitoring activities during October 2014 to September 2015 and October 2015 to May 2017 operational period. During that

evaluation period Ecology collected sub-slab soil vapor data, and indoor and outdoor ambient air.

DOH conducts health consultations in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

The former Frank Wear Cleaners property was located at 106 South Third Avenue in a commercial area of Yakima. In 2012, a soil vapor extraction (SVE) system was constructed at the site, and it has been operating since then. The SVE system has removed tetrachloroethylene, or tetrachloroethene (PCE) and Volatile Organic Compounds (VOCs) by inducing a vacuum beneath the childcare center concrete slab.

Dry cleaning operations occurred on the property from the early 1940s to 2000. It is unknown how the property was used prior to 1940. Groundwater contamination at the Frank Wear Cleaners site is predominantly from PCE. However, other dry cleaning related chemicals may have also been released. The contaminated groundwater reportedly flows from the former dry cleaner property to the south/southeast. It travels under the adjacent building that was occupied by the former's childcare centers. The site is unoccupied but plans to operate as a childcare center (personal conversation with Rachel, C, February 2023).

The former's childcare centers were located at 108 South Third Avenue. Previously, it was only licensed for children ages 1 to 5 years. Occupants of the childcare care center were typically in the building nine hours a day, five days a week [1].

In 2012, Ecology installed a soil vapor extraction system (SVE) at the site and began testing indoor air and soil gas below the childcare building. The results suggested a small amount of soil gas contaminated with PCE and other VOCs were moving into indoor air. The SVE system captures and treats the contaminants evaporating from the soil and groundwater. It was also designed to prevent vapors associated with the contaminated soil and groundwater at the site from entering indoor air at the childcare center. This was done by creating sub-slab depressurization (3). Since the SVE system started up in July 2012 and until May 2017, the SVE system has removed approximately 245 pounds of PCE and 302 pounds of VOC.

After the SVE system startup, Ecology tested and collected indoor and outdoor air. In 2014 – 2015, and 2016 – 2017, Ecology collected indoor air samples from these locations: NE Corner Nap/Play Area and SE Corner Nap/Play Area, main floor, and basement at the childcare center. Outdoor ambient air samples were collected at the northwestern corner of the property. Indoor air and outdoor air testing was done for volatile organic compounds (VOCs) using EPA Method TO-15; some contaminants were analyzed using selective ion mode (SIM) [2]. Soil gas below the sub-slab was also collected in December 2014, March 2015, June 2015, and September 2015. They were also collected in January 2016 and April 2017. Indoor air, outdoor ambient air, and subslab vapor samples were collected on a quarterly basis (Dec 2014, March 2015, June 2015, and September 2015) to evaluate the vapor intrusion at the childcare center. During the October

2015 to May 2017 sampling period, indoor air, outdoor ambient air, and subslab vapor sampling was conducted at the childcare center on an annual basis due to budget constraints.

Indoor and outdoor air samples were collected using 6 Liter (L) Summa canisters. Soil vapor samples were collected with a 400-milliliter (mL) Summa Canisters. Leak testing, using helium, was conducted prior to sub-slab testing. Windows were reportedly closed and the heating, ventilation, and air conditioning (HVAC) system was operating during each sampling event [2, 3]. Attachment A, Table A1 summarizes the indoor air results and the concentration range during 2014, 2015, 2016, and 2017 sampling events.

Ecology conducted indoor air testing at the former childcare center on September 25 and October 20, 2011. In January 2012, DOH conducted an assessment of indoor air data and concluded that breathing the maximum concentrations of VOCs found in indoor air for approximately one year was not expected to harm the health of children or adults [4]. In July 2012 and December 2013, DOH reviewed indoor air contaminant data from the Buckle My Shoe Early Learning Center and concluded also that breathing the contaminants did not expect to cause harmful health effects [5].

Site visit

On April 14, 2023, staff conducted a site visit at the former Frank Wear drycleaner facility. We toured the facility in the company of the site manager from Ecology and a representative of the licensing agency. The site manager shared recent groundwater results from the monitoring wells for 2018 to 2020. The levels of PCE, trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and vinyl chloride are still elevated above state cleanup levels in some wells. We noticed that the SVA system is operating and working well. Since the granular activated carbon (GAC) filters were removed and replaced in April 2017, we recommend replacing these filters. The site manager said that Ecology will be collecting new indoor air data at the former childcare center in the summer. I shared a summary of this letter and promised them to send a draft for comments and review.

Discussion

Indoor air samples collection at the former's childcare centers began after July 2012, when a Soil Vapor extraction (SVE) system was constructed at the former Frank Wear Cleaners Site. Indoor air samples were analyzed for 62 contaminants between July 2012 and December 2013 [6].

SVE system operation, maintenance, and monitoring continued on a quarterly basis between September 2012 and September 2015, and on an annual basis between October 2015 and May 2017. Indoor air, outdoor ambient air, and subslab soil vapor sampling at the childcare center were collected during those periods. Historical data have demonstrated that PCE concentrations in the indoor air and subslab soil vapor have significantly decreased since startup of the SVE system in July 2012 [2]. The SVE system and the extraction of soil vapor has been effective at mitigating PCE and VOCs at the former's childcare centers. Until May of 2017, 245 pounds of PCE and 302 pounds of VOC have been removed from the former Frank Wear Cleaner site.

Exposure Pathway

Inhalation of VOCs is the only expected route of exposure for the children and childcare workers at the former's childcare centers.

Skin Contact (Dermal)–The skin provides an effective barrier for most environmental contaminants, but some contaminants do cross the skin and enter the body. TCE can enter the body from skin contact with products that are liquid and contain TCE. It can enter the body through the skin from vapors in the air or from contaminated water while bathing, showering, or swimming. If anyone touches contaminated soil, only a small amount will be absorbed through the skin. The transfer of chemicals through the skin will depend on the chemical and are limited by duration of contact. Based on the low levels of COCs found in the soil, it is unlikely that exposure can occur through skin contact with contaminated soils. Thus, dermal contact is not considered an exposure route of concern.

Results

DOH used a multi-step process to determine which of the contaminants tested for in indoor air might pose a possible health threat to the children and childcare workers.

DOH first compared the highest concentrations of each contaminant found in the childcare center's indoor air to health comparison values. *Health comparison values are concentrations of contaminants that are unlikely to cause people to get sick. This is done to be protective of the most sensitive individuals (i.e., children and older adults). It is also done to account for our lack of certainty regarding the adverse health effects of low levels of contaminant exposure.* If a contaminant was noted as being less than a reporting limit[a], DOH compared the reporting limit to the health comparison values.

The primary air health comparison values used by DOH were ATSDR's cancer risk evaluation guides (CREGs) and environmental media evaluation guides (EMEGs) [7]. The air CREG is the concentration of a contaminant in air that is expected to cause no more than one additional cancer in a million persons exposed over a lifetime. An EMEG is a concentration in air below which adverse non-cancer health effects are not expected to occur. If no ATSDR health comparison values were available, DOH used an Environmental Protection Agency (EPA) reference concentration (RfC) or EPA regional screening levels (RSLs) for air [8]. An EPA RfC is an estimate of a continuous human inhalation exposure (including sensitive subgroups) that is likely to be without significant risk of harmful non-cancer effects during a lifetime. The EPA RSLs are as protective as ATSDR's EMEGs.

If a contaminant did not exceed the health comparison value, no further evaluation of that contaminant is necessary. This is because we do not expect those contaminants will pose a health threat. When a contaminant is found to be above a health comparison value, further evaluation is needed. *However, just because a contaminant was found above the comparison value does not necessarily mean it will cause people to get sick.* When a contaminant does not have a health comparison value available, a health comparison value for a contaminant similar in structure may

[a] Reporting limits are the lowest concentration at which a chemical can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision.

be used as a substitute. If no substitute is available, the contaminant is further evaluated.

As shown in Table A1, several indoor air contaminants, including some that were not detected above the reporting limits, were above the health comparison values. Table A2 shows 2017 soil gas data for the contaminants of potential concern (COPC) detected at the former's childcare centers. These contaminants were carried forward as possible chemicals of potential concern and compared to sub-slab, and outdoor air levels (Table A3). This step was particularly important for identifying whether the contaminants that were not detected in indoor air but had a reporting limit above the health comparison value, were a site related contaminant that needed further evaluation.

Table A3 summarizes indoor air, sub-slab and outdoor air contaminant samples. It shows concentration ranges and whether a contaminant might be dry cleaning related; and provides a determination regarding further assessment of a contaminant. Contaminants that were not detected in indoor air, soil gas, and outdoor air, were not carried forward for further assessment because it was assumed they were not present. This narrowed the number of contaminants down to four, referred to as COPC, that were carried forward for further health assessment (see Table A3):

- Benzene
- Chlroform
- 1,2- Dichlorothane
- Trichlorothene (TCE)

DOH has not evaluated the potential source of these four COPCs; however, as noted in Table A3, some of them are considered dry cleaning related chemicals. The maximum concentration of each of the four COPC was less than their respective non-cancer health comparison value. As a result, no further assessment of the non-cancer health effects associated with these contaminants is necessary. The four COPC did, however, exceed their respective cancer health comparison values. Therefore, further assessment of the carcinogenic health threat posed by those contaminants is needed. *It is important to understand that exceeding the cancer comparison value does not imply that people will develop cancer when exposed to these levels.* Further discussion of the cancer risk associated with these contaminants follows.

Evaluating Cancer Risk

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 people living in the United States will develop cancer at some point in their lives.(8)

To evaluate the inhalation cancer risk associated with the COPC found in indoor air at the formers Early Learning Centers, DOH used the maximum detected concentration of each contaminant. When the maximum detected concentration was less than the laboratory reporting limits, DOH conservatively used the maximum reporting level for evaluating inhalation cancer risks. DOH also

conservatively assumed that children and adult exposures would be 52.14 weeks per year (2 weeks were allowed for vacations away from the learning center), 5 days per week, and 9.9 (1 to < 2years), 9.6 (2 to < 6 years), and 11.8 (birth to < 1 year and a full-time worker) hours per day.

Attachment B, Table B1 and Table B2 contain the exposure assumptions and site-specific exposure parameters used to estimate non-cancer and cancer risks. The results of DOH's estimated cancer risk evaluation for the COPCs found in indoor air are also included in Table B3. As noted in Table B2, DOH estimated the following approximate cancer risks for a child (birth to < 1 year, 1 to < 2 year, and 2 < to 6 years) and a part- and full-time worker exposed to the maximum amount of the chemicals of concern found in indoor air at the former's Early Learning Centers:

- 2 additional cancer cases per 1,000,000 similarly exposed children.
- 4 additional cancer cases per 1,000,000 people similarly exposed adults.

Cancer Risk

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 cancer cases for the number of persons similarly exposed over 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

When compared to the cancer risk terms provided in the adjacent box, the estimated cancer risk for a child (1 to 6 years old) is considered slight. The estimated cancer risk for a childcare worker is considered slight. These risk levels are all below a level DOH considers a health threat.[b] It is important to note that these estimates are for excess cancers that might result, in addition to, those normally expected in an unexposed population. It is also important to note that these are estimated risk based on using the maximum indoor air concentration detected over few indoor air sample events. The actual risk is likely lower and could be as low as zero.

Conclusions

DOH concludes that breathing the contaminants found in indoor air during the October 2015 to May 2017 operational periods at the former's Childcare Centers is not expected to cause harmful health effects.

[b] DOH generally considers there to be an increased health threat when an assessment shows 1 additional cancer in a population of 10,000.

Recommendations

Although the VOCs found in indoor air during July 2012 and December 2013, October 2014 to September 2015, and October 2015 to May 2017 operational periods, are not expected to cause harmful health effects. DOH recommends that:

- Ecology continues monitoring indoor air at the former's childcare centers to ensure that the VOCs associated with the Frank Wear site do not increase in the future. The occurrence and frequency of the Ecology indoor air testing and type of analysis should be based on site specific conditions (e.g., changes in subsurface conditions (e.g., increases or decreases in soil gas, soil, or groundwater contaminant concentrations)).

- Ecology replaces GAC filters since they were removed in April 2017.

Although there are some low levels of COCs in the soil, DOH recommends:

- Limiting exposure (especially for children) to these contaminants in the soil.

- No digging into the soil in the childcare center playgrounds and in the former Frank Wear drycleaner property. If you are considering gardening, we suggest installing raised garden beds and placing landscape fabric between the ground and new soil to limit exposure while gardening.

Next steps

DOH is available to review new indoor air data and update the conclusions and recommendations of this health evaluation.

DOH is available to provide outreach and education materials to parents and community members.

DOH appreciates the opportunity to assist Ecology with the Frank Wear Cleaner site. Please contact me at 360-236-3192 if you have any questions.

Sincerely,

Elmer Diaz
Health Assessor
Toxicologist
Site Assessments and Toxicology Section

cc: Lenford O'Garro, Department of Health
Lori Hernandez, Child Care Licensing Supervisor, Region 2, Yakima Office - Department of Children, Youth, and Families (DCYF)

Attachment A –Screening Level Summary Tables

Table A1: Indoor Air Contaminant Concentration Range for the former's Childcare Centers between 2012 – 2013, 2014 – 2015, and 2015 – 2017 and Health Comparison Values, Frank Wear Cleaners Site, Yakima, Yakima County, Washington.

Chemical	Cancer Class	Indoor Air Concentration Range (µg/m^3) (2012-2013)	Indoor Air Concentration Range (µg/m^3) (2014-2015)	Indoor Air Concentration Range (µg/m^3) (2015-2017)	Health Comparison Value (ug/m^3)	Health Comparison Value	Possible Chemical of Potential Health Concern
Benzene	KL	**<0.24 - 4.4**	**<0.28 – 1.3**	**<0.28 – 0.82**	9.6 0.13	Chronic MRL CREG	NC - No **C - Yes**
Chloroform	LI	**<0.74 - 2.9**	**<0.81 – 5.4**	**<0.64 – 1.6**	98 0.043	Chronic MRL CREG	NC - No **C - Yes**
1,2-Dichloroethane	B2	**<0.12 - 0.34**	**<0.13 - 0.86**	**<0.13 - 0.1**	2,400 0.038	Chronic MRL CREG	NC - No **C - Yes**
cis 1,2-Dichloroethene	IN	<0.11 - <0.15	<0.14 – 2.3	<0.10 – 2.3	790	Intermediate MRL[c]	NC - No
trans-1,2 Dichloroethene	IN	<0.55 - <0.74	<0.64 - <0.81	<0.52 - <0.78	790	Intermediate MRL[c]	NC - No
Ethylbenzene	2B	**0.26 - 1.5**	**<0.16 – 2.1**	0.22 – 0.31	260 0.97	Chronic MRL EPA Cancer RSL	NC - No C - No
Methylene Chloride	LC	<1.0 - 13	<1.1 – 1.4	<0.92 - <1.3	1,000 100	Chronic MRL CREG	NC - No C - No
Tetrachloroethene (PCE)	LC	<0.19 - 2.5	<0.24 – 5.6	<0.18 - 1.5	270 3.8	Chronic MRL CREG	NC - No C - No
Trichloroethene (TCE)	CH	**<0.022 - 0.52**	**<0.031 - 0.16**	**<0.05 - 0.14**	41 2.6E-07 (2 EPA) 0.04 (CREG)	Chronic MRL IUR (TCE action level)[k] CREG	NC - No **C - Yes**
Toluene	IN	1.3 - 17	0.75 – 4.3	1.2 – 9.6	300	Chronic MRL	NC - No
m,p-Xylene	DI	0.70 - 5.0	0.33 – 6.1	0.71 – 6.1	100	EPA Non-cancer RSL[a]	NC - No
o-Xylene	DI	0.27 - 1.8	<0.16 – 1.4	0.26 – 2.7	100	EPA Non-cancer RSL[a]	NC - No
Vinyl Chloride	KL	<0.035 - <0.048	<0.035 - 0.086	<0.034 - <0.052	77 0.11	Intermediate MRL CREG	NC - No C - No

Orange highlighted cells - contaminants only tested in August, September, and November 2012, ug/m^3 - micrograms per cubic meter, < - less than the reporting limit, E - Exceeds instrument calibration range, **Bold** - One or more samples exceeded the health comparison value, NC - Non-Cancer, C - Cancer, -- No cancer classification available

EPA Cancer Classes: DI - Data are inadequate for assessment of human carcinogenic potential, KL - EPA: Known/Likely human carcinogen, B2- Probable human carcinogen (inadequate human, sufficient animal studies); D - Not classified as to human carcinogenicity, CA - Carcinogenic to humans, LC - Likely to be carcinogenic to humans, LI - Likely to be carcinogenic to humans, CN - Carcinogenic potential cannot be determined, NS - Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential, IN - Likely to be carcinogenic to humans, SU - Suggestive evidence of carcinogenic potential, CH - Carcinogenic to humans

IARC Cancer Classes: 3 - not classifiable, 2B - possibly carcinogenic to humans (limited human evidence; less than sufficient evidence in animals

Chronic MRL - ATSDR's Minimal Risk Level - Non-cancer, CREG – IUR- EPA Inhalation Unit Risk - ATSDR's Cancer Risk Evaluation Guides, EPA - U.S. Environmental Protection Agency, EPA RfC - EPA reference concentration, EPA RSL - EPA regional screening level, [a] - target hazard index (HI) = 1.0, [b] - used 1,2-dichlorobenzene as a surrogate, [c] - used trans 1,2-dichloroethene as a surrogate, [d] - used 1,3-dichloropropene as a surrogate, [e] - used methanol as a surrogate, [f] - used ethyl benzene as a surrogate, [g] - used 1,1-Difluorethane as a surrogate, [h] - used Chlorodifluoromethane as a surrogate, [i] - used hexane as a surrogate, [j] - used 1,2,4-Trimethylbenzene as a surrogate, k – EPA TCE action level for pregnant women.

Table A2: Soil gas Contaminant Concentration Range for the former's childcare Centers 2017 and Health Comparison Values, Frank Wear Cleaners Site, Yakima, Yakima County, Washington.

Chemical	Cancer Class	Subslab Soil Vapor Concentration Range (µg/m^3)	Health Comparison Value (ug/m^3)	Health Comparison Value Reference (6;7)	Possible Chemical of Potential Health Concern
Benzene	KL	<0.16 – 1.2	4.3	CREG	C - No
Chloroform	LI	**<0.25- 1.4**	**1.4**	**CREG**	**C - Yes**
1,2-Dichloroethane	B2	<0.41-1.0	1.3	CREG	C - No
cis 1,2-Dichloroethene	IN	<0.4-4.14	NA	NA	NA
trans-1,2 Dichloroethene	IN	<0.4-<0.8	26,000	Intermediate EMEG	NC - No
Ethylbenzene	2B	<0.44-1.0	8,700	Chronic EMEG	NC - No
Methylene Chloride	LC	<0.35-0.95	2,100	CREG	C - No
Tetrachloroethene (PCE)	LC	<0.69 – 23	130	CREG	C - No
Trichloroethene	CH	<0.55	7	CREG	C - Yes
Toluene	IN	<0.76-5.8	130,000	Chronic EMEG	NC - No
m,p-Xylene	DI	<0.44-3.4	NA	NA	NA
o-Xylene	DI	<0.44-1.4	NA	NA	NA
Vinyl Chloride	KL	<0.13	3.7	CREG	C - No

Orange highlighted cells - contaminants only tested in August, September, and November 2012, ug/m^3 - micrograms per cubic meter, < - less than the reporting limit, E - Exceeds instrument calibration range, **Bold** - One or more samples exceeded the health comparison value, NC - Non Cancer, C - Cancer, -- No cancer classification available

EPA Cancer Classes: DI - Data are inadequate for assessment of human carcinogenic potential, KL - EPA: Known/Likely human carcinogen, B2- Probable human carcinogen (inadequate human, sufficient animal studies); D - Not classified as to human carcinogenicity, CA - Carcinogenic to humans, LC - Likely to be carcinogenic to humans, LI - Likely to be carcinogenic to humans, CN - Carcinogenic potential cannot be determined, NS - Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential, IN - Likely to be carcinogenic to humans, SU - Suggestive evidence of carcinogenic potential, CH - Carcinogenic to humans

IARC Cancer Classes: 3 - not classifiable, 2B - possibly carcinogenic to humans (limited human evidence; less than sufficient evidence in animals

Chronic MRL - ATSDR's Minimal Risk Level - Non-cancer, CREG - ATSDR's Cancer Risk Evaluation Guides, EPA - U.S. Environmental Protection Agency, EPA RfC - EPA reference concentration, EPA RSL - EPA regional screening level, [a] - target hazard index (HI) = 1.0, [b] - used 1,2-dichlorobenzene as a surrogate, [c] - used trans 1,2-dichloroethene as a surrogate, [d] - used 1,3-dichloropropene as a surrogate, [e] - used methanol as a surrogate, [f] - used ethyl benzene as a surrogate, [g] - used 1,1-Difluorethane as a surrogate, [h] - used Chlorodifluoromethane as a surrogate, [i] - used hexane as a surrogate, [j] - used 1,2,4-Trimethylbenzene as a surrogate

Note: Per ATSDR soil vapor intrusion (SVI) guidance, doses are not calculated for soil gas data or groundwater data for the vapor intrusion pathway. Refer to the SVI guidance for more information.

Table A3: Comparison of Indoor Air, Sub-slab and Outdoor Contaminant Ranges and Contaminant Source Assessment for the former's childcare centers, Frank Wear Cleaners Site, Yakima, Yakima County, Washington.

Chemical	Indoor Air (IA) Concentration Range (µg/m^3) for COPC	Subslab (SS) Concentration Range (µg/m^3)	Outdoor Air (OA) Concentration Range (µg/m^3)	Detected in IA, OA, or SS	Possible Site Related IA Contaminant Requiring Further Evaluation	Source(s) of Contaminant Possibly Dry Cleaning Related	Carry Contaminant Forward for Further Evaluation
Benzene	**<0.28 – 0.82**	<0.16 – 1.2	NA	IA, SS	Yes	Yes - benzene is a component of some dry-cleaning chemicals [9]	**Yes**
Chloroform	**<0.64 – 1.6**	**<0.25- 1.4**	<0.9	All	Yes	Yes - dry cleaning agent; however, it is formed when chlorine is added to water [10]	**Yes**
1,2-Dichloroethane	**<0.13 - 0.1**	<0.41-1.0	<0.15	All	Yes	No - used in the production of solvents like vinyl chloride [11]	**Yes**
Ethylbenzene	0.22 – 0.31	<0.44-1.0	NA	IA, SS	No	No - most used to produce styrene; found in gasoline, carpet glues, paints, inks, pesticides, tobacco products [12]	**No**
Trichloroethene	**<0.05 - 0.14**	<0.55	<0.20	All	Yes	Yes - breakdown product of tetrachloroethylene; solvent [13]	**Yes**

Orange highlighted cells - contaminants only tested in August, September, and November 2012, ug/m^3 - micrograms per cubic meter, < - less than the reporting limit, E - Exceeds instrument calibration range,
Bold - One or more samples exceeded the health comparison value, IA - indoor air, OA - outdoor air, SS - sub slab, NC - Non Cancer, C - Cancer, -- No cancer classification available

Attachment B – Cancer Risk Equations, Assumptions, and Estimated Cancer Risks

This attachment provides the equation and assumptions used for determining the estimated increased cancer risk and the results associated with a child (1-5 years), an older child, and an adult inhaling the maximum concentration of the four COPCs found in indoor air at the Former's Early Learning Centers in Yakima, Washington.

Air Inhalation Exposure Equation

$$\textbf{Adjusted EPC} = \textbf{EPC} \times \textbf{EF}_{\textbf{noncancer}} \qquad \textbf{Equation 1}$$

EPC = exposure point concentration, $EF_{noncancer}$ = exposure factor (unitless)

Hazard Quotient

$$\textbf{HQ} = \textbf{Adjusted EPC} \div \textbf{HG} \qquad \textbf{Equation 2}$$

HQ = hazard quotient, EPC = exposure point concentration (µg/m^3 or ppb), HG = health guideline (e.g., inhalation MRL, RfC)

$$\textbf{CR} = \textbf{Adjusted EPC} \times \textbf{IUR} \times (\textbf{ED} \div \textbf{LY}) \qquad \textbf{Equation 3}$$

$$\textbf{ADAF-adjusted CR} = (\textbf{Adjusted EPC} \times \textbf{IUR}) \times (\textbf{ED} \div \textbf{LY}) \times \textbf{ADAF} \qquad \textbf{Equation 4}$$

$$\textbf{Total CR} = \textbf{Sum of the CR for all exposure groups} \qquad \textbf{Equation 5}$$

CR = cancer risk (unitless), EPC = exposure point concentration (µg/m^3 or ppb), IUR = inhalation unit risk ((µg/m^3 or ppb)$^{-1}$),
ED = exposure duration (years), LY = lifetime years (78 years), ADAF = age-dependent adjustment factor (unitless),
EF (cancer) = exposure factor (cancer) calculated as follows: EF (non-cancer; unitless) x exposure group specific exposure duration (years) ÷ lifetime of 78 years.

Table B1: Exposure assumptions used to estimate non-cancer and cancer risk associated with maximum concentration of the COPCs at the former's childcare centers, Yakima, Yakima County, Washington. We used site-specific exposure parameters, and ATSDR default exposure assumptions.

Exposure Group	Non-cancer Exposure Factor Chronic RME
Birth to < 1 year	0.35
1 to < 2 years	0.29
2 to < 6 years	0.29
Full time worker	0.35
Part time worker	NC

Abbreviations: NC = not calculated; RME = reasonable maximum exposure
Cancer EFs are not shown in the table because they are calculated using age-specific durations.
The general formula is $EF_{cancer} = EF_{noncancer} \times$ Exposure Duration for $Cancer_{Exposure\ Group}$ (years) ÷ 78 years.
These exposure factors do not apply for a few special air contaminants (acetone, ammonia, 2-butanone, chloroform, formaldehyde, hydrogen sulfide, and sulfur dioxide).
See the Air Inhalation Pathway - Exceptions for Exposure Factor Adjustment file on the PHAST resources page for the exposure factors for these contaminants.

Table B2: Site specific exposure parameters used to estimate non-cancer and cancer risk associated with maximum concentration of the COPCs at the former's childcare centers, Yakima, Yakima County, Washington.

Exposure Group	Daily (hours/day) RME	Weekly (days/week) RME	Annually (weeks/year) RME	Age-Specific Exposure Duration (years) RME	Notes
Birth to < 1 year	11.8	5	52.14	1	-
1 to < 2 years	9.9	5	52.14	1	-
2 to < 6 years	9.6	5	52.14	4	-
Full time worker	11.8	5	52.14	20	-
Part time worker	NA	NA	NA	NA	-

Abbreviations: RME = reasonable maximum exposure

Table B3: Estimated increased cancer risk associated with the indoor air COPC at the former's childcare centers, Yakima, Yakima County, Washington

Chemical	Maximum Concentration (ug/m^3)	Unit Risk[a]	Inhalation Slope Factor (mg/kg-day)[b]	Child RME Cancer Risk	Adult RME Cancer Risk
Trichloroethene (TCE)	0.14	1.0E-06 †	0.0035	2.8E-08	5.2E-08
Benzene	0.82	7.8E-06	0.0273	1.5E-07	5.8E-07
Chloroform	1.6	2.3E-05	0.0805	8.4E-07	3.3E-06
1,2-Dichloroethane	0.1	2.6E-05	0.091	6.0E-08	2.3E-07
			Total Cancer Risk	1.8E-06	4.2E-06

[a] air unit risk = risk per $\mu g/m^3$ = slope factor x 1/70 kg x $20m^3$/day x 10^{-3}
[b] inhalation slope factor = unit risk x 70 kg x 1000/$20m^3$ per day
TCE Inhalation unit risks of 2.1E-06 [NHL], 1.0E-06 [liver], 1.0 E-06 [kidney] $(\mu g/m3)^{-1}$
Child ages includes: birth to < 1 year; 1 to < 2 years; 2 to < 6 years
RME – Reasonable Maximum Exposure
* used ethylbenzene unit risk as a surrogate
** mutagenic mode of action

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