Letter Health Consultation

Evaluation of Indoor Air Results for Homes
Located in the Proximity of the Site

CHEM FAB SITE

DOYLESTOWN, BUCKS COUNTY, PENNSYLVANIA

Prepared by
Pennsylvania Department of Health

FEBRUARY 11, 2013

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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pennsylvania
DEPARTMENT OF HEALTH

To: Cindy E. Santiago, On Scene Coordinator, US Environmental Protection Agency (EPA) Region 3

From: Farhad Ahmed, Epidemiologist/Program Director, Health Assessment Program, Division of Environmental Health Epidemiology

Subject: Indoor air vapor intrusion analysis for the Doylestown community living near the Chem Fab Site and follow-up actions and recommendations

During 2010 and 2011 the U.S. Environmental Protection Agency (EPA) performed a vapor intrusion investigation for homes in the proximity of the Chem Fab Superfund Site in Doylestown, Pennsylvania. Vapor intrusion is the movement of gas vapors into indoor air of structures located over a subsurface plume of contamination. The purpose of EPA's investigation was to assess whether site-related volatile organic compounds (VOCs) are migrating from the property and affecting the nearby community.

As part of this investigation, EPA collected indoor and outdoor ambient air samples from homes located near the former Chem Fab facility (Attachment A). In July 2011, EPA requested that the Pennsylvania Department of Health (PADOH) evaluate the 2010 and 2011 data to determine whether VOCs in the indoor air pose a public health threat to residents. The purpose of this letter health consultation (LHC) is to summarize PADOH's evaluation and to provide relevant public health conclusions and recommendations.

PADOH performed this work under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). PADOH and ATSDR are committed to ensuring residents living near the Chem Fab Site have the best information to safeguard their health. More information about PADOH and ATSDR are available online at http://www.portal.health.state.pa.us/portal/server.pt/community/department_of_health_home/17457 and www.atsdr.cdc.gov), respectively.

Background and Statement of Issues

The Chem Fab Site (the Site) is located on North Broad Street in Doylestown. Chem Fab Corporation operated an electroplating and metal processing facility on the Site from 1965 to 1994 and stored waste chemicals on the property. EPA removed 117 drums of chemicals and 8,400 gallons of liquid waste in 1994. The contaminants that EPA has found at the Site include chromium (including the hexavalent form), trichloroethylene (TCE); carbon tetrachloride; cis-1,2-dichloroethene; 1,1-dichloroethene; tetrachloroethene (PCE); 1,1,1-trichloroethane; and vinyl

chloride [EPA, 2012]. Past processes on the Site contaminated the underlying groundwater with metals and VOCs--especially with chromium and TCE [PADEP, 2009]. The contamination in the on-site soil continues to migrate into the surface water and groundwater. In the past, community concerns have focused on contaminated groundwater in private wells. In 1990, EPA connected residences and businesses affected by the groundwater contamination to municipal (public) waterlines. More recently, the Site has affected three nearby municipal (public water) wells [EPA, 2012].

In 2008, PADOH published the *Chem Fab NPL Site Health Consultation* (HC), coauthored by ATSDR that addressed the contaminated groundwater issue. In the HC, PADOH and ATSDR determined that there was a potential for gas vapor intrusion into the indoor air of homes near the Site. PADOH and ATSDR further recommended that EPA characterize the indoor air quality in homes located over the plume [ATSDR, 2008].

Results and Discussion

EPA collected indoor air from homes near the Site; the samples were collected in two rounds (one in summer 2010 and one in winter 2011) [EPA, 2010; ATSDR, 2011]. EPA collected sub-slab (underneath the foundation of homes) air samples, at the same time that they collected indoor air and ambient air samples were collected in summer of 2010 to determine whether any site-related VOC levels were abnormally high. A total of 33 samples were collected in May 2010 from nine homes and one school located near the former Chem Fab facility.

In 2010 EPA requested access permission from 28 homeowners to sample indoor air of homes near the Site; 10 homeowners gave consent. EPA sampled the 10 homes in May 2010. After EPA evaluated the preliminary data, EPA prepared letters, which contained EPA's evaluations and conclusions, for the homeowners. In fall 2010, EPA requested that the PADOH review the 2010 data and the follow-up letters for homeowners. PADOH reviewed the letters, and concurred with EPA's conclusions [EPA, 2010].

Based on the 2010 results, EPA decided that there did not appear to be an immediate threat to residents' health; however, EPA initiated a second round of sampling in winter 2011 as a preventive measure. Because gas vapors move in different ways depending on the temperature and air pressure, EPA performed the 2011 sampling during colder weather than the previous sampling [EPA, 2011a]. In order to sample indoor air of homes, EPA again requested access permission for the 10 homes previously sampled; only six homeowners gave access to EPA. EPA sampled the six homes in February 2011. During winter 2011, EPA requested access permission from an additional 35 homeowners; only one homeowner granted access to EPA. EPA tested the home in April 2011. Altogether, EPA tested the indoor air of seven homes in winter/spring 2011 [EPA, 2011a].

EPA conducted the 2011 round in a similar manner as the 2010 sampling. They first used a handheld instrument that detects VOCs (from about 1 part per billion or ppb to about 2,000 ppb), to perform an initial screen of the indoor air. EPA next collected indoor air and sub-slab VOC samples in the home using special equipment (summa canisters). EPA collected 3 to 5 air samples for approximately 24 hours in each home [EPA, 2010. EPA performed the sampling using a standard EPA method called "Method TO15". Method TO15 is used to test for a specific

list of VOCs (information about this method is available online at http://www.epa.gov/ttnamti1/files/ambient/airtox/to-15r.pdf). EPA expanded the list of VOCs analyzed in the second round of sampling; some VOCs detected in 2011, were not tested for in 2010 [EPA, 2010; EPA, 2011a].

The indoor air results for the homes are listed in Attachment B: Table 1 and Attachment B: Table 2. Results for VOCs detected in the sub-slabs of homes are listed in Attachment B: Table 3. In addition, EPA collected and analyzed seven samples of outdoor (ambient) air. Results for VOCs detected in the outdoor air are also listed in Attachment B: Table 3.

Toxicological Evaluation of VOCs in Indoor Air of Homes

PADOH determined that breathing contaminated indoor air of homes near the Site is a completed exposure pathway. In addition to potential vapor intrusion of site-related VOCs, use of household products and chlorinated drinking water could affect home indoor air quality.

PADOH assumed that: 1) children were the most vulnerable; 2) estimated exposure frequency was 8,400 hours (24 hours per day, 7 days per week, 50 weeks per year) out of the total possible 8,760 hours; and 3) exposures were continuous and could have lasted as long as 30 years (for adults).

As part of PADOH's evaluation, PADOH used ATSDR comparison values (CVs) to screen out VOCs *below* levels of health concern. For the rest of the evaluation, PADOH divided the VOCs in the indoor air into two groups as follows. The first group is VOCs with *levels above the ATSDR comparison values* (CVs); these VOCs are listed in Attachment B: Table 1. VOCS detected, but without an assigned ATSDR CV, comprise the second group; these VOCs are listed in Attachment B: Table 2. PADOH compared the levels using an alternate screening value, as discussed later.

For further evaluation and an initial screening, PADOH used the maximum levels detected in the indoor air. Where maximum levels exceeded CVs or an alternate screening value, PADOH used maximum levels of all indoor air results from the same home for comparison to CVs. PADOH's calculations used to reach their conclusions are shown in Attachment B: Table 4. For VOCs that ATSDR considers to be (known or probable) human carcinogens, PADOH estimated the increased cancer risks based on the previously stated assumptions above.

As noted, PADOH divided the VOCs detected into two groups, for evaluation purposes:

1) *The levels of five VOCs exceeded ATSDR CVs.* The highest concentration of four out of the five VOCs (benzene; 1, 3-butadiene; chloroform; and trichloroethylene) were above the ATSDR CREG but below the non-cancer or noncarcinogenic (health effects other than cancer) ATSDR CVs. Therefore, PADOH did not evaluate any of these four VOCS further for non-cancer health effects. The fifth VOC, *1, 1-dichloroethene, was marginally higher* than its CV (see Attachment B: Table 1). PADOH further discusses this VOC later in this section.

To assess potential additive effects from multiple contaminants, the sum of the HQs for each contaminant represents the hazard index (HI). If the HI is less than 1.0, it is highly unlikely that significant additive or toxic interactions would occur, so no further evaluation is necessary. If the HI is greater than 1.0, then further evaluation is necessary. It is important to note that if a HI exceeds 1 it does not necessarily mean adverse effects will occur. The following equation was utilized to calculate the HI:

Hazard Index (HI)

$$HI = \frac{C_1}{MRL \text{ or } RfC} + \frac{C_2}{MRL \text{ or } RfC} + \frac{C_3}{MRL \text{ or } RfC} + \ldots$$

Where: C= Concentration ($\mu g/m^3$); MRL = Minimum Risk Level ($\mu g/m^3$); and RfC= Reference Concentration ($\mu g/m^3$)

Therefore, for the five VOCs: Benzene, 1,3-Butadiene, Chloroform, 1,1-Dicholoroethene and Trichloroethylene (TCE), respectively, using the highest values for each (All units are in $\mu g/m^3$) :
HI = 8.6 / 10 + 0.7 / 2 + 1.5 / 100 + 87.2 / 200 + 1.24 / 2 = **2.3**

Because the HI >1, PADOH examined target organs for each health guideline. Adding together the HQs for any chemical with the same target organ, the target organ specific His were still <1. For hepatic effects, the HI = 0.41, and for developmental effects, the HI = 0.97. The developmental HI value is close to 1 but this is a very conservative estimate because the maximum concentrations were used.

Chemical	Max Conc	Health guideline	HQ	HQ>0.1?	Target Organ
Benzene	**8.6**	**9.6**	**0.86**	**Yes**	**Immunological**
1,3-Butadiene	**0.7**	**2**	**0.35**	**Yes**	**Developmental**
Chloroform	**1.5**	**98**	**0.01**	**No**	**Hepatic**
1,1-Dichloroethylene	**87.2**	**200**	**0.40**	**Yes**	**Hepatic**
TCE	**1.24**	**2**	**0.62**	**Yes**	**Developmental**
			Sum=2.3 (HI)		

Four out of the five VOC levels were above their ATSDR cancer risk evaluation guide (CREG) (see Attachment B: Table 1). The fifth VOC, 1, 1-dichloroethene, does not have a CREG, is not known to cause cancer, and therefore was not evaluated for cancer risk (EPA: based on 1999 cancer assessment guidelines). PADOH evaluated the four VOCs for increased cancer risk. PADOH classified all four VOCs as *no apparent increased cancer risk* for exposures to the levels detected (Attachment B: Table 1). These VOCs are also commonly found in household

products or in chlorinated drinking water (see Attachment B: Table 5 *Common Sources of Indoor Air Contaminants*).

The additional information used to assess the seven VOCs is as follows:

- EPA detected a maximum of 1,1-dichloroethene level at 87.24 µg/m^3 in the indoor air of one of the homes. ATSDR does not have a chronic CV for this compound, but EPA's chronic RfC is 200 µg/m^3. The value of 87.24 µg/m^3 is well below EPA's chronic value, but above the ATSDR intermediate (exposures for 15 days to 364 days) environmental media evaluation guide (EMEG) of 80 µg/m^3. The estimated dose for a child, consistently breathing this level, is 0.039 mg/kg/day. The estimated dose for an adult is 0.019 mg/kg/day. In the ATSDR toxicological profile for 1,1-dichloroethene, the intermediate no observable adverse effect level (NOAEL) in test animals was 19.3 milligrams per kilogram body weight per day (mg/kg/day) [ATSDR, 1994]. The estimated dose is three orders of magnitude below the NOAEL. In addition, the arithmetic mean (average) of all sample results for the same home was well below the ATSDR CV. Therefore, *the levels found in the homes are within adequate margins of safety*. EPA detected a similar level of 1,1-dichloroethene in the sub-slab of the same home. However, when PADOH applied the EPA attenuation factor (based on an EPA model for gas vapor intrusion), the levels were 10-fold lower. This was the only home where EPA detected 1,1-dichloroethene (a possible site-related VOC) in the sub-slab.

- EPA reviewed studies of VOCs in the indoor air of residences in North America. EPA identified a total of 18 indoor air studies that reported summary statistics, including percentiles, with sampling dates ranging between 1981 and 2005. These studies are considered to provide information on typical background indoor air concentrations because they were conducted in residences that are not expected or known to be located over contaminated soil or groundwater or have effective vapor intrusion mitigation systems in place. [EPA June 2011]

- For the Chem Fab site the benzene levels in the home sub-slabs and outdoor ambient air were similar to typical North American background levels. Since benzene is not a site contaminant, efforts should be made to reduce household sources of benzene, such as from smoking.

- EPA detected a maximum 1,3-butadiene concentration of 0.66 µg/m^3 in residential indoor air.. ATSDR does not have a chronic environmental media evaluation guide (EMEG) for 1,3-butadiene, but the acute (exposures for 14 days or less) EMEG is 200 µg/m^3. The maximum level of *1,3-butadiene detected in the indoor air was about 300 times lower* than the acute EMEG.

- EPA detected a maximum chloroform level of 1.46 µg/m^3 in the indoor air of homes tested. The average level of chloroform in indoor air ranged from 0.16 to 0.42 µg/m^3 in rural areas and from 0.5 µg/m^3 to 16.7 µg/m^3 in urban areas [ATSDR, 1997]. The *chloroform levels in the homes were within typical background* concentrations.

2) *Fourteen VOCs detected in the indoor air do not have ATSDR CVs* (Attachment B: Table 2). None of these VOCs are listed as (known or probable) human carcinogens by EPA. EPA has developed residential indoor air regional screening levels (RSLs) for seven of the fourteen VOCs [EPA, 2011b]. Additional information used in the assessment of the fourteen VOC levels includes:

   - EPA detected the maximum indoor air levels of 4-methyl-2-pentanone; cyclohexane; dichlorodifluoromethane; methyl ethyl ketone; and trichlorofluoromethane *below their respective EPA RSLs*. EPA did find high levels of dichlorodifluoromethane in the sub-slab of one home only in 2010; however, if EPA's attenuation factor is applied, the result for this VOC was 10-fold lower (see Attachment B: Table 2) [EPA, 2010]. EPA detected dichlorodifluoromethane at very low levels in some of the other home sub-slabs. Generally, this VOC is sometimes detected where refrigerants are being or have been in use.

   - For 1,3,5-trimethylbenzene (1,3,5-TMB), EPA does not have a RSL. However, EPA has a RSL of 7.3 µg/m^3 for 1,2,4-trimethylbenzene (1,2,4-TMB), based on the EPA provisional Reference Concentration [EPA, 2011b]. For PADOH's evaluation, the 1,2,4-TMB RSL value was used as a surrogate to screen the 1,3,5-TMB levels. The 1,3,5-TMB levels were *below this surrogate EPA RSL*.

   - EPA detected the maximum indoor air levels of 1,2,4-trichlorobenzene and 1,2,4-TMB slightly above their respective EPA RSLs (see Attachment B: Table 2). However, the arithmetic means (averages) for the results (for both VOCs), in the same home where the maximum levels were detected, were *below the EPA RSLs*. Further, EPA did not detect 1,2,4-trichlorobenzene in any sub-slabs. The 1,2,4-TMB sub-slab levels were similar to the indoor air levels. However, when PADOH applied the EPA attenuation, the levels were 10-fold lower.

   - PADOH used 4,216,000 µg/m^3 as an alternate screening number for the maximum level of 4-ethyltoluene in the indoor air of homes. This is the level at which test animal respiratory rates decreased to 50 percent in a National Institute of Health study [Sweirzc, 2000]. The levels in the indoor air were *1,000,000 (1 million) times lower than this alternate screening number*. Sub-slab levels were also 1,000,000 times lower than this alternate screening number.

Low VOC levels were detected in residential indoor air near the Site. PADOH would not expect the current VOC levels to harm people's health. However, in the event that situations at the Site change over time, further VOC vapor intrusion assessments could be necessary. Outdoor ambient air VOC levels were low. Currently, PADOH did not find any site-related VOCs that are accumulating in the sub-slabs of the homes.

Conclusions and Recommendations

PADOH concludes that contaminants currently detected are not likely to harm people's health. The basis for this conclusion is that the levels of VOCs detected in the indoor air of homes near the Site were not high enough to cause adverse health effects for residents. However, not all homes were tested and further assessments may be indicated if situation changes in the future

EPA should consider re-sampling the home with high sub-slab levels of dichlorodifluoromethane to determine if the detection was an anomaly, although this is not a site-related contaminant.

EPA should consider re-sampling those homes closest to the plume of groundwater contamination if site conditions change.

For homes with elevated benzene, efforts should be made to reduce household sources of benzene, regardless of the source.

Sincerely,

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Attachment A:

Map of the Residential Areas Located Near the Former Chem Fab Facility

Attachment B: Tables

Table 1: Volatile Organic Compounds (Indoor Air) Above Agency for Toxic Substances and Disease Registry Comparison Values

Volatile Organic Compounds	***Range of Result* µg /m^3**	***Round(s) Sampled***	***ATSDR CV (Non-cancer)* µg /m^3***	***ATSDR CV/CV (Cancer)* µg /m^3***	***Estimated Increased Cancer Risk+***	***Cancer Risk Values******
Benzene	ND-8.6	2010/2011	10/chronic EMEG	0.1/CREG	No Apparent	2.87E-05
1,3-Butadiene	ND-0.7	2011	200/acute EMEG	0.03/CREG	No Apparent	9.00E-06
Chloroform	ND-1.5	2010/2011	100/chronic EMEG	0.04/CREG	No Apparent	1.48E-05
1,1-Dichloroethene	ND-87.2	2010/2011	80/intermediate EMEG	N/A	Not known to cause cancer	none
Trichloroethylene (TCE)	ND-1.24	2010/2011	2/Chronic RMEG**	0.24/CREG	No Apparent	2.18E-06

ATSDR CV = The Agency for Toxic Substances and Disease Registry comparison value.
CV Source = Source of ATSDR CV used for the health assessment.
* = Health Guidelines from ATSDR's Sequoia CV Database February 2012
**=Reference Dose Media Evaluation Guide
+ = Based on the estimated number of persons that would be expected to develop increased cancers per 100,000 persons exposed (*No Apparent*) or per 1,000,000 persons (*Insignificant*) chronically exposed to this level of the VOC.
ND = no detection.
EMEG = environmental media evaluation guide.
CREG = cancer risk evaluation guide.
N/A = This VOC is not known to cause cancer and therefore does not have an ATSDR cancer CV.
*** = Using Air Exposure Dose Equation and then Calculating the Cancer Risk for each of the contaminants, using the maximum concentration in column 2 of table above

Source: U.S. Environmental Protection Agency (EPA) Region 3. 2010 and 2011. *Vapor Intrusion Sampling Results* reports for of homes near Chem Fab Site.

Table 2: Volatile Organic Compounds Detected in Indoor Air with no ATSDR CVs

Volatile Organic Compounds	*Rounds Sampled*	*Range of Result* µg/m^3 (ppb)	*EPA RSL* µg/m^3	*Alternative Screening Number from CDC/NIOSH* µg/m^3
Cyclohexane	2011	ND-4.5 (1.3)	6,300	N/A
Dichlorodifluoromethane	2010/2011	ND-19.8 (4.0)	100	N/A
Ethanol	2011	ND-1,788 (949)	None	1,900,000$^+$
4-Ethyltoluene	2011	ND-4.9 (1.0)	None	4,216,000†
Ethyl Acetate	2011	ND-19.5 (5.4)	None	1,400,000$^+$
Freon TF (Freon 113)	2010/2011	ND-2.3 (0.3)	None	7,600,000$^+$
Heptane	2011	ND-8.2 (2.0)	None	350,000$^+$
Isopropanol	2011	ND-86.0 (35.0)	7,300	N/A
Methyl Ethyl Ketone (2-Butanone)	2010/2011	ND-9.1 (3.1)	5,200	N/A
4-Methyl-2-pentanone	2011	ND-4.1 (1.0)	None	205,000$^+$
1,2,4-Trichlorobenzene	2010/2011	ND-5.2 (0.7)**	2.1	40,000$^+$
Trichlorofluoromethane	2010/2011	ND-11.8 (2.1)	73 0	N/A
1,2,4-Trimethylbenzene (1,2,4- TMB)	2010/2011	ND-9.8 (2.0)***	7.3	125,000$^+$
1,3,5-Trimethylbenzene (1,3,5-TMB)	2010/2011	ND-2.5 (0.5)	7.3*****	125,000$^+$

** Average atmospheric levels in the US are typically < 1 ppb by volume. So 0.7 ppbv it not a problem as it is below the background level. Source = Sept 2010 ATSDR Draft Tox Profile.
*** The chronic RfC for 1,2,4-TMB is 20 µg/m^3 and so 9.8 µg/m^3 is not a problem. Source = IRIS Toxicological Review of TMB (Interagency Science Consultation Draft) 2012
EPA RSL = U.S. Environmental Protection Agency (EPA) residential air regional screening levels. November 2011. Online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOV2011.pdf.
ND = no detection.
None = EPA does not have a RSL for the VOC; therefore another screening number was used.
N/A = Not applicable; the EPA RSL was used as the screening number.
* = EPA uses the 1,2,4-TMB RSL as a surrogate screening value for 1,3,5-TMB.
+ = Recommended Exposure Limit (REL) from the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH); this level is based on eight (8) or ten (10) hour lengths of exposures per day, called a time weighted average (TWA).
† = The concentration at which a test animal respiratory rate decreased to 50 percent in an NIH study. The study is online at http://www.ncbi.nlm.nih.gov/pubmed/11276844.
Source: U.S. Environmental Protection Agency (EPA) Region 3. 2010 and 2011. *Vapor Intrusion Sampling Results* reports for of homes near Chem Fab Site.

Table 3: Volatile Organic Compounds in the Outdoor Air and Home Sub-slabs

Volatile Organic Compounds	*Rounds Sampled*	*Range of Sub-slab Results*	*Maximum Sub-slab Results, Attenuated*†	*Range of Outdoor Air Results**
Benzene	2010/2011	ND-3.2 (1.0)	0.32 (0.10)	ND-1.0 (0.3)
Chloroform	2010/2011	ND-97.7 (20)	9.77 (2.0)	ND
Cyclohexane	2011	ND-1.7 (0.5)	0.17 (0.05)	ND
Dichlorodifluoromethane	2010/2011	ND-1,484 (300)	148.4 (30.0)	ND-3.02 (0.61)
1,1-Dichloroethene	2010/2011	ND-91.2 (23)	9.12 (2.3)	ND
Ethanol	2011	ND-96.1 (51)	9.6 (5.1)	ND
4-Ethyltoluene	2011	ND-2.5 (0.5)	0.25 (0.05)	ND
Ethyl Acetate	2011	ND-2.5 (0.7)	0.25 (0.07)	ND
Freon TF	2010/2011	ND-5.4 (0.7)	0.54 (0.07)	ND
Isopropanol	2011	ND-4.7 (1.9)	0.47 (0.19)	ND
Methyl Ethyl Ketone (2-Butanone)	2010/2011	ND-8.6 (2.9)	0.86 (0.29)	ND-3.8 (1.3)
4-Methyl-2-pentanone	2011	ND-4.1 (1.0)	0.41 (0.10)	ND
Trichloroethylene (TCE)	2010/2011	ND-3.28 (0.61)	0.33 (0.06)	ND
Trichlorofluoromethane	2010/2011	ND-30.9 (5.5)	3.09 (0.55)	ND-1.7 (0.3)
1,2,4-Trimethylbenzene	2010/2011	ND-8.4 (1.7)	0.84 (0.17)	ND
1,3,5-Trimethylbenzene	2010/2011	ND-2.80 (0.57)	0.28 (0.06)	ND

Units in the table are micrograms per cubic meter ($\mu g/m^3$); however, numbers in parentheses ( ) are in parts per billion.
ND = no detection.
* = All results fell within typical background ambient levels.
† = U.S. Environmental Protection Agency (EPA) attenuate sub-slab results per their model.

Source: U.S. Environmental Protection Agency (EPA) Region 3. 2010 and 2011. *Vapor Intrusion Sampling Results* reports for of homes near Chem Fab Site.

Table 4: Dose and Increased Cancer Risk Calculations

Dose (mg/kg/day) = $\frac{\text{C (µg/m}^3\text{) x IR (m}^3\text{/day) x EF (units cancel) x CF (mg/µg)}}{\text{BW (kg)}}$				
Variables; (units)	*Inhalation rate (IR); cubic meters per day (m^3/day)*	*Exposure frequency (EF) ([exposures in hours per year]/[total possible hours per year])**	*Conversion factor (CF); micrograms per milligram (mg/µg)*	*Body weight (BW); kilograms (kg)*
Child (1-6)	4.5	(Intermediate/chronic exposures) EF = 8400 hours/8760 hours or 0.96	0.001	10
Adult	15.2			70
Theoretical Increased Cancer Risk = Adj D ($\mu g/m^3$) x IUR ($\mu g/m^3$)$^{-1}$ x [ED (y)/AT (y)]				
Variables; (units)	*Adjusted dose (Adj D); (µg /m^3)*	*Inhalation unit risk (IUR); ($\mu g/m^3$)$^{-1}$*	*Exposure duration (ED; year (y)*	*Averaging time (AT); year (y)*
Adult	Adjusted concentration per EF above*	Chemical-specific	30	70
*= EF is based on exposure time (hours) per year per total possible time (hours) per year.				

Table 5: Common Volatile Organic Compounds (VOCs) Found in Indoor Air of Homes and Some Sources of these VOCs

VOCs	***Some Common VOC Sources***
Benzene	Benzene is found in tobacco smoke, gasoline, and automobile exhaust. Benzene is used to make rubbers, lubricants, dyes, detergents, drugs, pesticides, plastic, resins, and synthetic fibers.
1,3-Butadiene	This VOC is used to make plastics. About seventy-five percent of the manufactured 1,3-butadiene is used to make synthetic rubber including for tires on cars and trucks.
Chloroform	Chloroform is found in chlorinated water and in some consumer products and foods.
Cyclohexane	Cyclohexane is found in petroleum products.
Dichlorodifluoromethane	Dichlorodifluoromethane is used in refrigerators.
1,1-Dichloroethylene	This VOC is used to make water pipes, glues, and flexible plastic films (for food wraps and packaging materials). It is used to make coatings for fibers and plumbing.
Isopropanol	Isopropanol is found in household rubbing alcohol and cleaners, and in adhesives.
Methyl ethyl ketone	Methyl ethyl ketone is used in glues, vanishes, and other household products.
Methylene chloride	Methylene chloride is found in certain pesticides, spray paints, automotive cleaner, paint strippers, photographic film, and other household products.
Tetrachloroethylene (PERC)	This VOC is also called perchloroethylene (PERC) and used in dry cleaning solutions, metal degreasers, water repellents, silicone lubricants, fabric finishers, insecticides, and adhesives.
1,2,4-Trichlorobenzene	This VOC is used to make herbicides and as a solvent.
Trichloroethylene (TCE)	TCE is used in metal degreasers, adhesives, paint removers, correction fluids, and spot removers.
Trichlorofluoromethane	Trichlorofluoromethane is also called Freon 11. It is used in refrigerators.
1,2,4-Trimethylbenzene	This VOC is found in gasoline treatments. It is a diesel exhaust component.
Source: The Agency for Toxic Substances and Disease Registry web pages online at: http://www.atsdr.cdc.gov/; 2) The US Environmental Protection Agency web pages online at: http://www.epa.gov/; and 3) The Centers for Disease Control and Prevention, National Institute of Occupational Health and Safety (NIOSH) Guide to Chemical Hazards online at http://www.cdc.gov/niosh/npg/	