# **Health Consultation**

Review of Indoor Air Data from January 2012 through April of 2012, at the Navy Yard Mills Site

DRACUT, MA

JULY 26, 2012

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

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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#### HEALTH CONSULTATION

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#### DRACUT, MA

Prepared By:

Division of Community Health Investigations Eastern Branch Region I

### Summary and Statement of Issues

This consultation has been prepared in response to a request by the Environmental Protection Agency (EPA), Region I. EPA specifically requested that ATSDR review indoor air data for trichloroethylene (TCE) and tetrachloroethylene (PCE) from January through April of 2012. The data were collected by EPA Region I from the Navy Yards Mill site in Dracut, Massachusetts.

# Background Site Description and History

At the request of the Massachusetts Department of Environmental Protection (MassDEP), the U.S. Environmental Protection Agency (EPA) initiated an investigation in January of 2008 to identify the source of contamination contributing to vapor intrusion within several buildings located at the Site. The investigation included a review of MassDEP-provided data of previous and current actions. In 2008, EPA collected soil, groundwater, sub slab soil vapor and indoor samples. Data from these samples confirmed the presence of high levels of volatile organic compounds (VOCs) in the soil and groundwater at several locations across the Site.

The Navy Yard Mills site is located at 76 through 100 Pleasant Street in Dracut, MA. The site is located in a mix of commercial and residential buildings. No residential buildings currently exist on the site. The site is bordered by a condominium complex to the northwest, Beaver Brook to the northeast, Pleasant Street to the southeast, and School Street to the southwest. Beaver Brook was formerly used to power mill operations.

The site consists of a mill complex of eleven distinct interconnected mill buildings. The buildings are designated as Building Numbers 1 through 20. Most of the property is paved, with Beaver Brook and a wooded area located along the northeastern portion of the site. The buildings have been renovated into commercial spaces, and some are currently occupied by commercial clients. Although there are no aboveground storage tanks (ASTs) or underground storage tanks (USTs) on site, historical information indicates that a UST, having an approximately 800 to 1,000-gallon storage capacity, was used to store gasoline and was located near Building Number 1, along Pleasant Street. Three 5,000-gallon capacity ASTs were used to store wool oil and were located southwest of Building Number 6. One 2,500-gallon capacity tank (unknown whether an AST or UST) was used to store vitriol and was located west of Building Number 8.

The Site was originally used as a cotton mill and subsequently as a woolen mill. Information regarding potential contamination resulting from mill operations is limited to the former presence of fuel oils, gasoline, sulfuric acid, and unspecified dyes. During the 1960s, mill operations ceased and, beginning in 1971, portions of the Site were rented out to commercial clients. From about 1980 (possibly earlier) to 2000, United Circuits, Inc. manufactured printed circuit boards and occupied portions of Building Numbers 1, 2, 3, and 19. According to EPA records, United Circuits, Inc. was listed as a Large Quantity Generator of hazardous waste, which included the following: various acids and bases; hydrogen peroxide; VOCs including tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, acetone, and isopropyl alcohol. They also handled several different streams of wastewater treatment, plating bath solutions and residues from electroplating operations. The basements of Building Number 1, and later the ground floor of Building Number 2, were used for storage of virgin chemicals and waste materials. In addition, an industrial wastewater treatment plant was located in the basement of Building Number 1. United Circuits, Inc. was involuntarily dissolved in 2007.

Buildings 1, 3, 3A, 4, 19, and 20 are occupied by businesses. Figure 1 depicts the building layout on the property. Buildings 3 and 3A house a self-storage facility which only has intermittent visitors. Building 20 is used for auto storage and does not have a consistent employee presence. The eastern side of Building 19 houses a baseball batting and practice (indoor) area and the western side of Building 19 contains a separate business, a wood working business. The baseball practice area utilizes two rooms which are used for batting practice. The two rooms are connected, with a large, metal sliding door dividing the two rooms. These rooms are referred to as the main room, which is the larger, primary practice area, and the second room, which is used for practice and also as a weight and exercise room. Buildings 1 and 4 share a common basement (referred to as the *basement of Building 1*). It is our understanding the occupants of Buildings 1 and 4 do not access the basement.



Figure 1 Map of Navy Yard Mills Site in Dracut, Massachusetts

# **Demographics**

No one currently lives on the contaminated property. There are two employees that work in Building 1 and four to six people that work in Building 4 for approximately a 40 hour work week. Building 19 has two separate tenants: Vintage Millworks employees approximately six to ten people, and Future Stars (Baseball practice area) has one fulltime employee, but can host up to 25 children daily from ages 5 years old to adulthood and their parents for up to two hours a day on the weekdays and an additional four hours on the weekends.

# **Environmental Sampling**

Soil vapor samples taken by the EPA during January of 2011 detected PCE and TCE in the subslab (areas below the foundation of Building 1) at concentrations up to 71,000  $\mu$ g/m<sup>3</sup> and 39,000  $\mu$ g/m<sup>3</sup> respectively. Indoor air sampling in the occupied Buildings was collected during January through April of 2012. The maximum concentrations of PCE and TCE collected from the subslab of the basement of Building 1, (which was collected in January of 2011), are presented in Table 1. These data were included to indicate the potential for infiltration from the basement and subslab into the interior of the buildings. The samples collected from the subslab of the basement of Building 1 were collected when carbon air cleaning units (Austin Healthmate HM400, serial number 20666393) and soil vapor extraction systems were off (representing a likely worst case scenario).

Table 1. Maximum contaminant concentration collected from the Navy Yard Millsite, Dracut, MA, on January 19, 2011, as a 24-hour summa sample from thesubslab of the unoccupied basement of Building 1 (left of entrance).

	Maximum subslab Concentration (µg/m <sup>3</sup> )		
Chemical	carbon units and SVE system turned on	carbon units and SVE system turned off	
Tetrachloroethylene (PCE)	Not sampled	71,000	
Trichloroethylene (TCE)	Not sampled	39,000	

The indoor air samples from the interior of Buildings 1, 4, and 19 were collected with carbon air filtration units both on and off. These samples were obtained from the occupied spaces within each Building (i.e., not the basement). The collection of samples when the units were off was included to represent a likely worst case scenario (although most of these units were off during a site visits on February 16, 2012, and April 25, 2012, this probably represents a more common scenario). The results of the air samples for PCE and TCE are presented in Tables 2 through 7. The air was collected for analysis in one of two ways; either using 8-hour sample canister or instantaneous grab sample. The 8-hour canister analysis is more likely to reflect actual exposures. If the buildings were

characterized using multiple 8-hour summa canisters, we used the 8-hour summa canister results. If there was only one 8-hour summa canister measurement and several grab samples, we used the maximum of either to evaluate exposures.

Table 2. Contaminant concentration ranges collected from the Navy Yard Mill site,Dracut, MA, during February and April of 2012 from the indoor air of Building 1first (ground) floor office (8-hour summa canister samples).

	Concentration Range(µg/m <sup>3</sup> )		Comparison Value	
Chemical	Carbon units turned off turned on		Concentration (µg/m <sup>3</sup> )	Source
Tetrachloroethylene	96-110	68 (one	40	RfC
(PCE)		sample)		
Trichloroethylene	54-61	43 (one	2	RfC
(TCE)		sample)		

Table 3. Contaminant concentration ranges collected from the Navy Yard Mill site,Dracut, MA, during February and March of 2012 from the indoor gap in theflooring between Buildings 1 and 4 from the first floor area (four indoor grabsamples).

	Concentration	Range (µg/m <sup>3</sup> )	Comparis	on Value
Chemical*	Carbon units turned off	Carbon units turned on	Concentration $(\mu g/m^3)$	Source
Tetrachloroethylene (PCE)	244-624	128.9-540	40	RfC
Trichloroethylene (TCE)	102.1-279	59.1-320	2	RfC

\* Note: it is our understanding that no one is breathing in the air from the gap between Buildings 1 and 4.

Table 4. Contaminant concentration ranges collected from the Navy Yard Mill site, Dracut, MA, during February through April of 2012 from <u>Building 4</u> indoor air on the first floor(8-hour summa canister samples).

	Concentration Range (µg/m <sup>3</sup> )		Comparison Value	
Chemical	Carbon units Carbon units turned off turned on		Concentration (µg/m <sup>3</sup> )	Source
Tetrachloroethylene	96-250	87 (one	40	RfC
(PCE)		sample)		
Trichloroethylene	54-160	49 (one	2	RfC
(TCE)		sample)		

Table 5. Contaminant concentration ranges collected from the Navy Yard Mill site,Dracut, MA, during February through April of 2012 from the main room ofBuilding 19 (baseball practice area) indoor air (8-hour summa canister samples).

	Concentration Range (µg/m <sup>3</sup> )		Comparison Value	
Chemical	Carbon units	Carbon units	Concentration	Source
	turned off	turned on	$(\mu g/m^3)$	
Tetrachloroethylene	23-24	7 (one sample)	40	RfC
(PCE)				
Trichloroethylene	15 (all samples	20 (one	2	RfC
(TCE)	had the same	sample)		
	results, and			
	were collected			
	during April of			
	2012)			

Table 6. Contaminant concentration ranges collected from the Navy Yard Mill site, Dracut, MA, during January of 2011, February through April of 2012 from the <u>second room of Building 19</u> (baseball practice area) indoor air (three grab and one 8-hour summa canister samples).

	Concentration Range (µg/m <sup>3</sup> )		Comparison Value	
Chemical	Carbon units	Carbon units	Concentration	Source
	turned off	turned on	$(\mu g/m^3)$	
Tetrachloroethylene (PCE)*	61-81 (grab samples)	42-67 (all grab samples)	40	RfC
	38 (8-hour summa)			
Trichloroethylene (TCE)*	31-38 (grab samples) 22 (8-hour	32-47 (all grab samples)	2	RfC

\* Note: since this area was not fully characterized (three grab samples and one 8-hour summa canister), the maximum concentrations used for PCE and TCE were from the grab samples.

Table 7. Contaminant concentration ranges collected from the Navy Yard Mill site,Dracut, MA, during February through April of 2012 from the millworks section ofBuilding 19 indoor air (three grab and one 8-hour summa canister samples).

	Concentration Range (µg/m <sup>3</sup> )		<b>Comparison Value</b>	
Chemical	Carbon units	Carbon units	Concentration	Source
	turned off	turned on	$(\mu g/m^3)$	
Tetrachloroethylene (PCE)*	ND-21 (grab samples)	12 (one grab sample)	40	RfC
	4.3 (8-hour summa)			
Trichloroethylene (TCE)*	1.6-6 (grab samples)	12 (one grab sample)	2	RfC
	2 (8-hour summa)			

\* Note: since this area was not fully characterized (three grab samples and one 8-hour summa canister), the maximum concentrations used for PCE and TCE were from the grab samples.

# **Exposure Assumptions:**

EPA has asked ATSDR to review data from January through April 2012 and evaluate potential health implications related to exposures that may have occurred specifically during this period. This site consists of several buildings; three of which are currently occupied and have elevated levels of PCE and TCE in the indoor air. In order to evaluate the possible risks to individuals (e.g., pregnant women, children, adults) who may currently occupy some of the buildings at this site, we evaluated available indoor air sampling data for each building. Each building's evaluation includes the risk of non-cancer effects.

### Children, adolescents, and adults practicing baseball in Building 19:

One section of Building 19 contains a baseball practice center where children, adolescents and adults, attend regular (year-round) batting and related skills training. It is our understanding that children, adolescents, and adults attend for several hours per week. The youngest children who use the facility are 5 years old. Although we were unable to determine how many hours each age group spends in the practice area, we conducted a detailed assessment for each age group (from 5 year olds through adults). The exposures were assumed to have been occurring since January of 2012.

# Workers in Buildings 1, 4, and 19:

The exposure duration for office workers (Buildings 1, 4, and the millworks section of Building 19) is expected to be 10 hours per day and 5 days per week. The exposure

duration for workers in the baseball area in Building 19 is expected to be 10 hours per day 6 days per week (part-time baseball practice area workers typically work 6 hours per week). The exposures were assumed to have been occurring since January of 2012.

# **Public Health Implications:**

In order to evaluate the health implications of exposure to PCE and TCE, we reviewed the current scientific literature for these compounds. Recently, the EPA finalized a comprehensive review and derived a concentration that represents a daily exposure considered safe for the long term. This value is known as the "reference concentration" and is developed from scientific studies where an observed effect level was identified. A safety factor is then applied to take into account inter-individual variability in response and other uncertainties. The reference concentration (RfC) for PCE is  $40 \,\mu g/m^3$ . The RfC for TCE is  $2 \,\mu g/m^3$ . The RfC for PCE was finalized in February of 2012, and the RfC for TCE was finalized in September of 2011.

The EPA recommends that health risk assessors not use the Occupational Safety and Health Administration (OSHA) workplace standards to evaluate the health risk from vapor intrusion where the vapor intrusion has been identified in commercial/industrial settings and where the chemicals of concern for the vapor intrusion pathway are not used in the work place [EPA 2012c].

The maximum indoor air concentrations detected when the carbon air units were off were used to evaluate the risk of non-cancer. The selection of this value was based, in part, by observations made during two site visits (when most of the carbon air units were switched off), and as previously indicated, may represent a common scenario.

# Non-cancer PCE

The inhalation reference concentration (RfC) for PCE is 40  $\mu$ g/m<sup>3</sup> (EPA, 2012b). The hazard quotient (HQ) for each building and scenario were calculated and presented in Table 8. The HQ is the measured concentration divided by the RfC. Any HQ value less than 1 indicates that the air concentration is below the inhalation guideline and thus non-cancer effects are unlikely. When the HQ exceeds 1, that indicates that the RfC was exceeded and further detailed analysis is needed to better characterize the risks.

### **Building 1**

Because the HQ did not exceed one for Building 1 no further evaluation was necessary for non-cancerous effects in workers. Workers are not at risk of non-cancer effects from PCE in indoor air.

# **Building 4**

Because the HQ exceeded one for Building 4 we conducted a more detailed analysis of the non-cancer risk estimations for workers in Building 4. Workers in Building 4 are not at risk of non-cancer effects from PCE in indoor air.

# **Building 19**

Because the HQ for workers did not exceed one for the <u>main</u> room in Building 19 (baseball practice area), workers (and adults who watch family and friends practice sports) in that room are not at risk of harmful effects due to PCE exposure. The HQ exceeded one for workers in the <u>second</u> room (baseball practice area-exercise room). It is our understanding that workers in the baseball practice areas actively participate in the exercises (pitching, etc) and thus have higher breathing rates. The detailed analysis indicated that these workers, who spend <u>more than 30 hours per week</u> for many weeks, are at risk of changes in color vision from exposure to PCE.

Because children and adults exercise in the baseball practice areas of Building 19 and thus have higher breathing rates we conducted a more detailed analysis of the non-cancer risk estimations for children and adults. Children and adults who exercise in the <u>main</u> room or visit either room of the baseball practice area are not at risk of health effects associated with PCE exposure. However, children and adolescents who regularly workout in the <u>second</u> room (<u>more than six hours per week</u> for several weeks to several months) are at risk of changes in color vision from exposure to PCE.

Occupational investigations that examined workers exposed to PCE indicate that one of the principle targets of PCE exposure include harmful effects to the visual system resulting, specifically in an inability to distinguish colors in the blue-yellow range. Additional occupational information indicates dizziness and changes in memory may be a target of PCE exposure [EPA 2012a]. A summary of the non-carcinogenic risks for PCE in each occupied building is presented in Table 8.

Building	Maximum PCE µg/m <sup>3</sup>	Non-cancer Risk (HQ)
1*	110	0.8
4*	250	1.9
19 baseball main room-children	24	0.6
19 baseball second room-children	81	2.0
19 baseball-main room-workers	24	0.6
19 baseball second room-workers	81	2.0
19 millworks section*	21	0.2

 Table 8. Non-carcinogenic risks for PCE exposure detected at maximum

 concentration without air carbon units from the Navy Yard Mill site, Dracut, MA.

\* Note: the HQ was adjusted for 10 hours per day and 5 days per week.

#### **Cancer Risk Estimation:**

The Department of Health and Human Services, National Toxicology Program classifies PCE as reasonably anticipated to be a human carcinogen, and the International Agency for Research on Cancer (IARC) has determined that PCE is a probable human

carcinogen. These determinations are based on limited human epidemiological studies suggesting elevated risks for esophageal cancer, non-Hodgkin's lymphoma, and cervical cancer and sufficient animal studies showing that PCE induced leukemia in rats and liver cancers in mice [NTP 2011, IARC 1995]. The Environmental Protection Agency considers PCE a likely human carcinogen based on epidemiological evidence showing associations between PCE and bladder cancer, non-Hodgkin's lymphoma, and multiple myeloma [EPA 2011a].

# Cancer risk calculations related to PCE exposures will be conducted in the second Health Consultation that will review all available data.

# **Brief Description of Chemical:**

PCE is a synthetic compound used as a metal degreaser and fabric dry cleaner. PCE is nonflammable liquid with a sweet odor. There are no natural sources of PCE.

### **Non-cancer TCE**

The inhalation reference concentration (RfC) for TCE is  $2 \mu g/m^3$  (EPA, 2012a). That concentration is used to determine the Hazard Quotient (HQ). The HQ for TCE exceeded 1 in each building, indicating that the maximum air concentration in Buildings 1, 4, and 19 exceeded the RfC guideline. Since the HQ was exceeded we conducted a detailed analysis of the exposures for occupants of Buildings 1, 4, and 19.

Inhalation and ingestion studies in animals indicate that the principle targets of TCE exposure include harmful effects to the immune system resulting from damage to the thymus gland. Additional studies in animals indicated that TCE exposure in pregnant mice resulted in developmental problems in their offspring [ATSDR 1997, EPA 2012b]. A recently released epidemiologic study concluded that maternal residence in areas of soil vapor intrusion of TCE or PCE into indoor air was associated with fetal cardiac defects [Forand et. al., 2011]. Although the study did not evaluate a dose-response relationship, it does confirm that cardiac effects are the appropriate toxicological endpoint in humans and supports the use of the animal studies for the RfD/RfC. It also validates the route extrapolation from oral to inhalation in the RfC derivation.

# **Buildings 1 and 4**

### Women who are pregnant and work in Buildings 1 and 4:

A detailed analysis examining the impacts that TCE exposure may have on pregnant women who work in either Building 1 or 4 was conducted. The results indicates that these women (who work 10 hours per day, five days per week for several weeks to several months) may be at risk of developing health effects associated with TCE exposures such as damage to the immune system and having a child with heart problems.

### Adults who work in any section of Buildings 1 or 4

The detailed analysis examining adults who work in Buildings 1 or 4 indicate that the levels of TCE represent a level of concern to these adults. Adult workers (who work 10 hours per day, five days per week for several weeks to several months) may be at an increased risk of health effects associated with TCE exposures such as developing autoimmune effects (decreased thymus weight).

# **Building 19 (Baseball practice area: main and second rooms)**

# Children, adolescents, and adults using the <u>main</u> room of Building 19 (baseball practice center):

We conducted a detailed analysis for children, adolescents, and adults who use the <u>main</u> room where baseball practice occurs in Building 19. We examined the combined impacts of increased breathing rates while exercising and number of hours exposed. The results of the analysis indicates children and adolescents who play or practice baseball in the <u>main</u> room of Building 19 for <u>eight or more hours per week</u> for several weeks to several months are exposed to levels of TCE that represent a level of concern. Children and adolescents may be at an increased risk of damage to the immune system from reduced thymus weight and could put them at risk of autoimmune diseases.

# Children, adolescents, and adults using the <u>second</u> room of Building 19 (baseball practice center):

We conducted a detailed analysis for children, adolescents, and adults who use the <u>second</u> room where baseball practice (including weight-lifting and exercise bikes) occurs in Building 19. We examined the combined impacts of increased breathing rates while exercising and number of hours exposed. The results of the analysis indicates children and adolescents who play or practice baseball in the <u>second</u> room in Building 19 for <u>six</u> or more hours per week for several weeks to several months are exposed to levels of TCE that represent a level of concern. Children and adolescents may be at an increased risk of damage to the immune system from reduced thymus weight and could put them at risk of autoimmune diseases. Adults who play or practice baseball in the <u>second</u> room in Building 19 for <u>eight or more hours per week</u> for several weeks to several weeks to several months are exposed to levels of TCE that represent a level of concern. Adults may be at an increased risk of damage to the immune system from reduced thymus weight and could put them at risk of autoimmune diseases.

# Adult men and non-pregnant women who visit the <u>main</u> room of Building 19 (baseball practice center):

Adult men and non-pregnant women are <u>not</u> at risk if they <u>watch</u> family and friends practice sports in the <u>main</u> room at the baseball practice center.

# Women who are pregnant and visit the <u>main</u> room of Building 19 (baseball practice center):

Women who are pregnant and <u>visit</u> the <u>main</u> room of building 19 baseball practice area (for more than 35 hours per week for several weeks to several months) to <u>watch</u> family and friends practice sports may be at risk of developing health effects associated with TCE exposures such as having a child with heart problems.

# Adult men and non-pregnant women who visit the <u>second</u> room of Building 19 (baseball practice center):

Adult men and non-pregnant women who <u>watch</u> family and friends practice sports in the <u>second</u> room at the baseball practice center for <u>more than 35 hours per week</u> for several weeks to several months may be at an increased risk of damage to the immune system from reduced thymus weight and could put them at risk of autoimmune diseases.

# Women who are pregnant who exercise in the <u>main</u> room of Building 19 (baseball practice center):

Women who are pregnant and <u>exercise</u> in the <u>main</u> room of the baseball practice area (<u>for</u> <u>more than eight hours per week</u> for several weeks to several months) of Building 19 may be at risk of developing health effects associated with TCE exposures such as having a child with heart problems.

# Women who are pregnant and visit or exercise in the <u>second</u> room of Building 19 (baseball practice center):

Women who are pregnant, who <u>visit</u> the <u>second</u> room of the baseball practice area <u>for</u> <u>more than 10 hours a week</u> for several weeks to several months to watch family and friends practice sports or exercise in the <u>second</u> room of the baseball practice area (<u>for</u> <u>more than four hours per week</u> for several weeks to several months) of Building 19 may be at risk of developing health effects associated with TCE exposures such as having a child with heart problems.

# Adult workers in <u>any</u> room of Building 19 (baseball practice center):

It is our understanding that workers at the baseball practice areas actively participate in the exercises (pitching, etc). The detailed analysis indicate that the levels of TCE represent a level of concern for full-time adults (who work more than 20 hours per week

for several weeks to several months) who may be at an increased risk of damage to the immune system from reduced thymus weight and could put them at risk of autoimmune diseases. Women who are pregnant are at risk of having a child with heart problems. ATSDR was informed that part-time workers may <u>work up to six hours a week</u>. If so, they are not at risk of harmful effects from TCE.

A summary of the non-carcinogenic risks for TCE in each occupied building is presented in Table 9.

Table 9. Non-carcinogenic risks for TCE exposure detected at maximum concentration without air carbon treatment units from the Navy Yard Mill site, Dracut, MA.

	Maximum	
	TCE	Non-cancer
Building	$\mu g/m^3$	Risk (HQ)
1*	61	9
4*	160	24
19 baseball-main room-children	15	7.5
19 baseball second room-children	38	19
19 baseball-main room-workers	15	7.5
19 baseball second room-workers	38	19
19 millworks center*	6	0.9

\* Note: the HQ was adjusted for 10 hours per day and 5 days per week.

EPA identified two animal studies as the basis of the Reference Concentration (RfC) for noncancerous effects [EPA 2011b]. In these studies, where animals were exposed to TCE orally via drinking water, the most sensitive adverse effects involved the immune system and the developing fetus [Johnson et al. 2003, Keil et al. 2009]. EPA used physiologically based pharmacokinetic (PBPK) modeling to convert the oral dose in animals to a human equivalent concentration (HEC) of TCE in air [EPA 2011c]. In addition, for one rat study, EPA used the lower confidence limit of the benchmark dose response (BMDL<sub>01</sub>) to model (i.e., estimate) the air concentration that would yield a one percent response rate for fetal cardiac malformations. The result of these transformations is an HEC<sub>99</sub>, BMDL<sub>01</sub> of 21  $\mu$ g/m<sup>3</sup>. The HEC<sub>99</sub> is the human exposure concentration for which there is a 99% likelihood that a randomly selected individual will have an internal dose less than or equal to, in this case, the BMDL<sub>01</sub>. To summarize, EPA predicts that there is a small risk of fetal heart malformations for pregnant women exposed to TCE at 21  $\mu$ g/m<sup>3</sup>. EPA used an uncertainty factor of 10 to obtain the RfC of 2  $\mu$ g/m<sup>3</sup>.

EPA also used a 30-week mouse study and identified decreased thymus weight as a lowest observed adverse effect level (LOAEL). PBPK modeling was used to derive 190  $\mu$ g/m<sup>3</sup> as the HEC<sub>99</sub>, LOAEL. This concentration was divided by an uncertainty factor of 100 to derive the RfC.

At levels of 38  $\mu$ g/m<sup>3</sup> (second room in Building 19), 61  $\mu$ g/m<sup>3</sup> (Building 1), and 160  $\mu$ g/m<sup>3</sup> (Building 4), the concentrations are significantly greater than 21  $\mu$ g/m<sup>3</sup>, the modeled concentration where EPA estimates a 1% response for fetal cardiac malformations in rats. Although RfCs are generally used to evaluate chronic exposures, the fact that the critical effect for TCE is a developmental endpoint that is the result of exposure during pregnancy, it is appropriate to apply the RfC value to the evaluation of even short term exposures. In addition, the maximum detected TCE concentrations in indoor air samples approach  $(38 \mu g/m^3, 61 \mu g/m^3, 160 \mu g/m^3)$  the modeled concentration of 190  $\mu$ g/m<sup>3</sup> where EPA estimates affects to the immune system, specifically a decrease in thymus weight and an increase in markers associated with autoimmune disease. There is uncertainty in drawing conclusions about the potential health impacts from exposure of workers and non-workers (children, women, visitors) to these levels of TCE in the worker environment. One of the uncertainties is that since no suitable inhalation studies are available, the RfC is based on animal studies where exposure occurred through drinking water. PBPK modeling was used to convert an oral dose (in mg/kg/day) in animals to a human equivalent concentration in air (in  $\mu g/m^3$ ), and bench mark dose modeling was used to estimate the air concentration that equates to a 1% response rate for the fetal cardiac effects. The exposure level associated with a 1% response rate is a model prediction and is below the level that has been evaluated in any experimental study or exposed human population.

In spite of these uncertainties ATSDR concludes that exposure to the highest concentrations of TCE is a health concern for workers, particularly pregnant women, who work at the offices at Buildings 1, 4 and 19 at the former Navy Yard Mills site. These workers could be at risk of harmful effects involving the immune system (specifically, decreased thymus weight and increased markers for autoimmune disease), and pregnant women could be at risk for damage to the developing fetus. Actions should be taken to significantly reduce or eliminate indoor TCE levels.

### **Cancer Risk Estimation:**

The Department of Health and Human Services, National Toxicology Program classifies TCE as reasonably anticipated to be a human carcinogen. In humans, occupational exposure to TCE was associated with excess incidences of several cancers, particularly liver cancer, non-Hodgkin's lymphoma, and kidney cancer [NTP 2011]. Animal studies showed that TCE exposure caused tumors in mice and rats at several different sites, including liver and kidney, by inhalation or oral exposure [NTP 2011]. The International Agency for Research on Cancer (IARC) has determined that TCE is a probable human carcinogen based on epidemiological studies showing increased rates of liver cancer and non-Hodgkin's lymphoma, primarily in workers who were exposed to TCE on the job, and animal studies showing increased numbers of liver and kidney tumors upon oral administration [IARC 1995]. EPA characterizes TCE as carcinogenic to humans by all routes of exposure [EPA 2011]. This conclusion is based on human epidemiology studies showing associations between human exposure to TCE and kidney cancer, non-Hodgkin's lymphoma, and liver cancer.

Cancer risk calculations related to TCE exposures will be conducted in the second Health Consultation that will review all available data.

# **Brief Description of Chemical:**

TCE is a non-flammable liquid that has a sweet odor. This man-made compound is not detected naturally in the environment. TCE is used as a metal degreaser, paint thinner, spot remover and in the manufacture of adhesives.

# Conclusions

As requested by the EPA On-scene Coordinator (OSC), ATSDR focused on evaluating the health implications of exposure to PCE and TCE in the indoor air at three currently occupied buildings located on the site known as the former Navy Yard Mill Property. This review was conducted on a limited dataset (January through April of 2012). The review of the current data indicates that the maximum indoor air levels of PCE and TCE (as measured during the period from January through April of 2012) in *the occupied sections of Buildings 1, 4, and 19 (baseball practice areas) represent a public health hazard under certain scenarios*. Listed below are four tables (10, 11, 12a, and 12b), which describe the health concerns for each building.

Location	Who	Amount of time in	Health Concern
		this location	
Building 1	Workers	10 hours per day, 5	May be at risk for
		days per week for	developing
		several weeks to	autoimmune effects
		several months.	(decreased thymus
			weight) due to TCE
			exposure.
Building 1	Women workers	10 hours per day, 5	May be at risk of
	who are pregnant	days per week for	having a child with
		several weeks to	heart problems due
		several months.	to TCE exposure,
			and may be at risk
			for developing
			autoimmune effects
			(decreased thymus
			weight) due to TCE
			exposure.

Table 10. Table of health concerns for exposed individuals in Building 1 Navy YardMills Site, Dracut, Massachusetts.

Location	Who	Amount of time in	Health Concern
		this location	
Building 4	Workers	10 hours per day, 5	May be at risk for
		days per week for	developing
		several weeks to	autoimmune effects
		several months.	(decreased thymus
			weight) due to TCE
			exposure.
Building 4	Women workers	10 hours per day, 5	May be at risk of
	who are pregnant	days per week for	having a child with
		several weeks to	heart problems (due
		several months.	to TCE exposure),
			and may be at risk
			for developing
			autoimmune effects
			(decreased thymus
			weight) due to TCE
			exposure.

 Table 11. Table of health concerns for exposed individuals in Building 4 Navy Yard

 Mills Site, Dracut, Massachusetts.

Location	Who	Amount of time in this location	Health Concern
Building 19 Baseball practice area - <u>Main Room</u> - Batting cage area	Exercising children and adolescents	More than 8 hours per week for several weeks to several months.	May be at risk for autoimmune effects (decreased thymus weight) due to TCE exposure
Building 19 Baseball practice area - <u>Main Room</u> - Batting cage area and waiting area	Women who are pregnant	More than 8 hours per week who exercise for several weeks to several months.	May be at risk of having a child with heart problems due to TCE exposure. No risk for pregnant women who watch family and friends practice sports for less than 35 hours per week
Building 19 Baseball practice area - <u>Main Room</u> Batting cage area	Non exercising adult men and non-pregnant women who watch family and friends practice sports	Any length of time	No risk while watching family and friends practice sports
Building 19 (baseball practice areas <u>both rooms</u> ) full-time workers	Adult workers	More than 20 hours per week for several weeks to several months.	May be at risk for autoimmune effects (decreased thymus weight), and, if pregnant, at risk of having a child with heart problems due to TCE exposure. These workers (more than 30 hours per week in the <u>second room</u> ) may also be at risk for neurologic effects (altered color vision) due to PCE exposure.

 Table 12a. Table of health concerns for exposed individuals in Building 19 (Main

 Room in baseball practice area) Navy Yard Mills Site, Dracut, Massachusetts.

I				
	Location	Who	Amount of time in	Health Concern
			this location	
	Building 19 Baseball practice area - <u>Second Room</u> (exercise bikes and weights)	Exercising children, adolescents and adults	More than 6 hours (children) or 8 hours (adults) per week for several weeks to several months.	May be at risk for autoimmune effects (decreased thymus weight) due to TCE exposure, and non- adults may be at risk of neurologic effects (altered color vision) due to PCE exposure.
	Building 19 Baseball practice area - <u>Second Room</u> (exercise bikes and weights)	Women who are pregnant	More than 4 hours per week who exercise for several weeks to several months or 10 hours a week for several weeks to several months who watch family/friends practice sports.	May be at risk of having a child with heart problems due to TCE exposure.
	Building 19 Baseball practice area - <u>Second Room</u> (exercise bikes and weights)	Non exercising adult men and non-pregnant women who watch family and friends practice sports	More than 35 hours per week for several weeks to several months.	May be at risk for autoimmune effects (decreased thymus weight) due to TCE exposure.
	Building 19 (baseball practice areas <u>both rooms</u> ) full-time workers	Adult workers	More than 20 hours per week for several weeks to several months.	May be at risk for autoimmune effects (decreased thymus weight), and, if pregnant, at risk of having a child with heart problems due to TCE exposure. These workers (more than 30 hours per week in the <u>second room</u> ) may also be at risk for neurologic effects (altered color vision) due to PCE exposure.

 Table 12b. Table of health concerns for exposed individuals in Building 19 (Second

 Room in baseball practice area) Navy Yard Mills Site, Dracut, Massachusetts.

### Recommendations

- 1. Take immediate steps to stop or reduce exposure to PCE and TCE in indoor air in Buildings 1, 4 and Building 19 (baseball practice areas) at the former Navy Yard Mill site.
- 2. ATSDR will review the data provided by EPA and MA DEP from 2007 through the present.
- 3. ATSDR will review the data provided in recommendation number 2 and conduct a comprehensive health consultation to better characterize the possible health implications of exposures to PCE and TCE at the occupied buildings on this site.
- 4. ATSDR will review any additional data and remediation design plans when available.
- 5. ATSDR will work with MA DPH to educate the occupants of the impacted buildings regarding indoor air exposures.

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# **Appendix A. ATSDR Glossary of Environmental Health Terms**

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

#### Absorption

The process of taking in. For a person or an 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].

#### Additive effect

A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

#### Adverse health effect

A change in body function or cell structure that might lead to disease or health problems

#### Ambient

Surrounding (for example, ambient air).

#### Analyte

A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

#### Analytic epidemiologic study

A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

#### **Background level**

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

#### **Cancer risk**

A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

#### Carcinogen

A substance that causes cancer.

#### **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.

#### Completed exposure pathway [see exposure pathway].

#### 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.

#### **Descriptive epidemiology**

The study of the amount and distribution of a disease in a specified population by person, place, and time.

#### **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**

Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

#### EPA

United States Environmental Protection Agency.

#### Epidemiology

The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

#### 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].

#### **Exposure assessment**

The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

#### **Exposure pathway**

The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

#### Groundwater

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

#### Hazard

A source of potential harm from past, current, or future exposures.

#### Health consultation

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

#### **Health education**

Programs designed with a community to help it know about health risks and how to reduce these risks.

#### Inhalation

The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

#### Intermediate duration exposure

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic 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.

#### mg/m<sup>3</sup>

Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

#### Migration

Moving from one location to another.

#### 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 reference dose].

#### Mutagen

A substance that causes mutations (genetic damage).

#### Mutation

A change (damage) to the DNA, genes, or chromosomes of living organisms.

#### National Toxicology Program (NTP)

Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

#### No-observed-adverse-effect level (NOAEL)

The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

#### Physiologically based pharmacokinetic model (PBPK model)

A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

#### Plume

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

#### Point of exposure

The place where someone can come into contact with a substance present in the environment [see exposure pathway].

#### Population

A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

**ppb** Parts per billion.

**ppm** Parts per million.

#### Public health hazard

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

#### Public health hazard categories

Public health hazard categories are statements about whether people could be harmed by

conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

#### **Receptor population**

People who could come into contact with hazardous substances [see exposure pathway].

**Reference Concentration (RfC):** An estimate of a continuous inhalation exposure for a given duration to a group of people, that is not expected to cause adverse health effects over a lifetime.

#### **Reference dose (RfD)**

An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

**RfD** [see reference dose]

#### Risk

The probability that something will cause injury or harm.

#### **Risk reduction**

Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

#### **Risk communication**

The exchange of information to increase understanding of health risks.

#### **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].

#### 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.

**Soil gas or Soil Vapor:** is air existing in void spaces in the soil between the groundwater and the ground surface. These gases may include vapor of hazardous chemicals as well as air and water vapor.

#### Solvent

A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

#### Source of contamination

The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

#### **Special populations**

People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

#### Stakeholder

A person, group, or community who has an interest in activities at a hazardous waste site.

#### Substance

A chemical.

#### Teratogen

A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

#### **Toxic agent**

Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

#### **Toxicological profile**

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

#### Toxicology

The study of the harmful effects of substances on humans or animals.

#### Tumor

An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

#### **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 noobserved-adverse-effect-level (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].

**Vapor Intrusion:** (VI) is a process by which chemicals in soil or groundwater migrate to indoor air above a contaminated site.

#### Volatile organic compounds (VOCs)

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

#### Other glossaries and dictionaries:

Environmental Protection Agency (http://www.epa.gov/OCEPAterms/) National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)