Letter Health Consultation

GRANT MILL APARTMENT COMPLEX:
TRICHLOROETHYLENE VAPOR INTRUSION, FEBRUARY 2022

PROVIDENCE, PROVIDENCE COUNTY, RHODE ISLAND

Prepared by the
Rhode Island Department of Health

FEBRUARY 15, 2022

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

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Environmental Health Risk Assessment Program
Rhode Island Department of Health
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Agency for Toxic Substances and Disease Registry

Department of Health
Three Capitol Hill
Providence, RI 02908-5097
TTY: 711
www.health.ri.gov

Kelly J. Owens, Associate Supervising Engineer
Rhode Island Department of Environmental Management
Office of Land Revitalization and Sustainable Materials Management
235 Promenade Street
Providence, RI 02908-5767
kelly.owens@dem.ri.gov

CC: Ashley Blauvelt, RIDEM
Susan Forcier, RIDEM
Leo Hellested, RIDEM

February 15, 2022

Subject: Vapor Intrusion Assessment and Mitigation
Grant Mill, 295-299 Carpenter Street
Providence, RI 02909

Dear Ms. Owens and Ms. Blauvelt,

In December 2021, the Rhode Island Department of Environmental Management (RIDEM) requested the Rhode Island Department of Health (RIDOH) review the results of indoor air sampling (September 2021, November 2021) at 17 residences within the Grant Mill property in Providence, Rhode Island. This review was prepared in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR) as a letter health consultation. This document followed two earlier health assessments (RIDOH 2021a; RIDOH 2021b). These were completed in June 2021 and August 2021 and reviewed the results of indoor air sampling at 32 Grant Mill residences in February 2021 and July 2021 respectively. The consultant (Boston Environmental Corporation; BEC) identified elevated indoor air levels of chlorinated volatile organic compounds (VOCs), which they attributed to soil-vapor intrusion, and installed multiple sub-slab depressurization systems (SSDSs) in the basement, and repaired bathroom fans in select units before resampling in September 2021 and November 2021.

Despite the remedial actions, the maximum indoor air trichloroethylene (TCE) concentrations increased on the second, third, and fourth floor apartment units (Table 1) between February 2021 and November 2021. Although maximum concentrations of tetrachloroethylene (PCE) and cis-1,2-dichloroethylene (DCE) decreased between these time periods, the November 2021 results suggested that the remedial actions were less effective at reducing TCE indoor air concentrations. Given this result, there may be parallel issues of soil-vapor intrusion and building

material contamination, which BEC acknowledged was possible in the most recent site investigation report (December 2021). RIDOH evaluated the data for potential health effects through the inhalation exposure pathway following initial remediation steps.

RIDOH concluded that increased risks for non-cancer and cancer health effects could result from TCE inhalation over long-term exposure periods (e.g., >1 year) among Grant Mill tenants and short-term exposures among developing fetuses. Current TCE inhalation exposures from indoor air thus pose a public health hazard. Levels of PCE and DCE were below threshold levels for non-cancer health effects among tenants. However, the combined PCE, DCE, and TCE levels could have additive toxic effects because they act through the same adverse outcome pathways.

RIDOH recommends that the current owner (Grant Mill, LLC) continue to take comprehensive steps to reduce tenant VOC exposure levels by increasing ventilation because previous remediation steps (i.e., SSDS basement installation, bathroom fan repairs) have not sufficiently lowered maximum TCE indoor air levels. BEC and Grant Mill, LLC should continue to assess the site for contaminated building materials and continue to remediate as necessary to reduce current and future tenant exposure. Lastly, BEC and Grant Mill, LLC should continue to keep tenants updated about remediation efforts and the potential risks of chronic TCE inhalation exposure. As of December 2021, BEC has already accepted and implemented these recommendations (see Additional Considerations). The remainder of this letter health consultation presents detailed information supporting RIDOH's analysis, conclusions, and recommendations.

Background

In 1850, the Grant Mill building site (115,764 ft^2, 1.77 acres) was constructed as a cotton mill, and later used as a jewelry manufacturer until 1986 (Figure 1). In 2007, the building was converted into 85 loft-style apartment units distributed over 4 floors. Building space also includes mechanical rooms, elevator rooms, storage areas, offices, a media room, and an exercise room. Grant Mill, LLC purchased the property in 2017, following a Phase I Environmental Site Assessment by Paragon Environmental Services (PES) Associates (December 2016). At the time, no Recognized Environmental Conditions were identified, despite the facility's prior use as a jewelry manufacturer and likely use of solvents. Grant Mill, LLC planned to refinance the building in late 2020.

A November 2020 Phase I Environmental Site Assessment (Consultant: GRS-Global) recommended additional investigations based on the site's previous use as a cotton mill and jewelry manufacturer. In December 2020, Grant Mill, LLC hired BEC (Team Consultants: Woodard & Curran, EA Engineering, Lockwood Remedial Technologies, LLC) to conduct a Limited Phase II Environmental Site Investigation.

Discussion

Environmental Data

In December 2020 and January 2021, BEC assessed the site for potential soil-vapor intrusion from chlorinated VOCs at various locations on the property, not including apartment units. In

February 2021 (Appendix A), June 2021 (Appendix B), September 2021 (Appendix C), and November 2021 (Appendix D; partial dataset, n=8), BEC took additional indoor air samples from the apartment units on all four floors with tenant consent. Prior to sampling (24h indoor air concentrations, pre-cleaned Summa® 6L cannisters), tenants removed consumer products that might contain VOCs.

RIDOH focused on the February, June, September, and November 2021 datasets because tenants spent the majority of their time in the apartment units (ATSDR 2020). RIDOH used the maximum VOC concentrations on each floor (Tables 1-3) for the exposure assessment. The 95th upper confidence level (95UCL) of the mean was also applied to the first floor apartment samples as an additional exposure point concentration when more than eight samples were taken (ATSDR 2005). This included the first-floor apartment datasets for February, June, and September 2021, but not November 2021.

Between February and June 2021, BEC installed SSDSs in the basement as initial remedial actions. Between June and September 2021, the bathroom ventilation fans on the western end of the building were repaired. If these remediation steps sufficiently reduced VOC indoor air concentrations, then the indoor air concentrations would decrease over time (RIDOH 2021b).

Table 1. Unadjusted 24-hour TCE concentrations in indoor air by floor in 2021.

	TCE (ug/m^3)$^{\&}$							
Floor	Feb max	June max	Sept max	Nov max	Feb 95UCL	June 95UCL	Sept 95UCL	Nov 95UCL
MassDEP^	0.4							
1992 IA$^{\#}$	0.8							
1st (n=17)	**1.4**	**6.3**	**30**	**0.96**	**0.53**	**0.92**	**1.9**	NA
2nd (n=5)	**1.2**	**2.1**	**5.6**	**2.0**				
3rd (n=5)	**2.3**	**4.3**	**1.2**	**4.1**				
4th (n=5)	**2.6**	**1.6**	**0.41**	**3.6**				

$^{\&}$ug/m^3: microgram of VOC per cubic meter
^Massachusetts Department of Environmental Protection (DEP) Residential Indoor Air Threshold Values. Data in **bold** indicated the level was equal to or higher than the threshold.
$^{\#}$IA: Typical indoor air concentrations in 1992 (RIDEM internal data)

Table 2. Unadjusted 24-hour PCE concentrations in indoor air by floor in 2021.

	PCE (ug/m^3)							
Floor	Feb max	June max	Sept max	Nov max	Feb 95UCL	June 95UCL	Sept 95UCL	Nov 95UCL
MassDEP^	1.4							
1992 IA$^{\#}$	4.1							
1st (n=17)	**11**	**34**	**4.8**	1.2	**2.8**	**2.1**	**4.2**	NA
2nd (n=5)	**3.7**	0.8	**1.4**	0.78				
3rd (n=5)	**12**	**1.8**	0.79	1.2				
4th (n=5)	**15**	0.9	0.76	0.83				

^Massachusetts DEP Residential Indoor Air Threshold Values. Data in **bold** indicated the level was equal to or higher than the threshold.
$^{\#}$IA: Typical indoor air concentrations in 1992 (RIDEM internal data)

Table 3. Unadjusted 24-hour DCE concentrations in indoor air by floor in 2021.

	DCE (ug/m^3)							
Floor	Feb max	June max	Sept max	Nov max	Feb 95UCL	June 95UCL	Sept 95UCL	Nov 95UCL
MassDEP^	0.8							
1992 IA[#]	0.8							
1st (n=17)	0.25	<0.14[±]	<0.14	<0.14	NA	NA	NA	NA
2nd (n=5)	0.65	<0.14	<0.14	<0.14				
3rd (n=5)	**2.3**	<0.14	<0.14	<0.14				
4th (n=5)	**2.8**	<0.14	<0.14	<0.14				

^Massachusetts DEP Residential Indoor Air Threshold Values. Data in **bold** indicated the level were equal to or higher than the threshold.
[#]IA: Typical indoor air concentrations in 1992 (RIDEM internal data)
[±]If the DCE concentration was below the limit of detection (LOD), then the concentration was reported as <LOD

Between February 2021 and November 2021, TCE maximum concentrations increased on the second, third, and fourth floors (Table 1). The September 2021 first floor 95UCL similarly increased (Table 1). Although concentrations fluctuated during the summer, both the earliest (February 2021) and most recent datasets (November 2021) had higher TCE levels on the third and fourth floors than the first and second floors (Table 1).

These TCE results were inconsistent with the soil-vapor intrusion hypothesis. In that scenario with soil-vapor intrusion, higher VOC concentrations would be detected on the lower floors (Ma et al. 2020; ATSDR 2016). Given the building's history as a cotton mill and jewelry manufacturer, the TCE source(s) may be the building materials, potentially resulting from past chemical spills soaking into the floorboards and now evaporating. Additional remedial actions beyond SSDS installation and bathroom fan repairs will likely be needed to sufficiently reduce TCE levels in the apartment units.

While the first floor 95UCLs increased over time, the PCE maximum concentrations generally decreased on all floors (Table 2). Unlike the TCE trend, PCE concentrations were generally highest on the first floor (Table 2), which was consistent with the soil-vapor intrusion hypothesis (Ma et al. 2020; ATSDR 2016).

DCE was only detected in February 2021 and was not detected in the June, September, or November 2021 datasets (Table 3). Due to the continued non-detects in the sampled apartment units, DCE was not assessed for human health risks in this letter health consultation.

Exposure Scenario: Tenant Inhalation
In compliance with ATSDR guidance (ATSDR 2016), RIDOH assumed a chronic inhalation exposure scenario of 24 hours per day (h/d), 7 days per week (d/wk), and 52.14 weeks per year (wk/y). For evaluating the cancer health endpoints, a 50th percentile (*central tendency exposure* or CTE) residential occupancy period of 1.2 years and a 95th percentile (*reasonable maximum exposure* or RME) residential occupancy period of 8.0 years were used (US EPA 2011).

The equations (ATSDR 2020) for the hazard quotient (HQ) and elevated lifetime cancer risk (ELCR) are

$$HQ\ (unitless) = \frac{Exposure\ Point\ Concentration * Exposure\ Factor_{noncancer}}{Inhalation\ Minimum\ Risk\ Level}$$

$$ELCR\ (unitless) = Inhalation\ Unit\ Risk * Exposure\ Point\ Concentration * Exposure\ Factor_{cancer}$$

An HQ>1.0 and/or an ELCR>$1.0*10^{-6}$ are cause for concern,[1] or "elevated risk." For the tenant exposure scenario, a non-cancer exposure factor of 1 and cancer exposure factors of 0.015 (CTE) and 0.103 (RME) were used. ATSDR inhalation minimum risk levels and cancer inhalation unit risks are reported in Table 4. Tables 5 and 6 reported the HQs and ELCRs by floor and VOC, for both the CTE and RME of the residential occupancy period.

Table 4. Inhalation minimum risk level by VOC and concentration unit.

	TCE~			PCE~		
	ppm	ug/m^3 ^	IUR (ug/m^3)	ppm	ug/m^3 ^	IUR (ug/m^3)
Chronic	0.0004	2.1	$4.1*10^{-6}$	0.006	41	$2.6*10^{-7}$
Intermediate	0.0004	2.1		0.006	41	
Acute	0.0004	2.1		0.006	41	

(Stevens 1997; ATSDR 2019; Harper, Chessin, and Goldhaber 1996)
~ATSDR has adopted the chronic inhalation minimum risk levels for PCE and TCE as both the intermediate and acute minimum risk levels, based on available data.
^Conversion from ppm to ug/m^3 accounts for the ideal gas law

Only seven apartment units had indoor air samples taken at all four timepoints (Table 7), such that these samples were suitable to assess long-term, or chronic (>1 y), exposures. The indoor air TCE and PCE concentration averages were used to calculate additional HQs and ELCRs.

[1] An HQ less than 1.0 means that it is unlikely an exposed person would experience adverse non-cancer health effects, while an HQ equal to or greater than 1.0 means an increased likelihood. The ELCR measures the probability that a person may develop cancer sometime in their lifetime following exposure to a particular contaminant. An ELCR below $1.0*10^{-6}$ (one in one million) is very low or negligible risk, while an ELCR between $1.0*10^{-6}$ and $1.0*10^{-4}$ (one in ten thousand) is low risk and between $1.0*10^{-4}$ and $1.0*10^{-3}$ (one in one thousand) is moderate risk.

Table 5. TCE hazard quotient and excess lifetime cancer risk by floor in 2021. Values in **bold** denote an increase in risk from February to June, June to September, or September to November. Highlighted boxes denote elevated risk.

Floor	HQ (max)				HQ (95UCL)				ELCR (CTE)				ELCR (RME)			
	Feb	June	Sept	Nov	Feb	June	Sept	Nov	Feb	June	Sept	Nov	Feb	June	Sept	Nov
1st	0.64	**2.9**	**14**	0.44	0.24	**0.42**	**0.86**	NA	$8.6*10^{-8}$	$\mathbf{3.9*10^{-7}}$	$\mathbf{1.8*10^{-6}}$	$5.9*10^{-8}$	$5.9*10^{-7}$	$\mathbf{2.7*10^{-6}}$	$\mathbf{1.3*10^{-5}}$	$4.1*10^{-7}$
2nd	0.55	**0.96**	**2.6**	0.91					$7.4*10^{-8}$	$\mathbf{1.3*10^{-7}}$	$\mathbf{3.4*10^{-7}}$	$1.2*10^{-7}$	$5.1*10^{-7}$	$\mathbf{8.9*10^{-7}}$	$\mathbf{2.4*10^{-6}}$	$8.4*10^{-7}$
3rd	1.1	**2.0**	0.55	**1.9**					$1.4*10^{-7}$	$\mathbf{2.6*10^{-7}}$	$7.4*10^{-8}$	$\mathbf{2.5*10^{-7}}$	$9.7*10^{-7}$	$\mathbf{1.8*10^{-6}}$	$5.1*10^{-7}$	$\mathbf{1.7*10^{-6}}$
4th	1.2	0.73	0.19	**1.6**					$1.6*10^{-7}$	$9.8*10^{-8}$	$2.5*10^{-8}$	$\mathbf{2.2*10^{-7}}$	$1.1*10^{-6}$	$6.8*10^{-7}$	$1.7*10^{-7}$	$\mathbf{1.5*10^{-6}}$

Table 6. PCE hazard quotient and excess lifetime cancer risk by floor in 2021. Values in **bold** denote an increase in risk from February to June, June to September, or September to November.

Floor	HQ (max)				HQ (95UCL)				ELCR (CTE)				ELCR (RME)			
	Feb	June	Sept	Nov	Feb	June	Sept	Nov	Feb	June	Sept	Nov	Feb	June	Sept	Nov
1st	0.27	**0.83**	0.12	**0.03**	0.07	0.05	**0.10**	NA	$4.3*10^{-8}$	$\mathbf{1.3*10^{-7}}$	$1.9*10^{-8}$	$4.7*10^{-9}$	$3.0*10^{-7}$	$\mathbf{9.1*10^{-7}}$	1.3E-07	$3.2*10^{-8}$
2nd	0.09	0.02	**0.03**	0.02					$1.4*10^{-8}$	$3.1*10^{-9}$	$5.5*10^{-9}$	$3.0*10^{-9}$	$9.9*10^{-8}$	$2.1*10^{-8}$	$\mathbf{3.7*10^{-8}}$	$2.1*10^{-8}$
3rd	0.29	0.04	0.02	**0.03**					$4.7*10^{-8}$	$7.0*10^{-9}$	$3.1*10^{-9}$	$\mathbf{4.7*10^{-9}}$	$3.2*10^{-7}$	$4.8*10^{-8}$	$2.1*10^{-8}$	$\mathbf{3.2*10^{-8}}$
4th	0.37	0.02	0.02	**0.02**					$5.9*10^{-8}$	$3.3*10^{-9}$	$3.0*10^{-9}$	$\mathbf{3.2*10^{-9}}$	$4.0*10^{-7}$	$2.3*10^{-8}$	$2.0*10^{-8}$	$\mathbf{2.2*10^{-8}}$

Table 7. TCE and PCE average indoor air concentrations, hazard quotients, and excess lifetime cancer risk by unit, if samples were taken at all four timepoints (February, June, September, November). Highlighted boxes denote elevated risk.

Unit (deidentified)	TCE				PCE			
	Average (ug/m^3)	HQ	ELCR (CTE)	ELCR (RME)	Average (ug/m^3)	HQ	ELCR (CTE)	ELCR (RME)
Floor 1 – Unit A	9.5	4.3	$5.8*10^{-7}$	$4.0*10^{-6}$	3.0	0.07	$1.2*10^{-8}$	$7.9*10^{-8}$
Floor 1 – Unit B	1.2	0.53	$7.1*10^{-8}$	$4.9*10^{-7}$	2.9	0.07	$1.1*10^{-8}$	$7.8*10^{-8}$
Floor 1 – Unit C	0.63	0.29	$3.8*10^{-8}$	$2.6*10^{-7}$	3.3	0.08	$1.3*10^{-8}$	$8.8*10^{-8}$
Floor 2 – Unit A	2.7	1.2	$1.7*10^{-7}$	$1.2*10^{-6}$	1.5	0.04	$6.0*10^{-9}$	$4.1*10^{-8}$
Floor 3 – Unit A	1.4	0.63	$8.4*10^{-8}$	$5.8*10^{-7}$	0.82	0.02	$3.2*10^{-9}$	$2.2*10^{-8}$
Floor 3 – Unit B	2.6	1.2	$1.6*10^{-7}$	$1.1*10^{-6}$	1.4	0.04	$5.6*10^{-9}$	$3.9*10^{-8}$
Floor 4 – Unit A	1.8	0.81	$1.1*10^{-7}$	$7.5*10^{-7}$	1.5	0.04	$5.8*10^{-9}$	$4.0*10^{-8}$

Based on the maximum concentrations, between February 2021 and November 2021, the risks for TCE-related non-cancer and cancer health effects increased on the third and fourth floors at Grant Mill. From Table 5, increased risks for non-cancer health effects would be expected from chronic TCE inhalation exposures. Under the RME exposure scenario (8.0 y tenancy), increased risks for cancer health effects were above the level of concern (one in one million people) for TCE inhalation. Multiple remediation steps took place between the sampling events to address soil-vapor intrusion; however, the estimated health risks increased regardless. Notably, maximum PCE concentrations decreased in the units' indoor air between these time periods and were below the levels of concern for non-cancer and cancer health effects (Table 6).

For the seven units with indoor air average concentrations (Table 7), three demonstrated increased risks for both non-cancer and cancer health effects from chronic TCE inhalation exposures. The increased TCE-related cancer risks were specific to the RME exposure scenario (8.0 y tenancy) and did not apply to the shorter-term CTE exposure scenario (1.2 y tenancy). The average PCE indoor air concentrations were below the levels of concern for non-cancer and cancer health effects (Table 7).

These findings suggest parallel issues of soil-vapor intrusion and building material contamination. Prior to November 2021 resampling, BEC remediation efforts focused on vapor intrusion in the basement and repairing the building's bathroom fans. However, in the most recent site investigation report (December 2021), BEC acknowledged that soil-vapor intrusion may not be the main TCE contamination source and installed carbon filter systems in apartment units on the western side of the building as a protective measure. Additional indoor air sampling occurred in January 2022 to assess whether further actions need to be taken.

Public Health Implications

A wide range of adverse non-cancer health effects have been associated with low levels of TCE inhalation exposures (Appendix E). The developing fetus is a particularly sensitive target of TCE toxicity, with the ATSDR TCE MRL of 2.1 ug/m^3 based on fetal heart malformations observed in rodents (ATSDR 2019). The Massachusetts DEP has issued an Imminent Hazard value for TCE residential indoor air of 6 ug/m^3 for women early in pregnancy ("Trichloroethylene (TCE) in Indoor Air" 2017). At one first floor Grant Mill apartment (Table 7), the average TCE air levels exceeded 6 ug/m^3, a level at which unborn babies may experience elevated risks of non-cancer health effects should the mother be exposed during the first trimester. BEC has taken extra steps (e.g., portable gas chromatograph) with this unit's tenants to identify potential sources.

Major cardiac development in humans occurs over a three-week period during the first three months of pregnancy (Dhanantwari et al. 2009), and TCE inhalation exposures during this period may increase the risk of fetal heart malformations (ATSDR 2019). From animal studies, in utero TCE exposures may also lead to spontaneous abortion, small birth weight, immune system defects, and central nervous system defects (ATSDR 2019), although fetal heart malformation is considered the most sensitive health endpoint.

In human occupational exposure studies, acute TCE inhalation exposure has led to central nervous system depression, loss of consciousness, and death (ATSDR 2019). Chronic TCE inhalation exposure has resulted in damage to the liver, kidneys, skin, immune system, and reproductive system (ATSDR 2019). There may also be an increased risk of developing autoimmune diseases, such as scleroderma (e.g. hardening/tightening of skin and connective tissues) (ATSDR 2019). For at least the three units with elevated hazard quotients (Table 7), BEC should provide tenants with additional information about chronic TCE health effects and actionable ways to reduce inhalation exposures. Such methods may include recommending that tenants occupy these apartments no more than one year.

PCE inhalation exposures have similar adverse health effects (Stevens 1997; Harper, Chessin, and Goldhaber 1996), although PCE-related risks for non-cancer health effects were not expected at Grant Mill. However, ATSDR assumes the health effect risks from TCE and PCE exposures will be additive (ATSDR 2004). At Grant Mill, the risks for non-cancer health effects may be further increased when combining TCE and PCE inhalation exposures.

TCE is also a known human carcinogen, associated with kidney cancer, liver cancer, and non-Hodgkin's lymphoma (ATSDR 2019). In this evaluation, an elevated lifetime cancer risk from TCE was found at Grant Mill at the RME residential occupancy period of 8.0 y (Table 6) (US EPA 2011). As with the non-cancer health effects, ATSDR assumes the cancer risks from TCE and PCE to be additive (ATSDR 2004) and the risks for cancer health effects may be further increased when considering the combined TCE and PCE inhalation exposures. The above-listed health effects have been included in a site-specific frequently asked questions document with current tenants as the target audience (Appendix E). RIDOH is prepared to share this document with current tenants (e.g., hard copy community board post), should BEC require assistance.

Limitations of Analysis

The indoor air VOC concentrations accounted for four 24 h time periods, which were suitable for evaluating acute inhalation exposures. However, it is important to note that ATSDR has adopted the chronic inhalation minimum risk levels for TCE as both the intermediate and acute minimum risk levels (ATSDR 2019). Increased risks for adverse health effects may be expected from chronic, intermediate, and acute TCE inhalation exposures at Grant Mill.

RIDOH did not have access to information detailing how long current tenants have lived in their Grant Mill apartment units. RIDOH's evaluation was based on the most recent sampling events and recommended residency occupancy periods from previous research (US EPA 2011).

Conclusions and Recommendations

Based on the February, June, September, and November 2021 datasets, RIDOH reached the following conclusions.

1. Increased risks for non-cancer and cancer health effects would be expected from chronic TCE inhalation exposures among Grant Mill tenants.
2. Increased risks for non-cancer and cancer health effects would not be expected from chronic PCE inhalation exposures among Grant Mill tenants.

From these conclusions, RIDOH made the following recommendations, which were also provided in the earlier letter health consultation completed in June (RIDOH 2021a).

1. Grant Mill, LLC should continue to take steps to reduce tenant TCE inhalation exposures by increasing ventilation.
2. Grant Mill, LLC and BEC should continue to assess the site for contaminated building materials and remediate as necessary to reduce future tenant exposures.
3. Grant Mill, LLC and BEC should continue to keep tenants updated about remediation efforts and the potential risks of chronic TCE inhalation exposure.

Additional Considerations

In the most recent site investigation report (December 2021), BEC acknowledged that soil-vapor intrusion may not be the main TCE contamination source and that building material contamination may be a parallel source. In early December 2021, as a conservative measure, BEC installed carbon filter systems in apartment units on the western side of the building, where the maximum TCE indoor air concentrations were detected. Additionally, BEC has distributed updated letters to tenants with the September and November 2021 sampling results. BEC also hosted a virtual Zoom meeting on December 8, 2021 to answer remaining tenant questions, comments, and concerns. Further tenant communication is strongly recommended for those in units with demonstrated chronic TCE inhalation exposures (Table 7).

Additional indoor air sampling occurred in January 2022 to assess whether further actions need to be taken. When the January 2022 sampling event is completed, RIDOH is available to assess the updated indoor air VOC data for potential health effects.

If there are any questions, please contact me at carolyn.poutasse@health.ri.gov.

Sincerely,

Carolyn M. Poutasse, PhD
Environmental Health Risk Assessment Toxicologist

Report Preparation

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Author

Carolyn Poutasse, PhD
Environmental Health Risk Assessment Toxicologist
Rhode Island Department of Health

Reviewers

Michael Byrns, PhD
Principal Environmental Health Risk Assessment Toxicologist
Rhode Island Department of Health

Caroline Hoffman, MPH
Senior Public Health Promotion Specialist
Rhode Island Department of Health

Melissa Orpen-Tuz, ACRW, CPRW
Assistant Health Program Administrator
Rhode Island Department of Health

Robert Sucsy, MPH
Epidemiologist
Rhode Island Department of Health

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Figure 1. Satellite view of the Grant Mill building.

Appendix A. February 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	NS		NS		NS	
Floor 1	0.36		<0.19	U	<0.14	U
Floor 1	8.5		1.2		0.25	
Floor 1	1.7		0.42		<0.14	U
Floor 1	7.2		1		<0.14	U
Floor 1	1.3		0.3		<0.14	U
Floor 1	2.3		0.4		<0.14	U
Floor 1	11		1.4		0.19	
Floor 1	0.97		0.33		<0.14	U
Floor 1	0.37		<0.19	U	<0.14	U
Floor 1	0.87		<0.19	U	<0.14	U
Floor 1	0.78		<0.19	U	<0.14	U
Floor 1	2.3		0.6		0.14	
Floor 1	3.9		0.72		<0.14	U
Floor 1	9.3		0.42		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	4.2		0.52		<0.14	U
Floor 1	0.45		<0.19	U	<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 2	0.42		<0.19	U	<0.14	U
Floor 2	3.7		0.71		0.59	
Floor 2	0.54		<0.19	U	<0.14	U
Floor 2	3.2		1.2		0.24	
Floor 2	2.2		0.41		0.65	
Floor 3	0.28		<0.19	U	<0.24	U
Floor 3	4.3		1.1		0.78	
Floor 3	1.9		0.99		0.3	
Floor 3	2.5		0.6		0.25	
Floor 3	12		2.3		2.3	
Floor 4	1.7		0.54		0.25	
Floor 4	3.9		1.1		0.65	
Floor 4	1.8		0.57		0.18	
Floor 4	4.3		1.7		0.23	
Floor 4	15		2.6		2.8	

NS=Not Sampled.

U flag indicated that the VOC was not detected.

Appendix B. June 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	0.28		<0.19	U	<0.14	U
Floor 1	2.8		<0.19	U	<0.14	U
Floor 1	2.1		0.52		<0.14	U
Floor 1	34		<0.19	U	<0.14	U
Floor 1	0.73		0.37		<0.14	U
Floor 1	0.81		<0.19	U	<0.14	U
Floor 1	0.58		<0.19	U	<0.14	U
Floor 1	0.93		<0.19	U	<0.14	U
Floor 1	3		<0.19	U	<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 1	0.27		<0.19	U	<0.14	U
Floor 1	1.4		<0.19	U	<0.14	U
Floor 1	0.47		0.56		<0.14	U
Floor 1	2.9		6.3		<0.14	U
Floor 1	0.71		0.71		<0.14	U
Floor 1	1.9		<0.19	U	<0.14	U
Floor 1	3.5		0.52		<0.14	U
Floor 1	0.42		<0.19	U	<0.14	U
Floor 1	0.32		<0.19	U	<0.14	U
Floor 2	<0.24	U	<0.19	U	<0.14	U
Floor 2	0.33		0.45		<0.14	U
Floor 2	<0.24	U	<0.19	U	<0.14	U
Floor 2	0.8		2.1		<0.14	U
Floor 2	0.43		<0.19	U	<0.14	U
Floor 3	<0.24	U	0.28		<0.14	U
Floor 3	0.41		0.94		<0.14	U
Floor 3	0.62		1.8		<0.14	U
Floor 3	1.8		4.3		<0.14	U
Floor 3	1.2		0.82		<0.14	U
Floor 4	0.43		0.19		<0.14	U
Floor 4	0.38		0.6		<0.14	U
Floor 4	<0.24	U	<0.19	U	<0.14	U
Floor 4	0.62		1.6		<0.14	U
Floor 4	0.85		<0.19	U	<0.14	U

NS=Not Sampled.

U flag indicated that the VOC was not detected.

Appendix C. September 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	NS		NS		NS	
Floor 1	0.24		<0.19	U*	<0.14	U
Floor 1	NS		NS		NS	
Floor 1	0.34		0.19		<0.14	U
Floor 1	0.71		0.95		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	1.4		<0.19	U	<0.14	U
Floor 1	0.33		0.3		<0.14	U
Floor 1	4.8		30		<0.14	U
Floor 1	1.2		3.3		<0.14	U
Floor 1	3.3		3.6		<0.14	U
Floor 1	4.2		1.2		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	0.49		0.34		<0.14	U
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	1.4		5.6		<0.14	U
Floor 2	NS		NS		NS	
Floor 3	NS		NS		NS	
Floor 3	0.79		1		<0.14	U
Floor 3	0.34		1.2		<0.14	U
Floor 3	0.28		1.2		<0.14	U
Floor 3	0.6		0.99		<0.14	U
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	<0.24	U	0.23		<0.14	U
Floor 4	0.76		0.41		<0.14	U

NS=Not Sampled.

U flag indicated that the VOC was not detected.

Appendix D. November 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	<0.24	U	0.96		<0.14	U
Floor 1	0.45		0.19		<0.14	U
Floor 1	0.83		0.25		<0.14	U
Floor 1	1.2		0.26		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	0.78		2		<0.14	U
Floor 2	NS		NS		NS	
Floor 3	NS		NS		NS	
Floor 3	NS		NS		NS	
Floor 3	0.4		1.5		<0.14	U
Floor 3	1.2		4.1		<0.14	U
Floor 3	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	0.83		3.6		<0.14	U
Floor 4	NS		NS		NS	

NS=Not Sampled.

U flag indicated that the VOC was not detected.

Appendix E. ATSDR ToxFAQs for TCE.

Trichloroethylene - ToxFAQs™

CAS # 79-01-6

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Trichloroethylene is used as a solvent for cleaning metal parts. Exposure to very high concentrations of trichloroethylene can cause dizziness headaches, sleepiness, incoordination, confusion, nausea, unconsciousness, and even death. Trichloroethylene has been found in at least 1,051 of the 1,854 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is trichloroethylene?

Trichloroethylene is a colorless, volatile liquid. Liquid trichloroethylene evaporates quickly into the air. It is nonflammable and has a sweet odor.

The two major uses of trichloroethylene are as a solvent to remove grease from metal parts and as a chemical that is used to make other chemicals, especially the refrigerant, HFC-134a.

What happens to trichloroethylene when it enters the environment?

- Trichloroethylene can be released to air, water, and soil at places where it is produced or used.
- Trichloroethylene is broken down quickly in air.
- Trichloroethylene breaks down very slowly in soil and water and is removed mostly through evaporation to air.
- It is expected to remain in groundwater for long time since it is not able to evaporate.
- Trichloroethylene does not build up significantly in plants or animals.

How might I be exposed to trichloroethylene?

- Breathing trichloroethylene in contaminated air.
- Drinking contaminated water.
- Workers at facilities using this substance for metal degreasing are exposed to higher levels of trichloroethylene.
- If you live near such a facility or near a hazardous waste site containing trichloroethylene, you may also have higher exposure to this substance.

How can trichloroethylene affect my health?

Trichloroethylene was once used as an anesthetic for surgery. Exposure to moderate amounts of trichloroethylene may cause headaches, dizziness, and sleepiness; large amounts may cause coma and even death. Eating or breathing high levels of trichloroethylene may damage some of the nerves in the face. Exposure to high levels can also result in changes in the rhythm of the heartbeat, liver damage, and evidence of kidney damage. Skin contact with concentrated solutions of trichloroethylene can cause skin rashes. There is some evidence exposure to trichloroethylene in the work place may cause scleroderma (a systemic autoimmune disease) in some people. Some men occupationally-exposed to trichloroethylene and other chemicals showed decreases in sex drive, sperm quality, and reproductive hormone levels.

How likely is trichloroethylene to cause cancer?

There is strong evidence that trichloroethylene can cause kidney cancer in people and some evidence for trichloroethylene-induced liver cancer and malignant lymphoma. Lifetime exposure to trichloroethylene resulted in increased liver cancer in mice and increased kidney cancer and testicular cancer in rats.

The Department of Health and Human Services (DHHS) considers trichloroethylene to be a known human carcinogen. The International Agency for Research on Cancer (IARC) classified trichloroethylene as carcinogenic to humans. The EPA has characterized trichloroethylene as carcinogenic to humans by all routes of exposure.

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

Trichloroethylene

CAS # 79-01-6

How can trichloroethylene affect children?

It is not known whether children are more susceptible than adults to the effects of trichloroethylene.

Some human studies indicate that trichloroethylene may cause developmental effects such as spontaneous abortion, congenital heart defects, central nervous system defects, and small birth weight. However, these people were exposed to other chemicals as well.

In some animal studies, exposure to trichloroethylene during development caused decreases in body weight, increases in heart defects, changes to the developing nervous system, and effects on the immune system.

How can families reduce the risk of exposure to trichloroethylene?

- Avoid drinking water from sources that are known to be contaminated with trichloroethylene. Use bottled water if you have concerns about the presence of chemicals in your tap water. You may also contact local drinking water authorities and follow their advice.
- Prevent children from playing in dirt or eating dirt if you live near a waste site that has trichloroethylene.
- Trichloroethylene is used in many industrial products. Follow instructions on product labels to minimize exposure to trichloroethylene.

Is there a medical test to determine whether I've been exposed to trichloroethylene?

Trichloroethylene and its breakdown products (metabolites) can be measured in blood and urine. However, the detection of trichloroethylene or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because trichloroethylene and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure.

Has the federal government made recommendations to protect human health?

The EPA set a maximum contaminant goal (MCL) of 0.005 milligrams per liter (mg/L; 5 ppb) as a national primary drinking standard for trichloroethylene.

The Occupational Safety and Health Administration (OSHA) set a permissible exposure limit (PEL) of 100 ppm for trichloroethylene in air averaged over an 8-hour work day, an acceptable ceiling concentration of 200 ppm provided the 8 hour PEL is not exceeded, and an acceptable maximum peak of 300 ppm for a maximum duration of 5 minutes in any 2 hours.

The National Institute for Occupational Safety and Health (NIOSH) considers trichloroethylene to be a potential occupational carcinogen and established a recommended exposure limit (REL) of 2 ppm (as a 60-minute ceiling) during its use as an anesthetic agent and 25 ppm (as a 10-hour TWA) during all other exposures.

Reference

This ToxFAQs™ information is taken from the 2019 Toxicological Profile for Trichloroethylene produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ on the web: www.atsdr.cdc.gov/ToxFAQs

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Appendix F. Trichloroethylene at Grant Mill Apartments: Frequently Asked Questions, February 2022.

What is the Environmental Issue at Grant Mill?

Grant Mill, LLC by Heritage Properties has owned the building since 2017. They planned to refinance the building in late 2020, which required an environmental assessment because of its history as a jewelry manufacturer.

In January 2021, environmental consultants (Boston Environmental Corporation; BEC) collected soil, groundwater, and air samples. With these samples, Grant Mill first learned that *volatile organic compounds (VOCs)* were in the air of some apartments.

What Are These Chemicals?

Jewelry manufacturing used VOCs as solvents and degreasers. Some common VOCs are *tetrachloroethylene (PCE)*, *trichloroethylene (TCE)*, and *cis-1,2-dichloroethylene (DCE)*.

In manufacturing, VOCs were often spilled on the ground or the floor by accident. When this happens, they can stay around or in the building for years. Over time, spilled VOCs can evaporate and move into the building's air. This is called *vapor intrusion*. People in the building **may** breathe in the vapors and experience *inhalation exposures*.

Are These VOCs in My Apartment Unit?

Select Grant Mill apartment units had indoor air samples taken in February, April, June, September, and November 2021. The test results have been sent to tenants, and BEC is available to answer testing-specific questions sent to the Community Manager (jmichaud@heritageprop.net).

TCE was a frequently found VOC in the apartment units. Although the levels were lower than what an occupational worker might be exposed to, some units had relatively high TCE levels for residential areas.

Do I Need to Leave My Apartment?

Tenants do not need to evacuate their apartments. So far, only one Grant Mill apartment unit indoor air samples had a TCE level above 20 micrograms per cubic meter ($\mu g/m^3$), which is the short-term Imminent Hazard value for TCE residential indoor air for the general population. BEC immediately took steps to reduce TCE levels in this unit.

How Can TCE Affect My Health?

Both high-level short-term (*acute*; <14 days) and low-level long-term (*chronic*; >365 days) TCE exposures can lead to negative health effects. Breathing in TCE **may** lead to:

- Headache, dizziness, poor coordination, decreased concentration, loss of consciousness (neurological)
- Lung irritation
- Liver, kidney, and immune system damage

TCE exposures have also been associated with Parkinson's disease, a common neurodegenerative disorder, although other genetic and environmental factors may contribute.

Chronic exposures to low TCE levels has also been linked to cancer. Animal and epidemiological studies have also shown that breathing low levels of TCE for many years **may** lead to cancer in the liver, kidney, or lung. EPA considers TCE and PCE to be probable human carcinogens and DCE a possible human carcinogen.

Are My Children at Risk?

Developing babies are very sensitive to TCE toxicity and **may** experience birth defects, such as fetal heart malformations, if the mother is exposed. In June and September 2021, only one Grant Mill unit had TCE levels over 6 $\mu g/m^3$, which is the Imminent Hazard value for TCE residential indoor air for women in their first trimester.

NOTE: TCE levels above 6 $\mu g/m^3$ do **not** mean that birth defects will definitely happen to an unborn baby. It means that actions should be taken to lower TCE levels and reduce the health risks. Women who are pregnant or may become pregnant may want to review their unit's TCE indoor air results from the consultant as a precaution.

What's Grant Mill Doing About These Chemicals Now?

The Rhode Island Department of Environmental Management (RIDEM) supervises the assessment and *remediation*, or clean up, of these chemicals. BEC cooperates with RIDEM and the Rhode Island Department of Health (RIDOH) through the remediation process.

Between February 2021 and November 2021, BEC installed *sub-slab depressurization systems* throughout the building and repaired the ventilation system. Carbon filter systems were installed in December 2021, and BEC took more air samples in January 2022. These samples will help evaluate whether these actions are effectively lowering VOC indoor air levels at Grant Mill.

What Can I Do About VOCs in My Apartment?

Increasing air ventilation can lower VOC indoor air levels. This includes simple actions like opening a window or turning on a fan (ex: kitchen or bathroom).

Who Can I Contact for More Information?

For questions about your unit's test results or the building's remediation plans, please contact the Community Manager so they can forward questions to the consultant. For questions about potential VOC health effects, please contact RIDOH (carolyn.poutasse@health.ri.gov; michael.byrns@health.ri.gov).

Rhode Island Department of Health
Three Capitol Hill
Providence, RI 02908-5097
www.health.ri.gov