State of New Jersey
DEPARTMENT OF HEALTH
CONSUMER, ENVIRONMENTAL AND OCCUPATIONAL HEALTH SERVICE
PO BOX 369
TRENTON, N.J. 08625-0369

PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lt. Governor

www.nj.gov/health

JUDITH M. PERSICHILLI, RN, BSN, MA
Commissioner

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Mr. Thomas Longo, Director
Division of Environmental Health
Bergen County Department of Health Services
220 East Ridgewood Avenue – Suite 201
Paramus, NJ 07652
Email: TLongo@co.bergen.nj.us

Dear Mr. Longo:

The New Jersey Department of Health (NJDOH) has prepared this Letter Health Consultation (LHC) to evaluate the public health implications of exposures to indoor air contaminants detected at the Crown Village Condominium complex located in Edgewater, Bergen County.

This LHC was prepared under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). This evaluation is based on indoor air data collected during a vapor intrusion investigation by a Licensed Site Remediation Professional (LSRP). The LSRP work is overseen by the New Jersey Department of Environmental Protection (NJDEP) under the Site Remediation Reform Act of 2009. NJDEP inspects and reviews LSRP submittals to ensure that remediation work is completed in accordance with NJDEP's applicable standards and regulations, and monitors remediation timeframes to ensure that responsible parties remediate sites in a timely manner [NJDEP 2014].

Background and Statement of Issues

In October 2022, NJDOH was contacted by a resident in Building 2 at the Crown Village Condominium complex, who was concerned about indoor air sampling results she received for her unit. The data showed elevated levels of tetrachloroethylene (PCE) and trichloroethylene (TCE) in the indoor air of her unit. PCE is used as a dry-cleaning agent and metal degreasing solvent. TCE is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers. Both these chemicals can contaminate soil or groundwater from leaking storage tanks. The source of PCE and TCE at the Crown Village Condominium complex is likely from the prior industrial use of the property (Crown Wire). Following the concern expressed by the resident, NJDOH contacted the LSRP who performed the sampling. The LSRP explained that indoor air sampling was also conducted in other units within Building 2.

The LSRP informed NJDOH that the property was formerly industrial, and the PCE and TCE were discovered in groundwater during the removal of a heating oil underground storage tank. The levels of PCE and TCE in groundwater triggered a vapor intrusion investigation. NJDEP and the LSRP are currently investigating the extent of contamination at the site. This also includes characterizing the extent of off-site contamination.

The NJDOH confirmed with the NJDEP and the LSRP that the factsheet titled Potential Health Risks Associated with Exposures to Trichloroethylene (TCE) in Indoor Air was distributed to all building occupants. The dissemination of this fact sheet ensured that women who were pregnant or may have become pregnant during the remediation phase were able to make informed decisions given the potential health effects based on short term exposures to low levels of TCE while mitigation measures are being implemented.

The NJDOH reached out to the LSRP and NJDEP to learn if they had determined whether groundwater contamination had migrated off-site and potentially impacted adjacent properties. NJDEP indicated that the groundwater contamination from the Crown Village property has not been fully characterized but provided NJDOH with information pertaining to other nearby contaminated sites. The former J. Fletcher Creamer & Son Inc. site, which is located to the east of Crown Village, also has groundwater contaminated with PCE and TCE. These contaminants have impacted the indoor air of residential apartments on the property (Mariner's Landing Apartments). NJDOH reviewed information provided by the NJDEP for this site which indicated that vapor mitigation systems are effectively removing PCE and TCE in impacted buildings, and the systems are inspected annually by the LSRP for this site. Additionally, based on monitoring well results in April 2023, NJDEP sampled the indoor air of one residence on Garden Place north of the Crown Village condominium complex and found there were no detections of PCE and TCE in indoor air at this property. Three other properties on Garden Place refused access so indoor air impacts could not be determined.

This LHC evaluates the potential public health implications of PCE and TCE detected in the indoor air of all units of Building 2. There are 24 units in this building with eight units on each floor (three floors). All units in Building 2 were sampled between August and December 2022. Portable carbon air purifiers were provided to each unit with elevated levels of TCE and/or PCE to reduce levels of these contaminants until a permanent remediation system could be installed. As described below, two permanent remediation systems have recently been installed.

The indoor air of two units (on the first and second floor) was resampled in December 2022 to determine the effectiveness of interim measures put in place to reduce PCE and TCE levels. These interim measures included sealing vapor entry points and providing additional carbon air purifiers. Results indicated these measures reduced PCE and TCE levels prior to the implementation of the permanent remediation system.

In January 2023, a sub-slab depressurization system (SSDS) was installed beneath the portion of Building 2 where the highest concentrations of PCE and TCE were found under the building and in the indoor air. An SSDS creates a negative pressure below the building slab and the vapor in the soil beneath the building is vented outside, thus mitigating vapor intrusion into the building. Indoor air samples were collected in February 2023 in three units. Results confirmed that the SSDS was operating properly and was effectively reducing PCE and TCE

levels in the indoor air. In early May 2023, a soil vapor extraction (SVE) system was installed to supplement the SSDS and further reduce indoor air levels of PCE and TCE. SVE systems extract vapor from the soil above the water table by applying a vacuum to extract vapor for above-ground treatment. Follow-up indoor air sampling of all 24 units in Building 2 is expected to be conducted over a period of weeks starting in June 2023.

ATSDR Evaluation Process

An evaluation of site-related environmental contamination follows a two-tiered approach:

1. **Screening analysis**
   First, maximum concentrations of detected substances are compared to environmental media-specific comparison values. If contaminant concentrations exceed the environmental comparison value, these substances are selected for further evaluation. These are considered contaminants of concern.

2. **In-depth analysis**
   If contaminant concentrations are above these comparison values, NJDOH reviews exposure scenarios (such as duration and frequency), the toxicology of the contaminant, and epidemiology studies to determine likelihood of harmful health effects. During this part of the evaluation process, NJDOH estimates site-specific exposure doses and compares those to health guideline values, which are developed based on data drawn from the epidemiologic and toxicological literature. Many uncertainty factors, sometimes known as safety factors, are applied to ensure that the health-based comparison values amply protect human health.

Screening Analysis

Environmental Comparison Values

ATSDR develops comparison values to screen environmental contamination for further evaluation. Many comparison values are available to screen contaminants to identify contaminants of concern. One example is ATSDR's Environmental Media Evaluation Guides (EMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncancer health effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) are considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million ($1x10^{-6}$) persons exposed over their lifetime (78 years).

In addition to ATSDR comparison values, other screening values may also be used when relevant. In this evaluation, we used NJDEP's residential indoor air remediation standards (RIARS), which are health-based benchmarks derived from the evaluation of cancer and other health effects besides cancer (noncancer) using current toxicity criteria. The indoor air health-based criterion for each contaminant is determined as the more stringent of the cancer or noncancer-based value [NJDEP 2021a]. The RIARS are established to ensure that building occupants are not exposed to levels of contaminants which may cause adverse health effects.

NJDEP also has Rapid Action Levels (RALs) which are higher than the RIARS and require actions to be taken more quickly to reduce levels.

When vapor intrusion is present, NJDEP requires actions be taken to reduce levels within 14 days of a RAL exceedance and within 120 days of a RIARS exceedance that is below a RAL [NJDEP 2021b]. According to the LSRP, immediate actions were taken for all properties exceeding the RIARS by providing carbon air filtration units to reduce the levels of PCE and TCE until the soil vapor extraction system is installed and operational. For the purposes of this evaluation, NJDEP RIARS were used to screen for contaminants of concern.

Indoor air samples were collected between August and December 2022 in Building 2. One indoor air sample was collected from each of the 24 units (eight samples per floor). **Table 1** summarizes the levels of PCE and TCE found in Building 2 compared to NJDEP RIARS and RAL. PCE and TCE were both found in 16 units. PCE and TCE were not detected in eight units. Two units with high levels of PCE and TCE were resampled in December 2022 after actions were taken to reduce levels. These actions included installing additional carbon air filtration units and sealing vapor entry points. As shown in **Table 1**, both PCE and TCE are contaminants of concern and were evaluated further for adverse health effects.

Table 1. PCE and TCE Levels for Crown Village Building 2 (August – December 2022)

Contaminant	First Floor Range ($\mu g/m^3$) *	Second Floor Range ($\mu g/m^3$) *	Third Floor Range ($\mu g/m^3$) *	NJDEP RIARS ($\mu g/m^3$)	Exceedance of NJDEP RIARS?	NJDEP RAL ($\mu g/m^3$)	Exceedance of NJDEP RAL?	Contaminant of Concern
PCE	ND - 650	ND - 280	ND - 120	11	**Yes**	84	**Yes**	**Yes**
TCE	ND - 280	ND - 110	ND - 44	1.1	**Yes**	4.2	**Yes**	**Yes**

ND = Not Detected; $\mu g/m^3$ = micrograms of PCE or TCE per cubic meter of air; RIARS = NJDEP Residential Indoor Air Remediation Standard; RAL = NJDEP Rapid Action Level; PCE = Tetrachlorethylene: TCE = Trichloroethylene
* PCE and TCE were found in six units on the first floor, five units on the second floor, and five units on the third floor

In-Depth Analysis

NJDOH evaluated the indoor air data to determine whether the detected concentrations of PCE and TCE pose a health concern. In order for any contaminant to be a health concern, the contaminant must be present at a high enough concentration to cause potential harm and an exposure pathway must be present.

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. Source of contamination (contaminated groundwater and soil beneath Building 2)
2. Environmental media and transport mechanisms (indoor air/vapor intrusion)
3. Point of exposure (units in Building 2)
4. Route of exposure (inhalation)
5. Exposed population (residents of Building 2)

Generally, ATSDR considers the following three exposure categories:

a. completed exposure pathways — all five elements of a pathway are present;
b. potential exposure pathways — one or more of the elements might not be present, but information is insufficient to eliminate or exclude the element; and
c. eliminated exposure pathways — one or more of the elements is absent.

Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

Completed Exposure Pathways

Inhalation of contaminated indoor air: Residents in Building 2 were exposed to elevated levels of PCE and TCE in the indoor air. Two units were resampled in December 2022 after interim measures (installing carbon air purifiers and sealing vapor entry points) were taken to determine if levels of PCE and TCE were decreasing. Results showed that these measures helped to reduce PCE and TCE levels in these units.

As noted previously, an SSDS has been installed beneath the portion of Building 2 where the highest concentrations of PCE and TCE were found beneath the building and in the indoor air. The system began operating on January 5, 2023. An SVE system was also installed to mitigate the soil vapor beneath the building, and further reduce indoor air levels of PCE and TCE. Indoor air samples will be collected in June 2023 to confirm that both systems are effectively reducing PCE and TCE vapors in the indoor air.

Evaluating the Potential for Health Effects Other than Cancer

As a completed exposure pathway was identified for 16 of the 24 units in Building 2 where PCE and TCE exceeded NJDEP RIARS and/or the RAL, the next step is the calculation of site-specific exposure doses. These calculated doses are then compared to health guidelines, which are based on data drawn from the epidemiologic and toxicologic literature and often include uncertainty or safety factors to ensure that they are amply protective of human health. When the calculated doses are below health guidelines, then health effects other than cancer are not likely. NJDOH compared the measured air concentrations of PCE and TCE in these 16 units to ATSDR's health guidelines known as a Minimal Risk Level (MRL).

MRLs identify exposures that could be potentially hazardous to human health. MRLs can be set for three different time periods depending on the length of time people are exposed to the substance:

- acute (about 1 to 14 days),
- intermediate (from 15 to 364 days), and
- chronic (exposure for 365 days or more)

Exposure above the MRLs (for the relevant time period) does not necessarily mean that health problems will occur. An MRL is an estimate of the amount of a chemical a person can breathe, eat, or drink each day without a detectable noncancer risk to health.

MRLs are based on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated from observed effect levels in animal toxicological studies or occupational studies. They are adjusted by a series of uncertainty factors or through the use of statistical models. In toxicological literature, observations might be reported as:

- **No-observed-adverse-effect level (NOAEL)**: A NOAEL is the ***highest*** tested dose of a substance that has been reported to have ***no*** harmful health effects on people or animals.
- **Lowest-observed-adverse-effect level (LOAEL)**: A LOAEL is the ***lowest*** tested dose of a substance that has been reported to ***cause*** harmful health effects in people or animals.

To provide perspective on the potential for health effects, a calculated exposure dose or air concentration is compared to the MRL and the applicable NOAEL or LOAEL. As the exposure dose or air concentration increases beyond the MRL and approaches the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

ATSDR's approach for evaluating inhalation exposures in a residential setting is to use the measured air concentrations of the contaminant and compare it to the MRL via a ratio known as a "hazard quotient." The hazard quotient is defined as follows:

$$\textit{Hazard Quotient (HQ)} = \frac{\textit{Measured Air Concentration}}{\textit{ATSDR Chronic MRL}}$$

To evaluate noncancer health effects for residents in Building 2, the measured air concentration of PCE and TCE for each unit was compared to the MRL to calculate the hazard quotient. Hazard quotients were calculated using the minimum and maximum concentrations of PCE and TCE detected on each floor.

As the hazard quotient increases above 1.0, the potential for harmful effects increases and further evaluation is warranted. This further evaluation includes comparing the measured air concentration to the LOAEL or NOAEL to determine the likelihood of noncancer health effects. If the hazard quotient is less than 1.0, harmful noncancer health effects are not expected.

Table 2 summarizes the range of PCE and TCE levels detected on each floor of Building 2 and the calculated hazard quotients. As noted in this table, the maximum hazard quotients exceed 1.0 for both PCE and TCE. Therefore, both contaminants will be evaluated further for potential health effects.

Table 2. Calculated Hazard Quotients for PCE and TCE – Crown Village Building 2

Contaminant	Range of Detected Concentrations (µg/m^3)			ATSDR Chronic MRL (µg/m^3)	Minimum Hazard Quotient	Maximum Hazard Quotient	Is Further Evaluation Needed?
	First Floor	Second Floor	Third Floor				
PCE	6.0 - 650	2.7 - 280	3.6 - 120	41	0.1	16	**Yes (HQ >1)**
TCE	7.4 - 280	1.9 - 110	3.4 - 44	2.1	0.9	133	**Yes (HQ >1)**

Example Hazard Quotient Calculation for PCE = Maximum PCE concentration on first floor (650 µg/m^3) / ATSDR

Chronic MRL (41µg/m^3) = 16; Example Hazard Quotient Calculation for TCE = Maximum TCE concentration on first floor (280 µg/m^3) / ATSDR Chronic MRL (2.1µg/m^3) = 133; µg/m^3 = micrograms of PCE or TCE per cubic meter of air; PCE = Tetrachloroethylene; TCE = Trichloroethylene; HQ = Hazard Quotient

Health Effects of PCE in Indoor Air:

As described above, the LOAEL is the lowest tested amount of a substance that has been reported to cause harmful health effects. At a LOAEL of 11,530 µg/m^3, an epidemiological study of dry cleaner workers showed a significant decrease in blue-yellow color vision compared to controls, and workers who experienced continued exposure demonstrated a further deterioration in color vision when evaluated two years after the initial measurements. The MRL of 41 µg/m^3 is derived from this study by applying some safety factors to account for human variability among other factors.

Other occupational studies showed workers exposed to PCE concentrations ranging from approximately 76,000 to 277,000 µg/m^3 performed below expectation on tasks assessing memory, motor skills (reaction times), visual and executive function deficits following low-level exposure for one year or more [Echeverria 1995]. Another human study showed mild tubular damage to the kidneys at an adjusted LOAEL of 16,280 µg/m^3. **Table 3** summarizes these health effects.

Table 3. Health Effect Levels – PCE

Study	ATSDR MRL Derivation Study (human)	Other Studies (Human)	
LOAEL (µg/m^3)	11,530	16,280	76,000 -277,000
Health Effect	Decreased color vision	Mild kidney damage	Decreased neurological functions

Source: ATSDR Toxicological Profile for PCE available from: atsdr.cdc.gov/toxprofiles/tp18.pdf; µg/m^3 = micrograms of PCE per cubic meter of air; MRL = Minimal risk level; PCE = Tetrachloroethylene

The maximum concentration of PCE detected in Building 2 was 650 µg/m^3. This level is below the LOAEL of 11,530 µg/m^3. **Therefore, harmful noncancer health effects from PCE exposures are not likely for residents in Building 2.**

Health Effects of TCE in Indoor Air:

ATSDR adopted the US Environmental Protection Agency's (EPA) Reference Concentration (RfC) of 2 µg/m^3 as the chronic, inhalation MRL. The RfC is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime.

The RfC for TCE is based on two oral rodent studies. 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. EPA used physiologically based pharmacokinetic (PBPK) modeling to convert the oral dose in animals to a human equivalent concentration (HEC) of TCE in air. Based on these studies, the effect levels for TCE exposures in air are as follows:

- Mouse Study - Immunological Effects = 180 µg/m^3
- Rat Study – Fetal Heart Effects = 20 µg/m^3

EPA also cites a third study conducted in 1988 by the National Toxicology Program (of lower confidence) in support of the RfC where female rats were exposed to TCE by administering the chemical in corn oil by gavage for a 104-week period. EPA used PBPK modeling to convert the oral dose in animals to a HEC of 30 µg/m^3 TCE in air for kidney damage (**See Table 4**).

Table 4. Health Effect Levels - TCE

Study	**ATSDR MRL Derivation Study based on EPA RfC**		**EPA Support Study (National Toxicology Program)**
Effect Level (µg/m^3) *	20	180	30
Health Effect	Fetal Heart Effects (Rat Study)	Immune System Effects (Mouse Study)	Kidney Effects (Rat Study)

*The effect levels for these studies were derived using EPA models to derive "human equivalent concentrations (HECs);" Source: Toxicological Profile for TCE available from: atsdr.cdc.gov/ToxProfiles/tp19.pdf; µg/m^3 = micrograms of TCE per cubic meter of air; TCE = Trichloroethylene; MRL = Minimal Risk Level

ATSDR Threshold Approach for evaluating TCE:

TCE is unique because animal studies have shown that *short-term* exposures can increase the risk of health impacts on the developing fetus in the first trimester of pregnancy. Specifically, these animal studies show that exposure to low levels of TCE during the three-week period of heart formation in the first trimester of pregnancy could result in an increased risk of a heart defect in the unborn baby.

ATSDR considers a threshold of 6 µg/m^3 as a level of concern for fetal heart and kidney effects. **Table 5** summarizes the levels of TCE in the units of Building 2 and the corresponding effect levels.

Table 5. Summary of TCE Effect Levels for Crown Village – Building 2

TCE Concentration	**Crown Village Building 2 - Number of First Floor Units**	**Crown Village Building 2 - Number of Second Floor Units**	**Crown Village Building 2 – Number of Third Floor Units**	**Potential for Noncancer Health Effects**
Below 6 µg/m^3	2	6	5	No
Between 6 µg/m^3 [(a)] and 19 µg/m^3	2	0	1	**Yes**
Between 20 µg/m^3 [(b)] and 29 µg/m^3	0	0	1	**Yes**
Between 30 µg/m^3 [(c)] and 180 µg/m^3	3	2	1	**Yes**
Above 180 µg/m^3 [(d)]	1	0	0	**Yes**

[a] ATSDR Threshold of Concern for fetal heart and kidney effects; [b] Effect Level for fetal heart effects; [c] Effect Level for kidney effects; [d] Effect Level for immune system effects; µg/m^3 = micrograms of TCE per cubic meter of air; TCE = Trichloroethylene

As shown in Table 5, adverse noncancer health effects from exposure to TCE are not likely for 13 of the 24 units in Building 2. TCE levels in ten units exceeded the ATSDR threshold and effect levels for fetal heart and kidney effects. Therefore, women who may be pregnant or may have been pregnant while living in these units may be at an increased risk for fetal heart effects in their children from short-term exposures to TCE. There is also an increased risk for kidney effects in adults in these units. Additionally, there is an increased risk for immune system effects for adult residents in one unit.

It is important to note that the risks for health effects stated above is based on one sample from each unit. Using one data point for chronic exposures may overestimate the risk. It is also not known if TCE levels were higher or lower in these units prior to the discovery of the contamination beneath the building.

In order to protect the health of the residents in Building 2 with elevated TCE levels detected in their units, NJDOH provided the LSRP with a fact sheet explaining the health effects of short-term TCE exposures on the developing fetus. This fact sheet was provided to all residents where TCE was found to inform pregnant women of this short-term risk. This fact sheet can be found at nj.gov/health/ceohs/documents/tce_factsheet.pdf.

Evaluating the Potential for Cancer Health Effects

NJDOH evaluates the potential for cancer health effects by assessing the excess cancer risk relating to exposure over the background cancer risk. In New Jersey, approximately 45% of women and 49% of men (about 47% overall) will be diagnosed with cancer in their lifetime [NJDOH 2016]. This is referred to as the "background cancer risk."

The term "excess cancer risk" represents the risk on top of the background cancer risk and is referred to as the Lifetime Excess Cancer Risk, or LECR. An LECR of "one-in-a-million" (1/1,000,000 or $1x10^{-6}$ cancer risk) means that if 1,000,000 people are exposed to a cancer-causing substance at a certain level for a period of time, then one cancer above the background number of cancers may develop in those one million people over the course of their lifetime (considered 78 years).

To put the LECR of 10^{-6} in context of New Jersey's background cancer risk, the number of cancers expected in one million people over their lifetime is 470,000 (47%) in New Jersey. If these one million people are all exposed to a cancer-causing substance for a specific duration, then 470,001 people may develop cancer instead of the expected 470,000 over the course of their lifetime (78 years).

The NJDOH follows ATSDR's guidelines to evaluate theoretical cancer risks from environmental exposures (ATSDR 2022). A **concern for an increased risk** is categorized as an excess of one or more additional cancer cases per 10,000 people (expressed as risk in "the $1x10^{-4}$ range" or higher). This is a theoretical estimate of cancer risk that NJDOH and ATSDR use as a tool for deciding whether public health actions are needed to protect health. It is not an actual estimate of cancer cases in a community and is not a prediction that cancer will occur. NJDOH and ATSDR categorize **no concern for an increased risk** to include risks in the range between

one and nine additional cancer cases per 100,000 people (expressed as "the $1x10^{-5}$ range") and *an even lower* risk is represented by the range between one and nine additional cancer cases per 1,000,000 people (expressed as "the $1x10^{-6}$ range"). Health guidelines are typically developed for carcinogens based on one excess cancer case per 1,000,000 individuals exposed. According to the U.S. Department of Health and Human Services (DHHS), possible cancer classes of contaminants detected at a site are as follows:

- Known human carcinogen;
- Reasonably anticipated to be a carcinogen; and
- Not classified.

PCE - Studies in humans suggest that exposure to PCE might lead to a higher risk of developing bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma. In animals, PCE has been shown to cause cancers of the liver, kidney, and blood system. The U.S. Department of Health and Human Services (DHHS) considers PCE to be reasonably anticipated to be a human carcinogen. EPA considers PCE likely to be carcinogenic to humans by all routes of exposure. The International Agency for Research on Cancer (IARC) considers PCE to be a probable human carcinogen.

TCE - There is strong evidence that TCE can cause kidney cancer in people and some evidence for TCE-induced liver cancer and malignant lymphoma. Lifetime exposure to TCE resulted in increased liver cancer in mice and increased kidney cancer and testicular cancer in rats. The DHHS considers TCE to be a known human carcinogen. The IARC classified TCE as carcinogenic to humans. EPA has characterized TCE as carcinogenic to humans by all routes of exposure.

Calculating Cancer Risks for PCE and TCE

The LECR is calculated for residential exposures by multiplying the measured air concentration and exposure duration by the EPA's inhalation unit risk (IUR) for cancer. The IUR is the incremental risk posed by a specific concentration unit in air (usually per one microgram per cubic meter ($\mu g/m^3$) of the pollutant in air). This LECR calculation yields the relative increase of cancer risk (above the background rate) from exposure to individual pollutants.

The LECRs for each unit in Building 2 were calculated using ATSDR's guidance for inhalation exposures in residential settings and the year that Crown Village was constructed. Based on this information, an exposure duration of 33 years over a 78-year average lifetime was used to calculate the LECRs for residents in Building 2.

The formula used to calculate the LECRs for Building 2 is as follows:

$$LECR = C \times ED/AT \times IUR$$

Where:

LECR = Lifetime Excess Cancer Risk
C = Measured Concentration of PCE or TCE in air ($\mu g/m^3$)
ED = Exposure Duration (33 years)

AT = Averaging Time (Average Lifetime of 78 years)
IUR = Inhalation Unit Risk $(\mu g/m^3)^{-1}$

The LECRs for exposures to PCE in Building 2 ranged from approximately three in 10,000,000 ($3x10^{-7}$) similarly exposed people to seven in 100,000 ($7x10^{-5}$) similarly exposed people (**See Table 6**). The LECRs for exposures to TCE in Building 2 ranged from approximately three in 1,000,000 ($3x10^{-6}$) similarly exposed people to approximately five in 10,000 ($5x10^{-4}$) similarly exposed people (**See Table 7**).

Table 6. LECRs for PCE – Crown Village Building 2

Building Floor	Range of Detected PCE Concentrations ($\mu g/m^3$)	Exposure Duration (years)	Averaging Time (years)	PCE IUR $(\mu g/m^3)^{-1}$	LECR Range
First	6.0 - 650	33	78	2.6×10^{-7}	6.6×10^{-7} to 7.2×10^{-5}
Second	2.7 - 280	33	78	2.6×10^{-7}	3.0×10^{-7} to 3.1×10^{-5}
Third	3.6 - 120	33	78	2.6×10^{-7}	4.0×10^{-7} to 1.3×10^{-5}

Example LECR calculation using First Floor Maximum PCE of 650 $\mu g/m^3$: LECR = 650 $\mu g/m^3$ x 33 years/78 years x $2.6 \times 10^{-7} = 7.2 \times 10^{-5}$; $\mu g/m^3$ = micrograms PCE per cubic meter of air; IUR = Inhalation Unit Risk; LECR = Lifetime Excess Cancer Risk

Table 7. LECRs for TCE – Crown Village Building 2

Building Floor	Range of Detected TCE Concentrations ($\mu g/m^3$)	Exposure Duration (years)	Average Lifetime (years)	TCE IUR $(\mu g/m^3)^{-1}$	LECR Range
First	7.4 – 280	33	78	4.1×10^{-6}	1.3×10^{-5} to 4.9×10^{-4}
Second	1.9 - 110	33	78	4.1×10^{-6}	3.3×10^{-6} to 1.9×10^{-4}
Third	3.4 - 44	33	78	4.1×10^{-6}	5.9×10^{-6} to 7.6×10^{-5}

Example LECR calculation using First Floor Maximum TCE of 280 $\mu g/m^3$: LECR = 280 $\mu g/m^3$ x 33 years/78 years x $4.1 \times 10^{-6} = 4.9 \times 10^{-4}$; $\mu g/m^3$ = micrograms TCE per cubic meter of air; IUR = Inhalation Unit Risk; LECR = Lifetime Excess Cancer Risk

Since PCE and TCE were found together in 16 of the 24 units in Building 2, a total LECR was calculated for these units to assess the total theoretical cancer risk from exposures to both PCE and TCE (**see Table 8**).

Table 8. Total LECRs for PCE and TCE at Crown Village Building 2

Unit *	PCE Concentration (µg/m3)	TCE Concentration (µg/m3)	PCE LECR	TCE LECR	Total LECR
A	6	7.4	6.6×10^{-7}	1.3×10^{-5}	1×10^{-5}
B	8.9	9	9.8×10^{-7}	1.6×10^{-5}	2×10^{-5}
C	91	86	1.0×10^{-5}	1.5×10^{-4}	2×10^{-4}
D	87	51	9.6×10^{-6}	8.8×10^{-5}	1×10^{-4}
E	380	150	4.2×10^{-5}	2.6×10^{-4}	3×10^{-4}
F	650	280	7.2×10^{-5}	4.9×10^{-4}	6×10^{-4}
G	2.7	3	3.0×10^{-7}	5.2×10^{-6}	6×10^{-6}

Unit *	PCE Concentration (µg/m3)	TCE Concentration (µg/m3)	PCE LECR	TCE LECR	Total LECR
H	66	51	7.3×10^{-6}	8.8×10^{-5}	1×10^{-4}
I	3.4	1.9	3.7×10^{-7}	3.3×10^{-6}	4×10^{-6}
J	12	4.3	1.3×10^{-6}	7.5×10^{-6}	9×10^{-6}
K	280	110	3.1×10^{-5}	1.9×10^{-4}	2×10^{-4}
L	3.6	3.4	4.0×10^{-7}	5.9×10^{-6}	6×10^{-6}
M	20	16	2.2×10^{-6}	2.8×10^{-5}	3×10^{-5}
N	7.9	3.4	8.7×10^{-7}	5.9×10^{-6}	7×10^{-6}
O	120	44	1.3×10^{-5}	7.6×10^{-5}	9×10^{-5}
P	79	26	8.7×10^{-6}	4.5×10^{-5}	5×10^{-5}

***** To protect privacy, alphabetic letters were used to identify the units in Building 2 with PCE and TCE detections. PCE = Tetrachloroethylene; TCE = Trichloroethylene; LECR = Lifetime Excess Cancer Risk; $\mu g/m^3$ = micrograms of PCE or TCE per cubic meter of air.

As shown in **Table 8**, the total LECRs for 10 units in Building 2 (units A, B, G, I, J, and L through P) ranged from approximately four in 1,000,000 ($4x10^{-6}$) similarly exposed people to approximately nine in 100,000 ($9x10^{-5}$) similarly exposed people. **This indicates no concern for an increased theoretical cancer risk.**

The total LECRs for six units in Building 2 (units C, D, E, F, H, and K) ranged from one to six in 10,000 ($1x10^{-4}$ to $1x10^{-6}$) similarly exposed people. **This indicates a concern for an increased theoretical cancer risk.** As previously mentioned, this is a theoretical estimate of cancer risk that NJDOH and ATSDR use as a tool for deciding whether public health actions are needed to protect health. It is not an actual estimate of cancer cases in a community and is not a prediction that cancer will occur.

Conclusions

Based on the information available at the time of this evaluation, NJDOH concludes that:

1. For health effects other than cancer, exposures to elevated levels of TCE in the indoor air of 11 units (A through F, H, K, M, O, and P) may have harmed people's health. Women who are pregnant or may become pregnant are at an increased risk for fetal heart effects in their unborn children from *short-term* TCE exposure. There is also an increased risk for kidney damage and autoimmune effects in adults from chronic (long-term) TCE exposures.

2. For health effects other than cancer, exposures to elevated levels of PCE in the indoor air of all units are not likely to harm people's health. The maximum level of PCE detected in Building 2 was below the levels where adverse noncancer health effects were observed in toxicological studies.

3. Theoretical increased cancer risks are a concern for six units (C, D, E, F, H, and K) from exposures to PCE and TCE in the indoor air. There is not a concern for an increased theoretical cancer risk in the remaining units in Building 2.

Conclusion Uncertainties

1. This evaluation is based on one sample for each condominium unit prior to remedial measures being put into place. This may overestimate or underestimate the risk as it is not known if levels were higher or lower in the past.

2. This evaluation accounts for the most conservative scenario where the same people lived in the units since the building was constructed. Therefore, if people spent less time in their unit, the risk would be lower.

Recommendations

1. NJDOH recommends NJDEP and the LSRP ensure that indoor air levels of TCE and PCE in Building 2 are reduced and remain below NJDEP RIARS to be protective of public health. NJDOH is aware that interim measures (air purifiers and sealing vapor entry points) and permanent measures (an SSDS) have helped reduce levels of TCE and PCE. NJDOH is additionally aware that the LSRP will be testing the indoor air of all units in June 2023 following the installation of the SVE system.

2. NJDOH recommends NJDEP and the LSRP characterize the extent of the plume to determine if additional nearby residents and buildings may be impacted.

NJDOH will continue to review additional data as it becomes available. Please feel free to contact me at 609-826-4984 or by email at Christa.Fontecchio@doh.nj.gov with any questions or concerns.

Sincerely,

Christa Fontecchio

Christa Fontecchio, M.P.H.
Environmental and Occupational Health Surveillance Program
New Jersey Department of Health

c: Leah Graziano, R.S. Regional Director, ATSDR Region 2
Tom Varner, Licensed Site Remediation Professional
Nicholas Belecanech, NJDEP Case Manager

References:

ATSDR Toxicological Profile – PCE: atsdr.cdc.gov/toxprofiles/tp18.pdf

ATSDR Toxicological Profile – TCE: atsdr.cdc.gov/ToxProfiles/tp19.pdf

ATSDR Guidance for Inhalation Exposures. Atlanta, Ga: U.S. Department of Health and Human Services, Public Health Service, December 1, 2020.

ATSDR Newsletter for Health Assessors Including APPLETREE Partners "Describing Cancer Risk in ATSDR's Public Health Assessment Documents" January 2022 (not available online).

Cavalleri A; Gobba F; Paltrinieri M; et al. 1994. Perchloroethylene exposure can induce colour vision loss. Neurosci Lett 179:162-166.

Echeverria D, White RF, Sampaio C. 1995. A behavioral evaluation of PCE exposure in patients and dry cleaners: A possible relationship between clinical and preclinical effects. J Occup Environ Med 37(6):667-680.

NJDEP 2014. Overview of the Licensed Site Remediation Professional (LSRP) Program Available at: nj.gov/dep/srp/srra/lsrp/lsrp_program_overview.pdf

NJDEP 2021a. Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway Basis and Background May 2021. Available at: nj.gov/dep/srp/guidance/vaporintrusion/iars_vi_bb.pdf

NJDEP 2021b. New Jersey Department of Environmental Protection Site Remediation and Waste Management Program Vapor Intrusion Technical Guidance May 2021 Version 5.0.

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