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TO: File

FROM: Sharee Rusnak, Epidemiologist

SUBJ: Evaluation of Environmental Data from the Virginia Rail Neighborhood in Bethany, Connecticut

DATE: March 24, 2023

This Letter Health Consultation (LHC) was prepared to document our evaluation of private well analysis data from the Virginia Rail Neighborhood in Bethany, Connecticut. Well water analysis data was obtained from the Connecticut Department of Energy and Environmental Protection (CT DEEP).

BACKGROUND AND INTRODUCTION

In February 2022, CT DEEP Remediation Program requested that the Connecticut Department of Public Health (CT DPH) evaluate the public health significance of private well sampling analysis data in the Virginia Rail neighborhood in Bethany. The focus of this letter health consultation is to evaluate private well sampling analysis data from the Virginia Rail neighborhood.

In the winter of 2022, CT DPH received well water sampling analysis data as part of a well water contamination investigation in the Virginia Rail neighborhood. The source of the contamination is unknown. The Virginia Rail neighborhood includes 21 homes on Virginia Rail Drive, Cecar Road, Johnson Road, and Pole Hill Road. CT DPH received well water sampling analysis data from 17 of the 21 homes in the Virginia Rail neighborhood. Only one well out of 17 had volatile organic compound (VOCs) concentrations above state drinking water action levels (Als) and the homeowner immediately installed a whole house filter. ALs are health-based concentrations for private well water.

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Private Well Sampling Data

CT DPH received 25 samples from wells from 17 homes in the Virginia Rail neighborhood that were sampled from December 2021-January 2022. Five of the residences had detectable levels of VOCs, including tetrachloroethylene (PCE), trichloroethylene (TCE), and cis-1,2-dichloroethene (cis-1,2 DCE). As shown in Table 1, only one residence had a well with VOC levels above the CT Als. The contaminants detected above Als are PCE and TCE. While there is no CT AL for cis 1,2-DCE, there is a United States Environmental Protection Agency Maximum Contaminant Level (US EPA MCL) of 7 parts per million and there were no cis 1,2-DCE exceedances in the wells. A US EPA MCL is the maximum concentration of a chemical that is allowed in public drinking water systems.

Table 1. Summary of Private Well Sampling Analysis Data from 17 Residences in the Virginia Rail Neighborhood.

Contaminant	Concentration Range (ppb[#])	Number of Wells With one or More Exceedances of the Comparison Value/Number of Wells	Comparison Value (ppb)	Comparison Value Source
Tetrachlorethylene (PCE)	ND-16	1/17	5	CT AL[*]
Trichlorethylene (TCE)	ND-11	1/17	1	CT AL

[#]Parts per billion
[*]Connection Action Level

DISCUSSION

Exposure Pathway Analysis

To evaluate potential exposure to private well contaminants from the Virginia Rail neighborhood, CT DPH evaluated the environmental data and considered how people might come into contact with contaminants in private well water. The possible routes of exposure are dermal, inhalation, and ingestion. In other words, in order to be exposed to contaminants in private well water, one must come into contact with the well water by touching it, breathing vaporized water particles, or drinking the water. The main household activities that could expose adults and children are ingestion exposure from using water for drinking and cooking and inhalation and dermal exposure from bathing and showering. Thirty years is assumed to be the exposure duration.

Exposure to Trichloroethlyene (TCE) and Tetrachloroethylene (PCE)

Only one of the 17 homes sampled had a well whose water contained TCE and PCE levels that exceeded the AL. As stated previously, this residence immediately installed a whole house filter upon receiving their well water analysis results.

When determining the public health implications of exposure to hazardous contaminants, CT DPH considers how people might come into contact with contaminants and compares contaminant concentrations with health

protective comparison values. When contaminant levels are below health-based comparison values, health impacts from exposure to those levels are unlikely. Contaminant levels exceeding comparison values do not indicate that health impacts are likely but instead warrant further evaluation. In this health consultation, CT DPH used established ALs as health protective screening values. As stated previously, AL are health-based concentrations for private well water above which, CT DEEP is authorized to provide drinking water treatment or bottled water to residents. CT DPH only evaluated completed exposure pathways where private well contamination exceeded the ALs. General toxicology information on TCE and PCE can be found at: https://www.atsdr.cdc.gov/toxfaqs/tfacts19.pdf and https://www.atsdr.cdc.gov/toxfaqs/tfacts18.pdf.

Table 1 indicates that TCE and PCE were detected in 1 private well at levels above the AL in the Virginia Rail neighborhood. CT DPH used TCE and PCE concentrations found in the private well sample results from this well to estimate risk. A child/adult, aged 1-30, was assumed to be exposed to 11 ppb of TCE and 16 ppb of PCE for 30 years. CT DPH assumed that contact with private well water occurred daily (365 days/year) through normal routine activities like bathing, showering, and drinking and that children ingested 0.337 L/day and adults ingested 1.3 L/day of private well water (ATSDR 2023). To simplify risk calculations, CT DPH assumed that the total dose from dermal contact, ingestion and inhalation exposure was 3 times the ingestion dose (Ginsberg, 2011).

CT DPH calculated risk estimates based on TCE and PCE concentrations found in the private well. Risk calculations can be found in Appendix A.

Uncertainties

It is important to note that there is some uncertainty with regard to exposure duration assumptions in our risk estimate for both non-cancer and cancer effects. We do not know how long residents living in the Virginia Rail neighborhood area were exposed to TCE and PCE in their private well water. True exposure duration may be less than 30 years.

One must also emphasize that there is a large degree of uncertainty in the non-cancer and cancer risk calculations because of the lack of historical data on TCE and PCE in private well water in the Virginia Rail neighborhood. A single measurement may not be representative of past water concentrations. TCE and PCE concentrations in private well water could be greater or less than the concentration used in this risk assessment.

Lastly, there is uncertainty in using the screening approach (the total dose from dermal, inhalation, and ingestion exposure equals 3 times the ingestion dose to estimate total exposure dose. However, we expect that the screening approach would not result in an underestimate of the total dose.

Trichlorethylene
Non-cancer Effects

Using 11 ppb as the exposure level, the average daily dose from the site is 0.87 ug/kg/day. This dose exceeds the US EPA's reference dose (RfD) of 0.5 ug/kg/day (EPA 2011a). Because the dose from the site exceeded the RfD, non-cancer effects from past exposure to TCE in private well water from the site cannot be ruled out.

To provide further perspective on non-cancer risk calculations, CT DPH compared the estimated dose from the site with non-cancer effect levels from toxicology literature (Tables 2 and 3). Even using the TCE

concentration detected in the well water (from the well whose TCE levels exceeded the AL), the estimated dose from the site is much lower than range of lowest observable adverse effect levels (LOAELs) reported in rodent toxicology studies. Because of this, non-cancer effects from exposure to TCE are not likely.

Tables 2 and 3. Estimated Doses for TCE: A Comparison of Average Daily Doses (ADD) from Drinking Contaminated Water in the Virginia Rail Neighborhood in Bethany, CT to Noncancer and Cancer Effect Levels From Toxicology Literature

Table 2

TCE Dose from drinking water in the Virginia Rail Neighborhood in Bethany, CT (ug/kg/day)	Comments
0.32	Estimated LADD* for cancer effects using the private well concentration
0.87	Estimated ADD for non-cancer effects using the private well concentration

Table 3

Effect Level from the Literature (ug/kg/day)	Comment
33000-67000	Human equivalent LED_{01} # based on kidney tumors, in rats exposed by ingestion. (EPA 2011b)
500-3100	Range of human equivalent LED_{01} values based on liver tumors in mice by ingestion and inhalation (EPA 2011b)
3950	Human equivalent LED_{10} for testicular tumors in rats (EPA 2011b)
2800	LED_{01} for renal cell carcinoma in human workers (Charbotel 2006)
5000	LED_{01} for kidney cancer in German cardboard workers exposed by inhalation (EPA 2011b)
14-1400	Range of LED_{01} values for cancer (non-Hodgkin's lymphoma, liver cancer, kidney cancer) in Finnish workers exposed to TCE and other solvents (EPA 2011b)
50,000-2,400,000	LOAEL^ for renal effects in rats and mice (ASTDR 2019a)

*Lifetime Average Daily Dose
^Lowest Adverse Effect Level
#Lower 95% Confidence Limit on the effective dose to 1% of the population

Trichloroethylene
Cancer Effects

CT DPH used the cancer slope factor of 0.046 $(mg/kg/day)^{-1}$ when evaluating theoretical cancer risk for exposure to trichloroethylene. This cancer slope factor was derived by the US EPA in 2011 and is based on 3 rodent toxicity studies that in resulted developmental and immune system effects including, decreased thymus weight, developmental immunotoxicity effects and fetal heart malformations. (EPA 2011a).

If a community member was exposed to contaminated well water every day for 30 years at a concentration of 11 ppb, it would result in a lifetime average daily dose of 0.32 ug/kg/day. Using the US EPA's oral cancer slope factor, the theoretical risk would be 1 in 100,000 (EPA 2011a). This means that there might be 1 excess cancer in a population of 100,000 exposed to the contaminated well water every day for 30 years. This theoretical cancer risk estimate indicates low increased lifetime incremental cancer risk from exposure to TCE. When a theoretical cancer risk is less than 1×10^{-4}, or one excess cancer risk in 10,000 cases, then it is thought to be low increased risk of possible cancer related to that chemical exposure.

Background rates of cancer in the United States are 1 in 2 or 3 (NCI 2001). This means that in a population of 100,000, background numbers of cases would be approximately 33,333 to 50,000.

To provide further perspective on cancer risk calculations, CT DPH compared the estimated dose with effect levels from toxicology literature (Tables 2 and 3). The estimated average dose is lower than the effect level for cancer health effects reported both human and rodent toxicology studies. Because of this, cancer effects from exposure to TCE are not likely.

Tetrachlorethylene
Non-cancer Effects

Using 16 ppb as the exposure level, the average daily dose from the site is 1.27 ug/kg/day. This dose is less the US EPA's reference dose (RfD) of 6.0 ug/kg/day (EPA 2012). Because the dose is less than the RfD, non-cancer effects from past exposure to PCE in private well is unlikely.

Tetrachlorethylene
Cancer Effects

CT DPH uses the cancer slope factor of 0.0021 $(mg/kg/day)^{-1}$ when evaluating theoretical cancer risk for exposure to PCE. This cancer slope factor is based on animal studies with hepatocellular adenomas or carcinomas as the primary cancer outcome (EPA 2012).

If a community member was exposed to contaminated well water every day for 30 years at a concentration of 16 ppb, it would result in a lifetime average daily dose of 0.47 ug/kg/day. Using the US EPA's oral cancer slope factor, the theoretical risk would be approximately 1 in 1,000,000. This means that there might be 1 excess cancer in a population of 1,000,000 exposed to the contaminated well water every day for 30 years. This theoretical cancer risk estimate indicates low increased lifetime incremental cancer risk from exposure to PCE. When a theoretical cancer risk is less than 1×10^{-4}, or one excess cancer risk in 10,000 cases, then it is thought to be low increased risk of possible cancer related to that chemical exposure.

Background rates of cancer in the United States are 1 in 2 or 3 (NCI 2001). This means that in a population of 1,000,000, background numbers of cases would be approximately 333,333 to 500,000.

CONCLUSIONS

One private well in the Virginia Rail neighborhood had TCE and PCE concentrations that exceeded state drinking water action levels. These residents may have been ingesting this contaminated water for a long period of time. The residence whose private well had PCE and TCE levels that exceeded the AL has installed a whole house filter and is thus, no longer exposed to either contaminant.

In the past, residents were exposed to TCE and PCE in their well water from drinking the water, as well as inhalation and dermal exposure from bathing and showering. Exposure to the detected levels of both of these contaminants are not expected to harm people's health.

RECOMMENDATIONS

1. CT DPH recommends that community members who live in the affected area consult with their physicians if they have questions about health issues that could be related to exposure to contaminated private well water.

2. CT DPH recommends that the homeowner whose private well had TCE and PCE levels above ALs should maintain their whole house filters according to recommendations from their water treatment company.

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Appendix A
Risk Calculations

Virginia Rail, Neighborhood, Bethany Private Well Contamination

TCE

NONCANCER RISK (Assuming TCE concentration of 11 ppb)

Ingestion, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	1/BWc (1/kg)	1/Atnc (1/yr)	ADDi (ug/kg/day)	RfD (ug/kg/day)	Total ADDing (ug/kg/day)	HI
0.337	11.00	6.00	0.06	0.17	0.22	0.50	0.87	1.74

CANCER RISK (child/adult aged 1-30) (Assuming TCE concentration of 11 ppb)

Ingestion, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	1/BWc (1/kg)	1/Atc (1/yr)	ADDi (ug/kg/day)	Total ADDing	Total ADD	Conv to mg/kg/day	CSF	ELCR
0.337	11.00	6.00	0.06	0.01	0.02	0.08	0.32	0.00032	0.046	0.0000147

Ingestion, child/adult, aged 6-30 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	1/BWc (1/kg)	1/Atc (1/yr)	ADDi (ug/kg/day)
1.30	11.00	24.00	0.01	0.01	0.06

PCE

NONCANCER RISK (Assuming PCE concentration of 16 ppb)

Ingestion, Ave Concentration, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)	ED (yr)	1/BWc (1/kg)	1/Atnc (1/yr)	ADDi (ug/kg/day)	RfD (ug/kg/day)	Total ADDing (ug/kg/day)	HI
0.337	16.00	6.00	0.06	0.17	0.32	6.00	1.27	0.21

CANCER RISK (child/adult age 1-30) (Assuming PCE concentration of 16 ppb)

Ingestion, Ave Concentration, child, aged 1-6 years

Ing Rate (L/day)	[Conc] (ug/L)]	ED (yr)	1/BWc (1/kg)	1/Atc (1/yr)	ADDi (ug/kg/day)	Total ADDing	Total ADD	Conv to mg/kg/day	CSF	ELCR
0.337	16.00	6.00	0.06	0.01	0.03	0.12	0.47	0.00047	0.00210000	.00000098

Ingestion, PCE Concentration of 16 ppb, child/adult, aged 6-30 years

Ing Rate (L/day)	[Conc] (ug/L)]	ED (yr)	1/BWc (1/kg)	1/Atc (1/yr)	ADDi (ug/kg/day)
1.3	16.00	24.00	0.01	0.01	0.09

WHERE:

ADD_i	= Average daily dose from ingestion (ug/kg/day)
AT_{nc}	= Averaging time for non-cancer risk: 6 years
AT_c	= Averaging time for cancer risk: 70 years
Bw	= Child 50^{th} %tile body weight for age 1-6 yrs; 17 kg ; adult, 80 kg (EPA 2011c)
[Conc]	= TCE concentration: 11 ug/L; PCE concentration:16 ug/L
CSF	= Cancer slope factor, TCE: 0.046 $(mg/kg/day)^{-1}$ (EPA 2011a) PCE: 0.0021 $(mg/kg/day)^{-1}$ (EPA 2012)
ED	= Exposure duration; 6 years (child, age 1-6 years), 24 year (child/adult)
ELCR	= Estimated Lifetime Cancer Risk
HI	= Hazard index
Ing Rate	= Ingestion rate, child: 0.337 L/day, adult: 1.3 L/day (ATSDR 2023)
RfD	= EPA reference dose, TCE: 0.5 ug/kg/day (EPA 2011a), PCE: 6.0 ug/kg/day (EPA 2012)
Total ADD	= Total average daily dose from ingestion, inhalation (from bathing/shower and from household air), and from dermal contact (ug/kg/day)