

# Trichloroethylene Contamination

## Decommissioned OMCC site

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# Trichloroethylene – What is it?

- Volatile organic chemical (VOC) used primarily as an industrial solvent
- Colourless or blue liquid with a sweet, chloroform-like odour.
- Degreaser, metal cleaner, in some consumer products
- Used as an anaesthetic in the past
- Used in commercial settings since 1920's
- Not produced in Canada any longer
- Readily evaporates into air
- Can be persistent in groundwater

# TCE Production

*A widely used chemical in the past*

## Western Europe

1980 - 210 kt

1990 – 131 kt

## United States

1980 – 121 kt

1990 – 79 kt

## Japan

1980 - 82 kt

1990 – 57 kt

# Public Health's Role

- Assess health risk to the public
- Ensure appropriate actions to protect the public's health are taken
- Monitor the progression of those actions
- Communication to residents affected

# How are people exposed?

- Can be exposed to TCE through its presence in drinking water, air and food
- Certain segments of the population can be exposed via contaminated soil or occupational settings
  - Vapour intrusion from contaminated water and/or soil

# Pathways of Human Exposure to TCE

**Source of Contamination**



**Environmental Media**

Air

Soil

Water

Food

**Route of Exposure**

Inhalation

Ingestion

Ingestion

Ingestion

**Receptor person or population at point of exposure**



# Concentrations in community and residential air

- Outdoor air survey, Canada 1988-90 (Dann and Wang, 1992):
  - 11 urban, 1 rural site
  - Site mean concentrations ranged from 0.07  $\mu\text{g}/\text{m}^3$  to 0.45  $\mu\text{g}/\text{m}^3$  with an overall mean of 0.28  $\mu\text{g}/\text{m}^3$
- Indoor air survey (Otson *et al.* 1992):
  - 750 Canadian homes in 10 provinces
  - Mean concentration 1.4  $\mu\text{g}/\text{m}^3$ , max. 165  $\mu\text{g}/\text{m}^3$
- Exposure to TCE is widespread, even in areas without a source of contamination. Exposures to the public are coming down as TCE use is restricted.

# Estimated Daily Intake of TCE by Canadians

	Infant 0 – 0.5	Toddler 0.5 – 4	Child 5-11	Youth 12-19	Adult 20-70
Ambient air*	0.003 – 0.02	0.004 – 0.03	0.005 – 0.03	0.005 – 0.03	0.005 – 0.03
Indoor air*	0.33	0.45	0.52	0.43	0.38
Drinking Water*	0.02	0.01	0.007	0.005	0.004
Food*	0.02	0.02 – 0.04	0.01 – 0.04	0.006 – 0.02	0.004 – 0.01
<b>Total Intake</b>	<b>0.37 – 0.39</b>	<b>0.48 – 0.53</b>	<b>0.54 – 0.60</b>	<b>0.45 – 0.49</b>	<b>0.39 – 0.41</b>

Unit of measurement:  $\mu\text{g}/\text{kg}$  bw per day.

\*Source: CEPA, 1993.



# What is subsurface vapour intrusion?

- Chemicals in ground water or soil can volatilize (evaporate) and enter overlying buildings
- Naturally present chemicals (radon)
- Chemicals that entered the environment from a spill (TCE, hydrocarbon fuels)
- Rates of intrusion vary depending on many factors

# Ruling out TCE exposure pathways

- Soil (e.g. vegetables grown in backyard)
  - In general, plants would be unlikely to uptake appreciable amounts of TCE from vapours that might be present in the soil. (MOE plant experts)
- Air
  - When TCE is present in groundwater, it can evaporate, migrate through the soil and eventually enter basements through cracks and other openings in the foundation.

# Health Risks Associated with Exposure

- Health risks associated with exposure depend on:
  - How much a person was exposed to (the dose)
  - How long the exposure lasted (the duration)
  - How the person was exposed (breathing, eating, drinking, skin contact)
  - Other individual factors e.g. age, health, lifestyle choices, exposure to other chemicals, family traits

# Health Effects

- Acute effects
  - Drowsiness, memory impairment, anaesthesia
- Chronic effects
  - Cancer and non-cancer effects
  - Cancer is the main concern

# TCE Health Effects

- Acute effects:
  - Occur at levels starting from 540,000  $\mu\text{g}/\text{m}^3$  (EPA, 2001)
  - Effects include sleepiness/dizziness, headache, irritation, poor coordination, difficulty concentrating
  - Levels in this community much lower
  - Therefore, levels in this community do not give rise to acute effects

# Chronic Health Risks

- Cancer
  - Kidney, liver and lymphoid tissue cancers have been associated with TCE
  - Links between exposure to TCE and kidney and testicular tumours
  - TCE has been classified as probably carcinogenic to humans
- Other Health Risks
  - Studies have shown a small increase in the rate of reproductive effects (heart malformations in fetuses)

# Cancer Risks

- For many carcinogens, it is believed there is no threshold for risk and that any exposure is associated with some 'non-zero' risk
- Risk does not depend on level and duration of exposure
- Carcinogens vary in 'potency'; the amount of cancer risk that is associated with a given degree of exposure
- Quantitative risk assessment uses the results of studies in animals (and sometimes humans) to predict the probability of developing cancer at a certain level of exposure
- This type of assessment is often used by regulators to set standards and can also be used to predict the additional number of cancers 'expected' in a group of people with a given level of exposure to a particular carcinogen.

# TCE Exposure and Risk for Cancer

- An air level of **0.5** micrograms per cubic metre corresponds to a **1 in one million risk of cancer** over a lifetime (70 years)
- An air level of **5.0** micrograms per cubic metre corresponds to **1 in one hundred thousand risk of cancer** over a lifetime (70 years)
- An air level of **50.0** micrograms per cubic metre corresponds to **1 in ten thousand risk of cancer** over a lifetime (70 years)



# Cancer Risk (TCE)

- What does “1 in 10,000, 1 in a million, 1 in 100,000 risk of cancer in a lifetime” mean?
  - e.g. risk of 1 in 100,000
    - If you follow a population of 100,000 people over a lifetime, 33 000 will develop cancer in the absence of TCE (because of other causes).
    - If TCE is present, there will be 33,001 cases of cancer, that is, 1 additional case because of the TCE.
- Risk is present, but very small.

# What about effects other than cancer?

- Large amounts of information on toxicological effects of TCE
- Many different potential effects have been investigated
- The potential for toxic effects depends on how much one is exposed to, and for how long
- In the past, the effect considered to be most significant were on the nervous system, kidney and liver. These have been used as the basis for exposure limits.
- However, there is some evidence that effects on the fetus (cardiac development) may occur at lower levels and this has been used as the basis for the recent guideline for TCE in drinking water.

# Non-cancer effects (TCE) due to inhalation exposure

- Lowest concentrations at which adverse events have been observed in humans/animals (EPA)

<b>Central Nervous System</b>	38,000 – 86,000 $\mu\text{g}/\text{m}^3$	Signs of CNS toxicity (headache, dizziness) in workers
<b>Liver</b>	27,000 $\mu\text{g}/\text{m}^3$	Increased liver weight in mice
<b>Endocrine</b>	59,000 $\mu\text{g}/\text{m}^3$	Alterations in FSH, SHBG, and DHEA hormones in workers

# TCE levels in this community

- These concentrations:
  - Do not represent an acute health risk.
  - But may present a health risk if long-term exposure.
    - Cancer risk: Present, but very small
    - Non-cancer: Unlikely because community levels lower than levels at which non cancer effects have been seen

