



TCE - a new environmental problem?



Presented by Mark Chapman

URS Senior Principal Risk Assessor

What is TCE?

- Trichloroethylene, trichloroethene or TCE is an industrial volatile chemical
- First widely produced in the 1920s, production and use increased until the 1970s
- Widely used for metal degreasing in manufacturing including vapour degreasing
- Also used for decaffeinating coffee, dry cleaning and anaesthetic for surgery and inhalation analgesic in childbirth until about 1960
- Reduced usage and no longer manufactured in Australia, but use has not been discontinued

Phys-Chem Properties

•TCE:

- is a liquid at room temperature with a boiling point of approx 87C
- is sparingly soluble in water with a solubility of approximately 1,280 mg/L
- has a density of 1.46 g/mL, so is a sinker
- Has a vapour pressure of about 8 kPa (58 mmHg) at 20C



TCE Contamination in the news

ADVERTISER.COM.AU THURSDAY JULY 4 2014

toxic zone evacuation call



Worried residents still want answers

SAM KELTON
POLICE REPORTER

SLEEPLESS nights, unanswered questions and fears for your children's future: Clovelly Park residents are angry — and with good reason.

The years residents along Chestnut Court and Ash Ave have been told of the potential dangers of trichloroethylene in the area and have been given reassurances by officials that things would be OK.

But this week they learned the government has been sitting on a report since they first confirmed TCE was present in soil and air samples, leaving residents to try to make sense of the confusing and often conflicting information.

Frustrated about their own fate as well as their children's, residents want answers, and here they are.

TOXIC AREA: For left, the contaminated zone in Clovelly Park; left, resident Brian Allen; above, Ash Ave, which residents have been told to evacuate; below, the local playground. **PHOTOS: SAM KELTON**

WHAT IS TRICHLOROETHYLENE?

- Trichloroethylene (TCE) is a chemical solvent used in heavy industry. It was once used in oil and gas refineries, but was phased out and replaced by other chemicals.
- It is found in the groundwater at Clovelly Park after being used in the past in industry.
- It has moved into the soil and air at some properties.
- An high concentration of TCE is linked to kidney and liver cancer. It can also cause neurological effects, headaches and dizziness.

The contamination is believed to originate from four sites — two at the Moore factory and one each at the oil and gas refineries and the oil and gas refineries.

During SA police-ordered Detective Barrett and the Clovelly Park residents would go on a weekly list, but waiting lists for other applicants were unlikely to be affected.

Residents in the 23 Chestnut Court-located homes will be removed by the end of the year and negotiations have begun with the private owners of two houses facing "toxic" homes.

The Government last night announced it had identified yesterday as the earliest possible time it could start demolition and provide "comprehensive and accurate information".

Sister Maria Switall and Jo Switall's family was the first to move into No. 3 Chestnut Court, Clovelly Park, 24 years ago. Now they both suffer strange and rare diseases they fear are linked to contamination now detected in the air.

The house is one being told to be vacated in an area where residents have been told to move out and there is TCE contamination in the soil.

At 25, Mr Switall has had six miscarriages and has three autoimmune diseases, while his sister has nerve and muscular weakness. Her doctor cannot explain.

Part of the nightmare is not knowing if playing in the park next door to his has wrecked her health for life.

The EPA contamination notice in 2000 TCEPS between Australia and the United States is pending updates on its website. **PHOTO: JIM DUFFIN**

WORRY: CLOVELLY PARK RESIDENTS TOLD TO LEAVE HOMES

FEARS: Sisters Maria Switall and Jo Switall live in Clovelly Park as kids and now have unexplained health issues.

Reactions to chemicals were evident for years

... who live there for years ...
... something though I could ...
... the other thing we did was ...
... based two years ago when they ...

TCE contamination in the Clovelly Park area made the media (newspaper, radio and/or TV), every day for more than 40 days straight in mid-2014

Clovelly Park carcinogen danger forces residents to move house

Updated 3 Jul 2014, 2:37pm

Some residents in an Adelaide southern suburb are being told to relocate after a carcinogen was detected in air, soil and groundwater.

Clovelly Park residents have known of toxic contamination in the area for years but thought they were safe in their houses.

But now the South Australian Government has told residents from close to 30 properties they should move out and Environment Minister Ian Hunter is not ruling out the demolition of some houses.

"It may well be that those homes will be demolished and new ones will be built with new mechanisms with impermeable membranes [and] concrete slabs, but that's for down the track," he said.



PHOTO: Playground: Solvent vapours are a risk in air, soil and groundwater.

MAP: Clovelly Park 5042

EPA Site Contamination Branch - Focus on TCE Sites

Current

EPA assessment areas

- [Southeastern Edwardstown](#)
- [Beverley, Woodville West, Woodville South, Findon and Allenby Gardens](#)
- [Clovelly Park-Mitchell Park](#) **<new**
- [Glenelg East](#)
- [Hendon industrial area](#)
- [1102 South Road, Edwardstown](#)
- [Southern Edwardstown](#)
- [Edwardstown–South Plympton](#)

Why is TCE now a problem?

Handling and disposal

- High rate of production and use through most of the 20th century
- Currently thousands of sites identified across North America, Europe, Australasia as potential DNAPL sites
- Safe disposal often not practiced/regulated until the 1980's
- Common practice to dispose of waste solvent to a (well ventilated) dumping area and allow the solvent to evaporate
- MSDS advice from 1948
 - *“Waste trichloroethylene is flammable and generally can be burned in a furnace or spread on waste and burned on a burning ground.....”*
 - *“Bury away from water supply or allow solvent to evaporate to atmosphere”*

Why is TCE now a problem?

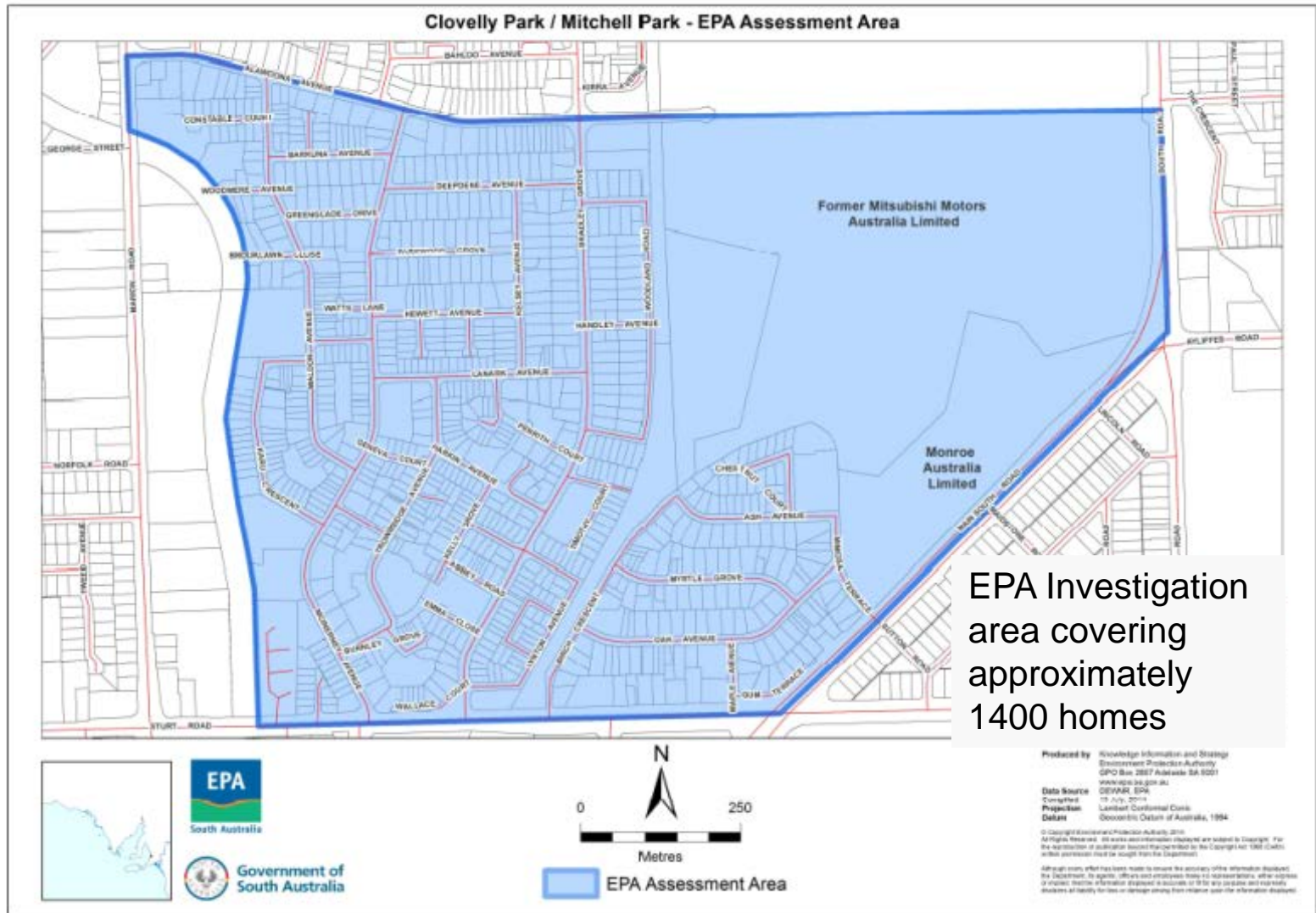
10-Fold Toxicity Data Changes in 2011-2012

- There are no Australian groundwater or ambient air guidelines for TCE
- Until about 2012, reference was generally made to the World Health Organisation toxicity data for inhalation ($23 \mu\text{g}/\text{m}^3$ for ambient air based on cancer risk)
- In September 2011 the US EPA released their updated TCE toxicity assessment. $2 \mu\text{g}/\text{m}^3$ for ambient air
- This US Guideline was adopted in the ASC NEPM in the derivation of soil vapour Health Investigation Levels $20 \mu\text{g}/\text{m}^3$ for soil vapour

Stability/longevity in the subsurface environment

- In aerobic environments PCE and TCE are not prone to biodegradation

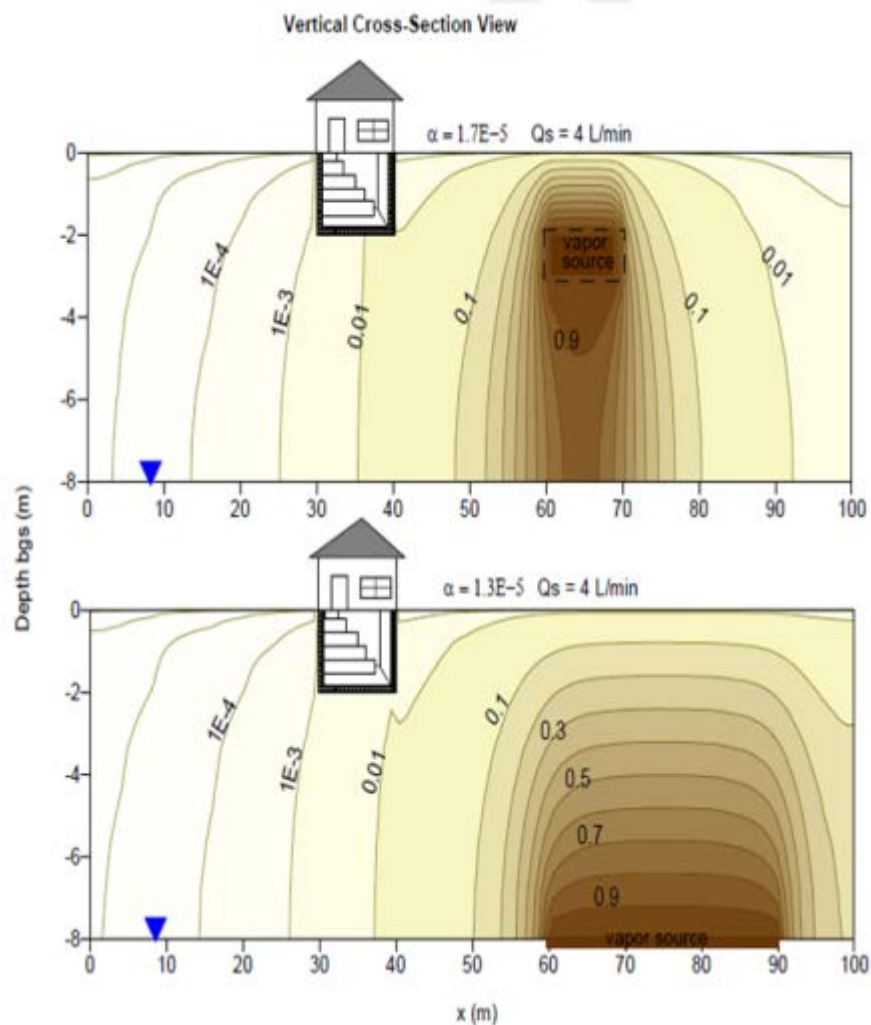
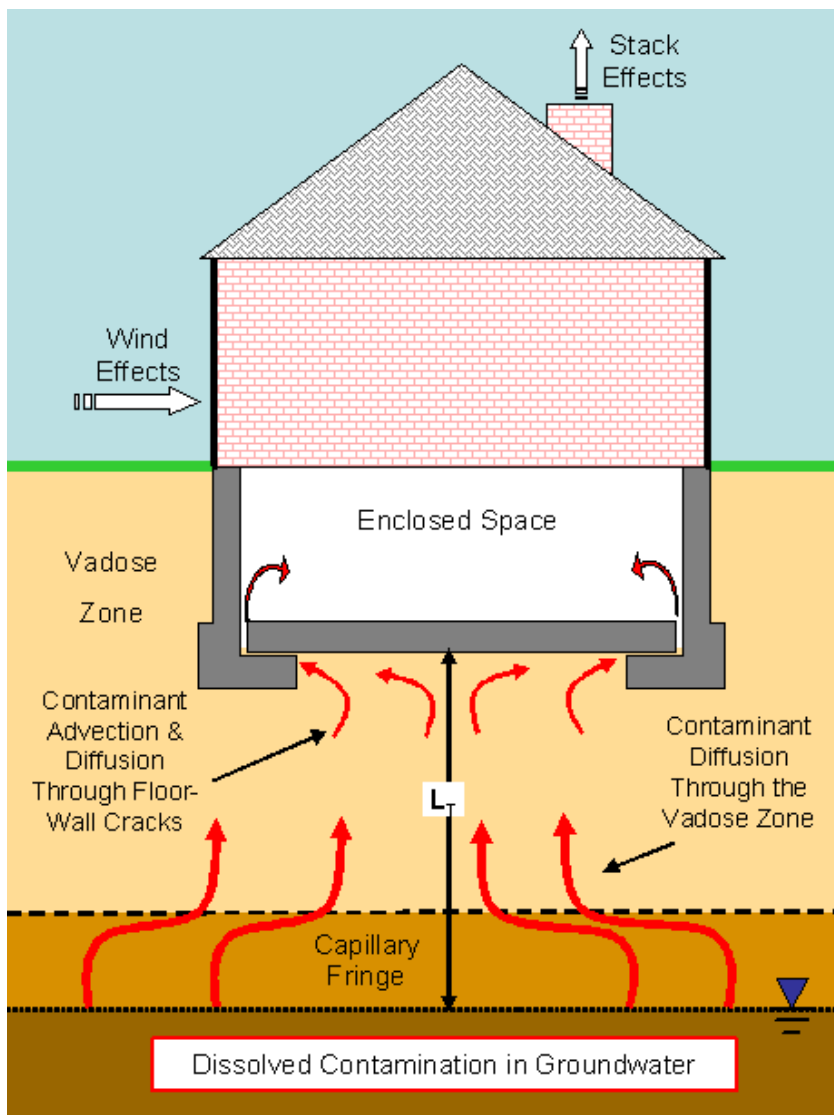
Mitchell Park – Clovelly Park Investigation Area



Edwardstown PCE/TCE Off-Site Investigation



Conceptual Model Vapour Intrusion



Conceptual Model for DNAPL in Subsurface (UK Env Agency)

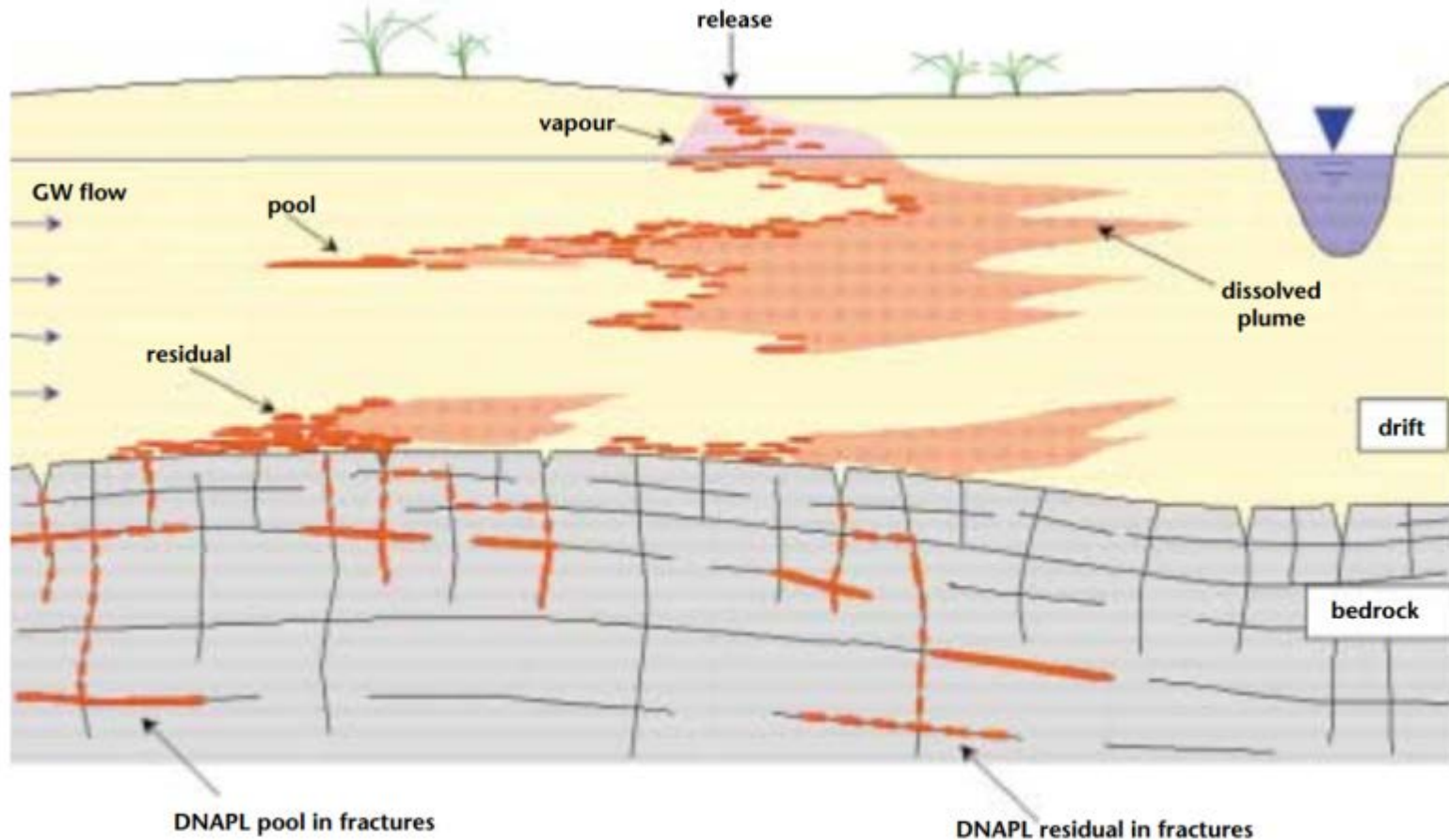


Figure 2 | DNAPL distribution in unconsolidated deposits (after Pankow and Cherry, 1996)

Heterogeneous Distribution in the Subsurface

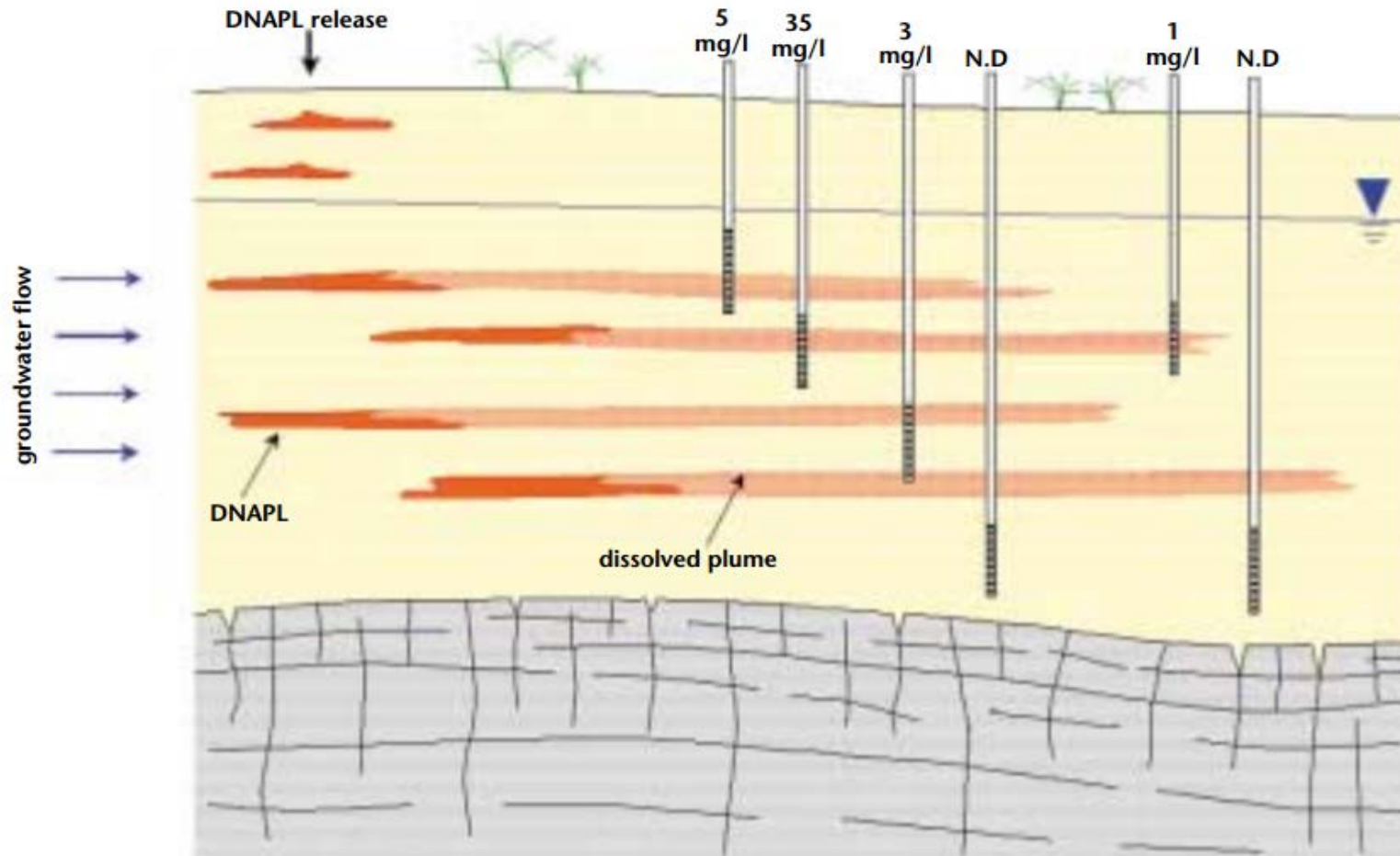


Figure 6a

Cross-section depicting spatial variability of groundwater concentrations in a plume

Solute concentration at the water table

From a vapour perspective, we are interested in concentrations at the top of the water table

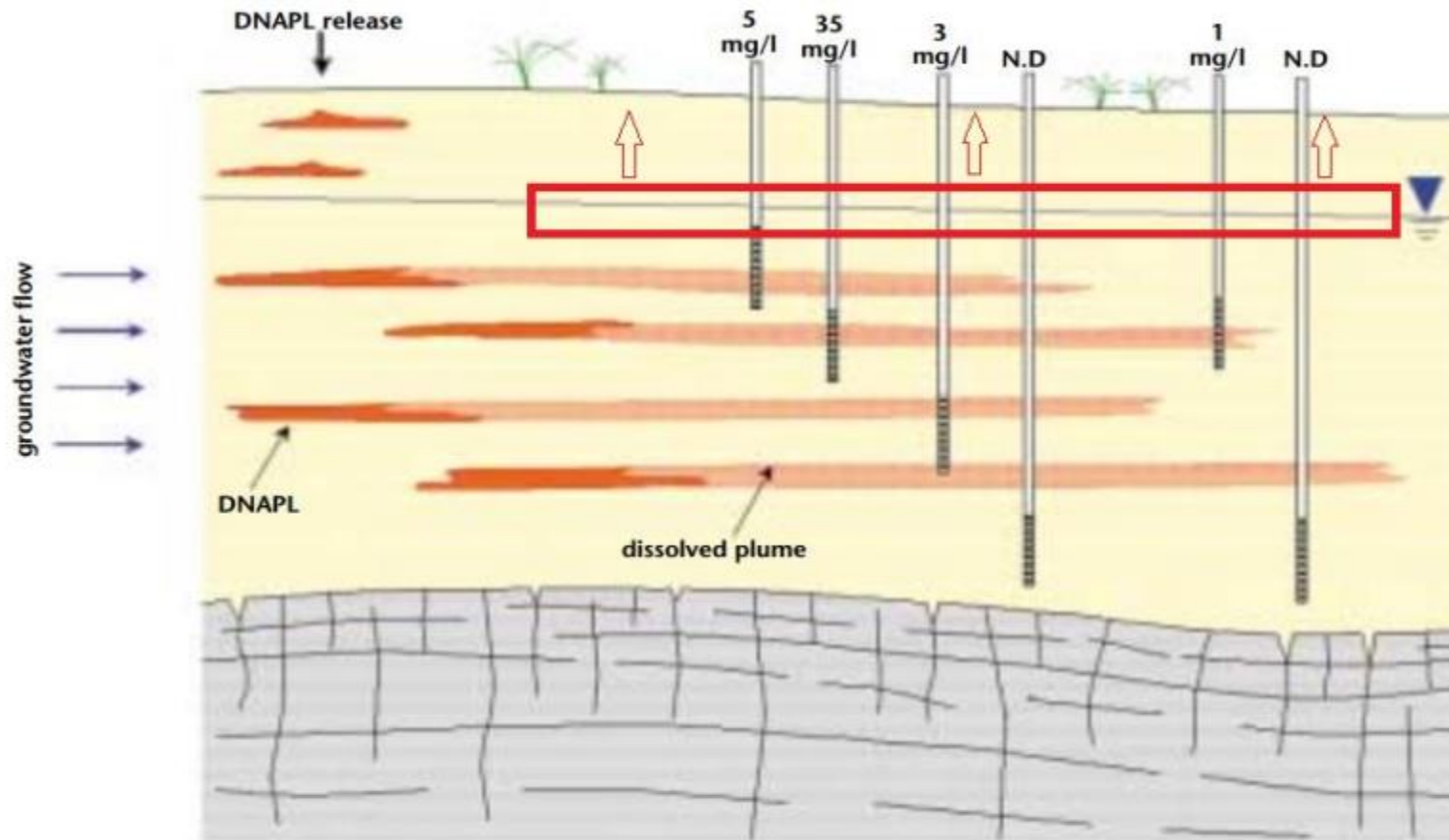
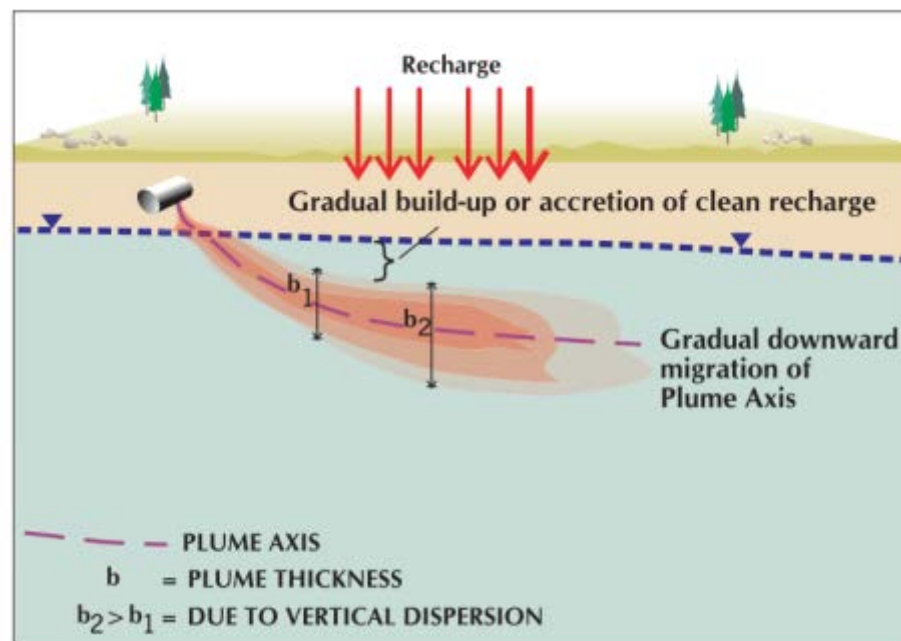


Figure 6a | Cross-section depicting spatial variability of groundwater concentrations in a plume

Plume Diving – Resulting in reduced vapour concentrations

- $D_{i_{air}} = 7 \times 10^{-2} \text{ cm}^2/\text{s}$
- $D_{i_{water}} = 1 \times 10^{-5} \text{ cm}^2/\text{s}$
- TCE diffusion rate in air is approximately 4 orders of magnitude greater than in water.

- Plume diving The gradual vertical migration of the solute plume within the aquifer

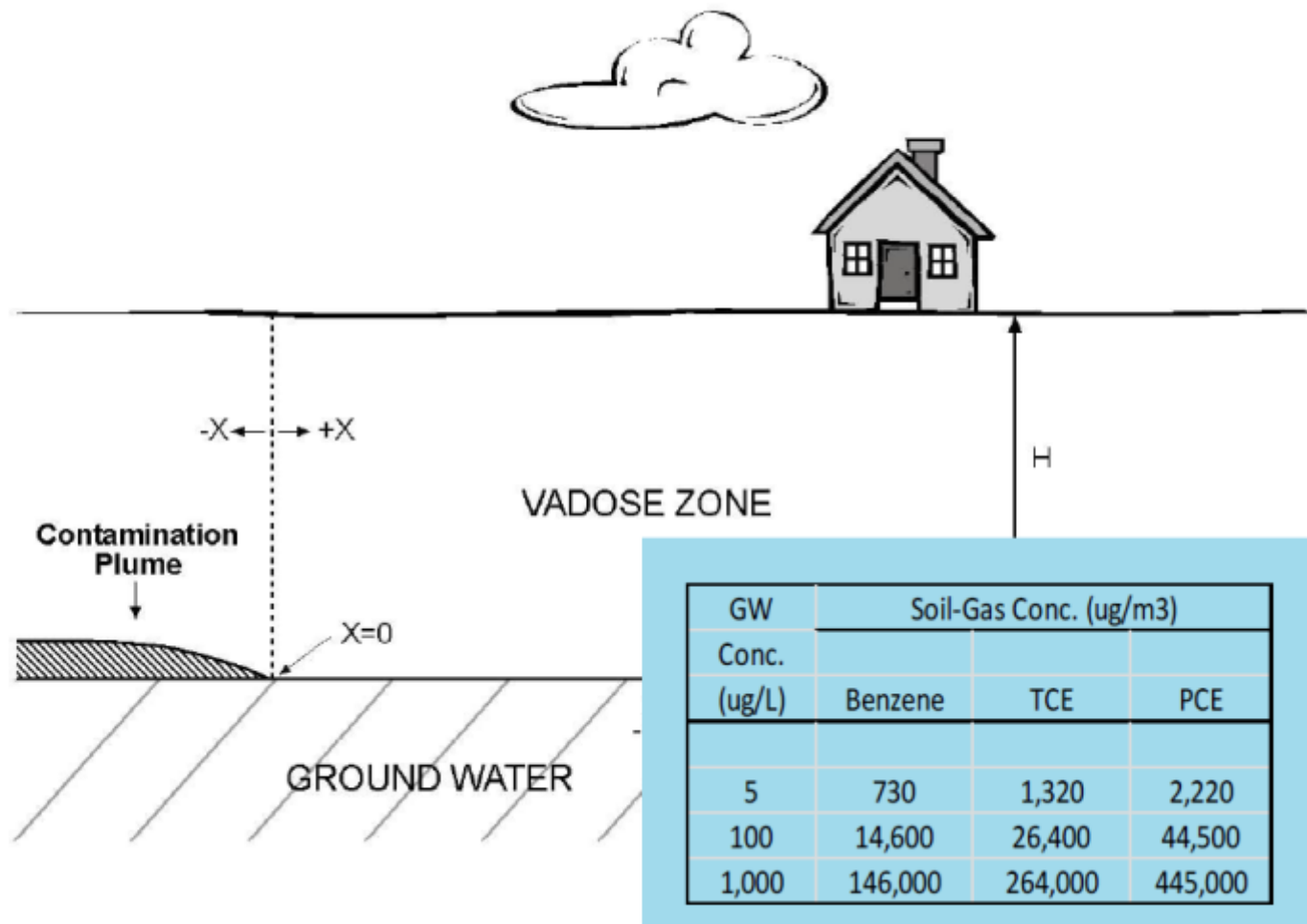


Several reasons why vapour concentrations may be lower than Henry's predictions

1. Depletion of solute concentrations at the water table interface due to relative diffusion rates
2. Fresh water recharge creating a fresh water "lens"
3. Potential for "flushing" of the solvent from soil vapour as water infiltrates after heavy rainfall

Henry's Law Predictions for Groundwater

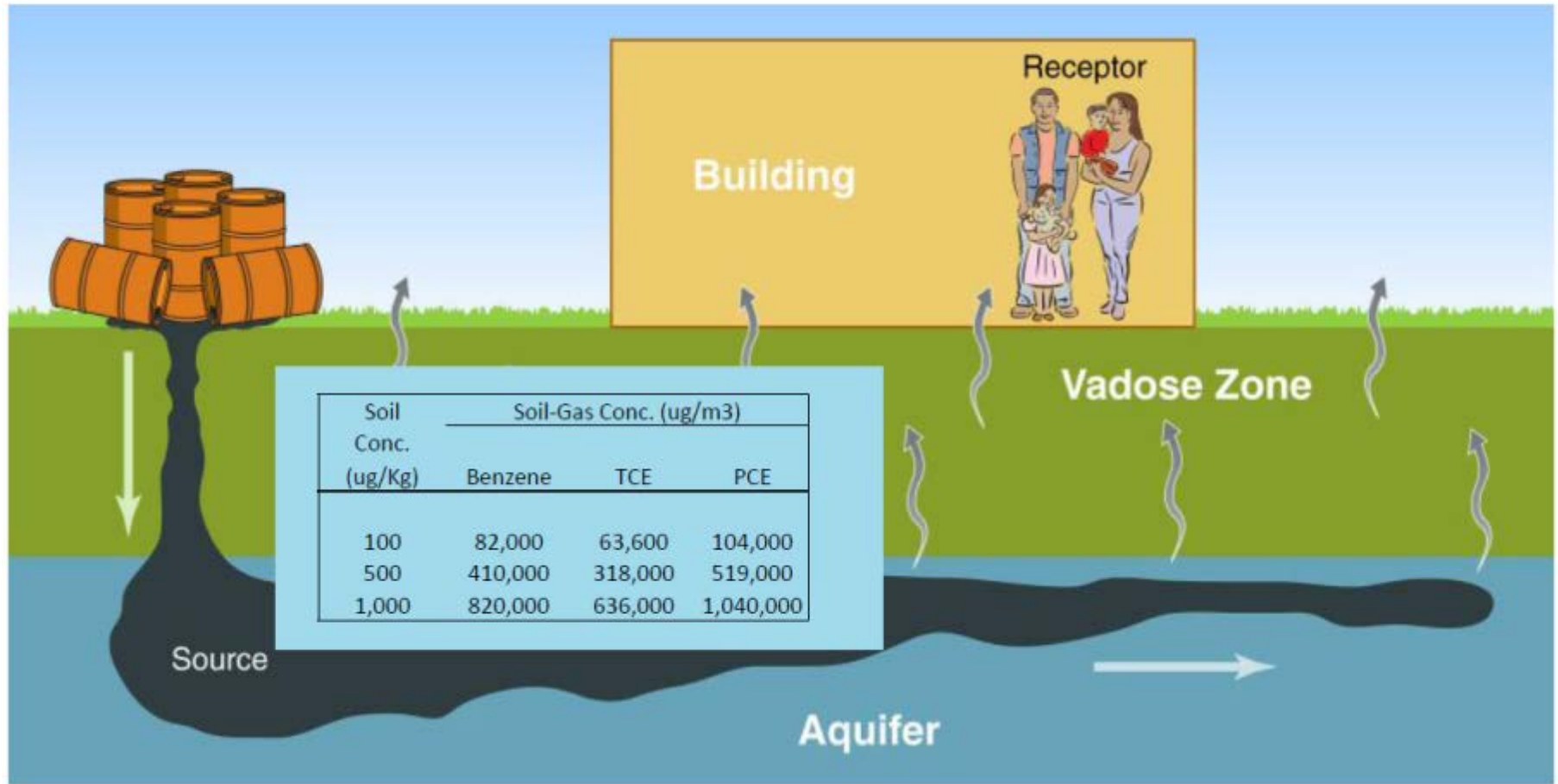
Vapor Intrusion



NEPM Soil
Vapour HIL for
TCE is **20 µg/m³**

Henry's Law Predictions for Soil

Vapor Intrusion



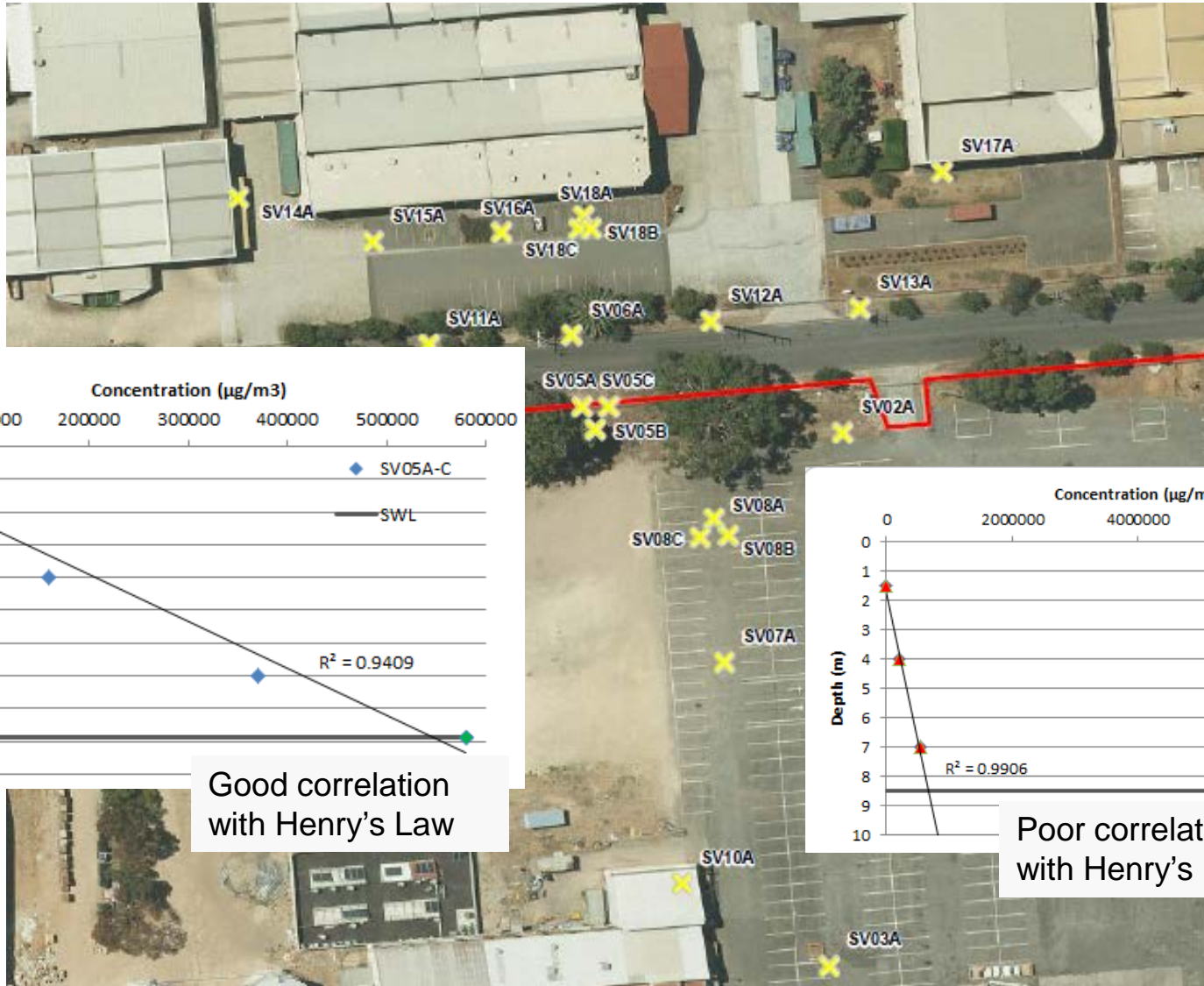
NEPM Soil Vapour HIL for TCE is **20 µg/m³**.

Need soil vapour data to assess soil sources in particular

How to Assess Exposure Concentrations and Risk

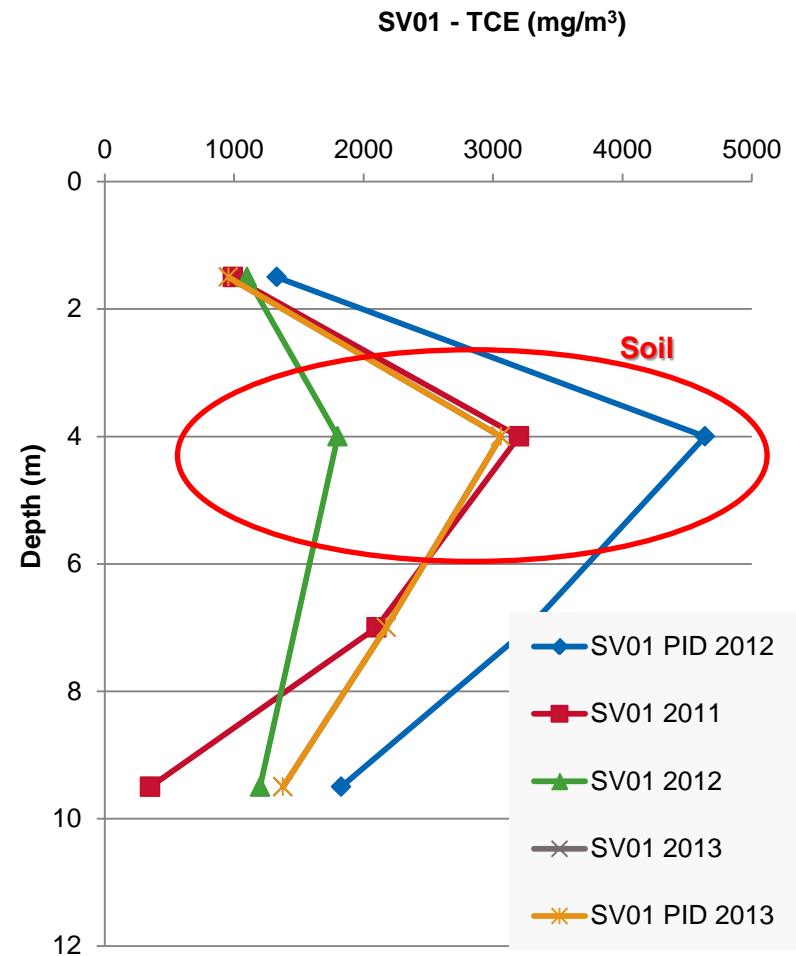
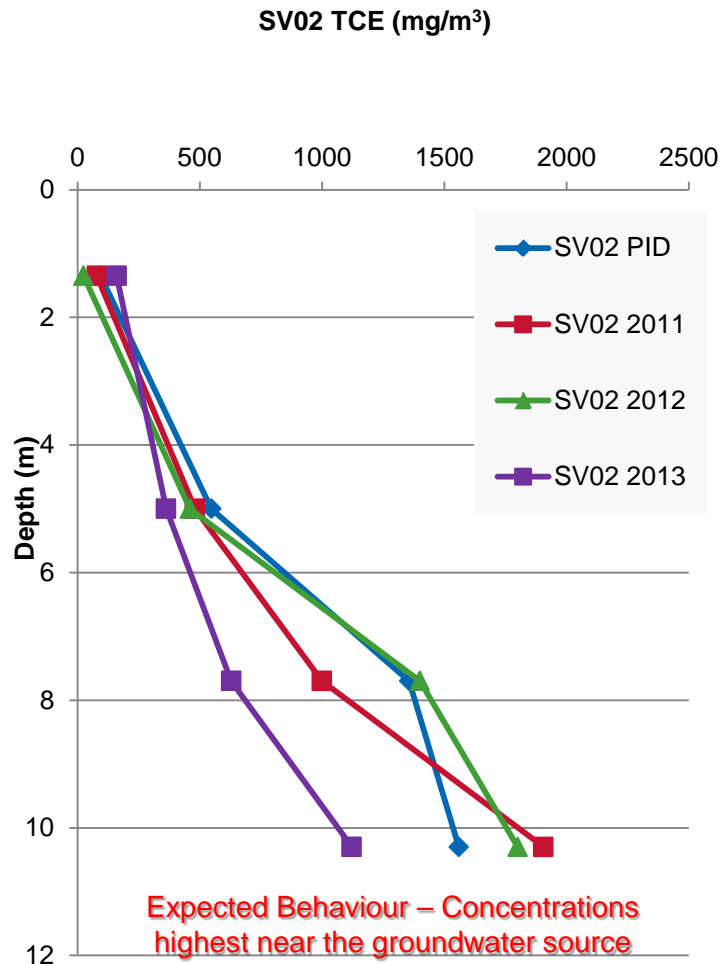
1. Identify area of concern, then what:
 2. Modelling transport from subsurface source concentrations (groundwater or soil vapour)
 3. Application of attenuation factors (conservative) from subsurface data
 4. Direct measurement of indoor air/exposure concentrations
- Which is the best approach?

Vapour concentrations based on groundwater data



Identify source term for modelling – nested wells

The source of vapours may not just originate from groundwater, depending upon historic use of the area

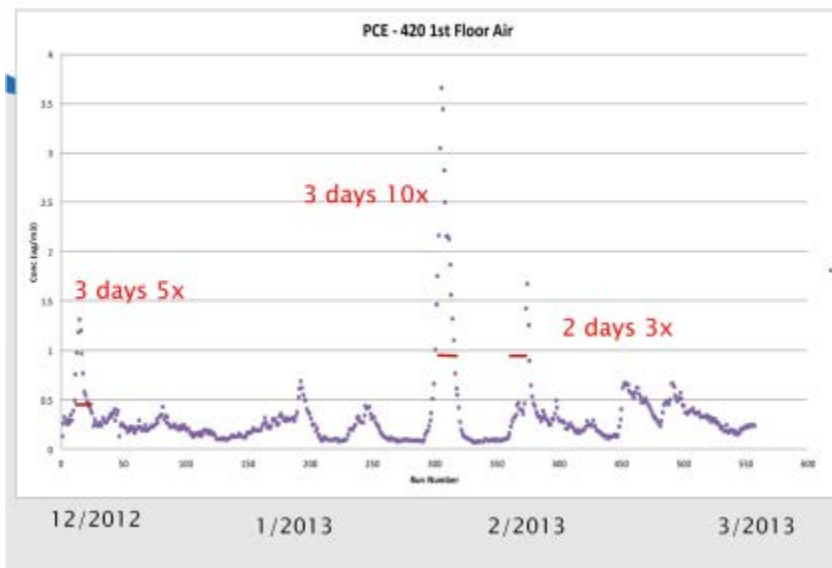


Indoor Air Data – Is this the best approach?



Notes:
All data in $\mu\text{g}/\text{m}^3$
* Duplicate data reported as 2.2 $\mu\text{g}/\text{m}^3$

Continuous Monitoring – PCE in Indoor Air



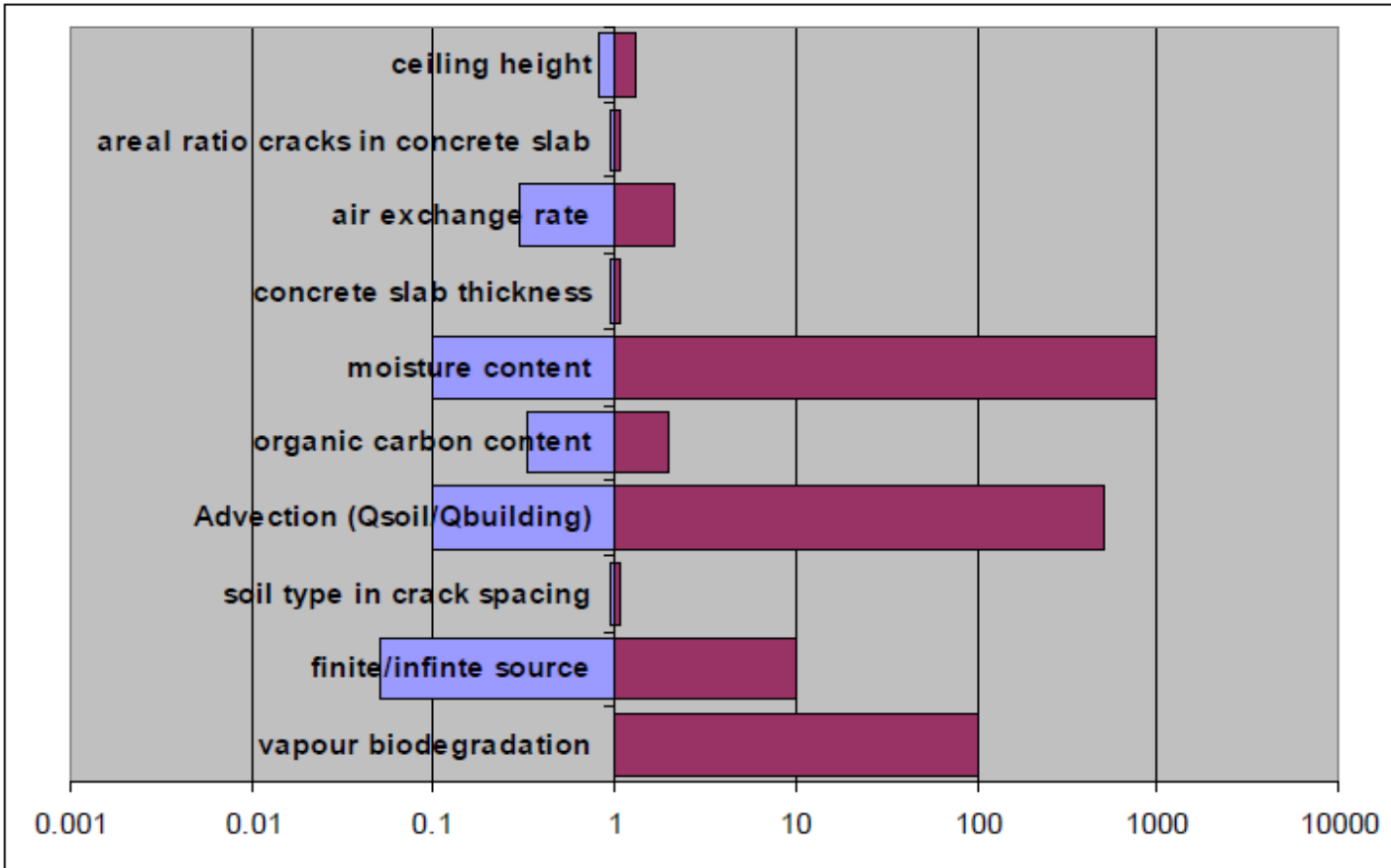
Temporal Variability Indoors
(US Data from Blayne Hartman)



Spatial Variability indoors

Is modelling the answer then to estimating indoor air concentrations?

- Johnson and Ettinger 1D vapour transport model
- CRC CARE Technical Report 10, Part 3 Sensitivity Analysis Summary
- **Concentrations (risks) can vary by several orders of magnitude depending upon assumptions for key variables**

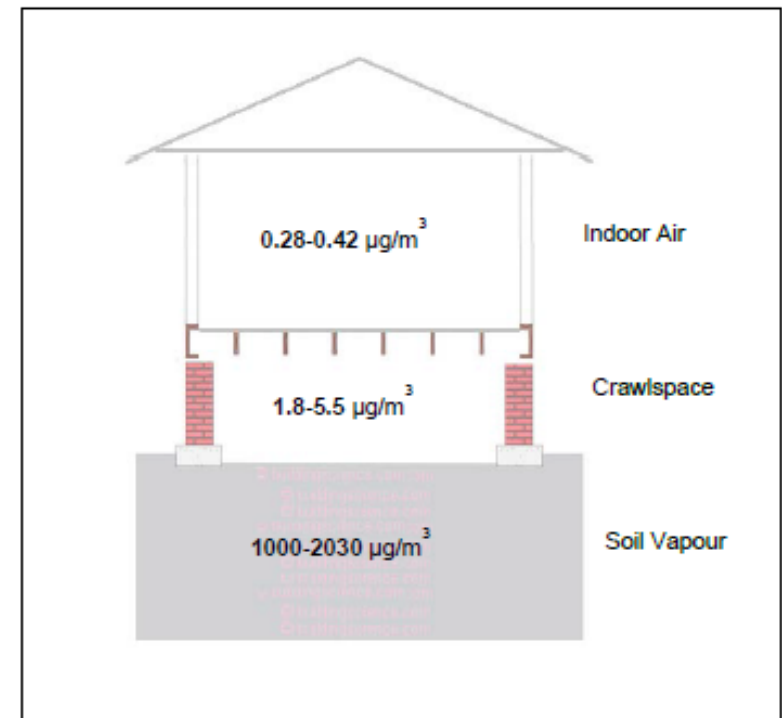


Lines of Evidence

- In practice, some **combination of modelling and monitoring is likely to be required** to provide sufficient lines of evidence to adequately assess Vapour Intrusion Risks for TCE



Figure 5-1 Attenuation of TCE Concentrations



- Modelling from groundwater and soil vapour concentrations were compared/calibrated against measured soil vapour, sub-slab and indoor air TCE concentrations.

Conclusions

- Due to its toxicity, longevity, volatility and historic widespread use, TCE is currently the most problematic volatile environmental contaminant
- It can migrate hundreds of meters or more in groundwater from source sites and can be present at material concentrations for many decades
- Determining potential risks posed by vapour intrusion generally requires multiple lines of evidence and is often a costly exercise

Thanks