



RACP AFOEM meeting

14 May 2022

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Environmental Public Health Branch



WHAT WE'LL COVER TODAY:

- **Introduction:**
 - How the environment can impact health
 - Who we are and what we do in Victoria
- **Understanding methods for setting criteria and risk assessment:**
 - EnHealth Framework for environmental health risk assessment
- **Case Studies:**
 - Arsenic and PFAS contamination at contaminated sites
 - Vapour intrusion – differences between occupational and non-occupational settings
 - Odour – health risks beyond toxicity, outrage and trust

Environmental Impacts and Health

Environmental health impacts are diverse, and the discipline is very broad



Air pollution caused 1500 premature deaths in 2012

Recall of infant formula, EleCare, Similac and Alimentum, due to potential microbial contamination

Signs of carbon monoxide poisoning

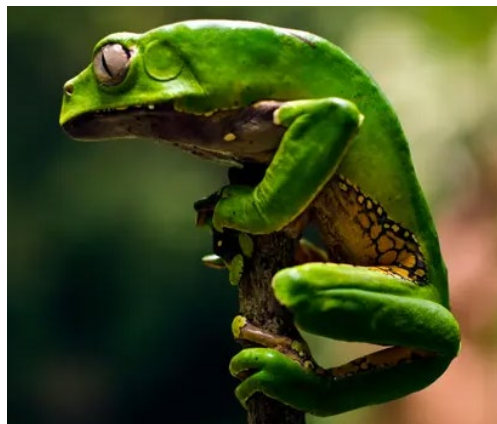
Headaches Nausea Dizziness Breathlessness Collapse Loss of consciousness



Surfers hospitalised after contact with sewage



Children with high blood lead concentrations



Traditional medicines



Poisonous mushrooms



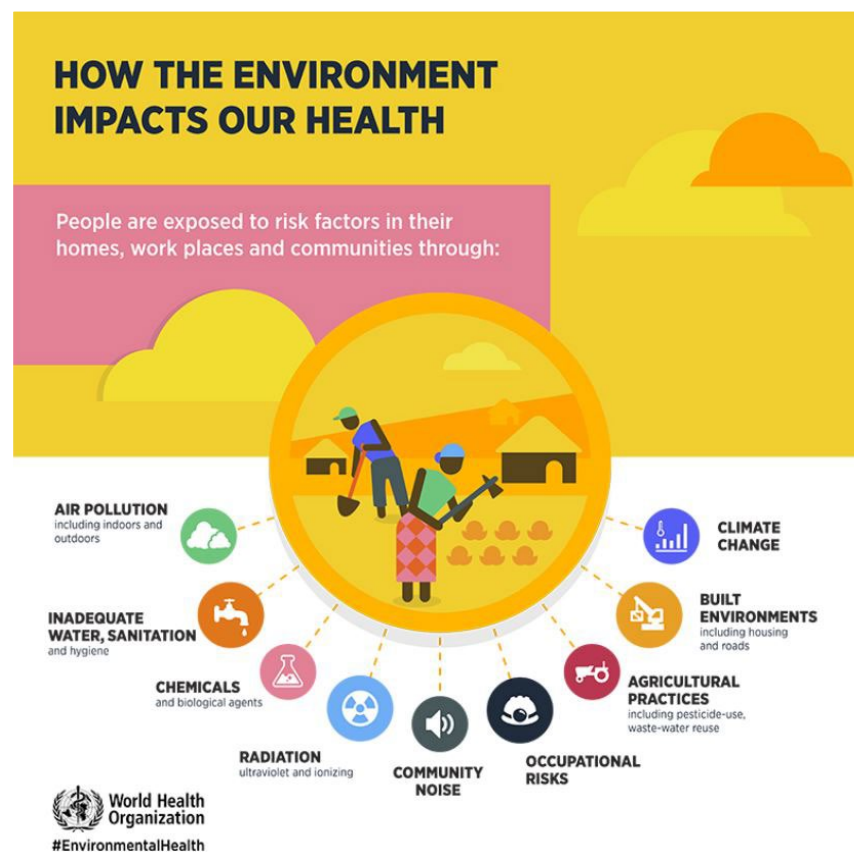
Noise



Maribyrnong River – PFAS fishing advice



What we do in Victoria



EPA

- **Pollution and waste:**
- air quality;
- contaminated land;
- industrial odour and noise;
- waste management;
- pathogenic risks

Dept of Health

- Communicable disease;
- legionella;
- drinking water;
- food safety,
- blood lead levels;
- radiation;
- pest control

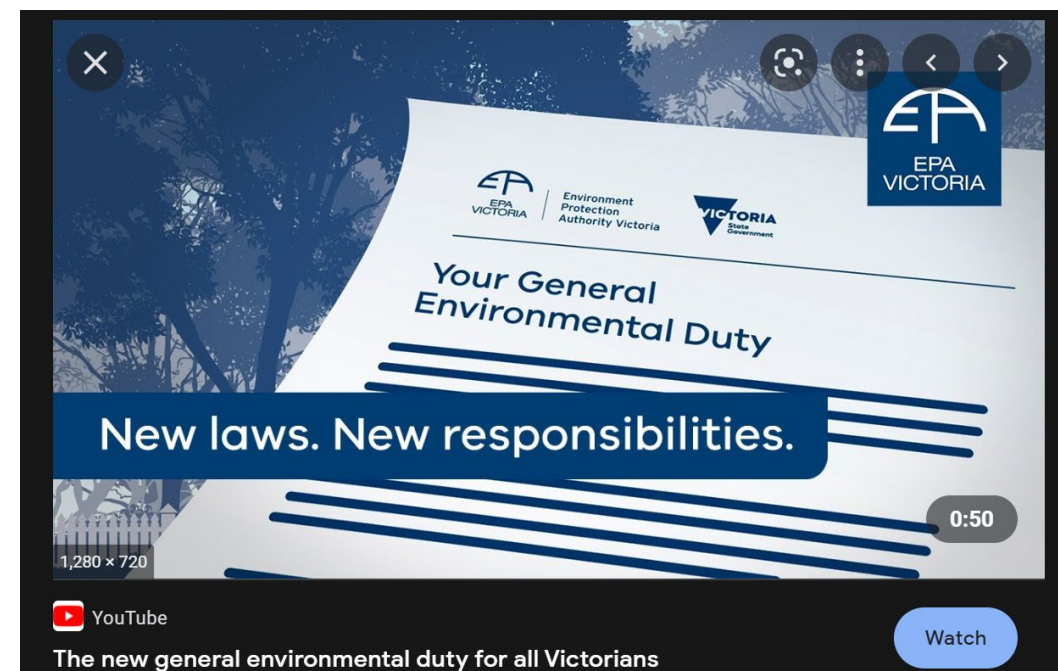
Councils

- **Domestic and small commercial scale:**
- dust
- odour and noise
- wood heater smoke
- spray drift
- dumping



Key Health Protection Legislation in Victoria

- Public Health and Wellbeing Act 2008
- Public Health and Wellbeing Regulations 2019
- Environment Protection Act 2017
- Environment Protection Regulations 2021
- Food Act 1984
- Safe Drinking Water Act 2003
- Radiation Safety Act 2005
- Other relevant legislation includes
 - Occupational Health and Safety Act 2017
 - Planning and Environment Act 1987
 - Mining legislation (multiple)
 - Consumers Affairs
 - Building and plumbing



<https://www.epa.vic.gov.au/about-epa/laws/new-laws/the-new-act-for-the-community>

Process of environmental risk assessment and criteria derivation



Before any assessment.....

What's the objective of the assessment report?

What are you being asked and by whom?

Are their questions addressed by the report objectives?

Australian guidance



EnHealth:

- Environmental Health Risk Assessment – Guidelines for assessing human health risks from environmental hazards (2012)
- Australian Exposure Factor Guidance Handbook (2012)
- Risk Communication Guidance (2021)

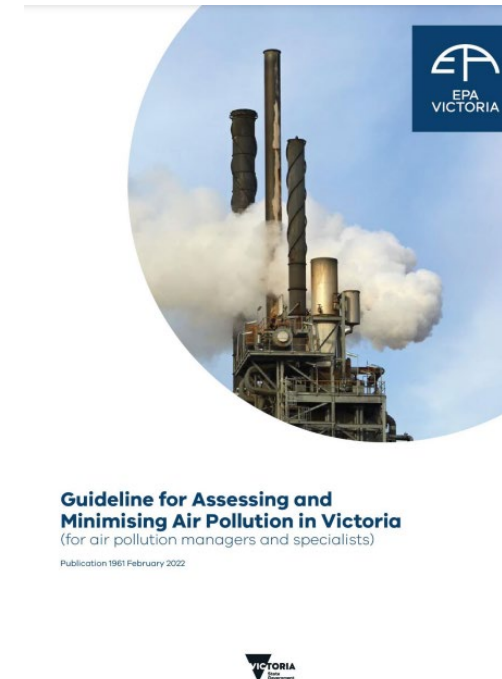
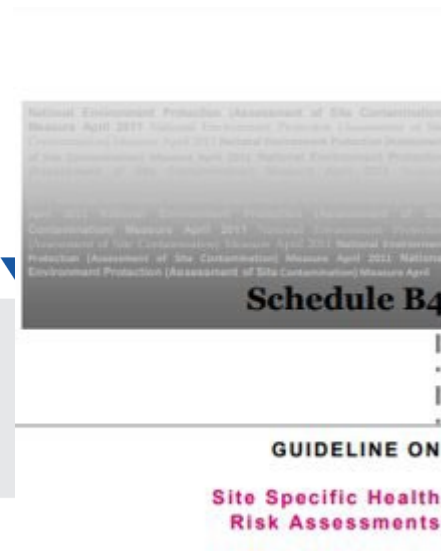
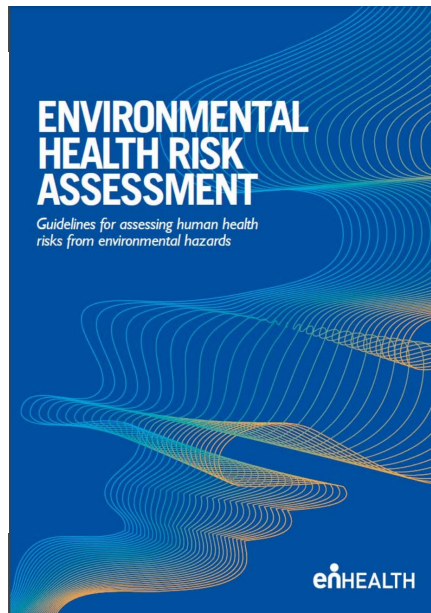
Other:

- NEPM – Assessment of Site Contamination (2013)
- Guidelines for assessing and managing air pollution in Victoria (2022)
- National Environmental Management Plan (2020)

AUSTRALIAN EXPOSURE FACTOR GUIDANCE

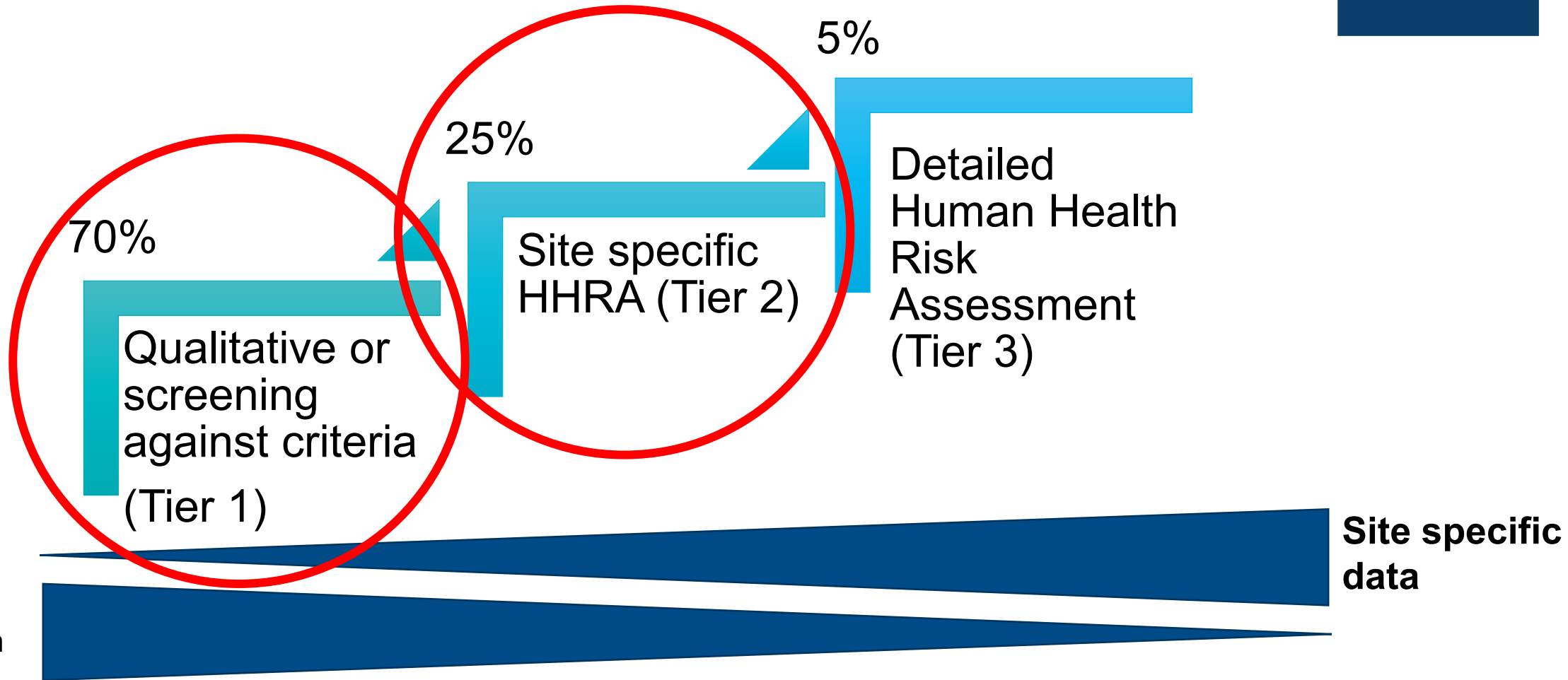
Guidelines for assessing human health risks from environmental hazards

www.health.gov.au
All information in this publication is correct as of June 2012



Iterative nature of health risk assessment

(Good news is you don't need to do detailed work every time!)



If 70% are tier 1 screening assessments how confident are we that criteria derived are fit for purpose and could they be misinterpreted?

Tier 1 assessment



Initial environmental assessment

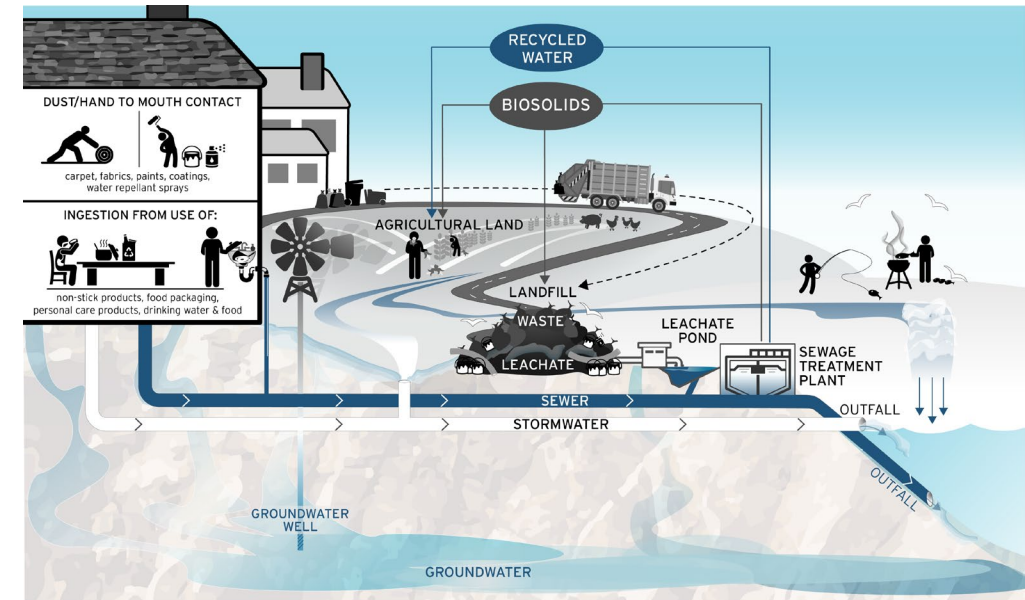
- Site history/problem formulation
- Initial conceptual site model (CSM)
- Target media

Screen against investigation levels

- Soil
- Water
- Air

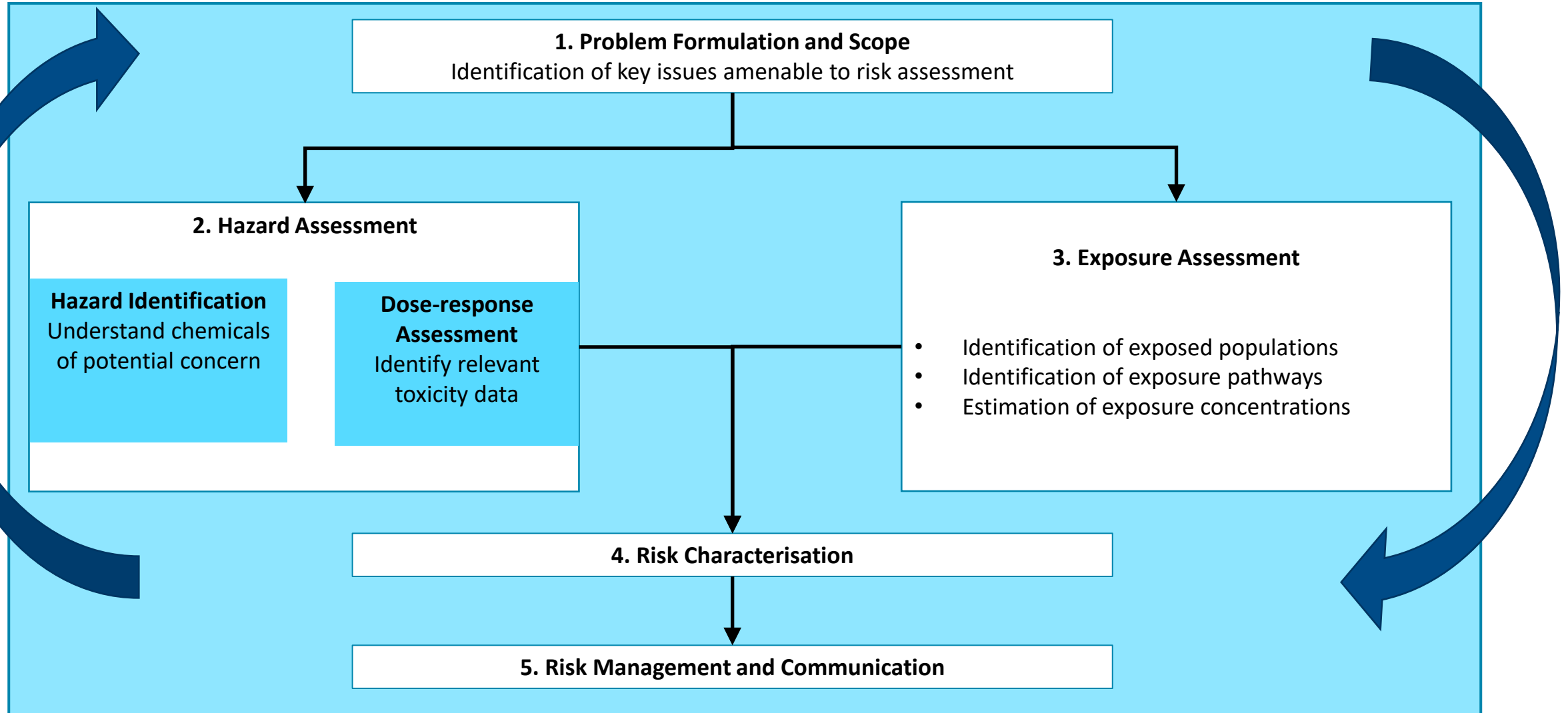
Exceed criteria – further investigation

- Further investigation and delineation
- Refine CSM
- Tier 2 human health risk assessment



EPA Victoria

Stages of Risk Assessment



1. Problem Formulation and Scope often undercooked step



Cardno Lane-Piper, 2014

- What activities took/will take place?
- What chemicals might have been used and what practices were typical (back door disposal?)
- Chem-phys properties and fate in environment –
 - will it volatilise
 - is it soluble
 - could it accumulate in food?
- How might it migrate to receptors?
 - Soil, drinking water, indoor air, food



2. Hazard Assessment

Consider:

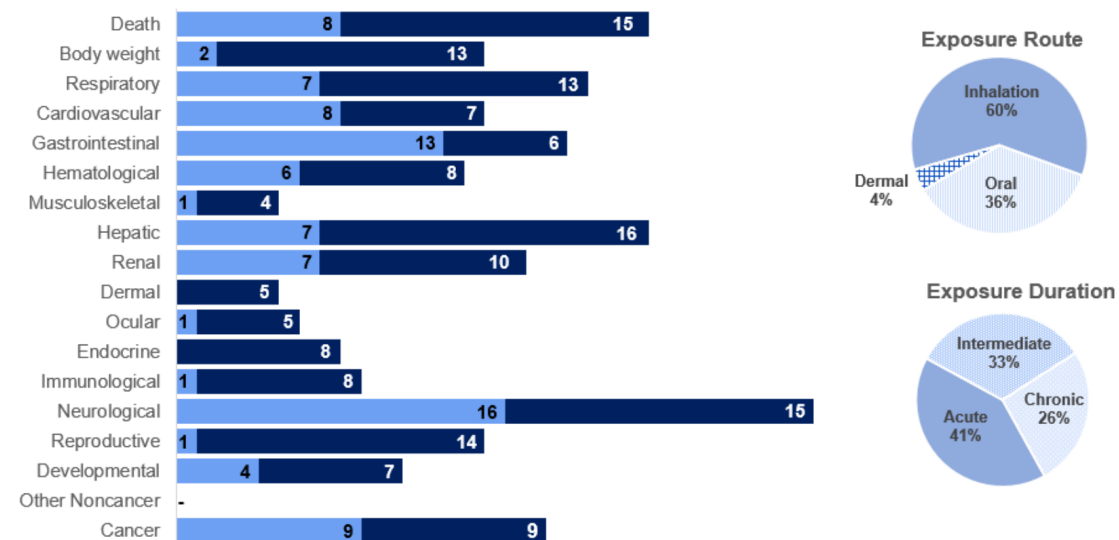
- what type of effects may occur (hazard identification)
- Relationship between exposure and effect (dose-response)

Typically use established toxicity values e.g. WHO, ATSDR, US EPA:

- Tolerable daily intake - TDI (mg/kg-bw/d)
- Reference concentrations – RfC (ug/m³)
- Cancer slope factor – CSF (mg/kg-bw/d)⁻¹

Figure 2-1. Overview of the Number of Studies Examining 1,2-Dichloroethane Health Effects

Most studies examined death, neurological, hepatic, and respiratory effects of 1,2-dichloroethane. Fewer studies evaluated health effects in **humans** than in **animals** (counts represent studies examining endpoint).



ATSDR, toxicological profile for 1,2 Dichloroethane

5.12 GUIDANCE ON SELECTING SOURCES OF TOXICOLOGICAL DATA AND ENVIRONMENTAL HEALTH CRITERIA

enHealth Environmental Health Risk Assessment Guidelines, 2012



2a. Hazard Identification

- What are the chemical properties – is it a solid, liquid or gas?
- What type of effects can it cause?

Acute Toxicity

Sub-chronic Toxicity

Chronic Toxicity

Reproductive Toxicity

Developmental Toxicity

Cancer



Criteria types

- Air quality
- Drinking water (limited)



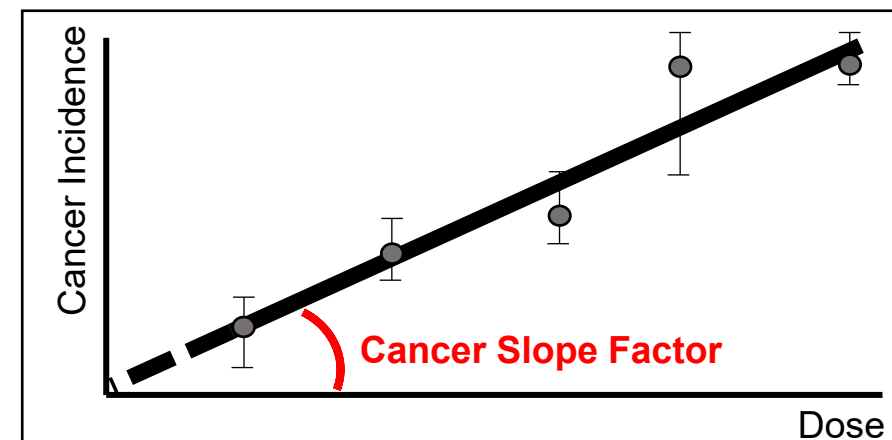
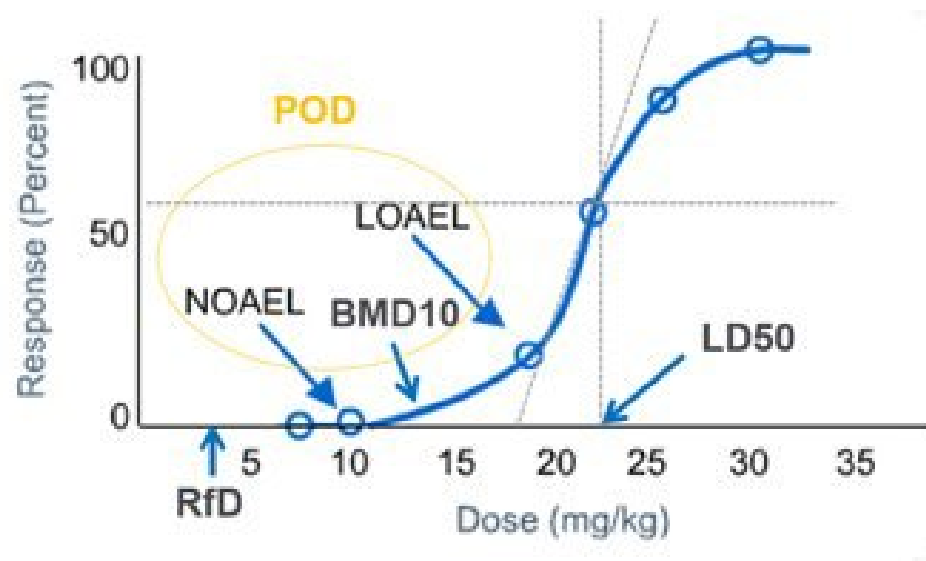
Criteria types

- Contaminated land
- Drinking water
- Air quality (indoor and outdoor)
- Food

- What data is available – human? animal? exposure duration and pathways? Toxicokinetics?

2b. Dose Response

Is it a threshold or non-threshold chemical?



- Threshold below which no risk
- find point of departure used: e.g. LOAEL, NOAEL, BMD10
- safety factors applied
- Health based guidelines – TDI, RfC etc

- No level where we can say definitively no risk
- Evaluate the probability of developing cancer based on lifetime exposure at a dose
- Extrapolates from lowest dose causing cancer to zero threshold
- Determine cancer slope factor used in risk characterisation

3. Exposure Assessment – Estimating a persons likely dose over time



- Who is being exposed and to what?
- How are they being exposed?
- How often are they being exposed and for how long?
- Is there temporal or spatial variation?

3. Exposure Assessment – So how do we do it? Assessing a chemical's intake - Ingestion



$$I(\text{mg/kg/day}) = \frac{C(\text{mg/kg}) \times IGR(\text{mg/d}) \times EF(\text{d/y}) \times ED(\text{y}) \times 10^{-6} \times BA}{AT(\text{d}) \times BW(\text{kg})}$$

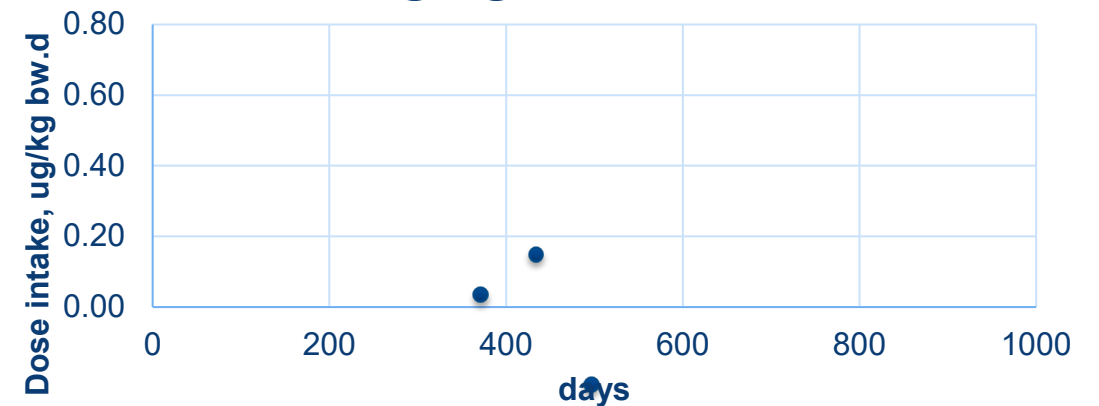
Where:

- I Intake of the chemical via ingestion.
- C Average concentration in the ingested item.
- IGR Ingestion rate (i.e. amount of that food item being ingested each day).
- EF Exposure frequency
- ED Exposure duration
- AT Averaging time
- BA Oral bioavailability
- BW Body weight

3. Exposure Assessment – where we spend most of our time

- Multiple exposure pathways
- Food exposure pathways very complex
 - Uptake/transfer factor confidence
 - Dynamic exposure for animal produce
- Best if you can measure produce directly

**Cattle, daily dose over time
ug/kg bw/d**



9 News, March 2019, unrelated site

3. Exposure Assessment – should you ever close the excel spreadsheet?

Example of some PFAS risk assessments that have come through the years

- Recommendation that childcare centre keep childrens consumption of tan bark and pine needs to 0.5 g/day
- Exposure from washing dogs with differing hair lengths
- Irrelevant intake rates – home consumption of liver at 90thile rate = slaughter of 6 animals a year

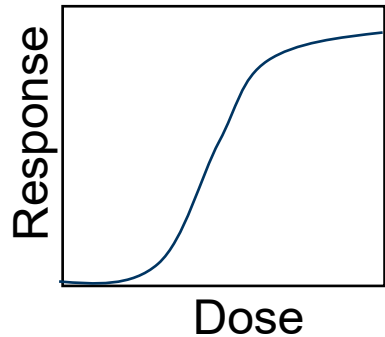


Speakers own photo



4. Risk Characterisation

Threshold chemicals:

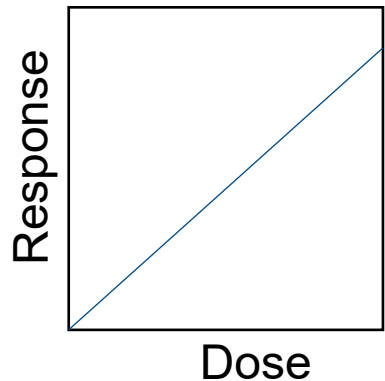


$$\text{Hazard Quotient (HQ)} = \frac{\text{Intake (mg/kg/day)}}{\text{Threshold TRV(mg/kg/day)}}$$

$$\text{Hazard Index (HI)} = \sum \text{Hazard quotients for each chemical}$$

Acceptable risk for threshold chemicals is HI less than or equal to 1

Non-threshold chemicals:



Incremental Lifetime Cancer Risk estimates additional cancer incidence at exposure dose.

$$\text{ILCR} = \text{Intake (mg/kg/day)} \times \text{Cancer Slope Factor (mg/kg/day)}^{-1}$$

Acceptable ILCR from contaminated land risk assessments is 1×10^{-5}

Case study

Hypothetical residential contamination

PFAS and arsenic contamination in soil

Residential Soil Health Investigation Levels - NEPM(ASC)

$$HIL_{x,i} \text{ (mg / kg)} = \frac{\text{Acceptable Intake}}{\text{Intake from Contamination}}$$

- Types of exposure scenarios considered in the criteria:
 - Soil and dust ingestion
 - Dust inhalation
 - Dermal contact
 - Home grown fruit and veg (10%)



Figure source <http://earthsci.org/education/teacher/basicgeol/groundwa/groundwa.html>



Case study 1: PFAS v's arsenic – which is more concerning?

Scenario residential house

- Two adults, mother living at property from young age
- Children aged 2 and 7
- Veggie patch approximately 1m x 1m
- Sandpit with purple tinged sand



Unrelated site, News 3

Chemical	HIL A Criteria, mg/kg	Soil result, mg/kg
Arsenic	100	1,000
PFOS + PFHxS	0.01	0.1

What are our thoughts?



Case study 1: PFAS v's arsenic – which is more concerning?

Lets look at the criteria in more detail

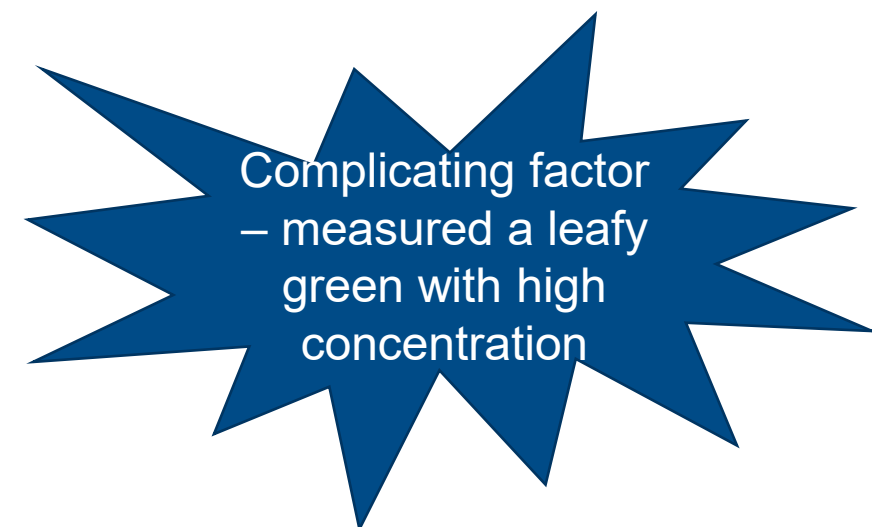
Chemical	Criteria, mg/kg	Background contribution	Soil ingestion	Food	Dermal contact	Inhalation of particles
Arsenic	100	50%	84.3%	9.9%	5.7%	0.1%
PFOS + PFHxS	0.01	20%	0.03%	96.8%	NA	0%

How reasonable are the criteria assumptions?

Quantity	Green Vegetables	Root Vegetables	Tuber Vegetables	Tree Fruit
kg/year	152	46	64	175



- Family of four
- Raised bed 1m x 1m
- Will it produce enough?



Background exposure to PFOS +PFHxS = approx. 7 to 12%

Background exposure to arsenic = 50%



Case study 1: PFAS v's arsenic – which is more concerning?

Lets modify our risk assessment, remember:

$$I(\text{mg/kg/day}) = \frac{C(\text{mg/kg}) \times IGR(\text{mg/d}) \times EF(\text{d/y}) \times ED(\text{y}) \times 10^{-6} \times BA}{AT(\text{d}) \times BW(\text{kg})}$$

Input	Media	Concentration	IR (soil, plant)	CF	EF	ED	BW	AT	EDI	TDI	Background	Hazard Quotient
unit		ug/kg	g/day	g to kg	d/yr	y	kg	d	ug/kg/d	ug/kg/d	ug/kg/d	
Property 1	Soil	100	0.1	0.001	365	6	15	2190	6.67E-04	0.02	0.0014	3.58E-02
	Leafy green	195	1	0.001	365	6	15	2190	1.30E-02	0.02	0.0014	6.99E-01
	Subtotal											7.35E-01

Refining arsenic does not have such impact – risk driver is arsenic exposure



HI is below 1

Did you see anything else of concern?

Case study

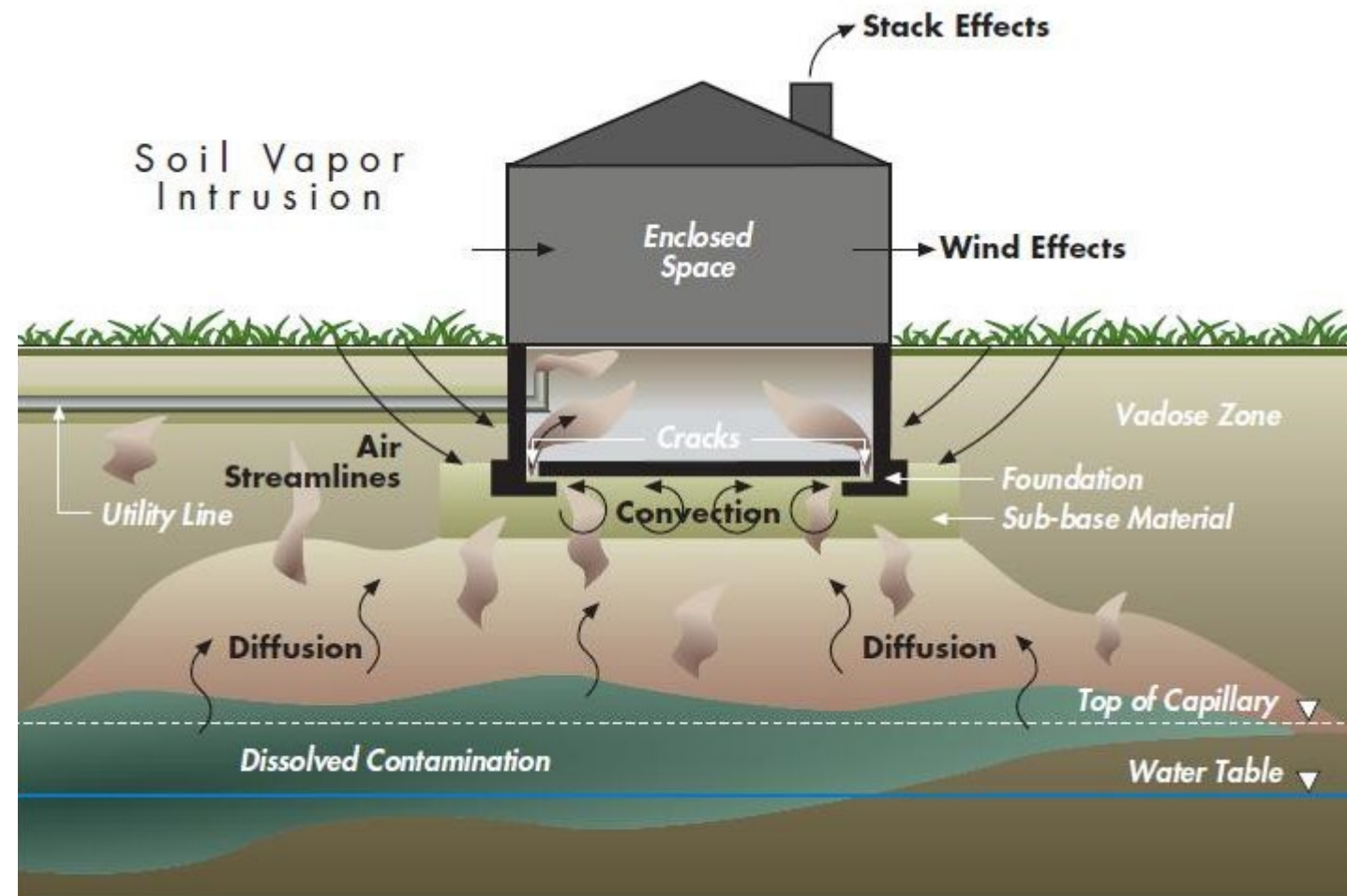
Vapour intrusion in residential settings

Some information on vapour intrusion

Vapour intrusion starts when volatile compounds such as TCE, benzene and others break away (**partitioning**) from soil and groundwater into gaps (**pore spaces**) between soil particles.

From the source, the vapour then moves through these pore spaces from areas of high concentration to low concentration (**diffusion**), closer to the building.

Differences in pressure can then draw the vapours toward and into the building (**advection**).





Problem formulation

Site setting:

- Soil vapour measured at old vacant service station identifies:
 - PCE and TCE in soil vapour
- Exceeds screening criteria by a significant margin

Next steps:

- Identify residential property next door
- Rule out shallow impacts to drinking water service lines,
- PCE volatilizing from groundwater up into indoor air
- Collect initial air quality samples – evacuated canisters over 24 hours

Soil vapour results

Chemical	Soil vapour criteria, ug/m ³	Soil vapour result, service station, ug/m ³
PCE	2000	20,000,000
TCE	20	2,000,000

Indoor air results

Chemical	Indoor air criteria (chronic), ug/m ³	Max indoor air result, ug/m ³
PCE	250	450
TCE	0.2	Not detected

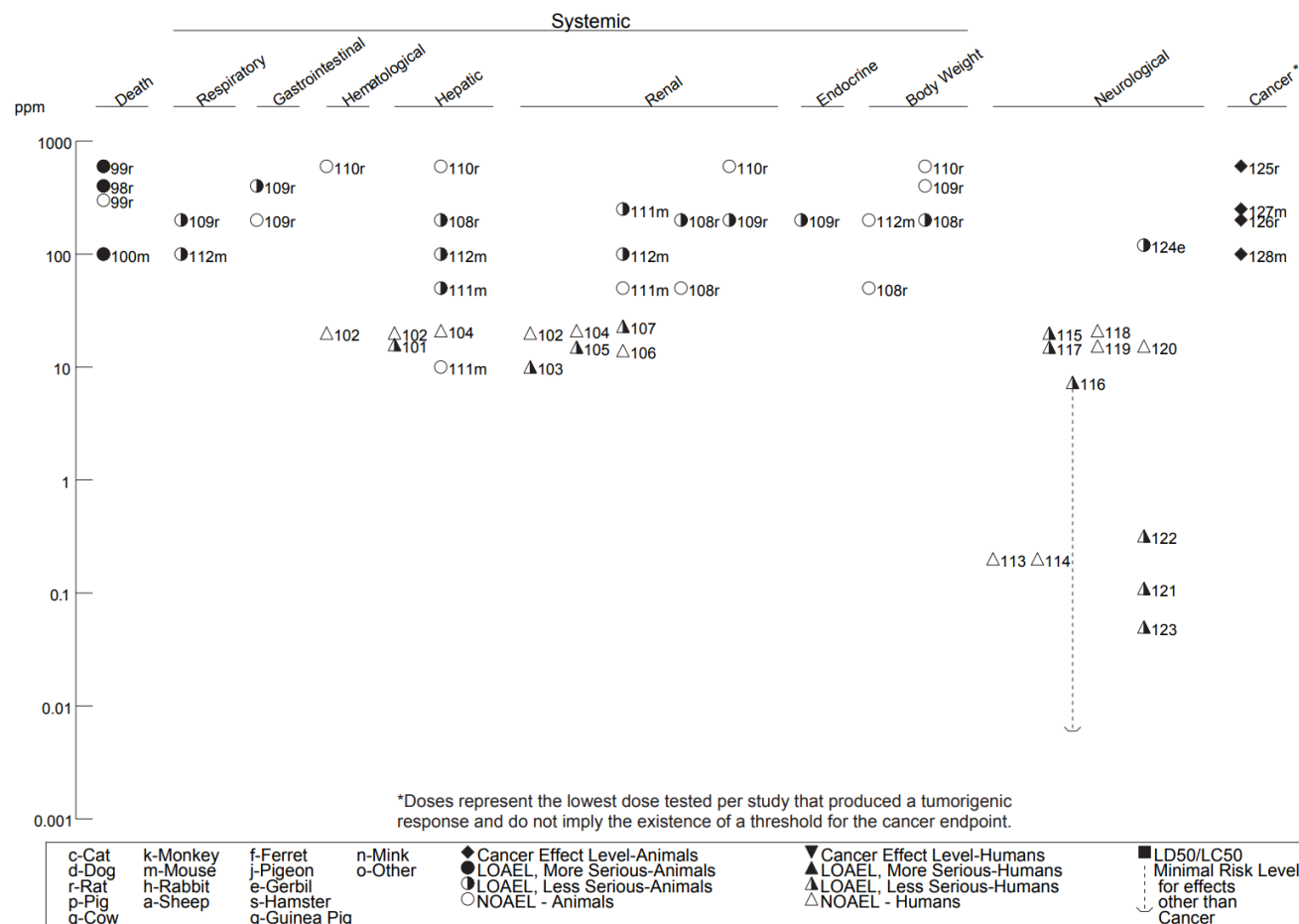


Hazard Assessment

What do we know about PCE?

- Acute health effects include irritation, nausea, headache, anaesthesia, typically observed at >826,000 ug/m³ or > 120 ppm.
- Most sensitive end point used in WHO criteria is indicators of early renal disease and neurological effects (colour vision contrast)
 - LOAEL = 102,000 ug/m³
 - Safety factors:
 - 4.2 occupational to residential exposures
 - 10 for the use of LOAEL
 - 10 for intraspecies variation
 - Final indoor air criteria = 250 ug/m³
- SA Health trigger level for accelerated intervention is 400 ug/m³
- For comparison - occupational TWA = 50 ppm (340,000 ug/m³) set to prevent irritation and subjective complaints.

Figure 3-1 Levels of Significant Exposure to Tetrachloroethylene - Inhalation (Continued)
Chronic (≥365 days)





Exposure Assessment

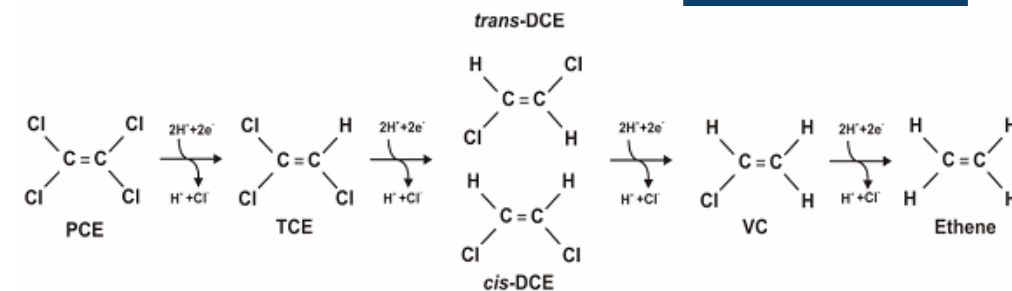
What we do know:

- PCE concentrations in indoor air have range between 280 and 450 ug/m³
- Residents have lived at the property for 4 years

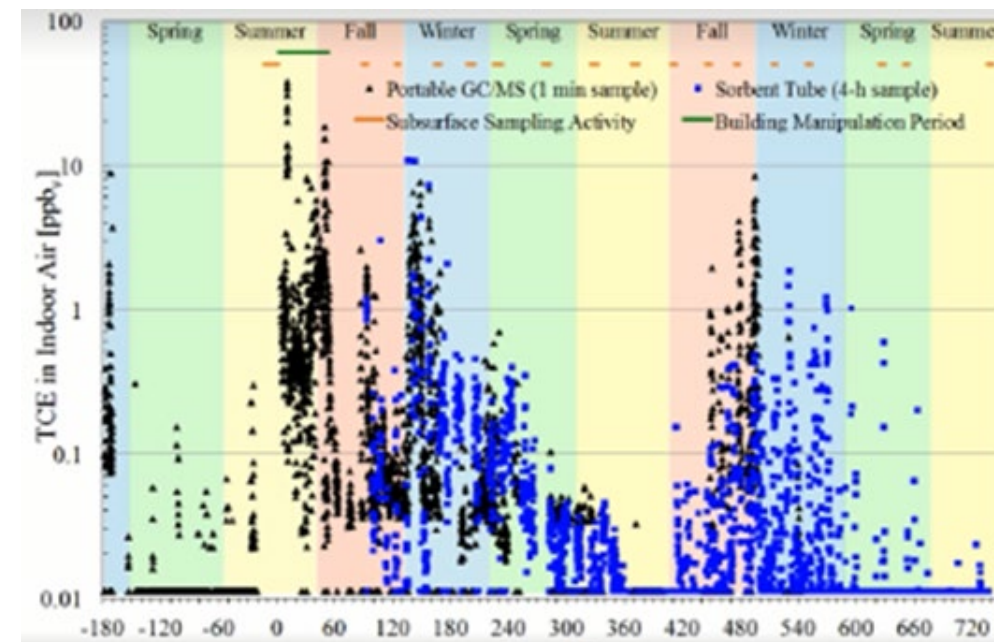
What we don't know:

- how certain are we about past exposures or temporal variation?
- there is no TCE or VC in indoor air right now but what about long term into the future? PCE breaks down into TCE and then VC.

What we don't know about exposure far exceeds what we do know



[https://clu-in.org/techfocus/default.focus/sec/bioremediation/cat/anaerobic_bioremediation_\(direct\)/](https://clu-in.org/techfocus/default.focus/sec/bioremediation/cat/anaerobic_bioremediation_(direct)/)



Seasonal differences in indoor air TCE concentrations, Geosyntec 2021



Risk management and communication considerations

- Reduce exposure soon rather than later
- Most contaminated land settings this is relatively easily achieved but not for vapour intrusion
- Challenges in reducing exposure in a reasonable timeframe are complex
 - Logistical – investigations and mitigations can be intrusive
 - Technical - timeframe to undertake a detailed investigation and implement successful remediation/mitigation may take in the region of 2 to 5 years
- Concept of vapour intrusion is very unusual – how's that going to impact decision making and risk communication?

Case study

Odour

Case Study 4: Kealba Landfill hotspots – odour and health

Issue:

- Landfill subsurface fire
- Source inert waste e.g. household, construction, fiberglass, plastic
- Generating strong odours, but limited to no visible smoke
- Started late 2019 and is continuing – throughout pandemic and lockdown
- Significant increase in reports between November 2020 and February 2020, and again now in March 2022



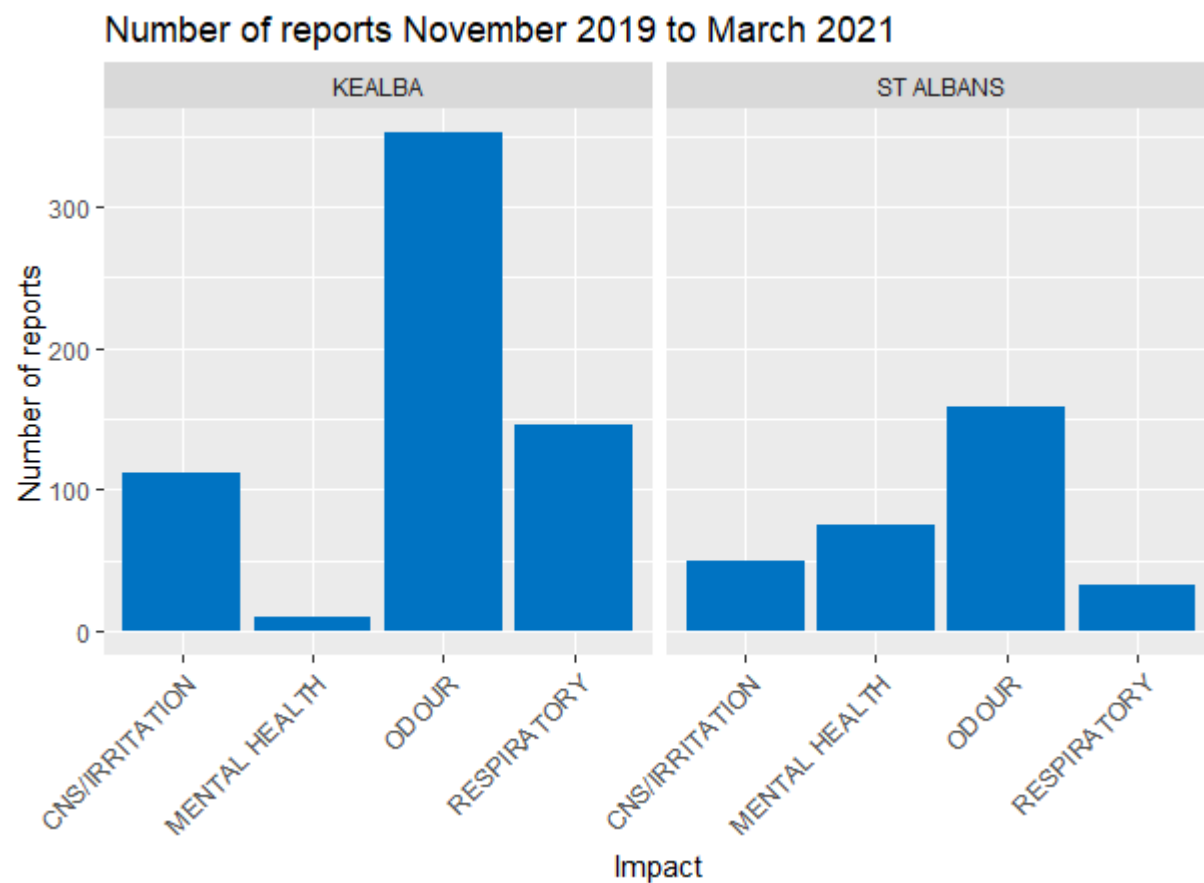
<https://www.theage.com.au/national/victoria/kick-in-the-guts-18-month-kealba-landfill-fire-to-burn-for-another-year-20210518-p57syd.html>

What Are Community Key health concerns?

- Are toxic chemicals impacting physical health:
 - Are short term health effects due to toxic chemicals or particulate matter?
 - Is there potential for long term health risks?
 - Impact of increased asthmatic events
- Frustrations that health messages appear to say experiences are ‘psychosomatic’
- Lack of regard for impact on mental health, wellbeing and quality of life



Receptor: What are people experiencing?



Symptoms typically characterized by:

- Nausea, headaches
- Irritation of the eyes, nose and throat
- Respiratory impacts – coughing, burning chest, increased asthma symptoms
- Mental health – anxiety, stress, insomnia, depression



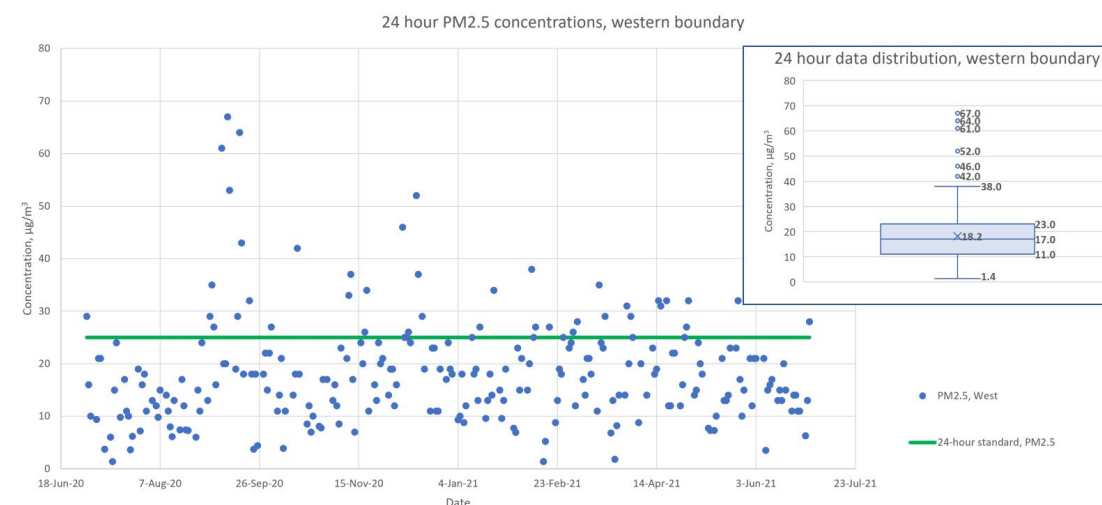
Could it be Volatile Organic Compounds or particulate matter?

VOCs

- VOC concentrations too low to cause acute health impacts
- Only 2 exceedances of indicator compounds across 188 sampling events
- Reduced sulfur, amines, ketones and aldehydes have very low odour thresholds and can result in health symptoms

Particulate matter

- **Kealba boundary:** 95%ile = 11 ug/m³, ave = 8.4 ug/m³
- **St Albans boundary:** 95%ile = 38 ug/m³, ave = 18 ug/m³
- *May be days where there were periods of time where concentrations could have resulted in symptoms for those living very close to the boundary, particularly in St Albans.*





Odour is the driver for community experience but.....

- Low risk of long term health impacts from exposure to VOCs or particulate matter may not feel like good news
- Low risk of long term health impacts does not mean no risk from short term health effects
 - Risk is higher for members of community with existing conditions
 - If odour still occurring – symptoms will continue

What can we do (in addition to regulation)?



- Interim review of all data to answer community questions
- Outreach to 45 General Practices to provide information, to highlight issue and community needs
- Mobilise ongoing air quality monitoring in St Albans and Kealba
- Updates on website, including links for mental health services

<https://www.epa.vic.gov.au/for-community/current-projects-issues/kealba#health-information>

Kealba Landfill remediation information for General Practitioners

Purpose

This factsheet provides information to general practitioners treating local community members impacted by the remediation of Kealba landfill. This update is for August 2021 and includes environmental monitoring data between July 2020 to June 2021. Further detailed information is provided in [Interim air pollution assessment for Kealba landfill hotspot remediation](#).

Landfill fire hotspots are areas of high temperature deep in the landfill that generate localised smoke and strong odours. Baysa Group, the operator of



Thank you!





1300 372 842 (1300 EPA VIC)

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