

CONTAMINATED SITE MANAGEMENT OPTIONS: FRAMEWORK AND CHALLENGES IN PRACTICE

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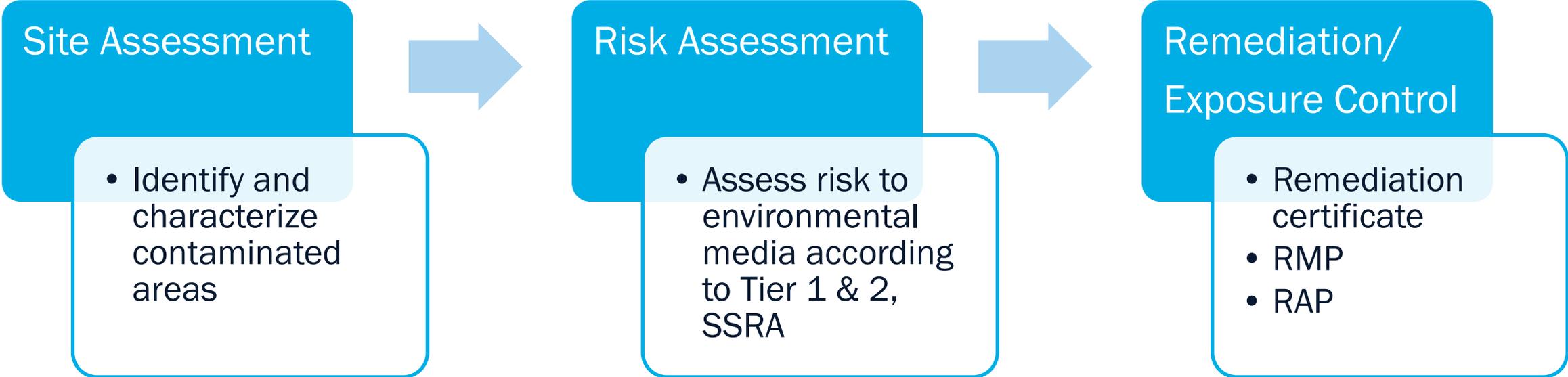


INTRODUCTION

- Overview of Alberta Framework for Contaminated Site Management
 - Site Closure – all site liabilities are assessed (Tier 1 or Tier 2) for intended land use.
 - Risk Management – site liabilities are assessed and managed (Exposure Control), attempting to return to productive land use.
- As consultants, we are exposed to many contaminated sites with their own challenges and it's our job to find the best mechanism to return the site to productive use.
 - While supporting our client
 - Working within the confines of regulations
 - Landowner requests
 - Remediation considerations (i.e., depth of contamination, nearest approved landfill, trucking routes, seasonality)



CONTAMINATED SITE MANAGEMENT PROCESS





CHALLENGES IN PRACTICE

Limited application of frameworks like SST to other contaminants (e.g., petroleum hydrocarbons).

Issues with applying soil contact and inhalation guidelines at deep depths, particularly below groundwater tables.

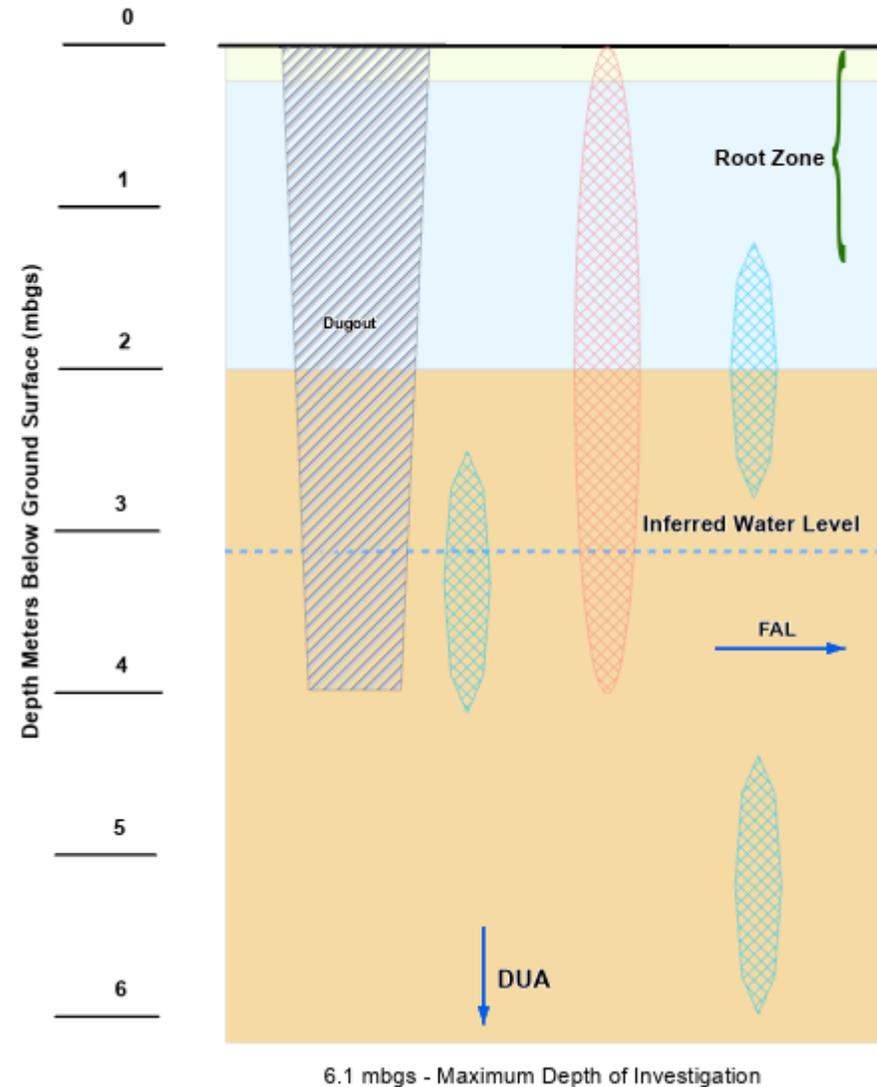
Lack of Tier 1 soil vapour guidelines despite their use in calculations.

Uncertainties in regulatory frameworks and their impact on decision-making.

Difficulties in obtaining regulatory approval for risk-based approaches and long-term monitoring plans.

SST VERSUS TIER 1

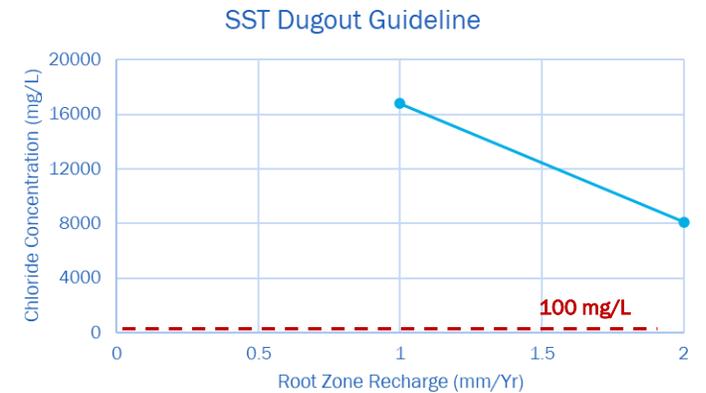
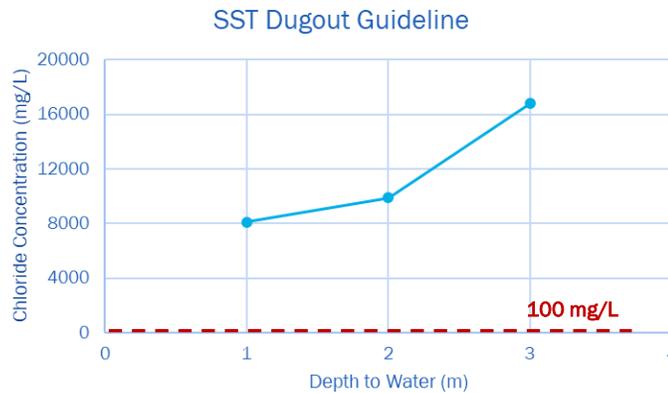
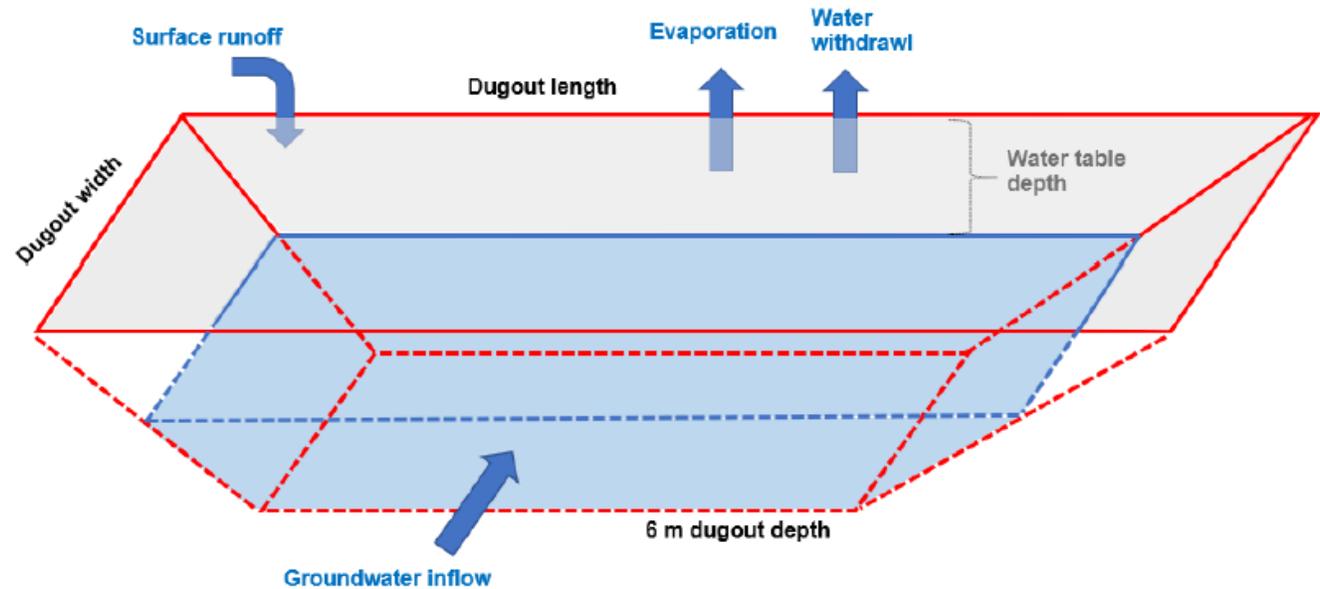
- Alignment between SST defaults and AEPA Tier 1 defaults
- Exposure Pathways (chloride)
 - Root Zone – No Tier 1
 - Dugout– Tier 1 of 100 mg/L
 - FAL – Tier 1 of 120 mg/L
 - DUA – Tier 1 of 250 mg/L
- SST allows mixing for dugout and DUA (not for FAL)





SST DUGOUT

- Can be placed anywhere onsite
- Adjustment factor for dilution, i.e., groundwater mixing with precipitation & runoff
- Influenced by
 - Geology & hydrogeology
 - Climate





WHY CAN'T WE APPLY THIS LOGIC TO OTHER PARAMETERS?





BORON – TIER 1 GUIDELINE – 1 MG/L MODIFIED TIER 2 GUIDELINE – 80 MG/L???

Boron, although not considered inert, is a common contaminant of concern commonly found in conjunction with salinity impacted sites due it's use with drilling fluid enhancement

Boron is stable in its elemental form and resistant to oxidation at lower temperatures.

Boron, which has an irrigation guideline, could also be assumed to be diluted by influences like surface water runoff and groundwater inflow.

And not just unique to Boron... why not Benzene??



BENZENE –LIVESTOCK GUIDELINE – 0.088 MG/L MODIFIED TIER 2 GUIDELINE – 7.04 MG/L???

Benzene does not have an irrigation guideline, but it does have a livestock and wildlife watering guideline. Why can't the same principle apply? PHC contamination is a concern at drilling sites and usually also requires remediation or risk management.

Benzene is highly volatile once exposed to air and is readily oxidized under the influence of air and water.

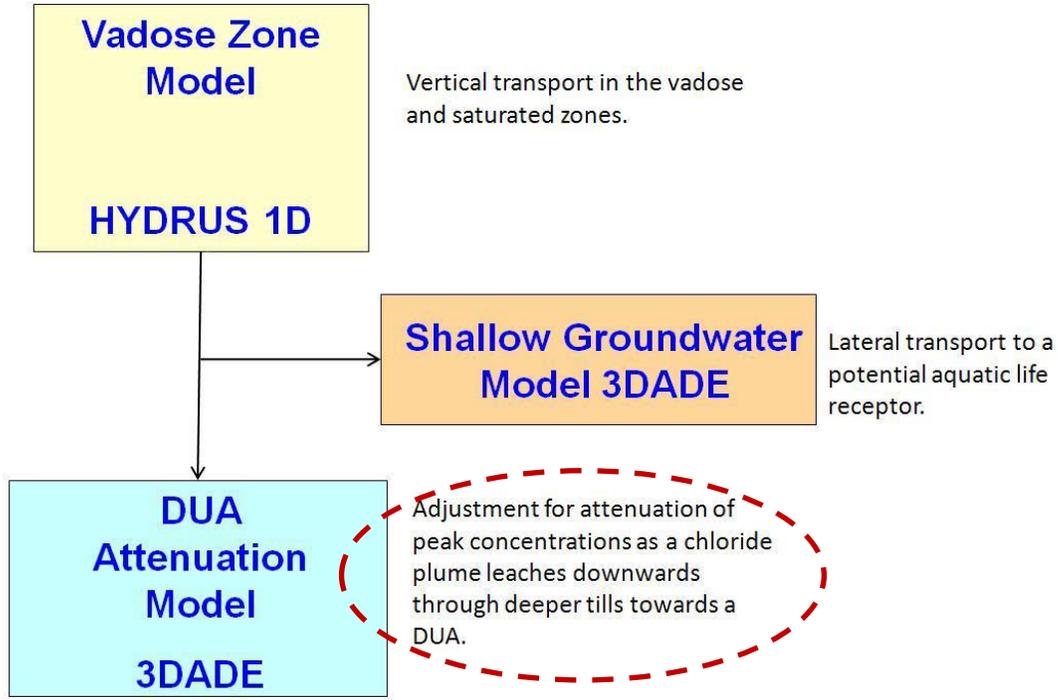
Same principle should apply to benzene, which would be highly influenced by additional clean sources of water.

Calculating Tier 2 guidelines for certain parameters while relying on Tier 1 for others is not a practical or logical approach.

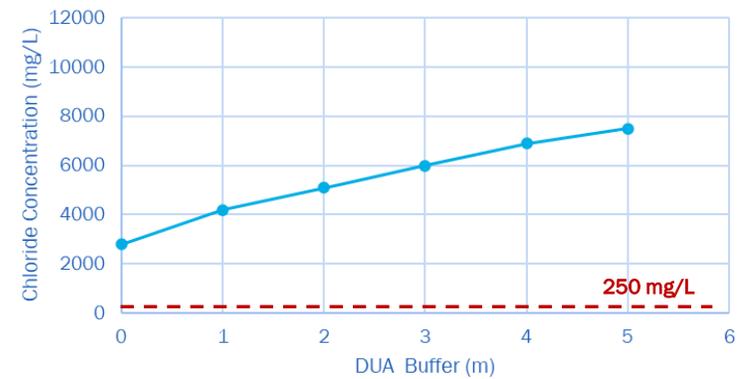


SST DUA

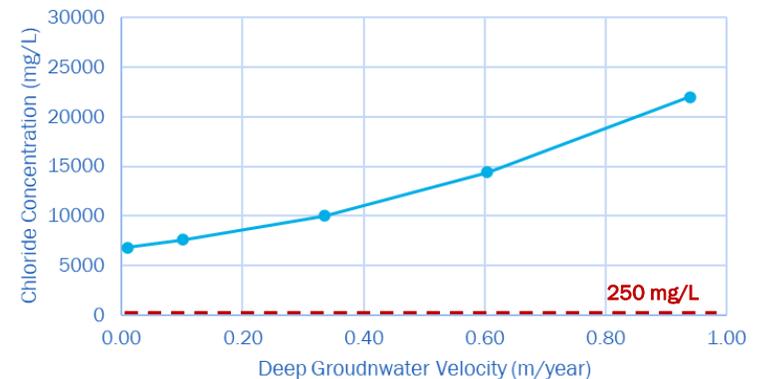
- Dilution of leachate water as it enters the DUA
- Attenuation due to lateral transport in the saturated zone above the DUA
- No attenuation due to lateral transport within the DUA



SST DUA Guideline



SST DUA Guideline



NOW TO APPLY THE RATIONALE TO ORGANIC COMPOUNDS (BENZENE)



NATURAL ATTENUATION



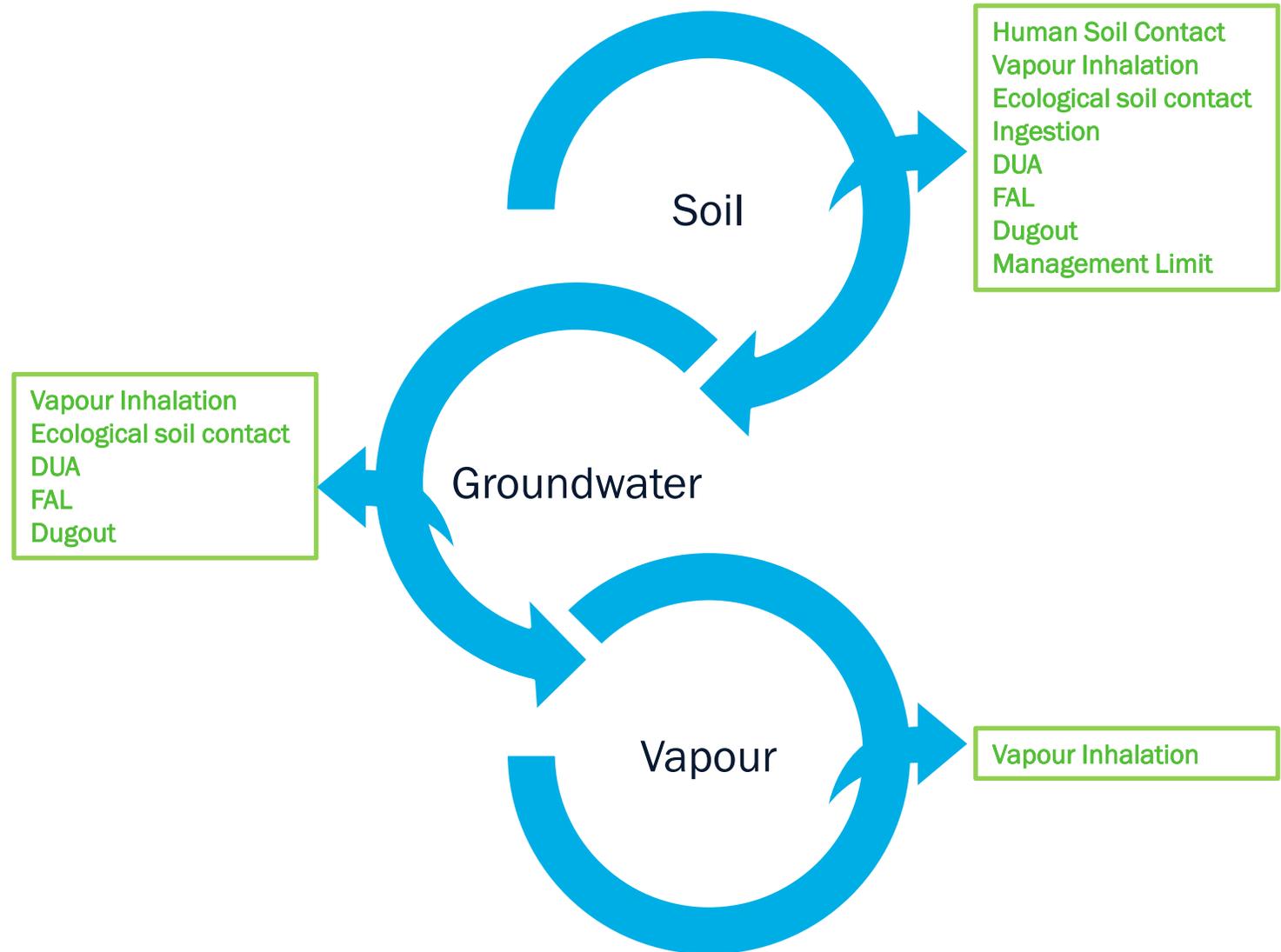
VOLATILE

Tier 1 DUA Guideline – 0.005 mg/L – could increase to 0.050 mg/L or higher?



MEDIA-FOCUSED REMEDIATION

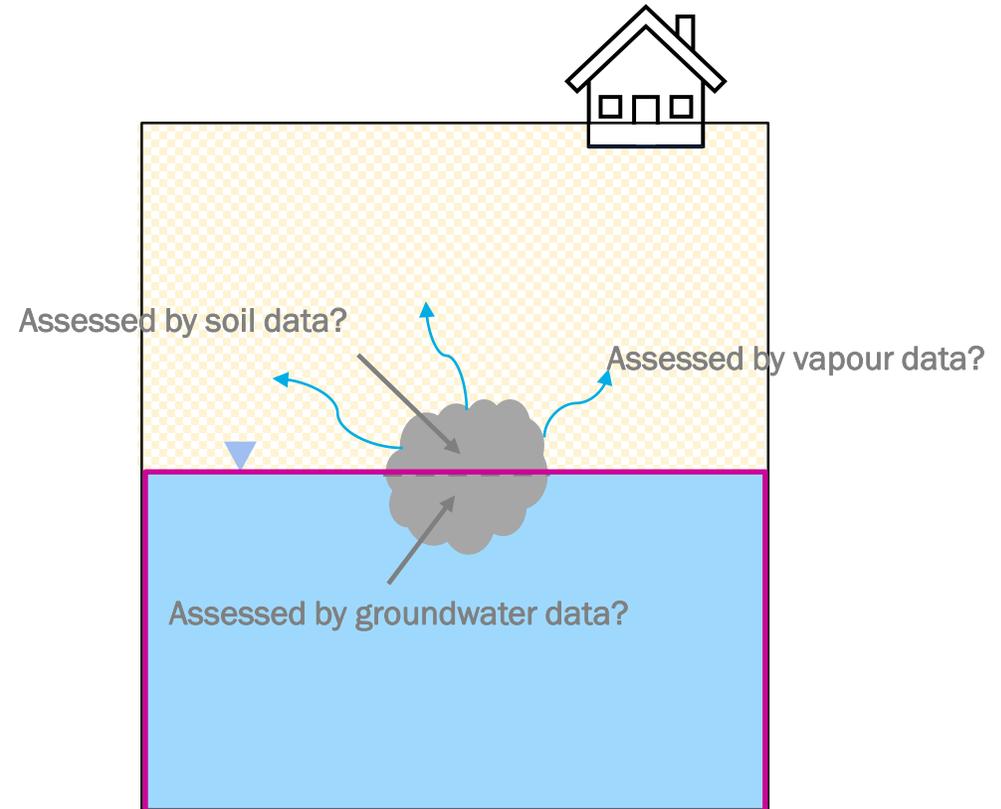
- Environmental media
 - Soil, groundwater and vapour
- Human receptors and exposure pathways
- Ecological receptors and exposure pathways
- Other – Management Limit





INHALATION PATHWAY

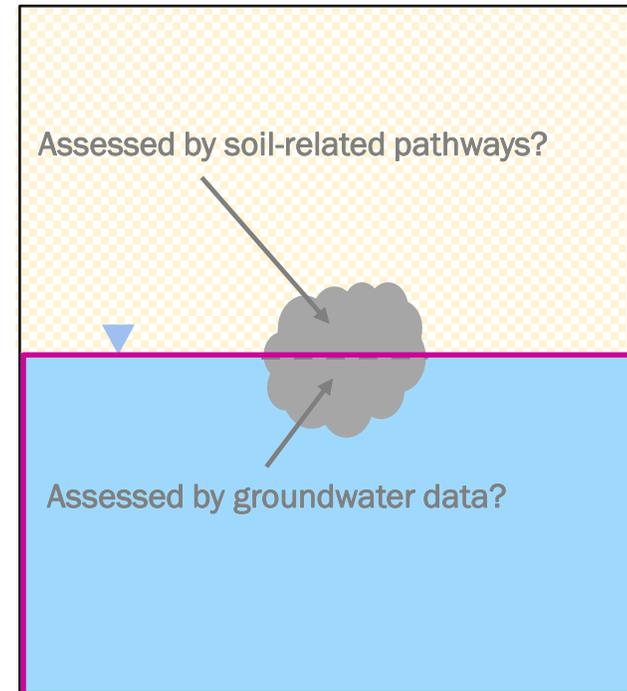
- **Soil exceedances in vadose zone**
 - Vapour sampling program
- **Soil exceedances below groundwater**
 - Groundwater sampling program
 - No risk if no groundwater exceedances
 - Vapour sampling if groundwater exceedances
- **Soil vapour data**
 - No Tier 1 guidelines
 - Tier 2 calculations





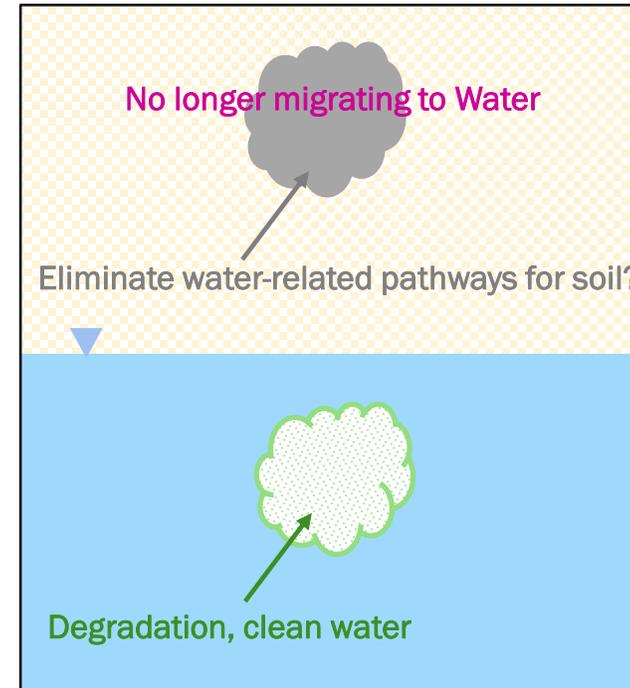
DUA/FAL PATHWAY

- Soil exceedances in unsaturated zone
 - Assess by soil-related pathways
- Soil exceedances below groundwater
 - Assess by groundwater data



HISTORICAL SOURCE

- Soil is contaminated and groundwater is clean
 - Contamination is not expected to migrate to groundwater if it hasn't after a long period (10 or 20 years?);
 - Eliminate water-related pathways for soil assessment
- Groundwater was contaminated but concentrations have declined to below guidelines
 - Concentration has been degraded after a long period (10 to 20 years?)
 - Eliminate water-related pathways for soil assessment



CCME (2014)

VAPOUR GUIDELINES

- Tier 1 soil and groundwater vapour inhalation guidelines tend to be conservative
- Tier 2 guidelines may yield limited difference
- Sampling of soil vapour provides a more direct indication of source vapour concentrations
 - No Tier 1 guidelines
 - Tier 2 calculation need regulatory review
- Publish Tier 1 vapour guideline?

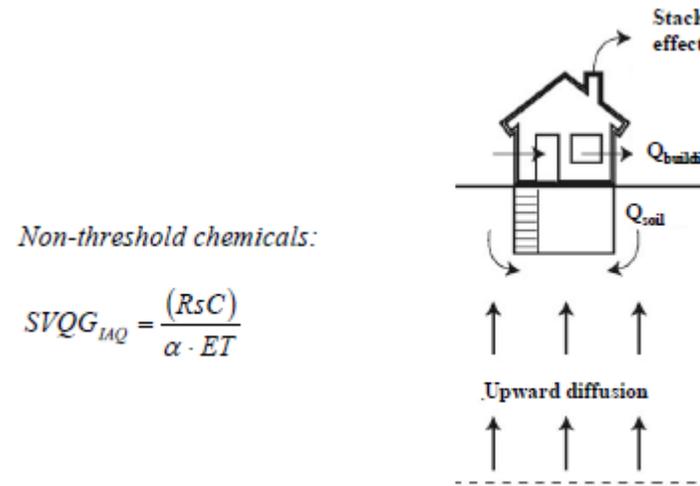


Figure 3. Conceptual Diagram of the J&E Model

AEPA (2024)

$$GWRG_i = \frac{RsC \times DF_i \times AF}{H' \times ET \times 10^3} \quad DF_i = \frac{1}{\alpha}$$

$$SRG_i = \frac{RsC \times [\theta_w + (K_{oc} \times f_{oc} \times \rho_b) + (H' \times \theta_a)] \times DF_i \times 10^3 \times AF}{H' \times \rho_b \times ET \times 10^6} + BSC$$



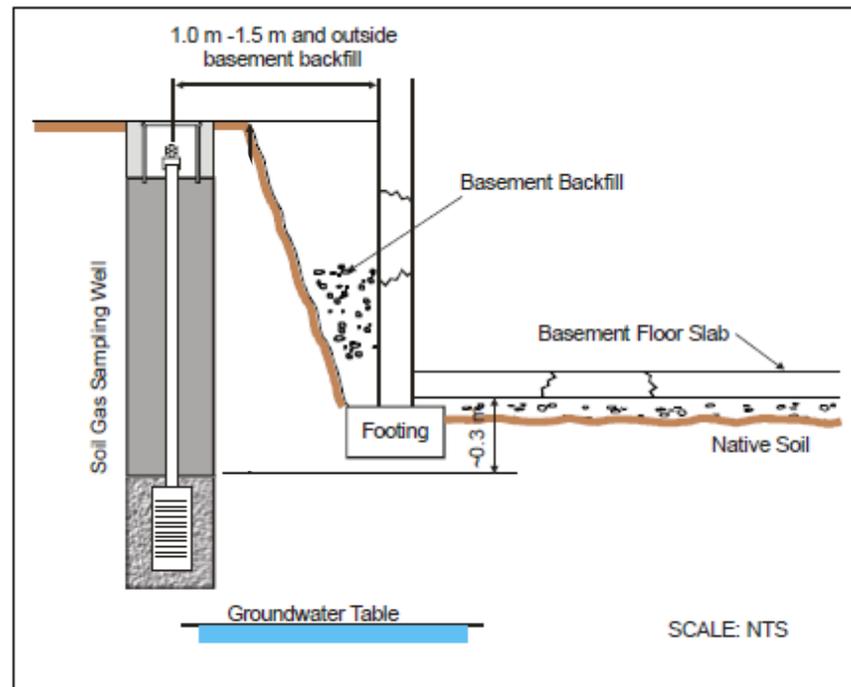
$$GWRG_i = SVQG_{IAQ} \times \frac{AF}{H' \times 10^3}$$

$$SRG_i = GWRG_i \times DF_1 + BSC$$

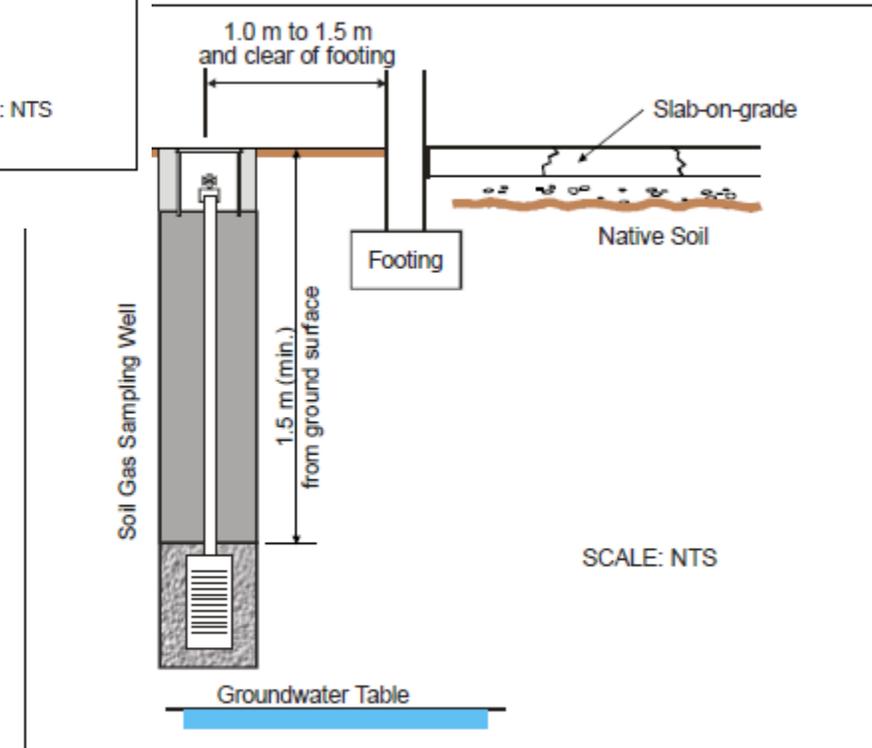
$$DF_1 = K_{oc} \times f_{oc} + \frac{(\theta_w + H' \times \theta_a)}{\rho_b}$$

VAPOUR SAMPLING

- 2014 CCME Guidance Manual
 - Half-way between foundation and contamination source (minimum of 1 m below foundation/grade in general)
- 2024 AB Tier 1
 - Minimum of 30 cm below foundation
- In practice, contamination sources close to surface
 - No guidance for vapour sampling depth



a) Building with Basement



b) Slab-on-Grade Construction



IMPACT ON SITE MANAGEMENT DECISIONS

Tendency for site owners to choose conservative remedial options.

Limited adoption of environmental net benefits concepts in remediation practices.

Missed opportunities to return land to productive use during long-term risk management.



OPPORTUNITIES FOR IMPROVEMENT

Encouraging adoption of environmental net benefits and productive land use concepts:

- **Transferring liabilities with sale of land so that remediation can be completed along with site redevelopment.**



Highlighting the need for clear regulatory guidance and framework:

- **Risk-based closure options (i.e., stable trends to support site closure).**



SUMMARY

Recognize challenges in practice and opportunities in contaminated site management.

Proposed feasible solutions and engagement of regulator is necessary.

Collaborative efforts between industry and regulators are required to address inconsistencies and improve outcomes.



QUESTIONS & COMMENTS ?