U.S. EPA "State of VI Science" Workshop 2023

Selecting Sampling Strategies for Efficient & Economical Vapor Intrusion Site Assessment & Long-Term Management – forming Soil Gas Safe Communities

Introduction

Verifying Cleanups Near Receptors

Henry Schuver*, DrPH
USEPA-OLEM-ORCR

March 21, 2023

*Personal opinions do not represent EPA policy (yet).

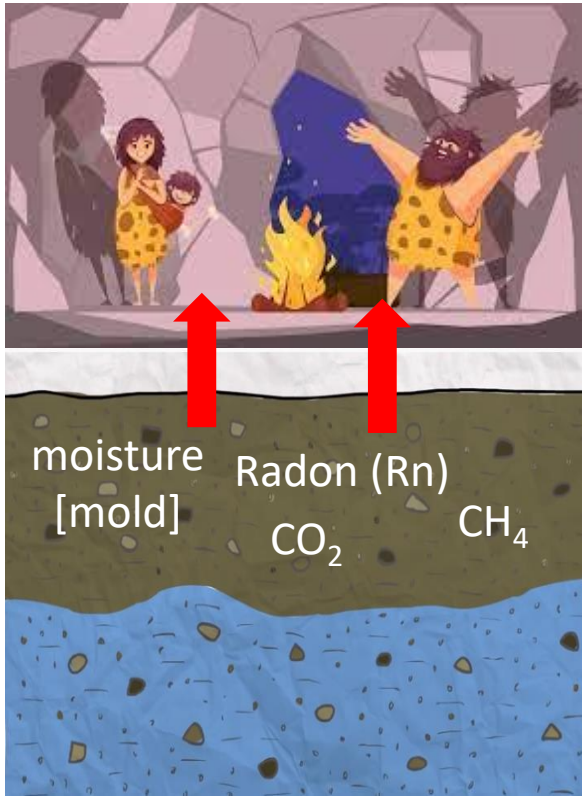
32nd Annual International Conference on Soil, Water, Energy, and Air, A Hybrid Workshop w/n Conference, March 21nd, 2023

Presentation archived at https://iavi.rti.org/

Agenda

- Background
  - Exhaustion with *progress so far*
- Barriers to Indoor assessments
- Comparison of related exposure pathways
- New perspective: Verifying Cleanups ‘Near’ Receptors
- Question: When does a spill of cVOCs stop spreading?
- Migration metrics to focus on stopping it & exposures
- ‘New’ Tools in the VI Toolbox

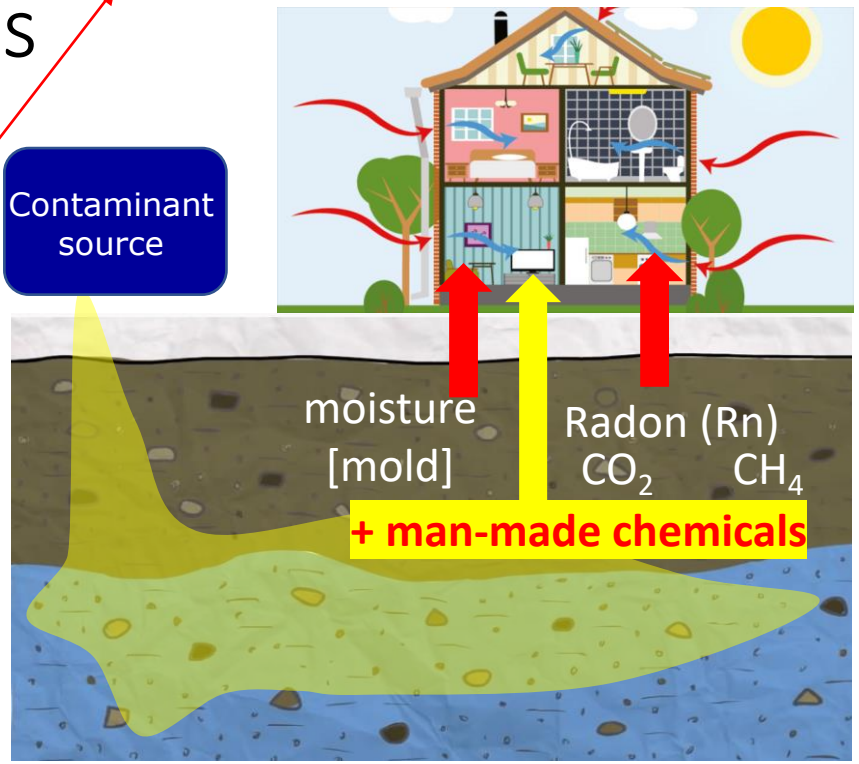
Soil Gas has been in **Intruding** into 'indoor' air since we lived in Caves; **'SGI' is Inevitable!**



Conc. were minimized by high exchange rates with 'cleaner' outdoor air

Getting worse >2x

Now: Our buildings/homes are increasingly tighter/weatherized for low/lower indoor air/energy loss



Same natural hazards, but at increasing concentrations as it is 'trapped' indoors

& now Petro- Chloro- & **Fluoro- + …**

Overview of 24 years of effort

- **We've tried ~Everything**
  - But
- Removing (un-needed) Conceptual constraints/**Barriers**
  - &
- Return to Congress' intent – **Cleanup**

Barriers w/ **EPC** assessments 'at' Receptors

1.1) Current **Focus** on ***indoor*** **E**xposure **P**oint **C**onc. for **ea. Bldg**.'s **mitigation decision**:

- **Adds 100x** more **uncertainty;** due to **Building** & **Weather/Climate** variables &
  - **Precludes** us from **communicating clearly** about what **samples mean** & **Responses coming**
  - **& Creates/Exaggerates each** of the **Barriers** below:

1.2) Social

- **Access** to **indoor** spaces (for '**every bldg**. 'at risk') for EPC sampling – Negatives for Owners

1.3) Technical

- **#** & **Timing** of indoor air **EPC** samples to document ~95%ile of distribution in **Every bldg.**

1.4) Economic `

- **Funding *in*sufficient** for teams to collect **enough samples** (in living spaces) of **Every bldg**.

Together these **Barriers** make Verifying exposures 'at' Receptors difficult (w/o $$)

*Ultimately, i.e., even for Sub-Slab & Soil Gas samples using attenuation factors to est. EPC.

1.2) Social Barriers- **Access** to indoors

- **Access** to indoor (personal) living space is a **major obstacle to:**
  - **All indoor-based** sampling (Indoor air & sub-slab)
    - & Indoor **Exposure *Mitigation*** (**SSD**) – Sub-Slab Depressurization systems
  - Currently If you **don't get indoors ~all progress stops** (for that bldg./receptors)
  - **We're asking them to**: **Open 'their' doors** to IAQ measurements **+ Uncertainty**
  - May find 'high' chemical (&/or radon) levels – often Clarity of responses lacking
    - **No good news** – just **another problem**
    - Didn't **know** they had, & Don't have **time** for
      - At a minimum, **Nagging worries** until it is addressed
      - Stigmatization of bldgs. **particularly if only an isolated few** (not majority) of community **w/ VI**
        - **Even if** many/most bldgs. **around them have similar or worse** exposures unaddressed
      - Potential **de-valuation of 'their' property** to naïve on-lookers/buyers

Why can't we do our work from Outside of Indoor personal living spaces?
Like we did/do for Groundwater

Major Implication of Indoor **Access** limitations

- We (regulators) have the obligation **to protect all bldgs./people** potentially impacted by releases of contamination, *until it has been cleaned up*.
- **Not just those willing to grant sampling teams access** to their indoor living spaces.
- We **need** to be ready to **Sample &/or Control VI** from **locations *Outside* of indoor spaces** so we can **provide** & **verify protection** for **All bldgs./people** & measure community-wide 'cleanup' progress
- The conc. of contaminants in the nearby media (e.g., soil gas) is a better initial metric (than EPC) for assessing the need for, and area-wide cleanup progress*

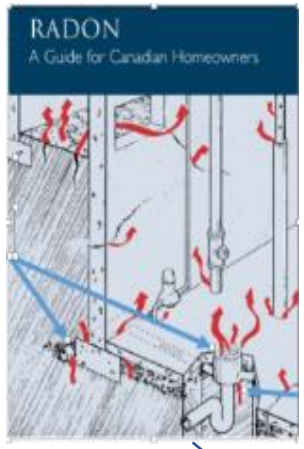
*In my opinion

Simple **C**onceptual **S**ite **M**odel (CSM) for Dilute GW Residential ***Soil Gas/Conduit Vapor*** Intrusion

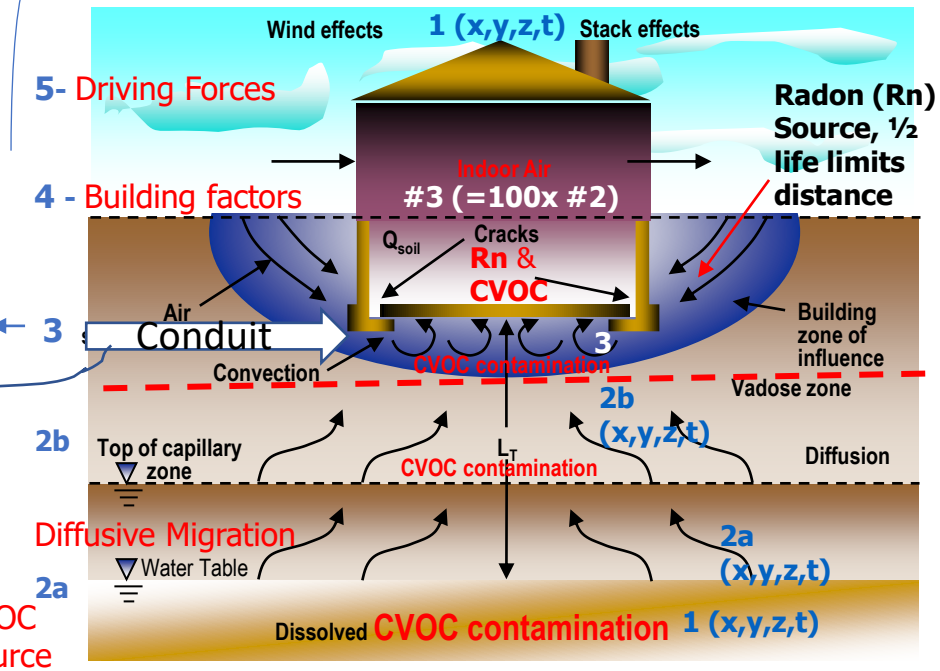
1.1) EPC **Focus** adds 100x Uncertainty

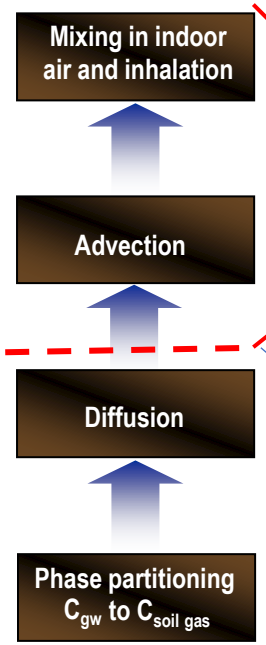
Many factors/sources of Variability across Space & Time

Bldg. are complex incl. ***Pipe/Conduit Flow pathways,*** both Direct & Indirect **5**



Five *Categories-of-Variables* for **Chlorinated** VOC (CVOCs)





100x

'Near'

>90% (reduced conc. between SS & IA)

Attenuation ~ Variation/Uncertainty in Indoor EPC

1-10%

~100x **Less** Variation/Uncertainty in Soil Gas than Indoor air (EPC)

Direct & Indirect non-natural 'pipe flow' preferential pathways

Mod. from slide by M. Bolas, Ohio EPA, presented Jan. 2006

The conc. of contaminants in the nearby media (e.g., soil gas) is a better initial metric (than EPC) for assessing the need for, and area-wide cleanup progress; with verification of adequacy by EPC across space (# of Bldgs.) & Time (i.e., **L**ong **T**erm **S**tewardship) in my opinion

Comparison of Radon, & Chemical contamination (in GW/DW & VI) in ≤2022

Key: Green highlight = Like VI
Yellow highlight = **Not** like VI

	Radon	**GroundWater** Contamination	**Vapor Intrusion** Contamination
Responsible / Managing **Party**?	Nature; So Bldg. Owner/Occupant	Person who spilled it (or Public)	Person who spilled it (or Public)
Is it **Everywhere**?	Yes	No; only where spilled & migrated	No; only where spilled & migrated
Source Cleanup possible?	No	Yes, at spill site, & in ground-water plume	Yes, at spill site, in groundwater plume, and vapors in soil gas
Source will be there '**forever**'*	Yes	Does Not need to be, Can be cleaned up/removed Or natural attenuation over decades	Does Not need to be, Can be cleaned up/removed Or natural attenuation over decades
Measurements for Response Decisions	Indoor Air/Exposure Point Conc. (**EPC**) in Every Bldg., + Every 2 yr.	All Contam. in Groundwater **Media >MCL** for **Cleanup** ← ? **Some** Bldg.'s Tap Water ← ?	Indoor Air/Exposure Point Conc. (**EPC**) in Every Bldg. + LTS, ***if*** Mitigation
Who Benefits from ***in*-bldg. Dil/Attenuation**	Bldg. Owner/Occupant Allows & 'permits' it	Dilution/Attenuation not allowed ← ?; (except in well-monitored Public systems)	Person who spilled it

GW pathway's reminder of RCRA's goal: **Cleanup** the Spill where ever it is (now)

- Means for RCRA
  - By the **R**esponsible **P**arty (RP)
  - To avoid spill/release becoming a **Public** problem
    - & provide
  - "***Protection*** *of Human Health and Environment*"

Congress' intentions (in HSWA & RCRA): my interpretation

"***Protection*** *of Human Health and Environment*" Does **NOT** require:

- We force our way **into every bldg**. for sampling Expo. Pt. Conc. (**EPC**)
- Try finding RME (**95th%**ile) with a few (reasonably affordable) samples
- **Proof** of unacceptable exposures in every building **before Mitigating**
- **One bldg. at a time!** – we will never get to **our goal**:
    - i.e.,
    - "***Protection*** *of* [**all**] *Human Health and Environment*"
        - by
    - **Cleaning up/Removing** the **contamination**
        - Where ever it is
            - &
        - Before it spreads further

Today's Perspective:
Verifying Cleanups 'Near' Receptors

- **Verifying** an accomplishment
  - Small effort compared to the achievement (& smaller with better cleanup)

- **Cleanups** remove spilled contamination
  - Cleanup is major effort & lasts forever (is intrinsically safe)
    - Only needs ~1 time verification
- **Near** is not 'at' receptors
  - It's **before** – contamination is kept a **separation distance/time** away

- **Receptors** are people in the way of a **still *un-controlled*** spill

When does a spill/release cVOCs stop?*

- We generally **know** when most **began** historically (1950s-80s)
  - These were inappropriate **transfer** of waste obligations **onto others' property**
    - #1 Reason RCRA Corrective Action was created to Avoid that, by
  - **Cleaning up** historical **releases** into the [natural] environment; but:
- **Observation** – *It appears*** that many:
  - Historical cVOC releases are **continuing to spread/un-controlled** today
    - As **cVOCs** partition/spread **into Soil Gas** without controls (& only exposure monitoring)

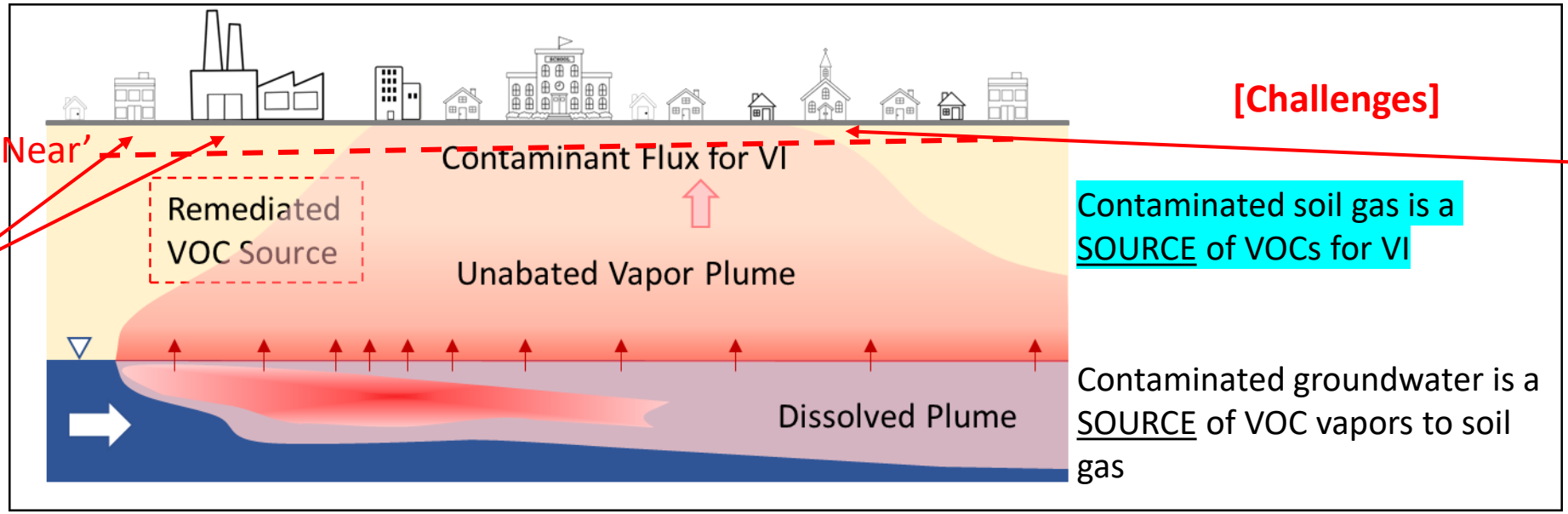
*Question for anyone/all Panels today
** to me

[Challenges & Successful Cleanups Near Receptors]

Slide by 'Bo' Stewart – Borrowed from his PM presentation later today, [mod. by notes & &]

What is a "Source of VOCs"?

- Step forward a few years or a decade AFTER SVE [at the Original Source release site] ceases



[Successful]

[Note: Only Bldgs. now potentially* protected from VI, by Cleanup]

[Challenges]

[Note: evolving front of VI impacted bldgs. over time (years)

Can that be: Included in 1x assess.? [Challenges] (observed by NYDEC 2x, slug releases)]

- Now what?

[*Potentially, since most cleanups at the original source have only a GW protection goal and may not achieve an appropriate Soil Gas Screening Level for VI.]

RCRA Cor. Action's Goal: **Cleanup** (of Spill/Released Contamination) '**Everywhere all the time'**

- Of coarse Cleanup means:
  - **ALL** media *at the* ***Original release/spill site***
    - **&** *as an initial priority*
  - *at least* **stopping** any **continuing release/spreading** of contamination?
- **Why can't more cleanups address cVOC contamination spreading into Soil Gas?**
  - From Groundwater and/or cVOCs in soils from GW – Since **Soil Gas is the source for VI**

We've focused on Migration before:

Migration of Contaminated *Groundwater* Under Control?*

- **YES**
  - Documented at ***almost all*** RCRA Corrective Action cleanup facilities!
  - It appears having a metric focused on;
  - Spreading of contaminated groundwater;
  - Helped control its spread and confidence that contamination is
  - Not continuing to spread

RCRA Metric for Cleanup Progress (1999) Environmental Indicator (EI)

Concept for consideration: Would this help? **Migration of Contamination *into* Soil Gas** Under Control?

- Stop any continuing release/flux of vapor contamination from:
  - Spill/soils, **Groundwater** (& soils contaminated by groundwater) into Soil Gas
  - Maybe it would? But could a large initial goal if a **deep** unsaturated zone
  - BTW; Who ‘permits’ that contaminant mass transfer on other people’s property?
  - Perhaps it should be the property owner/occupants (subject to flux) themselves?
- **On-going** release/**spreading** of contamination **needs to stop Somewhere**

Migration of Contaminated Soil Gas into the *'Human-built' Environment* Under Control?* 1

- The *final opportunity* to stop, **prior** to having Soil Gas 'at' the receptor
- The depth below ground, (i.e., '**Near**' Receptors)
- Where the 'Human-built' Environment begins,
- Depends on the depth of the local piping etc. connected to bldgs.
  - The 'Human-Built' Environment (HbE) is **so much more complex than nature**:
    - ~100x
  - There is **no point closer** to the receptor – that **can reliably control exposures****

*A proposal to move RCRA cleanup of VI problems forward nationally, for comment
**without need for excessive, ~continuous, monitoring, in my opinion

Migration of Contaminated Soil Gas into the *'Human-built' Environment* Under Control?* 2

- Observations & Proposal for Discussion:
  - Once **vapor contamination gets into** the **HbE** (Human-built Environment)
  - Detection and **control is so tenuous** that, sampling **verifying its non-presence**, will likely **cost** (RP/taxpayers) **more than;**
  - **Containing and treating** the contamination to render it **non-toxic**
  - To **confidently prevent exposures** (w/ **less** expenditure on LTS **monitoring**) and retaining **more funding** for **cleaning up/removing** and treating contamination;
  - Could draw a **high priority 'Near' receptors line ~15 feet below MbE**** to avoid migration into preferential pathways/conduits or other routes leading to indoor air with little attenuation

*My draft Proposal to move RCRA cleanup of VI problems forward nationally

**My est. & determined by local Human-built structures & barometric pumping

'New' (*under utilized*) Tools **in VI Toolbox**

- *Re*-Focus –
  - on **soil gas** as exposure media
- Technologies –
  - for **better** site assessment and **remediation**

Re-Focus on **Protection** by Cleanup of Contaminated Media Near Receptors

- Increase Regulatory attention/focus on:
  - **Nature & Extent** of vapor contamination in Soil Gas (~like we do for GW)
  - Making sure we're **Separating** vapor **contamination** from **Bldgs./Receptors**
    - Cut off pathway by a **'Separation zone'/ 'Margin of Safety'** by **bldg.** (~like is done w/ petro. VI)
  - **Transparency/clarity Documenting** where vapor contamination is:
    - Relative to Bldg./Receptors
    - So Owners/Occupants can see and know they are in 'soil gas safe' conditions
  - **Cleaning up** cVOC **contamination** in **Soil Gas that is a Source to VI*** (~like we do for GW)
    - **Part of the permanent remedy, and making sure the VI exposure threat is Not Forever**

*Economic analysis of this will be presented later in this workshop

A **re-allocation** of resources could help us Stop more exposure now, & in the future

- Large amount $$ spent sampling indoor air*
- Relatively little $$ are being used to reduce cVOCs **into & in** Soil Gas
- More cleanup of cVOCs going into Soil Gas, means;
- Less indoor air/exposure sampling is needed
- We need **more** soil/GW/soil gas **cleanup**, & **Less** indoor air **sampling****

*It appears to me, & **with little understanding gained**
****Sampling** does **not reduce exposure** or **remove/cleanup** much **cVOC mass**

'New' (*under utilized*) Technologies

- **S**oil **V**apor **E**xtraction (**SVE**) – **Removes** vapor contamination from soil gas
  - Long used for **Cleanup** of primary (hi-conc.) **original Source release/spill areas**
    - Typically w/ Leaching to GW (**Not VI**) based goals!
  - USEPA/ORD **proven SVE can prevent VI** in **multiple adjacent bldgs.**
  - **SVE *near receptors*** can **both:**
    - **Cleanup VOC contaminants** in **Soil Gas media,** i.e., the '**proximate**' **Source** of VI
      - &
    - **Prevent Exposure**
  - **Without going inside (every)** bldgs.' **personal living space!*** (~like GW cleanups)

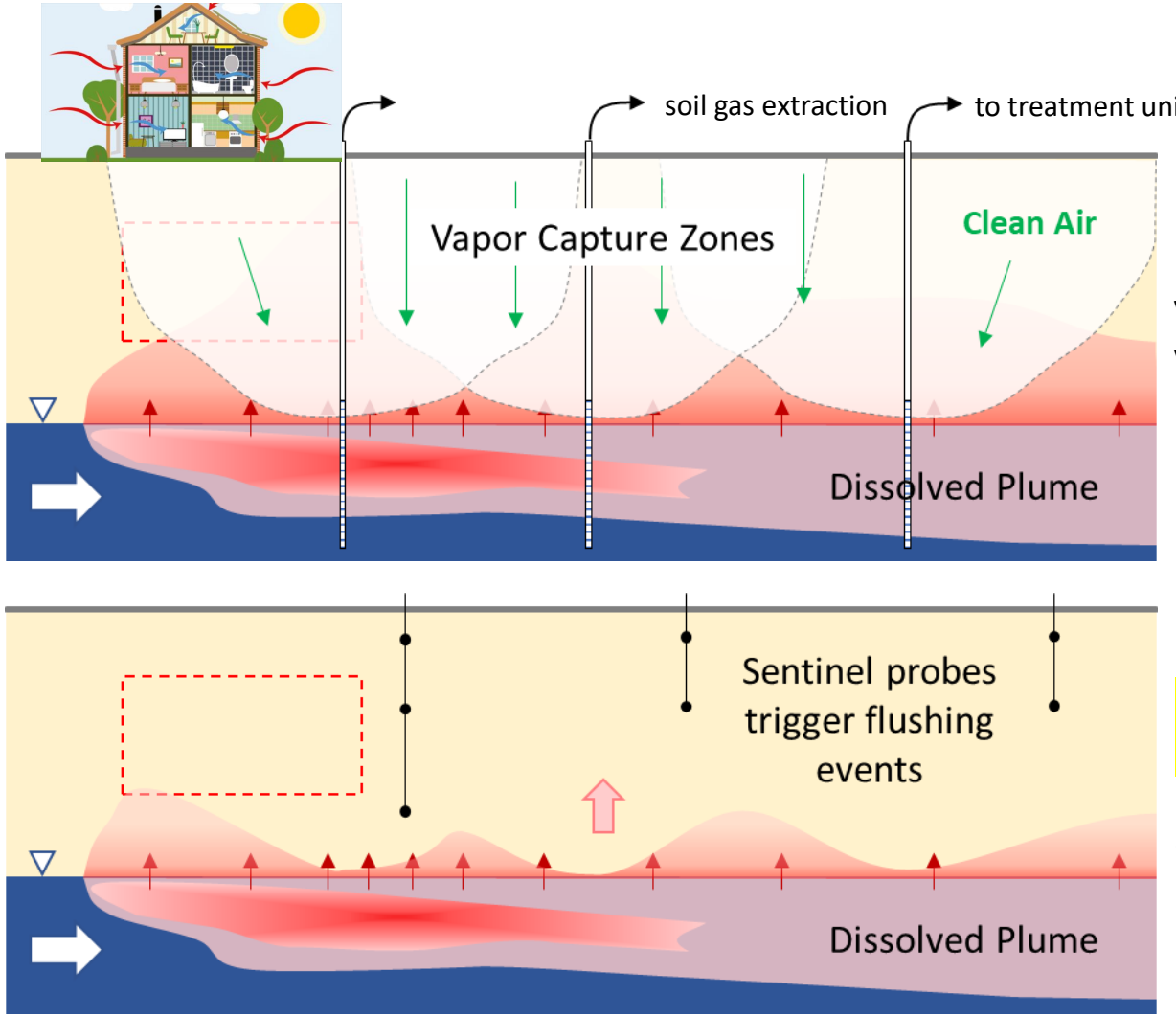
*We expect many VI impacted community members will likely find this helpful/appealing

Design and Operational Concepts for Cleanup [& prevention of VI exposures] with SVE near receptors

Slide from presentation by 'Bo' Stewart –2022
Modified w/ a home & [added comments]

[X-Section EXAMPLE:
VI-specific **LTS Documentation** to ensure a ***Soil Gas Safe Community*** through time (e.g., Qtrly)

Note:
'Deep'/thick separation zone between contam. Soil gas and Bldgs.]



Flushing several soil gas pore volumes suppresses the vapor plume, TEMPORARILY

Periodic monitoring of sentinel probes until a threshold concentration is detected; triggers flushing event

[**Could these SG probes be used to replace indoor air samples? e.g., in LTS Once bldg.-specific relationships to soil gas conc. are established**?]

Integration of ‘New’ & ‘Old’ Tools in VI Toolbox*

- ‘Large-area Deep’ **SVE** (Soil Vapor Extraction)
- ‘Local-area Shallow’ **SVE**
- Indoor **SSD** (Sub-Slab Depressurization)
- Indoor **EPC** Sampling (Exposure Point Conc.)
  - For example, sampling more rigorously than typical, but only in rotating voluntary community sentinel bldgs. verifying the interior and perimeter of protection for their community
- All Tools have advantages & uses in specific scenarios/areas
- Most efficient & effective applications will likely be well-integrated use;
  - Of all available tools**; [& We ALL want hear from those exploring their integration!]

* We need a **consensus body** to explore a better future for VI

**Including community preferences

Wrap up

- With a goal of:
  - **Protection** from, **not Proof** of, Un-acceptable VI Exposure
  - **Better Cleanups (of Soil Gas)**
    - That have **removed** more of the **source** (particularly ‘Near Receptors)
    - **Are intrinsically safe**, and
    - need **fewer samples** to **verify protection**

- A **Vertical separation distance** between cVOCs & MbE provides:
  - **More confident protection** &
  - Would **not need as frequent/# of samples** to ***verify it is Under Control***

Questions?

Summary of Comparisons

Currently Typical

More monitoring since no Soil Gas cleanup

- *If* access to indoor for samples
- *If* Proof of unacceptable EPC
- Bldg by bldg. response decisions
- Only response = 1-Bldg Mitigation
- Allow contam. to enter Soil Gas
- $$ Monitor exposure from soil gas
- Few sample from all avail. Bldgs.

Possible Alternative Approach

Less monitoring since more Soil Gas cleanup

- Protect/prevent from exposure
- All people/bldgs w/n community
- Create vertical separation zone
- Stop contam. migration to Bldgs.
- $$ Clean/remove contam. Soil Gas
- # samples need 1/separation dist.
- #x sample from few volunt. Bldgs.