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CURRENT DEVELOPMENTS IN VAPOR INTRUSION

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Introduction

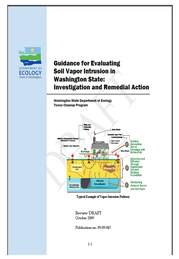
For over 15 years vapor intrusion (VI) has been an emerging issue. In 2002 EPA released the Draft Vapor Intrusion Guidance for comment. Since then, our understanding of the VI pathway as well as the methods for evaluating it have evolved. Other federal agencies and state agencies have developed their own guidance and have contributed to the updates to the EPA guidance. The Department of Ecology published a draft guidance in 2009 and has published two updates. This poster summarizes the current state of the guidance and provides examples of VI assessments in Washington State.

EPA Guidance

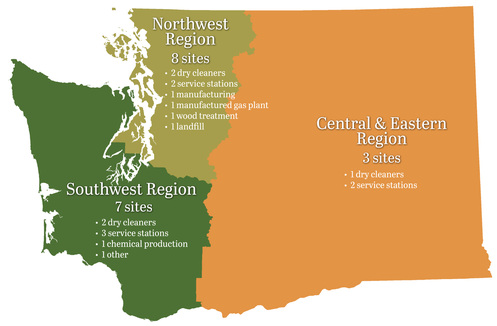
- OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (June 2015)
- Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites (June 2015)

Washington Department of Ecology Guidance

- Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action (October 2009)
- Updated Indoor Air Screening Levels in Appendix B of the Vapor Intrusion Guidance Document (February 2016)
  - Current toxicity values
  - Revised vapor attenuation factor
- Updated Process for Initially Assessing the Potential for Petroleum Vapor Intrusion. Implementation Memorandum No. 14 (March 31, 2016)



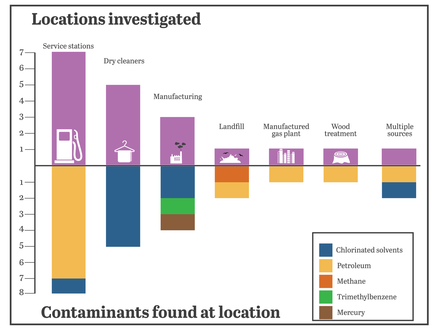
Methods: Sites Reviewed



Total sites reviewed: 19

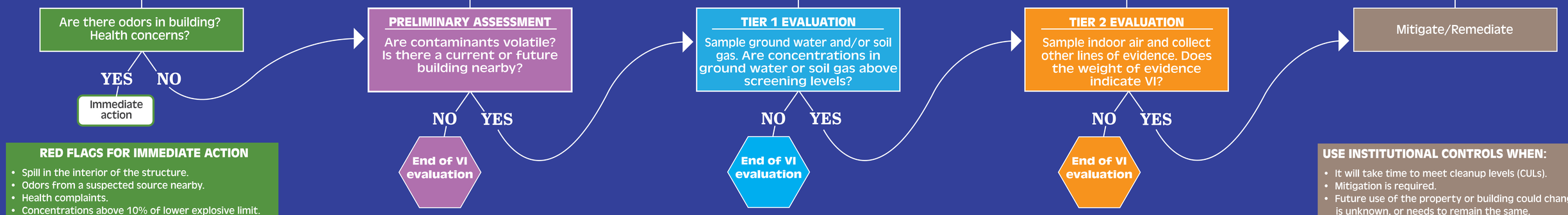
Lines of evidence	No. of sites
Ground water screening	9
Soil gas screening	16
Indoor air screening	5
Modeling	2

Johnson and Ettinger model in both cases



Land use	No. of sites
Commercial	13
Educational	3
Industrial	4
Recreational	1
Residential	3
Vacant	2

SITE CHARACTERIZATION



RED FLAGS FOR IMMEDIATE ACTION

- Spill in the interior of the structure.
- Odors from a suspected source nearby.
- Health complaints.
- Concentrations above 10% of lower explosive limit.
- NAPL in contact with building. *NAPL=non-aqueous phase liquid.

USE INSTITUTIONAL CONTROLS WHEN:

- It will take time to meet cleanup levels (CULs).
- Mitigation is required.
- Future use of the property or building could change, is unknown, or needs to remain the same.

PRELIMINARY ASSESSMENT

100-FOOT RULE MAY NOT BE SUFFICIENTLY PROTECTIVE WHEN:

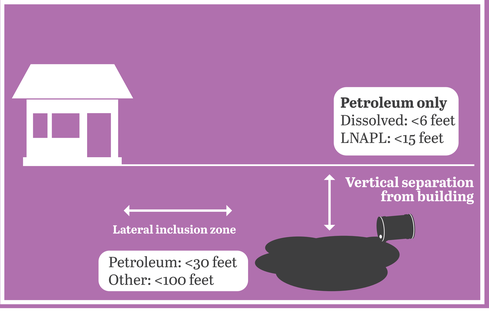

There is impervious surface between contamination and building.


Gas is under pressure, e.g. methane gas at a landfill.


There are preferential pathways (utilities, fractured bedrock).

Criteria

- Are contaminants sufficiently volatile and toxic?
  - Use Cleanup levels and risk calculations table (CLARC)
- Are buildings sufficently close to contamination?



TIER 1 EVALUATION

Tier 1 Decision-Making

Medium sampled	Result*	Recommended next step
Ground water	< VI screening level	End VI evaluation
Ground water	> VI screening level	Sample soil gas
Soil gas	< VI screening level	End VI evaluation
Soil gas	> VI screening level	Tier 2
Ground water and soil gas	> VI screening level < VI screening level	Re-sample for confirmation/ End VI evaluation.

*If result = VI screening level, re-sampling is recommended.

Trichloroethylene is complicated

- TCE toxicity:
  - Target organs for cancer: kidneys, non-Hodgkin lymphoma, liver.
  - Kidney cancer occurs via mutagenic mode of action.
  - Can cause fetal heart defects when pregnant women inhale vapors during a 3-week window in early pregnancy.
- Ecology's guidance: Trichloroethylene Toxicity Information and MTCA Cleanup Levels (September 2012).
  - Adjusts cleanup levels to account for mutagenic mode of action.
  - Does NOT address fetal heart defects.
  - CLARC links you to guidance.

EPA Guidance for Indoor Air TCE Inhalation

EPA Region 9: Response Action Levels and Recommendations to Address Near-Term Inhalation Exposures to TCE in Indoor Air from Subsurface Vapor Intrusion (July 9, 2014)

	Residential		Commercial/industrial 8-hour work day		Commercial/industrial 10-hour work day	
Response:	Accelerated 2 µg/m³	Urgent 6 µg/m³	Accelerated 8 µg/m³	Urgent 24 µg/m³	Accelerated 7 µg/m³	Urgent 21 µg/m³
Timeframe:	within a few weeks	within a few days	within a few weeks	within a few days	within a few weeks	within a few days

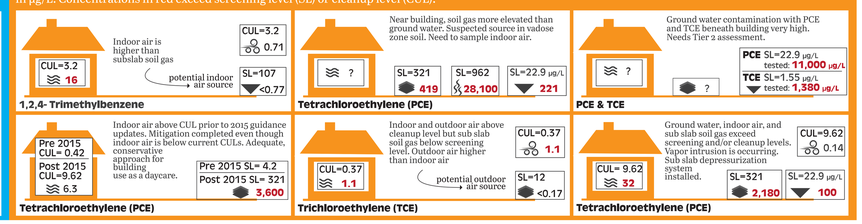
TIER 2 EVALUATION

Decision Matrix

Sub slab gas result	Indoor Air Result: Air CUL	2x noncancer CUL or 10x cancer CUL
Sub slab SL	Tier 2 Assessment complete - No mitigation necessary.	Repeat sampling. If indoor air is still above CUL, recheck for potential indoor sources. If none identified, consider installation of a SSDS.
10X Sub slab SL	Repeat sampling. If sub slab levels are still greater than 10x the screening level, consider installation of a sub slab depressurization system (SSDS).	Repeat sampling. If indoor air is still above CUL, recheck for potential indoor sources. If none identified, install a SSDS.
		Proceed with installation of a SSDS.

Indoor, Outdoor, and Sub Slab Sampling

All air and sub slab concentrations are in µg/m³. Ground water concentrations are in µg/L. Concentrations in red exceed screening level (SL) or cleanup level (CUL).



Lessons Learned

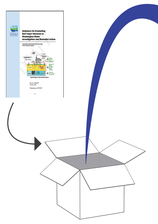
On the technical side:

- Property and building access can be challenging, especially off-site.
- Timing and frequency of sampling are important.
  - Seasons
  - Weather
- Survey potential indoor sources before sampling indoor air; remove all potential sources that could impact indoor air.
- Use current sampling approaches.

Regarding decision-making:

- Use current SLs.
- Use multiple lines of evidence.
- Public communication is important because people are sensitive about:
  - What they breathe.
  - Sampling inside their homes.
- Don't forget institutional controls.

Out of the Box Approaches



UNCERTAINTY ANALYSIS

The report for a complex VI assessment provided a chapter on uncertainty, including:

- Conservative bias in sampling program.
- Protectiveness of vapor attenuation factors.
- Protectiveness of screening levels.
- Potential for indoor sources of vapors.
- Chemical masking due to elevated reporting limits.
- Seasonal and temporal effects.

COMPOUND-SPECIFIC ISOTOPE ANALYSIS (CSIA)

- Analysis to measure ratios of naturally occurring stable isotopes in samples.
- Isotope ratios can be used to understand:
  - Potential contaminant sources.
  - Degradation.
  - Comingling of contaminant plumes.

MERCURY SAMPLING TECHNIQUES

- Techniques for sampling elemental mercury vapor are different from those for organic volatile compounds.
- Real time sampling techniques with detectors can be used for screening, such as a Lumex instrument.
- Longer term measurements can be made using a mercury sorbent trap (modified EPA method 30b).

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