

# SELECTED ISSUES FOR SOIL VAPOUR ASSESSMENT

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# PRESENTATION OUTLINE

- PCOCs and soil vapour precedence
- Outdoor air sampling
- Lateral migration
- What's in VPH
- Lateral migration
- High density land use standards project



## SOIL VAPOUR PRECEDENCE

- **Scenario:** Substance not a vapour contaminant based on soil or groundwater data, but based on measured soil vapour is a contaminant (attenuated vapour concentration exceeds Sch.11)
- Soil vapour data should be used for decision-making purpose, there may be vadose zone source and soil data may be unreliable, also more indication of potential exposure pathway
- **Scenario:** Substance not detected in soil or groundwater data, but based on measured soil vapour is a contaminant (attenuated vapour concentration exceeds Sch.11)
- Again soil vapour data is a more reliable indicator and should be used



## PCOC SELECTION

- **Scenario:** Initial site characterization indicates that detection of one substance of potential concern (xylenes) in soil
- Estimated soil vapour concentration from partitioning equation combined with attenuation factor indicate unacceptable risk
- What is appropriate analyte list for soil vapour (just xylenes?)



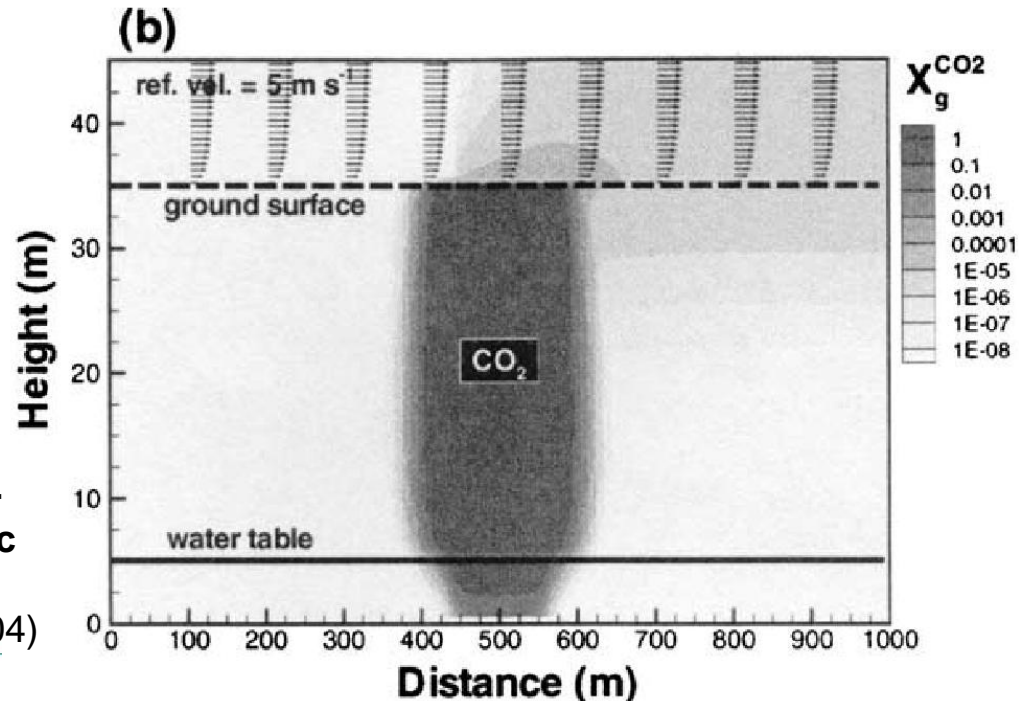
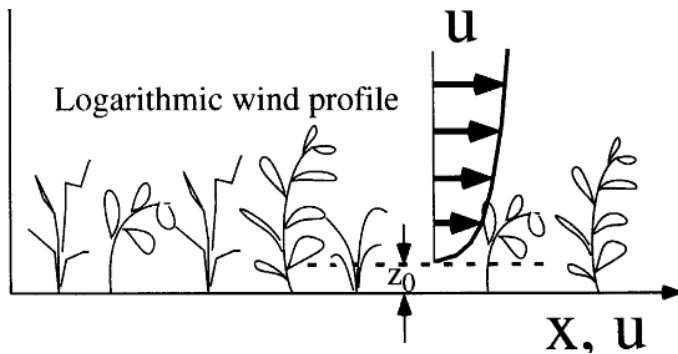
# OUTDOOR AIR SAMPLING

- **Issue:** When evaluating outdoor air pathway, one possible option is to collect outdoor air data for comparison to Sch. 11 standards, also important for lines of evidence evaluation
- May be a reasonable approach but limited guidelines currently exist as to sampling methodology (some discussion in SABCS soil vapour guidance)
- There are guidance documents that provide guidance on ambient air monitoring programs but do not seem to apply to sampling for evaluation of subsurface emissions
  - BC MoE Field Sampling Manual (2003)
  - Alberta Environment Air Monitoring Directive (2006)
  - Ontario MoE Operations Manual for Air Quality Monitoring in Ontario (2008)



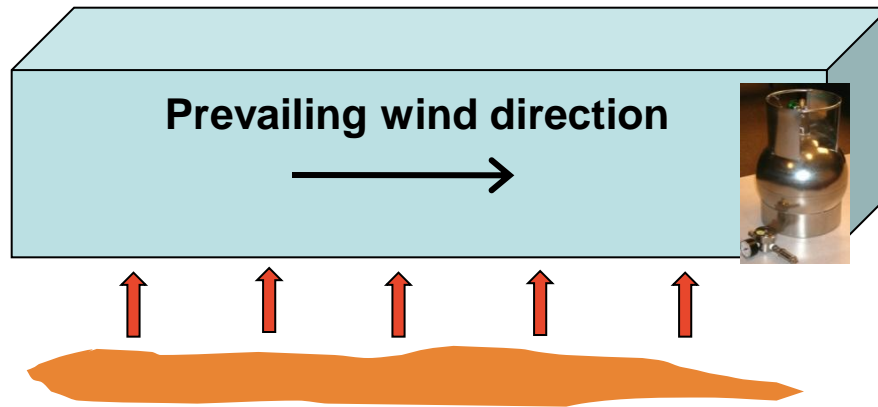
# OUTDOOR AIR SAMPLING

- U.S.EPA Office of Air and Radiation
- Guidance for landfill assessment, e.g., USEPA Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities. EPA-600/R-05/123a. September 2005
- possible approach could be to use air dispersion modeling to guide sampling design...?



**Coupled Vadose Zone and Atmospheric Surface-Layer Transport of Carbon Dioxide from Geologic Carbon Sequestration Sites** Curtis M. Oldenburg\* and Andre´ J. A. Unger *Vadose Zone Journal*, 3 (2004)

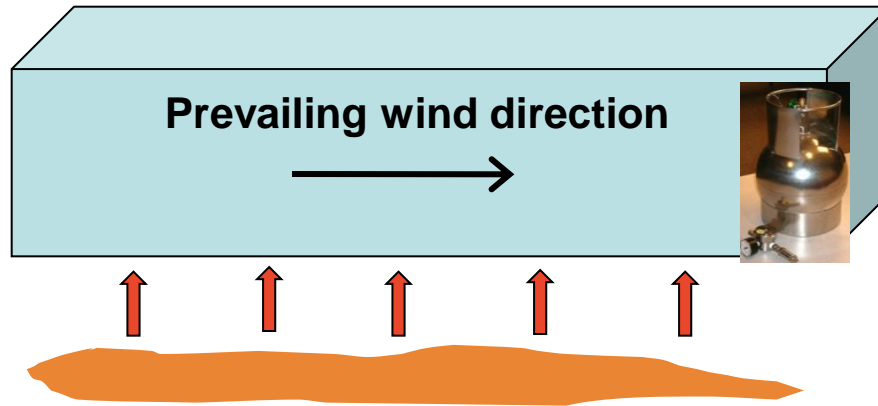
# OUTDOOR AIR SAMPLING PRACTICAL GUIDELINES



Box Model Concept  
(RISC 5 model)

- Height : 1.5 for commercial, 0.5 m for residential?
- Location: Downwind at edge of source
- Duration Sampling: 24 hour Frequency of Sampling: ?
- When to sample: Avoid weather extremes, generally would not want to sample when raining (moisture could affect Summa canister)

# OUTDOOR AIR SAMPLING PRACTICAL GUIDELINES



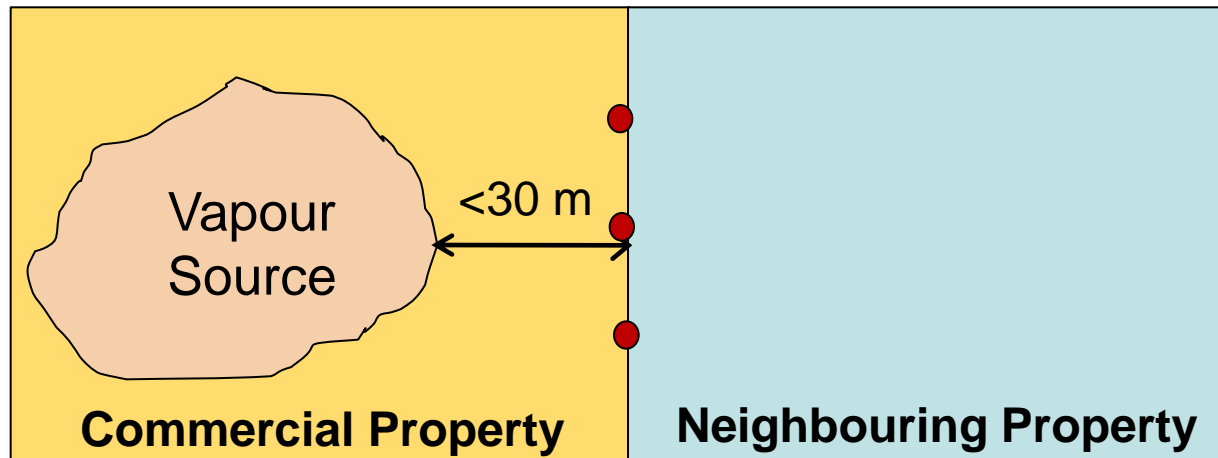
- What about cold weather? Effect on samplers?
- Obtain meteorologic data from nearest station
- Avoid air contamination sources (busy roads, air treatment systems)





# LATERAL MIGRATION

- **Scenario:** Soil vapour source on subject site that is less than 30 m from property line (30 m rule in TG4)



- If neighbouring property is residential, then residential standards apply to subject site
- Delineating to site boundary may be warranted
- Evaluation of upper cap and offsite notification also requires consideration of neighbouring land use

# LATERAL DIFFUSION

## LOWELL AND EKLUND 2003

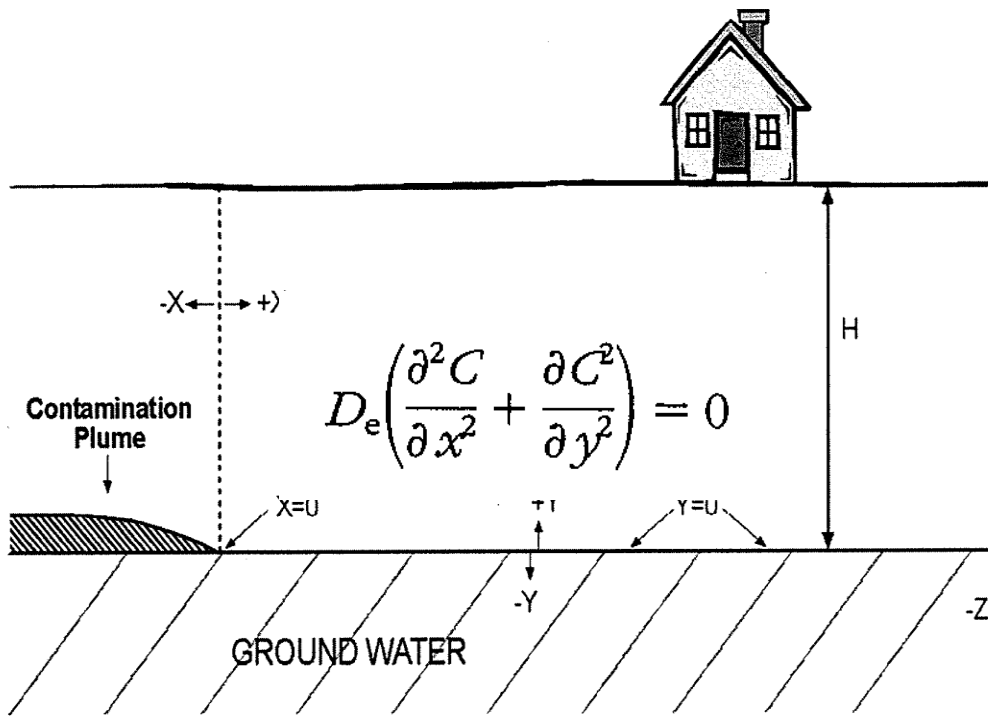
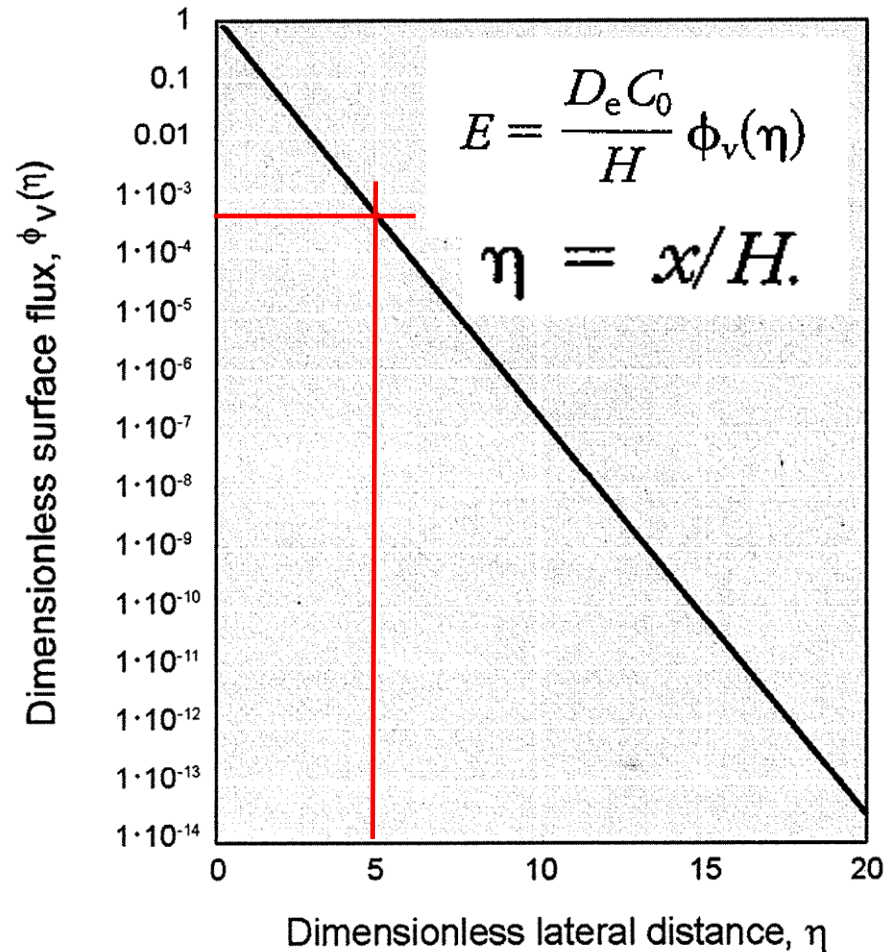
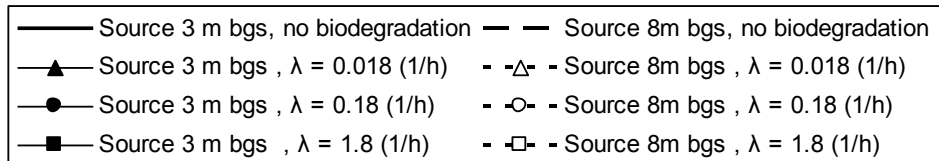
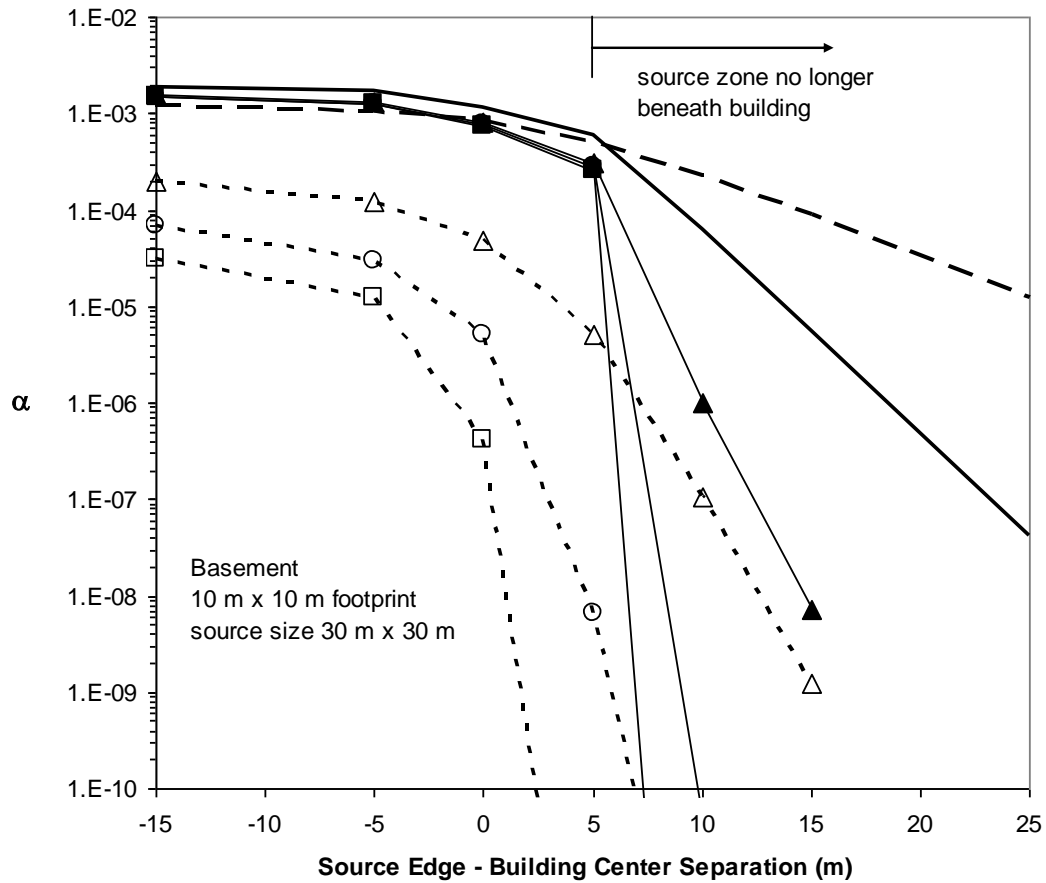


Figure 1. Schematic of the modeling scenario.



Lowell, P. and B. Eklund, 2003. VOC Emission Fluxes as a Function of Lateral Distance from the Source. Environmental Progress, V23, N1.

# LATERAL DIFFUSION WITH BIODEGRADATION ABREU and JOHNSON 3-D MODEL, 2005





## WHAT IS IN VPH?

- **Issue:** VPHv may include non-petroleum compounds
- **Context:** BC laboratory manual defines VHv6-13 as aggregate concentration of volatile hydrocarbons in air, quantitated against toluene and n-dodecane, with analysis by GC/FID or GC/MS by full scan; no discussion of removal of non hydrocarbon compounds in method
- Siloxanes may be subtracted from VPH results - Q&A posted to MoE Land Remediation website on June 21, 2010
- Some regulatory agency methods allow for subtraction of non-hydrocarbon components (e.g., Massachusetts air-phase method)



## WHAT IS IN VPH? – CASE STUDY #1

- **Context:** Fill site of unknown origin with possible minor petroleum impacts
- Subslab VPHv ranged from <200 to 5,600 ug/g; open scan TO-15
- Sample 1
  - VPH: 430 ug/g
  - Hexamethylcyclotrisiloxane: 6.3 ug/g
  - Ethanol: 100 ug/g
  - Hexamethyltrisiloxane: 30 ug/g
- Sample 2
  - VPH = 700 ug/g
  - Dibutyl ether: 410 ug/g
  - Hexamethyltrisiloxane: 4.7 ug/g



## WHAT IS IN VPH? – CASE STUDY #2

- **Context:** Fill site with minor weathered petroleum impacts
- VPH several thousand ppm
- Total siloxanes several hundreds ppm



## WHAT IS IN VPH? – ETHANOL??

- Possible sources include consumption alcohol, baking bread, fuel with ethanol, cleaners, disinfectants, detergents
- Saturated vapour concentration for pure ethanol = 62,000 ppmV
- New York state Summary of Indoor and Outdoor Levels of Volatile Organic Compounds from Fuel Oil Heated Homes 1997-2003
  - 50<sup>th</sup> percentile = 160 ug/g
  - 90<sup>th</sup> percentile = 1,300 ug/g
- Steve Hawthorne, Univ. Dakota report for U.S. DOE
  - School: Median = 14 ug/g; Max = 25 ug/g
  - Strip Mall: Median = 865 ug/g; Max = 6,300 ug/g
  - Office: Median = 44 ug/g; Max = 54 ug/g

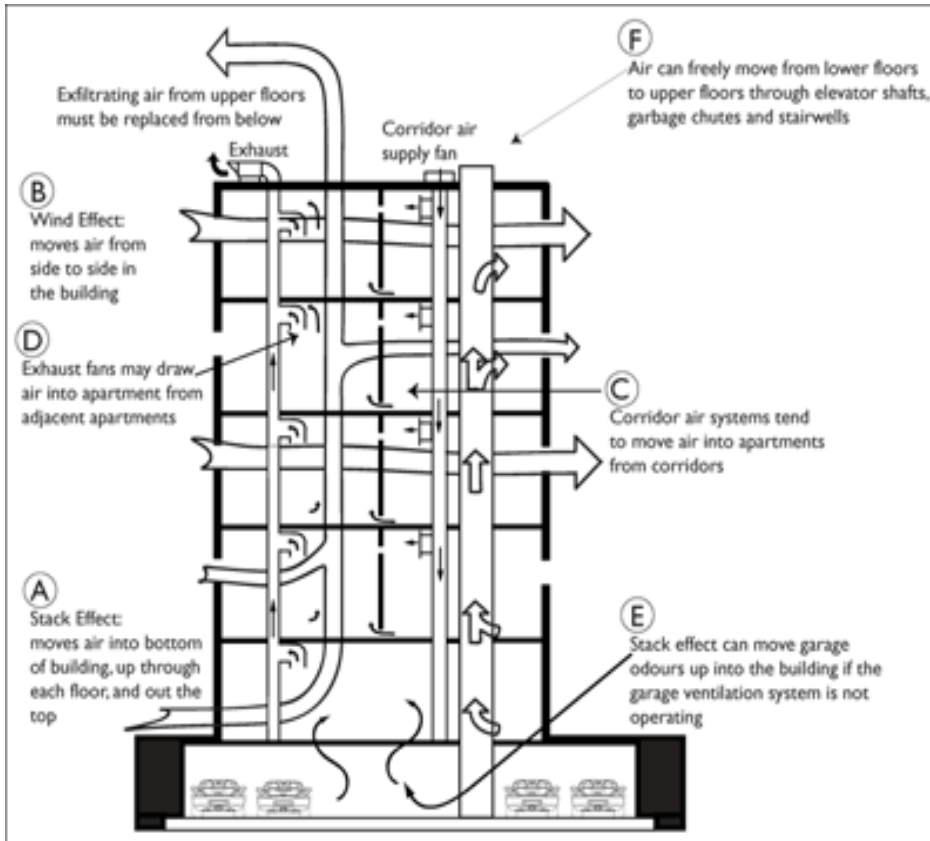


## HIGH DENSITY STANDARDS

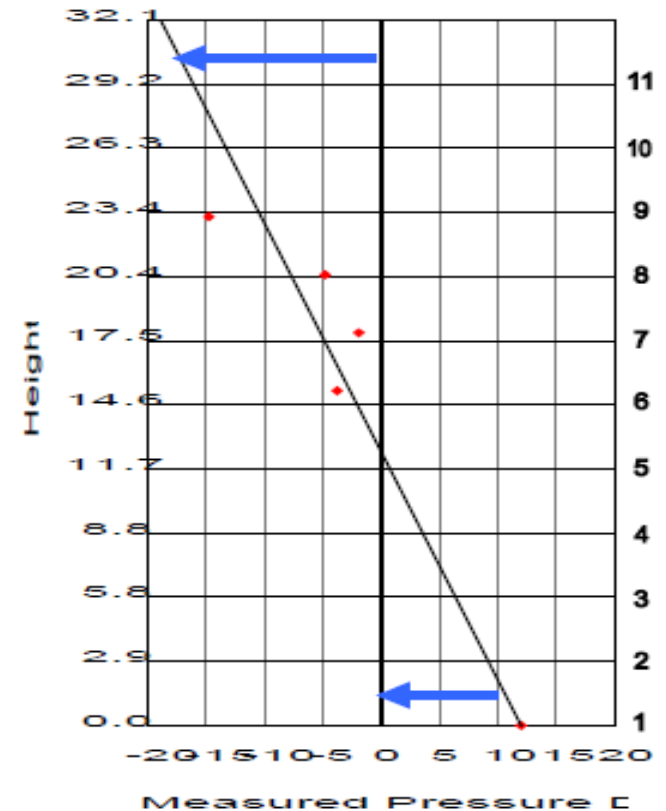
- **Issue:** Residential standards are believed to be overly conservative for a high density land use standard
- BC MoE has contracted Golder and SABCS to review science for high density land use and develop protocol for derivation of high density residential land use standards
- Review focuses on soil intake, ecological protection and soil vapour intrusion pathway
- Work in-progress but some initial findings ...
  - Soil vapour evaluation has focussed on key building factors affecting soil vapour intrusion
    - Ventilation rate
    - Building pressures
    - Foundation properties and preferential pathway

# HIGH DENSITY STANDARDS

## CMHC, 2005



## SASKATOON RESEARCH APARTMENT, 2008





# HIGH DENSITY RESIDENTIAL (preliminary draft findings)

	<b>Typical Ventilation Rate</b>	<b>Typical Building Pressures</b>	<b>Building Envelope relative to detached house</b>
Detached house (current scenario)	0.3 ACH	+10/-10 Pa?	
High density residential	0.35 to 0.45 ACH	+30/-30 Pa?	Likely lower crack ratio than detached house
Parking garage	0.75 cfm/ft <sup>2</sup> (~ 5 ACH) but BC Building Code allows for intermittent ventilation	Negative to rest of building	Likely lower crack ratio than detached house



# HIGH DENSITY RESIDENTIAL (preliminary draft findings)

Garage	Location	Capacity (# cars)	ACH [Tracer]	L/s · m <sup>2</sup> [Tracer]	cfm/ft <sup>2</sup> [Tracer]	Maximum CO (ppm)	Average CO (ppm)
Garage A	Denver	1,700	2.2–4.2	1.78	0.35	16	7
Garage B	Denver	250	5.0–7.0	4.57	0.90	20	4
Garage C	West Plains, N.Y.	1,000	0.0–2.6	1.11	0.22	40	15
Garage D	West Plains, N.Y.	138	3.6–4.5	3.00	0.59	19	12
Garage E	West Plains, N.Y.	258	5.8–8.8	5.68	1.12	25	14
Garage F	Rochester, Minn.	448	7.77	5.28	1.04	10	9
Garage G	Mahtomedi, Minn.	81 (trucks)	0.90–1.02	2.43	0.48	12	1

Table 2: Summary of field testing results for seven U.S. parking garages.



## CONCLUSIONS

- Care should be taken with selection of PCOCs and selection of media for site screening – good science should be followed
- Need for guidance on outdoor air sampling
- Lateral migration requirements of TG4 have implications for land use standard and off-site notification
- Rapid lateral decrease in concentrations for biodegradable chemicals – Support 15 m off-set?
- VPH can include non-petroleum hydrocarbons, which can bias the results – need for further evaluation of analytical methods to remove non-petroleum interferences
- High density residential standards project is providing useful background on vapour intrusion into apartments and garages, less conservative approach warranted