The Importance of Background VOC Concentrations In Petroleum Hydrocarbon Vapor Intrusion Decision Making

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URS

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We Know that:

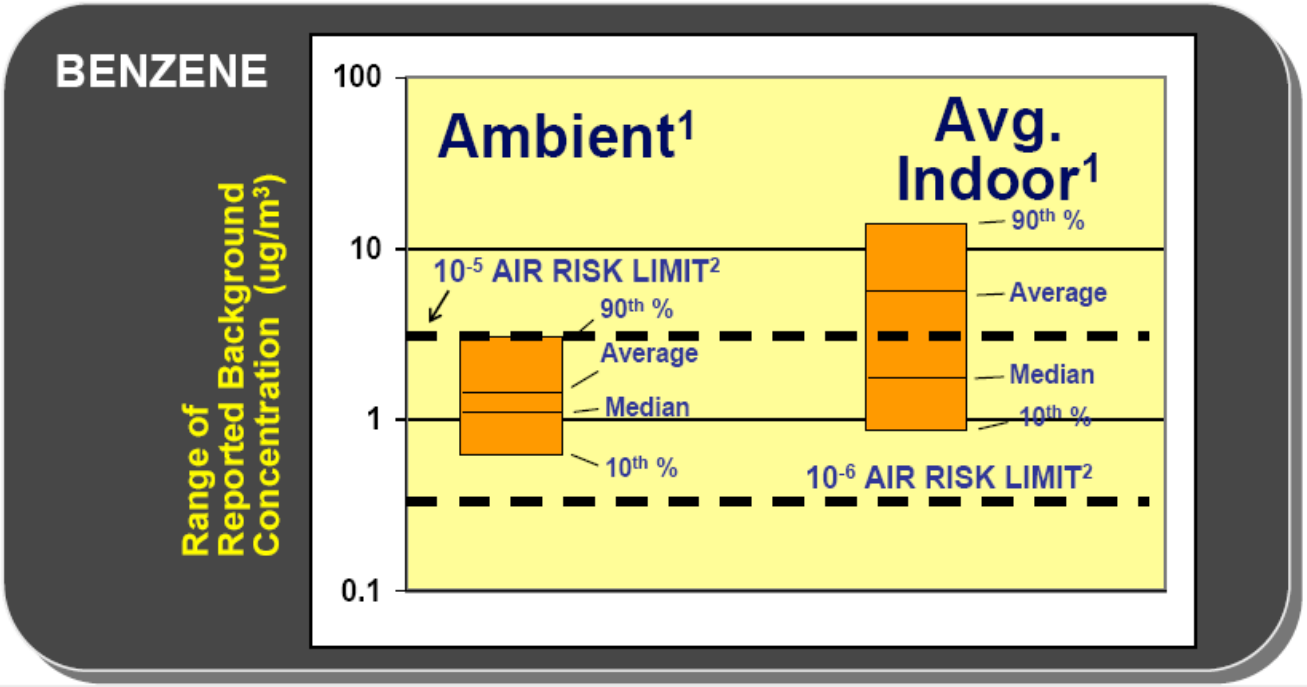
- For petroleum hydrocarbons, background concentrations are relatively high compared to "acceptable" concentrations of many compounds
- Thus, it will be difficult to determine if indoor contaminants are from subsurface contamination

This paper explores the difficulties for making decisions that background concentrations cause; and

Discusses some techniques that can be used to write good work scopes from which good data sufficient for making decisions can be collected.

Significance of Background Effects

2004 Backgrd vs. USEPA Risk-Based Limits



KEY POINTS:

- **2004 data show benzene exceeds risk limits in most homes.**
- **Adding ~0.4 ug/m3 (10^{-6} conc.) to avg indoor negligibly increases that concentration – we can't "see" it.**

1) Background concentrations from Sexton et al. 2004 ES&T 38(2); 423-430.
2) USEPA Draft Vapor Intrusion Guidance, November 2002

Temporal Concentration Variability May Be Of The Same Magnitude As Typical Range Of Indoor Air Concentrations

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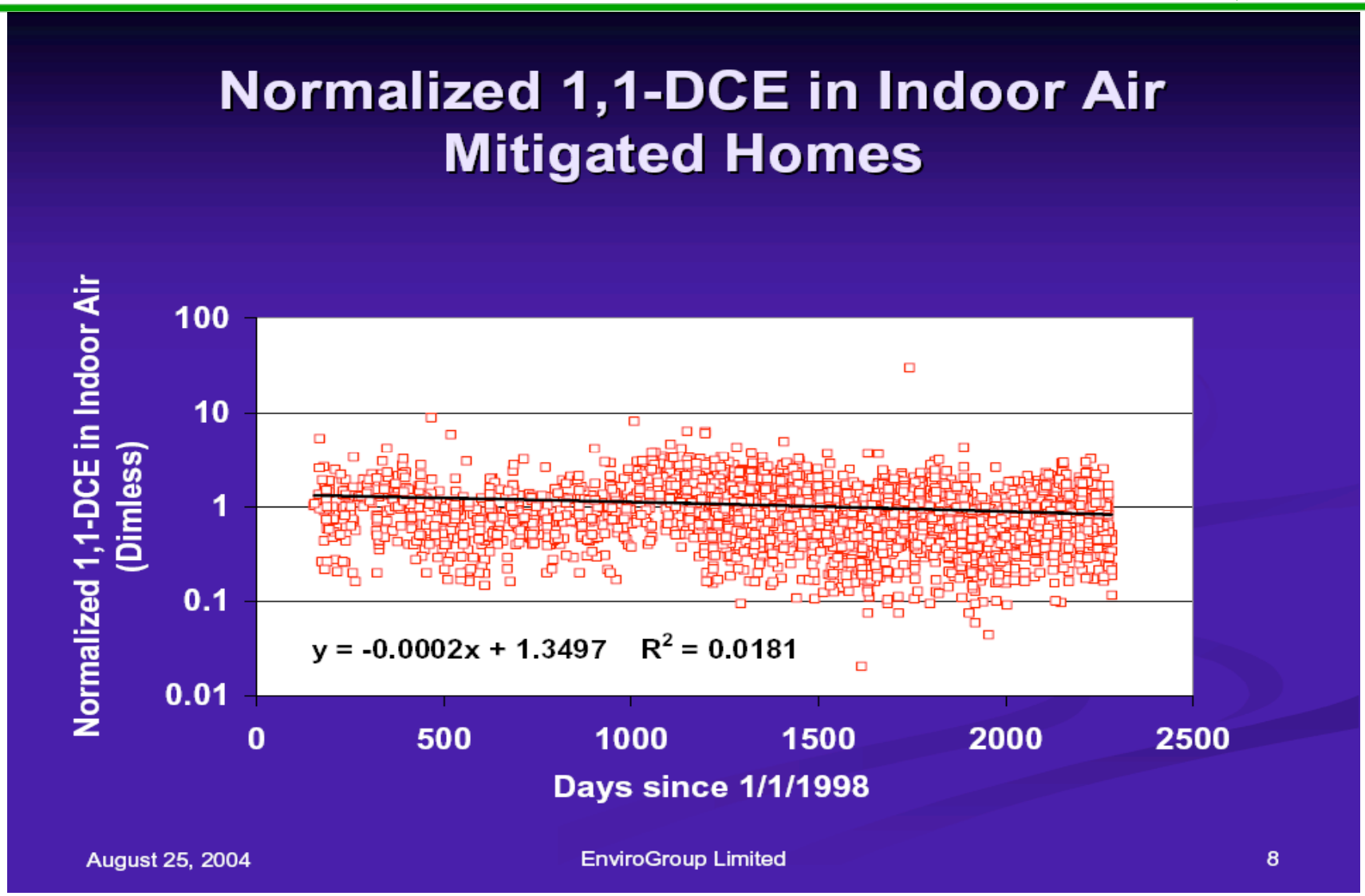
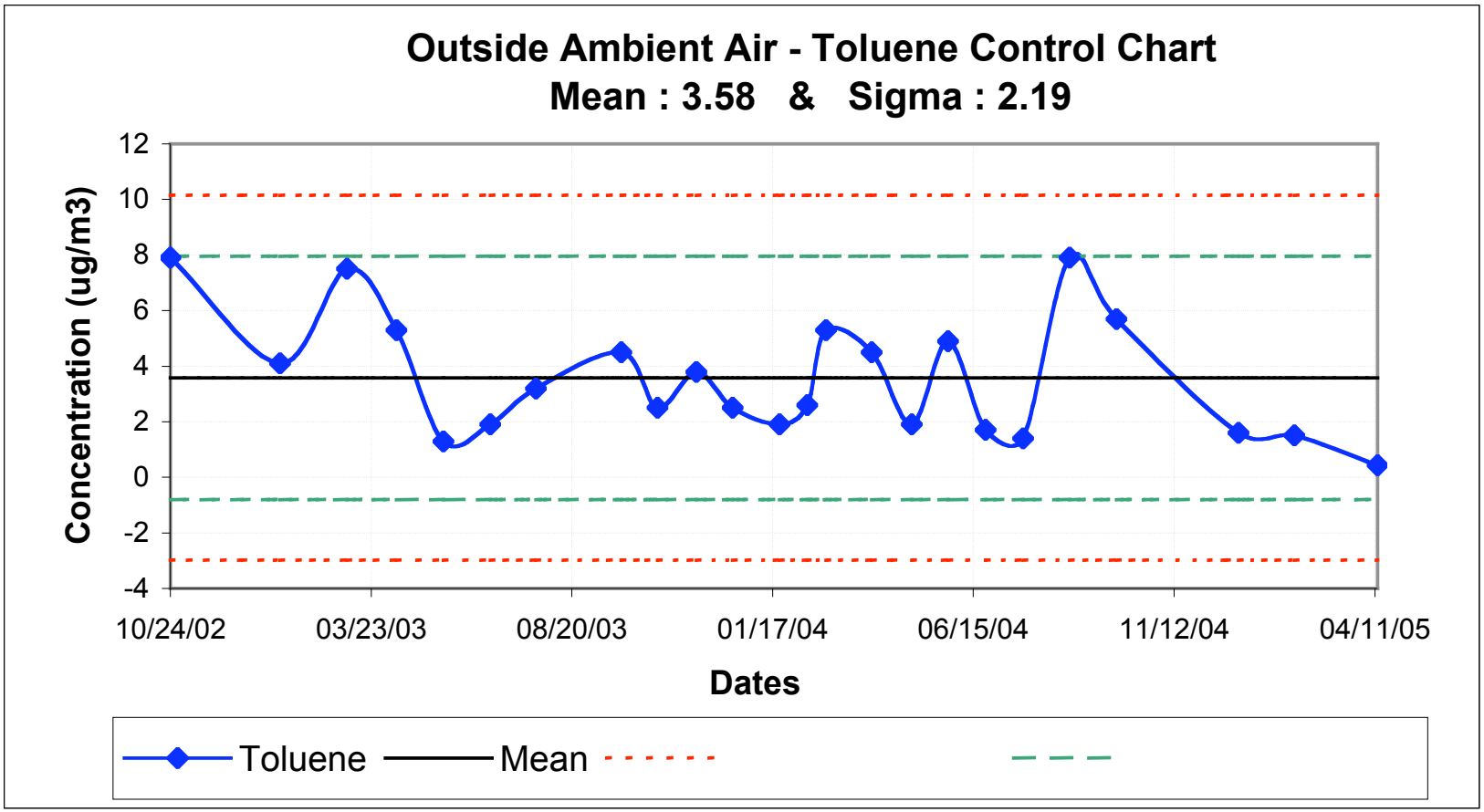


Kuehster, Folkes, & Wannemaker; MSRAS Conf, Indianapolis, August 25, 2004

Another Example of Temporal Variation



Example of Spatial Variation Among Structures

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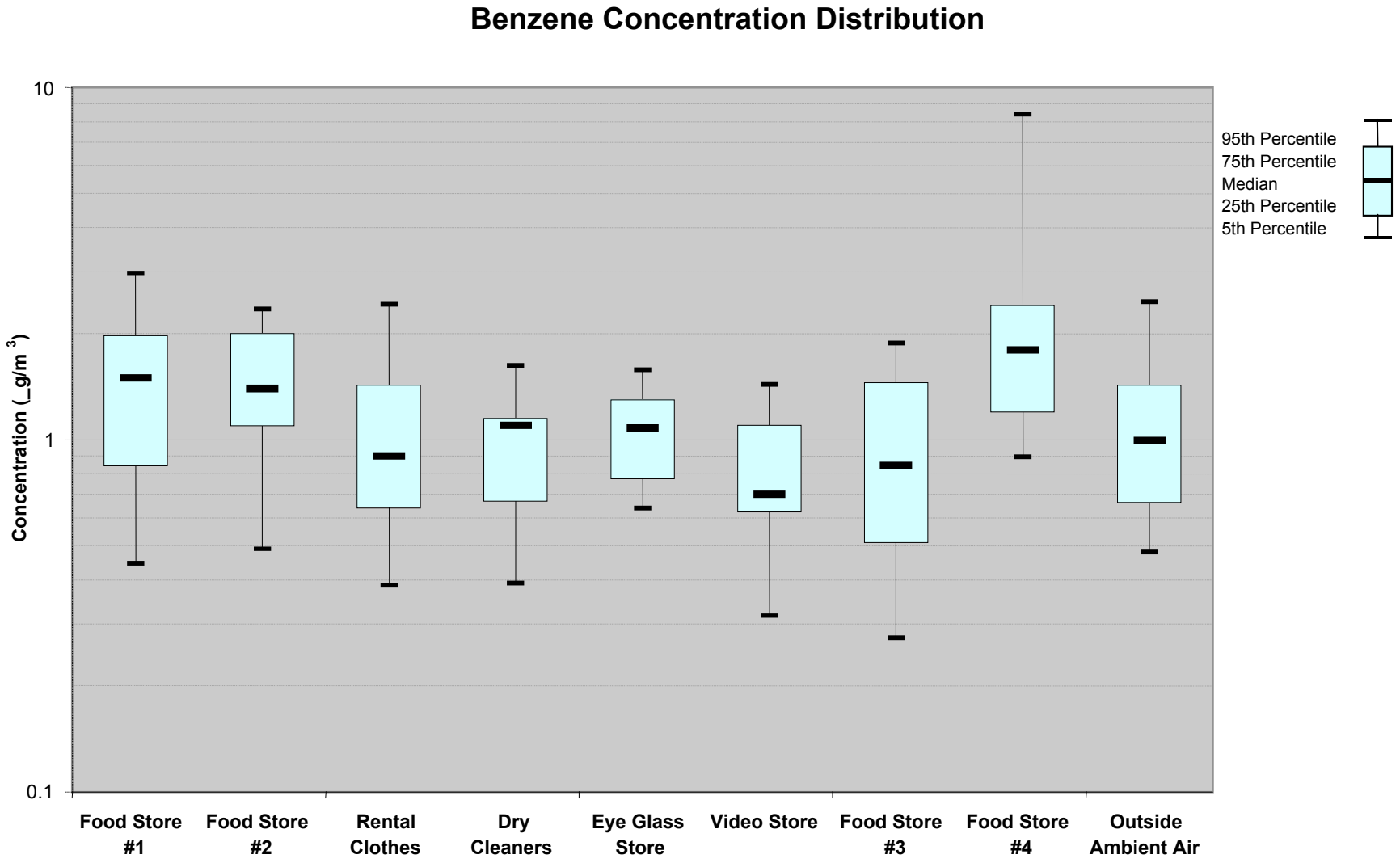

Three General Approaches To Using Indoor Air To Evaluate Vapor Intrusion

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1. Compare measured indoor air concentrations to published concentrations;

2. Compare measured indoor air concentrations to experimental controls (need large data sets, it will not be discussed further); or

3. Perform data analysis on a set of site-specific measured concentrations.

Compare Measured Indoor Air Concentrations To Published Concentrations

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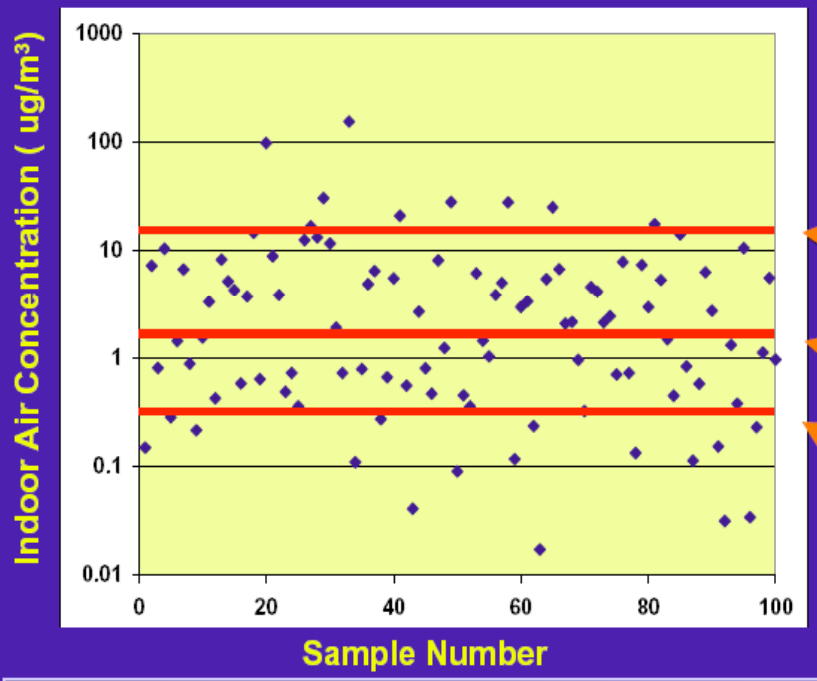
- There are three possible outcomes for such a comparison:
  - Indoor air will be >,=, or < the background (comparison) value
- Vapor Intrusion is likely to be easily identifiable only if the indoor air concentration > background (comparison) concentration
- This comparison will likely lead to false positives (see next slide);
- An issue is the comparison value should be:
  - Mean, median, 75th percentile, 90th percentile, etc.

Approach 1

Significance of Background Effects

Is Background Correction Possible?

EXPECTED BENZENE LEVELS IN 100 HOMES WITHOUT VI IMPACTS



	Screening Value (ug/m3)	Number of Homes w/ Exceedances
90th % Backgrnd	15.3	10
Median Backgrnd	1.9	50
USEPA Limit (10^{-6})	0.31	84

KEY POINT: ***Site-specific background can vary by >1000x, making site-specific correction of single measurement difficult.***

1) Indoor air limit (10^{-6}) from USEPA Draft Vapor Intrusion Guidance, November 2002
2) Median and 90th % background concentrations from Sexton et al. 2004 ES&T 38(2); 423-430.

Perform Data Analysis On Site Specific Data

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- At many petroleum contaminated situations; data sets are small and background concentrations are high
- Typically requires soil gas and ambient air data in addition to indoor data
- It may be useful to measure concentrations of more than just petroleum compounds – chlorinates and radon
- It may be useful to look at spatial and temporal distributions
- It may be useful to collect pressure gradients and meteorological data or measure air exchange rates or mass flux

- What is needed is a good understanding (CSM) of the site: the building, the possible constituents, likely concentrations, background concentrations, etc. to formulate a good work scope to collect the data necessary to make decisions.

Approach 3

Site Specific Factors Influence What Data is Important

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For Example:

- The type of contamination (diesel vs gasoline) and its' age is likely important
- If soil gas data is available, attenuation factors may be calculated
- If there is radon in the soil, radon data could be useful
- Work scopes should recognize these factors and be developed accordingly

- Let's run through a few example techniques.

Data Analysis Often Starts With Recognition Of Source Characteristics Or Constituents

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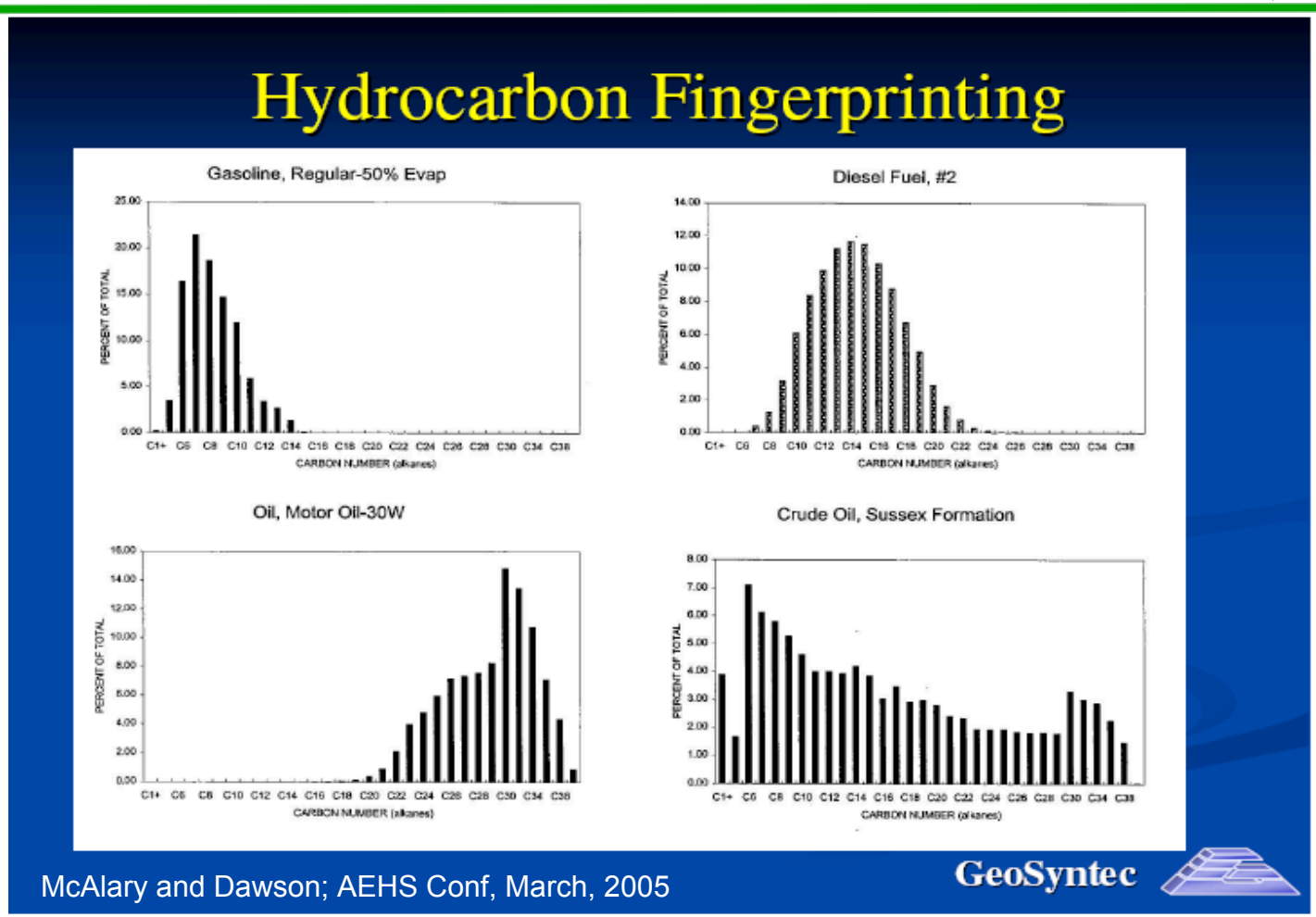

Has a soil gas analysis or ambient air testing suggested constituents other than petroleum hydrocarbons to consider?

Constituent Ratio Approaches

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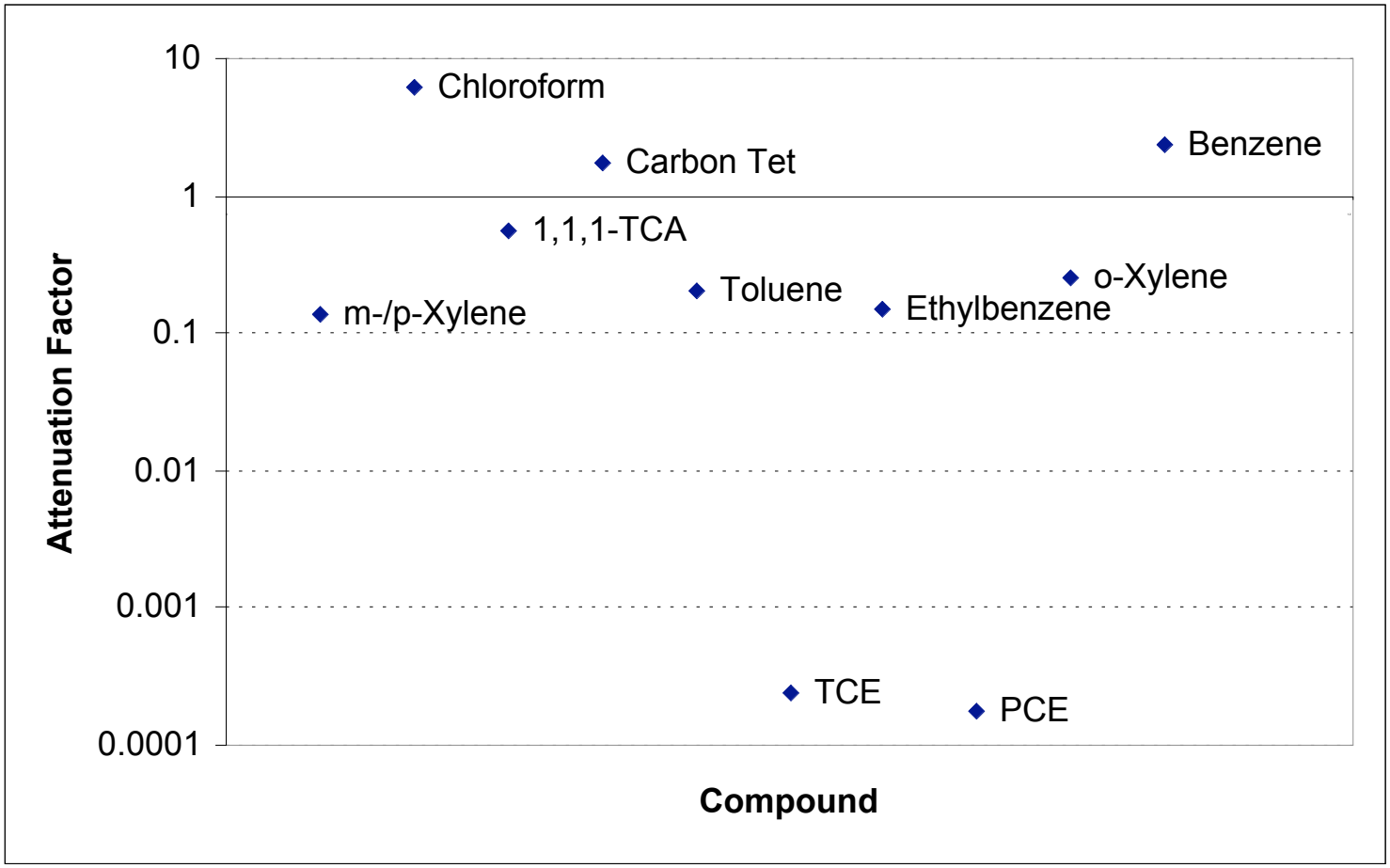
- Hawthorne's quantitative source apportionment methodology proposed to API
- Quantifying the attenuation factor using indicator compounds
- Use of a marker compound or ratio of compounds– TCE/1,1-DEC at Redfields site

- Limitations exist for each approach and all require good data and professional judgment

Data Analysis Often Includes Use Of Indicator Compounds



The Indicator compounds (tracers) provide a good estimate of the true attenuation factor

Comparison of Multiple Compounds Across Media

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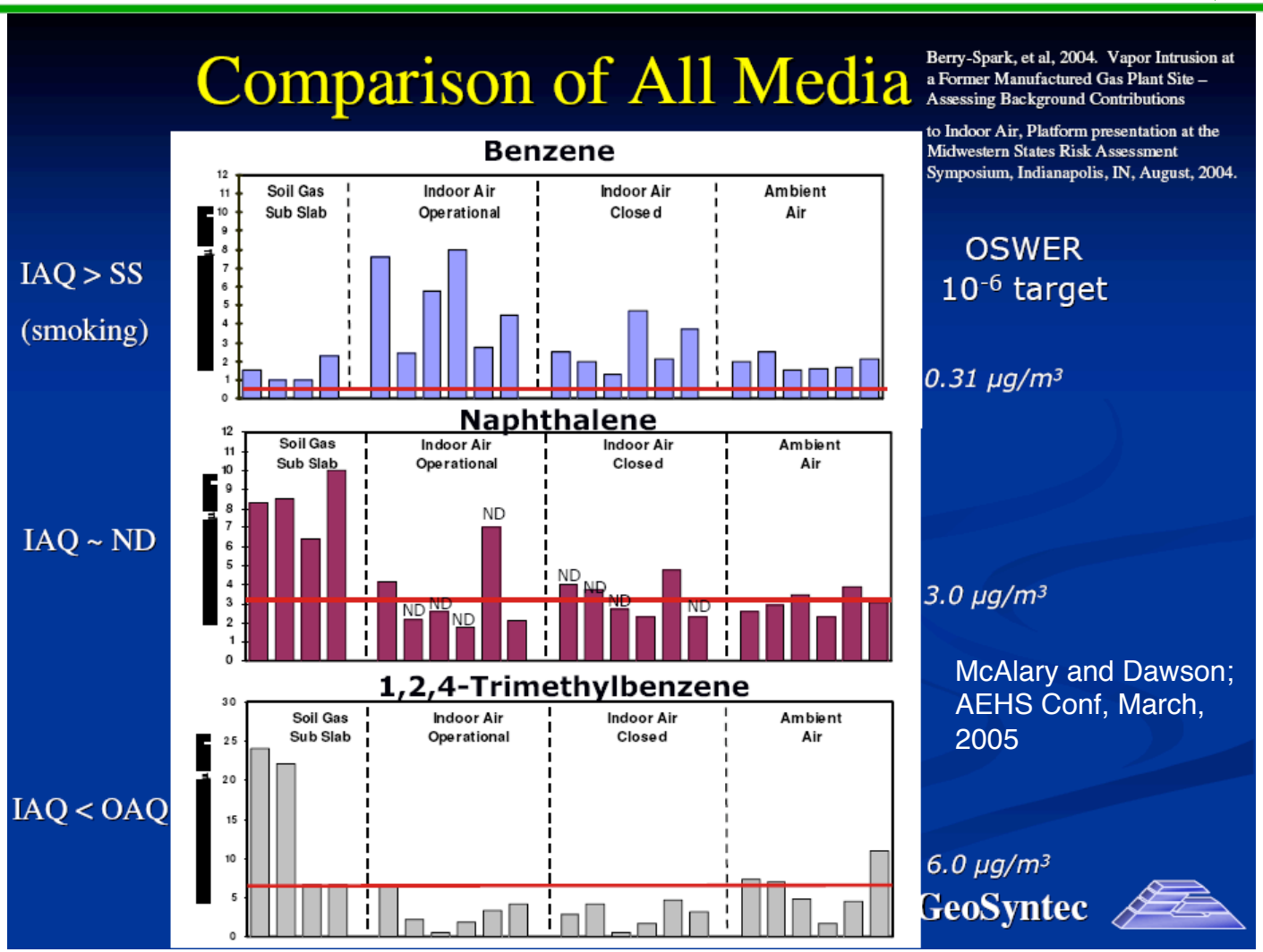

Spatial and temporal distribution and concentration ratios provide an indication of vapor intrusion or indoor source

Indicator Compound Approach on Multi-Building Site

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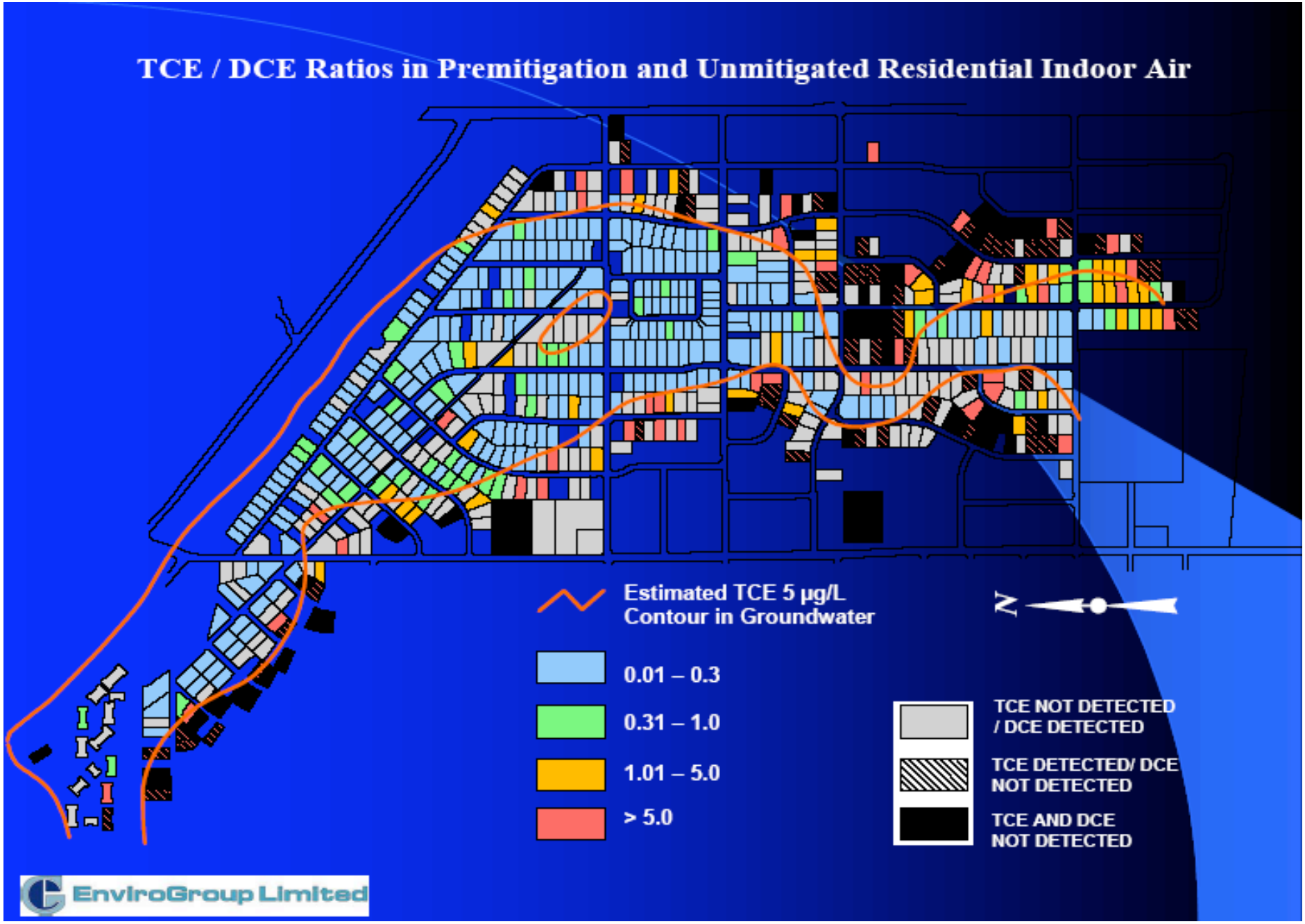
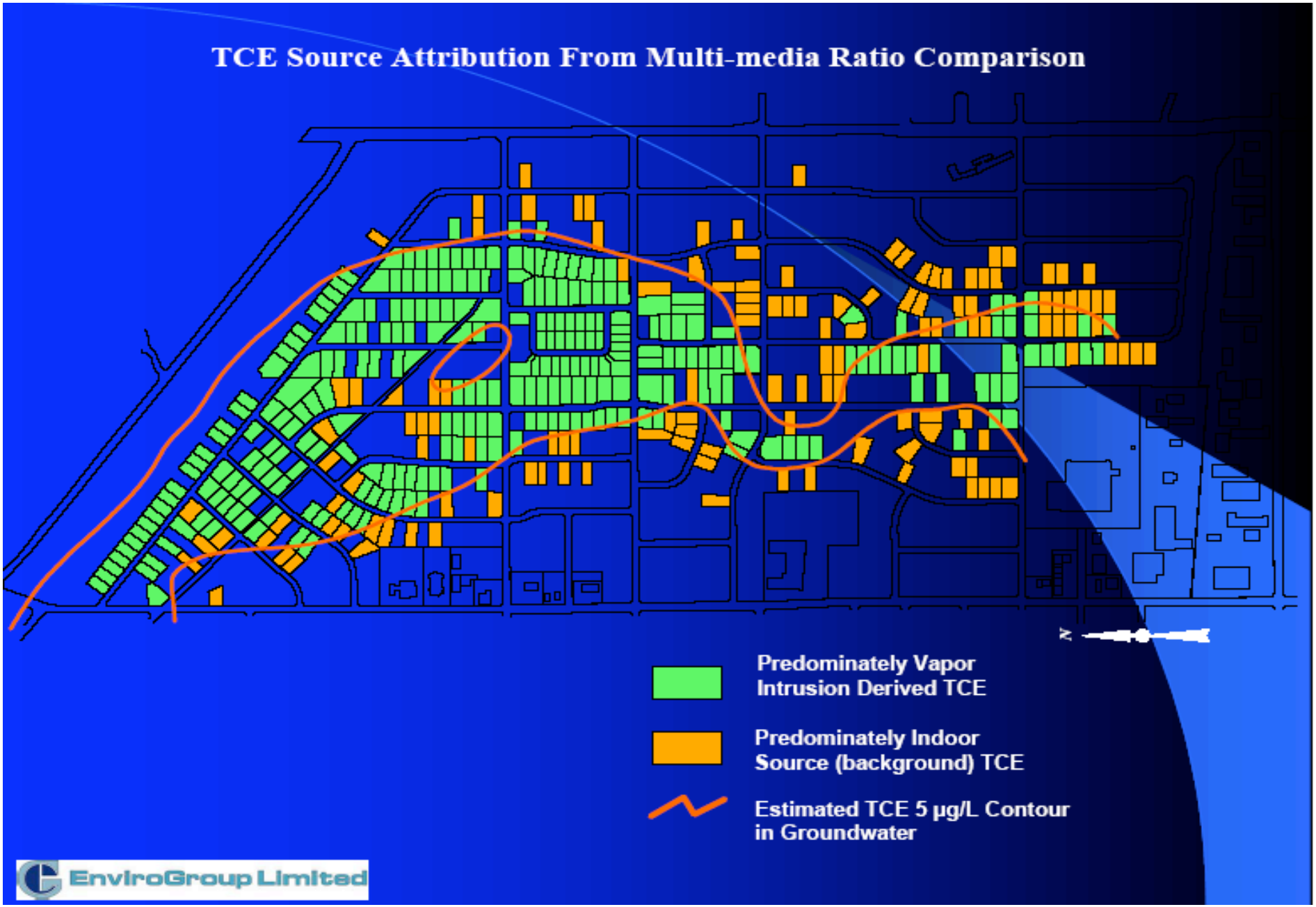
- Method:
  - Compare indoor air VOC ratios in residences over large plume of chlorinated solvents
  - Denominator VOC should have the lowest background concentration
- Data quality:
  - Needs relatively consistent groundwater or soil vapor VOC ratios
- Benefits:
  - Prediction of maximum probable vapor intrusion derived concentration
  - Definition of the outer extent of significant vapor intrusion
  - Identify locations with dominant indoor sources of VOCs



Kurtz, Folkes, Kuehster; MSRAS, August 25-27, 2004



Kurtz, Folkes, Kuehster; MSRAS, August 25-27, 2004

Other Techniques

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- Use of Radon as a tracer
- Measure pressure gradient – at industrial and commercial facilities building is pressurized
- Measure air exchange rates – can be easily performed with HVAC; more difficult in residences
- Determine if mass flux from source is sufficient to exceed standards
- Use emission flux measurements
- Use of models

Summary and Conclusions

- Background concentrations can make reaching clear cut decisions difficult

- What should be completed prior to taking indoor measurements:
  - Develop the Site Conceptual Model
  - Evaluation of soil gas data and vadose zone transport along the lines of the API Soil Gas Manual
  - If indoor sampling is necessary, clear work scope that considers data usage and likely decision methodologies:
    - Includes an analysis of risks and findings from vadose zone investigation
    - What data are we taking, why, and how will it be used.
    - What is the likelihood that more data will be needed in the future and why.
  - Desirable to have plan buy-in from interested parties

References:

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- Todd McAlary, GeoSyntec Consultants, Inc. and Helen Dawson, EPA Region VIII; "How TO Determine, Interpret, and Resolve Background Contributions from Indoor Air Data" presented at AEHS Vapor Intrusion Workshop, San Diego, Ca, March 14, 2005
- J.P. Kurtz, D. Folkes, T.E. Kuehster; EnviroGroup Limited; "Approaches to Quantification of Background VOCs in Indoor Air" presented at the Midwesten States Risk Assessment Symposium, Indianapolis, IN, August 25-27, 2004
- S Hawthorne and J Harju; "Identifying the Source of Benzene in Indoor Air Using Different Compound Classes from TO-15 Data", proposal to the American Petroleum Institute, Washington, D.C. November, 2004
- R Truesdale; Final Report Describing VI Attenuation Workshop, Database, Analysis of Attenuation Factors, Precluding Factors, and Recommendations for VI Guidance Modifications; Subtasks 2.10 Deliverable, EPA Work Assignment 5, EPA Contract No. 68-W-98-215. RTI International Memorandum, May 17, 2004