NJDEP VAPOR INTRUSION GUIDANCE

Diane Groth

New Jersey Department of Environmental Protection

diane.groth@dep.state.nj.us

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NJDEP Vapor Intrusion Current Policy

NJDEP Vapor Intrusion Website

www.nj.gov/dep/srp/guidance/vaporintrusion/

Currently contains links to eight documents, including:

- NJDEP Vapor Intrusion Guidance document (October 2005)
- NJDEP Certified Laboratories - EPA Method TO-15 & TO-17
- NJDEP Regulatory Reporting Format and Electronic Deliverables Requirements
- Method TO-15 Units Conversion Table (Excel format or zip file)

NJDEP Vapor Intrusion Committee

- Diane Groth, Chair
- John Boyer
- Tracy Grabiak
- William Hose
- Stephen Myers
- Paul Sanders
- Heather Swartz

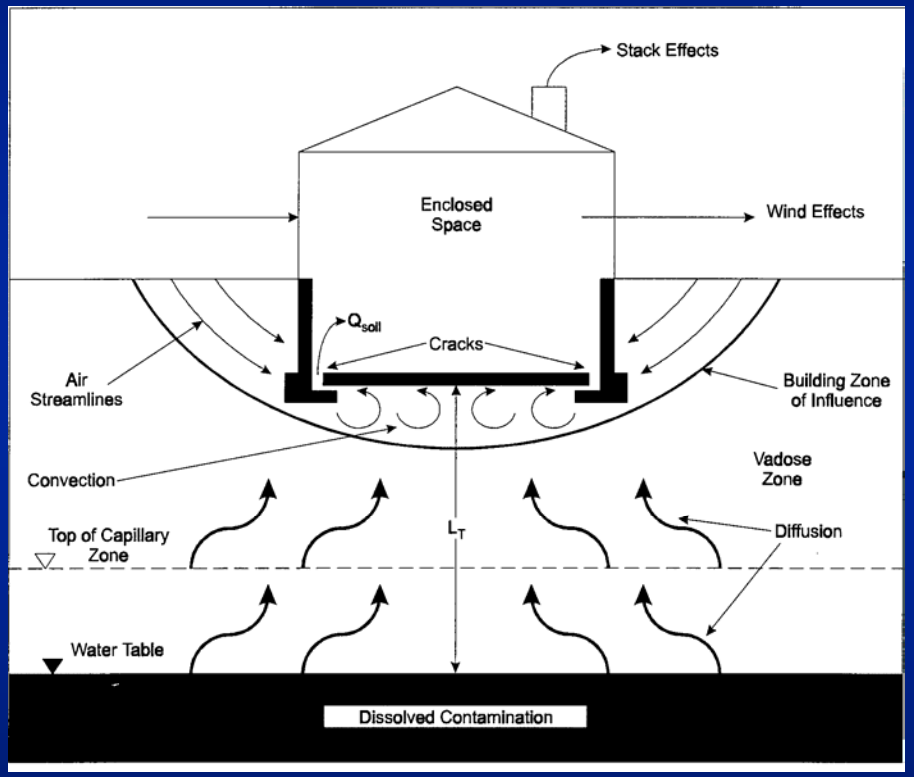
Conceptual Site Model: Issues To Be Considered

Sources of Vapor Intrusion

Vapor Migration Mechanisms

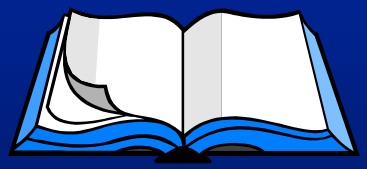
Receptors

Factors Affecting Vapor Migration



NJDEP Vapor Intrusion Guidance Document (2005)

- Conceptual Site Model
- Development of Screening Levels
- Investigative Procedures
- Petroleum Hydrocarbons & Biodegradation
- Background Indoor Air Contamination
- Data Interpretation
- Community Outreach
- Remedial Action



Program Outline

•Introduction/Indoor Air and Soil Gas Screening Levels

•Ground Water Screening Levels and Site Specific Evaluation Decision Framework

•Break

•Ground Water Investigation

• Soil Gas Investigation

•Questions/Lunch

• Indoor Air Investigation

Quality Assurance/Quality Control Requirements

• Data and Background Evaluation

•Break

• Community Outreach

• Remedial Actions

Questions

Vapor Intrusion Screening Levels

Indoor Air Screening Levels

- *Generic Screening Levels*
- *Rapid Action Levels*
- *Health Department Notification Levels*
- *Site-Specific Options*

Soil Gas Screening Levels

- *Generic Screening Levels*
- *Site-Specific Option*

Indoor Air Screening Levels (IASL): Residential

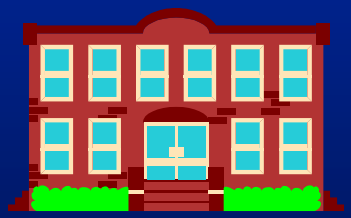
- Residential health-based indoor air screening values obtained from the USEPA Region III Risk Based Concentration (RBC) Table

- Typical residential exposure scenario:
  - Exposure Frequency - 350 days per year
  - Exposure Duration - 30 years
  - Includes age adjusted factor for carcinogens

Residential IASL (continued)

- Higher of the health-based indoor air screening value or analytical reporting limit using Method TO-15

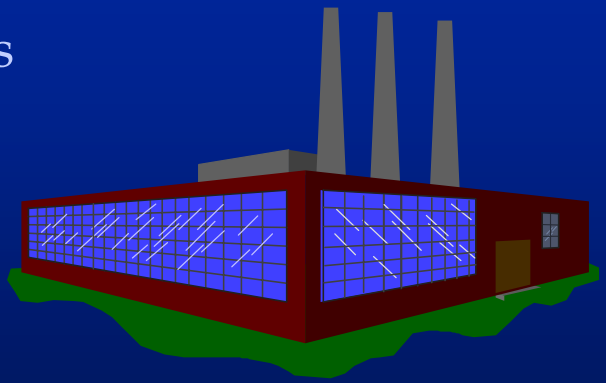
- Residential IASL applicable to residential properties, day care centers and schools



Indoor Air Screening Levels: Nonresidential

- Based on the Region III toxicity factors and the adult worker as the sensitive receptor

- Typical nonresidential exposure scenario:
  - Exposure frequency - 250 days per year
  - Exposure duration - 25 years



Nonresidential IASL

- Higher of the health-based indoor air screening value or analytical reporting limit using Method TO-15

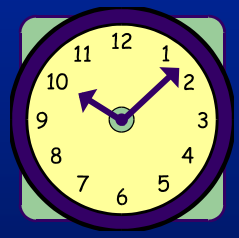
- Appropriate for the commercial/industrial facility not currently handling/using the subsurface contaminants of concern

- Facilities using the same chemicals consider the applicability of OSHA and the nonresidential screening levels

Additional Indoor Air Screening Levels

Rapid Action Levels (RAL):

- trigger levels (Table 2) for the initiation of prompt action
- 100X cancer health-based residential IASL
- 2X noncancer health-based residential IASL
- Exception: Trichloroethylene (TCE) RAL based on the HDNL



Additional Indoor Air Screening Levels (continued)

Health Department Notification Levels (HDNL):

- trigger levels (Table 2) for the notification of the local health department and/or NJ Department of Health & Senior Services (NJDHSS)
- purpose is to determine need for emergency action at occupied buildings
- one-half ATSDR acute Minimum Risk Level (MRL) or 1,000X cancer health-based residential IASL
- facilities with sensitive receptors below HDNL may be referred to NJDHSS on case by case basis

Indoor Air Screening Levels: Site-Specific Options

Site-Specific IASL may be developed based on:

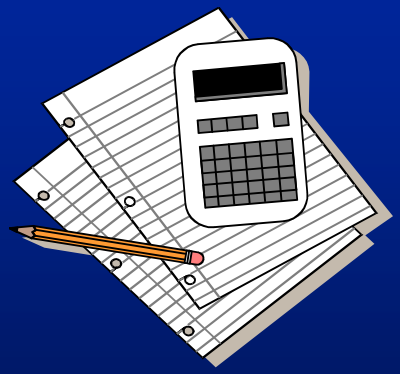
- chemical toxicity factor changes in IRIS/USEPA Region III Table

- changes in risk assessment methodologies/exposure parameters not yet reflected in guidance

Soil Gas Screening Levels (SGSL)

- Calculated using the health-based indoor air screening values and an attenuation factor of 0.02 (or 50X health-based IASL)

- Higher of the health-based soil gas screening value or analytical reporting limit using Method TO-15



Soil Gas Screening Levels: Site-Specific Option

Develop alternate attenuation factors to determine site-specific SGSL

Screening Level Updates

- Value updates on the web site every 6 months
- Refer to the web site for latest information

NJDEP Vapor Intrusion Website

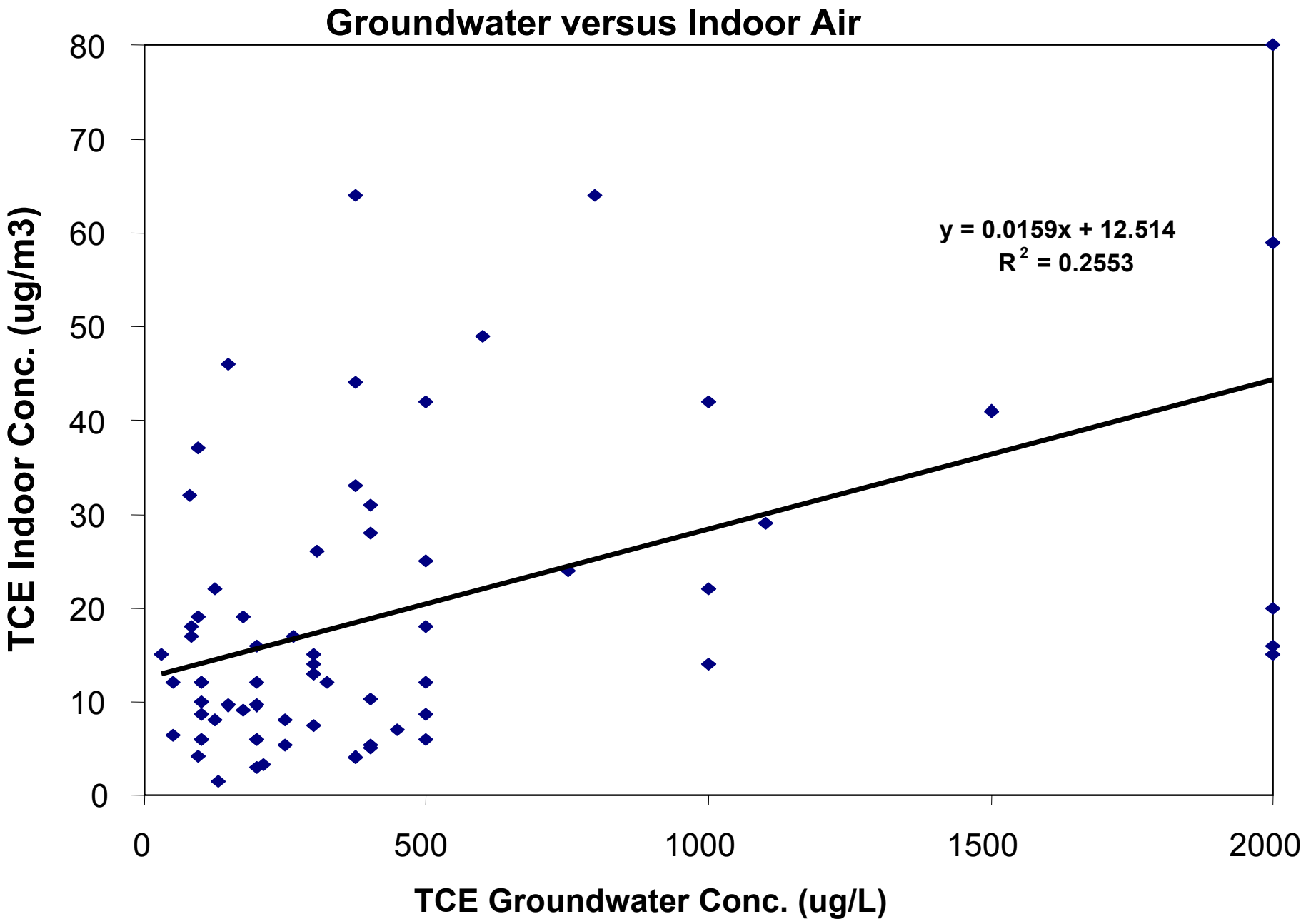
www.nj.gov/dep/srp/guidance/vaporintrusion/

NJDEP VAPOR INTRUSION GUIDANCE Ground Water Screening Levels: Default Values and Site-Specific Evaluation

Paul Sanders
New Jersey Department of Environmental Protection
paul.sanders@dep.state.nj.us

Why are the Ground Water Screening Levels Low?

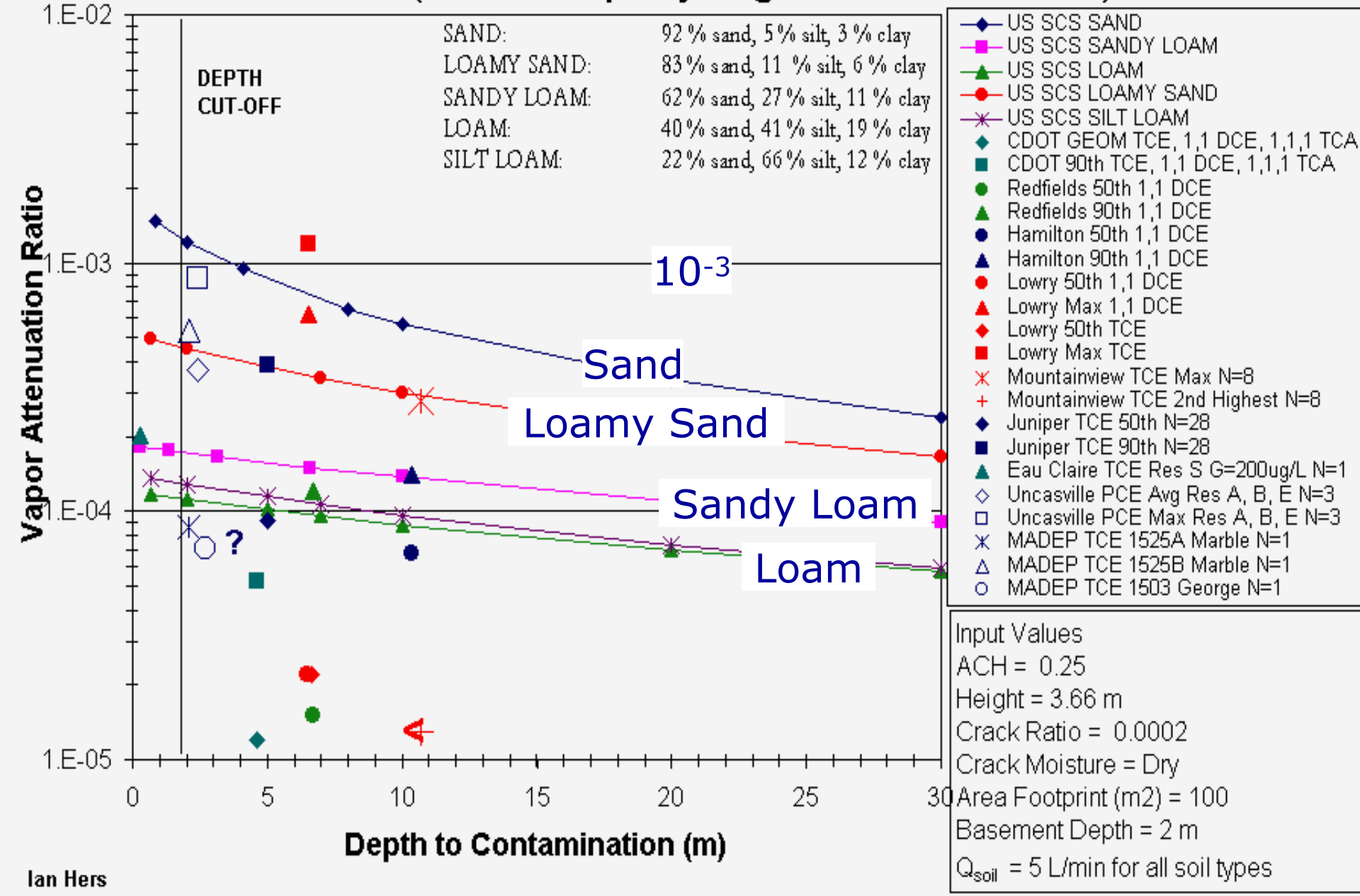
- 10^{-6} risk level for carcinogens
- Higher groundwater concentrations most often the problem, but:
- Need to protect all homes to this level


Groundwater versus Indoor Air
y = 0.0159x + 12.514
R 2 = 0.2553
TCE Indoor Conc. (ug/m3)
TCE Groundwater Conc. (ug/L)
0
10
20
30
40
50
60
70
80
0
500
1000
1500
2000

USEPA Indoor Air Guidance screening numbers were developed by considering both model predictions and field data

- Modeling: Johnson & Ettinger model used to calculate Attenuation Factors between the groundwater and indoor air
- Field data: Attenuation Factors calculated from actual site measurements of groundwater and indoor air concentrations

ALPHA'S CHLORINATED SOLVENTS - GROUNDWATER TO INDOOR AIR PATHWAY (Diffusion capillary fringe & unsaturated zone)



Ian Hers

NJDEP used modeling approach to develop Ground Water Screening Levels

- Allows for use of individual chemical properties
- Allows for adjustment of GW temperature
- Allows for easy calculation of GWSL using alternate soil textures

Generic Ground Water Screening Levels (GWSL)

- GWSL (Table 1) calculated using the Johnson & Ettinger (J&E) Model with NJ specific parameters
- Model parameters include:
  - sand soil
  - depth interval of 5 feet between building foundation and groundwater
  - ground water temperature of 13^0C
- J&E results for carcinogens multiplied by child adjustment factor (0.74)
- Defer to the NJ GWQS when the calculated health-based ground water screening levels fall below the NJ GWQS

Degradation of BTEX compounds often results in an additional dilution factor that is highly uncertain at this time

- EPA Guidance *(November, 2002):* 3X-10X
- Fitzpatrick/Fitzgerald (*Soil & Sediment Contamination, 2002*): 100X-1000X
- Ririe/Sweeney/Daugherty (*Soil & Sediment Contamination, 2002*): 500X - 35,000X

Petroleum Hydrocarbons & Biodegradation

- The Department recognizes biodegradation of hydrocarbons occurs
- GWSLs include a multiplier (10X) for benzene, ethylbenzene, toluene and total xylenes to address biodegradation
- NJDEP will track future developments regarding this issue

Default GWSL for Vapor Intrusion

	Health-Based GW to Indoor Air Value (µg/L)	*NJDEP GWQS (µg/L)*	***NJDEP GWSL (µg/L)***
Benzene	15	1	**15**
PCE	0.8	1	**1**
TCE	0.06	1	**1**
1,1-DCE	250	1	**250**
1,1,1-TCA	5,100	30	**5,100**
CCl_4	0.2	1	**1**
MTBE	78	70	**78**

Default GWSL are adequately protective of most conditions. Exceptions:

- Groundwater is less than 2 feet below building foundation
- Groundwater reaches fill material below building foundation
- Capillary zone reaches building foundation (Table 4-1 in guidance)
- Building foundation in direct contact with fractured bedrock

Site-Specific Options to the Generic GWSL

Option 1:

GWSL for Alternate Soil Textures (Table 3) have been developed for:

loamy sand

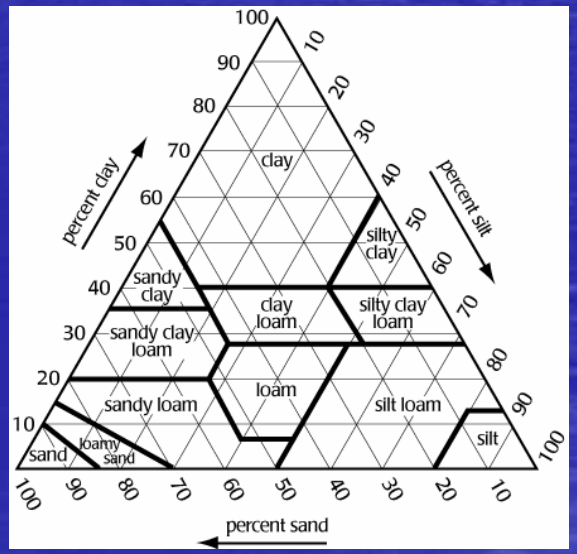
sandy loam

loam

Applicability based on lab soil grain size analysis with at least 75% of the soil profile as fine as above

Determining soil texture

- Collect soil core(s)
- Soil samples submitted to laboratory for texture analysis
- Textures assigned using USDA soil triangle
- At least 75% of soil vertical profile must be as fine as selected alternate texture



Sensitivity of Groundwater Screening Level (µg/L) to Soil Texture

Soil Texture	*Benzene*	*PCE*	*TCE*
Sand	15	1*	1*
Loamy sand	33	2	1*
Sandy loam	81	5	1*
Loam	120	7	1*

*PQL

Site-Specific Options to the Generic GWSL

Option 2: Site-specific use of the J&E model:

- Model available from http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm
- Soil texture layers#
- Depth to ground water and building foundation below grade
- Building air exchange rate, perimeter and first floor height*#
- Exposure duration and frequency (worker scenario)*
- Toxicity factors

**Requires institutional control and/or monitoring to address changes in future use*

#Requires use of advanced J&E spreadsheet

Site-specific soil texture layers

- Layers must be continuous across the site and may not be fractured, as demonstrated by soil borings
- Enter depth range of each soil layer in advanced version of J&E spreadsheet. Select built-in soil properties for each layer.
- For carcinogens, result must be multiplied by 0.74 (child adjustment factor)
- May have large effect on results if a continuous fine soil layer exists (e.g. silty clay)

Depth to Groundwater/Depth of Foundation

- The depth interval between the building foundation and water table is the controlling parameter
- For a given groundwater depth, the depth interval is greater for slab construction than for basement construction
- Enter depth of foundation and depth of water table on either the screening or advanced J&E spreadsheet
- For carcinogens, results must be multiplied by 0.74 (child adjustment factor)

Sensitivity of Groundwater Screening Level (µg/L) to GW Depth (sand soil)

Depth to GW (feet)	*Benzene*	*PCE*	*TCE*
11	15	1*	1*
20	19	1.0	1*
30	25	1.3	1*

*PQL

Adjustment of Building Air Exchange Rate

- Enter air exchange rate (hr^{-1}) in J&E advanced spreadsheet

Adjustment of Building Perimeter

- Q_{soil} = 5L/min x Perimeter (cm)/4000 cm
- Enter Q_{soil} and Perimeter in J&E advanced spreadsheet
- Height of lowest floor of the building may also be adjusted

Don't forget: child adjustment factor (0.74) for carcinogens!

Sensitivity of Groundwater Screening Level (µg/L) to Building Air Exchange Rate (sand soil)

Air Exchange Rate (hr^{-1})	*Benzene*	*PCE*	*TCE*
0.25	15	1*	1*
0.5	30	1.5	1*
1.0	60	3	1*

*PQL

Sensitivity of Groundwater Screening Level (µg/L) to Building Perimeter (sand soil)

Building Perimeter (m)	*Benzene*	*PCE*	*TCE*
10	15	1*	1*
20	23	1.1	1*
30	36	1.2	1*

*PQL

Toxicity Factors and Exposure Assumptions

- Toxicity factors: New IRIS or USEPA Region III factors may be used. Must modify J&E spreadsheet chemical properties database.
- Worker scenario allows for the following changes:
  - Elimination of child adjustment factor (0.74)
  - Exposure duration of 25 years
  - Exposure frequency of 250 days/year

NJDEP VAPOR INTRUSION GUIDANCE:
DECISION FRAMEWORK

John E. Boyer

New Jersey Department of Environmental Protection

john.boyer@dep.state.nj.us

November 2005

Stages of VI Pathway Assessment

Preliminary Assessment & Site Investigation

Stage 1 Assess potential for Vapor Intrusion

Stage 2 Rapid Action Determination

Stage 3 Evaluate Existing Data Against Generic Screening Levels

Remedial Investigation

Stage 4 Develop & Implement VI Investigation Work Plan:

4A. Delineate GW contamination

4B. Investigate soil gas

4C. Conduct sub-slab and indoor air sampling

Stage 5 Evaluate RI Data Using Generic Screening Levels

Stages of VI Pathway Assessment

Remedial Investigation (continued)

Stage 6 Prepare and Implement Site-Specific Investigative Approach

Stage 7 Evaluate Data using Generic Screening or Site-Specific Screening Levels

Remediation & Monitoring

Stage 8 Determine Appropriate Remedial Action

Stage 9 Implement Remedial Action, including Institutional and Engineering Controls

Stage 10 Establish a Long-Term Monitoring Program

Stage 11 Assess Ability to Terminate Remedial Action

Decision Flow Chart for Vapor Intrusion Pathway

Preliminary Assessment and Site Investigation (PA / SI)

Stage 1
Initial Assessment for Vapor Intrusion

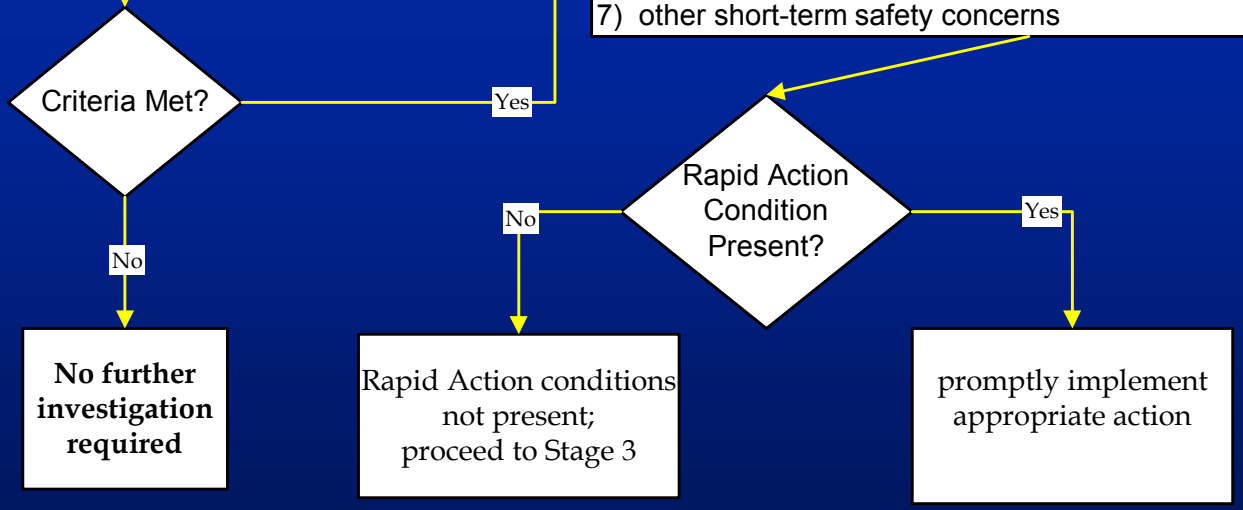
Criteria Required for Vapor Intrusion Investigation:

1) Contaminants of concern present (primarily volatiles);
2) Potential pathway exists; and,
3) Receptors near vapor source (current or future).

Stage 2
Rapid Action Determination

Primary conditions requiring rapid action:

1) Indoor air exceedance of Rapid Action Levels
2) known spill in structure
3) odors reported in structure
4) physiological effects reported
5) wet basement (or sump) with free product or contaminated GW
6) free product on wt under/immediately adjacent to structure
7) other short-term safety concerns



Rapid Action Determination

Qualitative Criteria

- Known spill in a structure (e.g., heating oil tanks)
- Physiological effects reported by occupants (with a known or suspected source nearby)
- Wet basement or sump with contaminated GW nearby
- Odors reported in a structure (with a known or suspected source nearby)
- Free product at the water table under or immediately adjacent to a structure
- Other short-term safety concerns.

Rapid Action Determination

Quantitative Criteria

Rapid Action Levels (RAL)

- trigger levels for the initiation of prompt action, whether further investigation or implementation of an Interim Remedial Measure

Decision Flow Chart for Vapor Intrusion Pathway

PA / SI

Stage 3
Compare Existing Data to Generic Screening Levels

Compare Existing Data to:

1) NJDEP Ground Water Screening Levels;
2) NJDEP Soil Gas Screening Levels; and/or,
3) NJDEP Indoor Air Screening Levels.

If no existing data, proceed to Stage 4.

Remedial Investigation (RI)

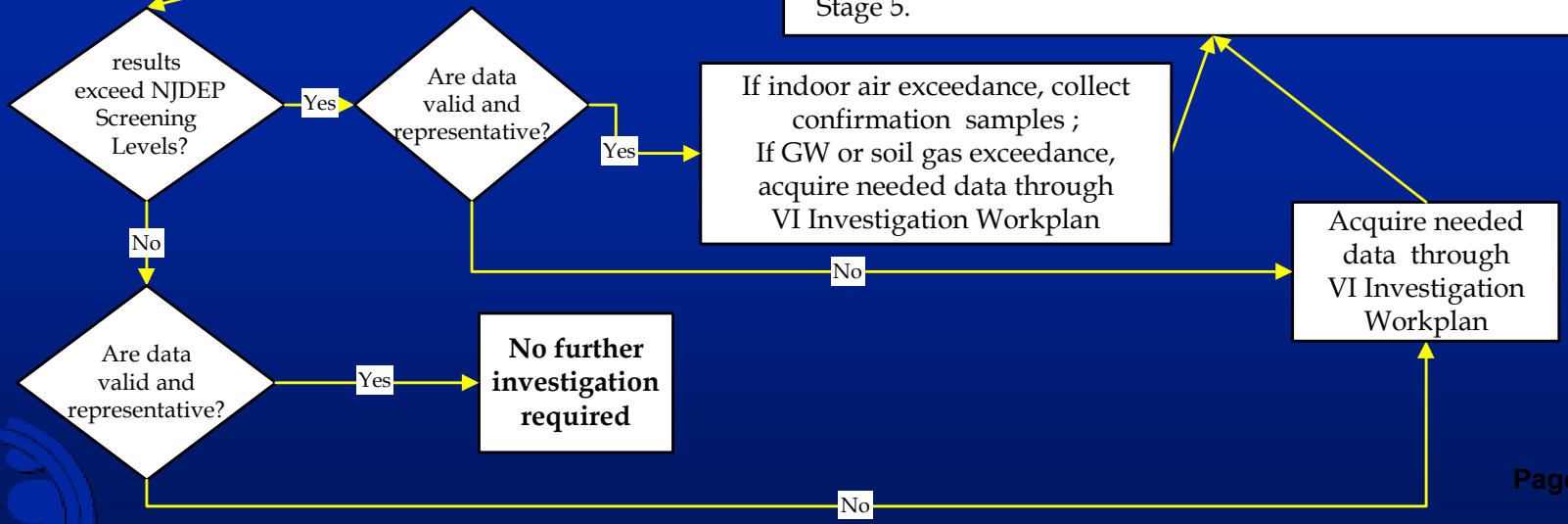
Stage 4
Develop & Implement VI Investigation Workplan

In order of preference:

Stage 4A - Ground Water (GW) Investigation
Delineate ground water contamination; then go to Stage 5

Stage 4B - Soil Gas Investigation
Assess near slab and/or sub-slab soil gas (for existing structures) or exterior soil gas (for future use); then go to Stage 5

Stage 4C - Indoor Air Investigation
Conduct sub-slab soil gas and indoor air sampling; then go to Stage 5.

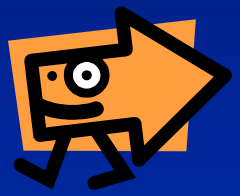
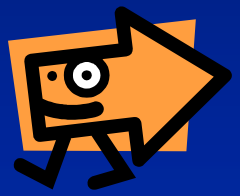


Comparing Existing Data With Generic Screening Levels (Stage 3)

Distance Criteria Using GWSL

- Investigate structures within 100 feet of shallow GW contamination in excess of GWSL
- 30-foot distance criterion utilized for petroleum-related GW contamination (including **MTBE**)
- use the 100-foot distance criterion for free product
- consider future land use even if buildings not present

General VI Investigative Procedures (Stage 4)

Ground Water  Soil Gas  Indoor Air

- Refer to the Decision Flow Chart for initial decision points
- Periodically update the CSM
- Consider preferential pathways when designing an investigative approach
- Additional reporting requirements for VI pathway

Preferential Pathways

"…a natural (e.g., shallow rock or vertically fractured soil) or manmade (e.g., buried utilities) feature that creates a sufficiently direct pathway from a source to a receptor to make the use of the default model for predicting indoor air concentrations unacceptable." Pennsylvania DEP

Technical Issues

- all VI investigations must assess the presence of preferential pathways.
- RP may be required to canvass the immediate area, locate all subsurface utilities and basements, and determine the presence/ absence of organic vapors in accordance with TRSR 7:26E-4.4(h)3.viii.
- The exact locations of all subsurface utilities and basements should be plotted on a scaled site map.

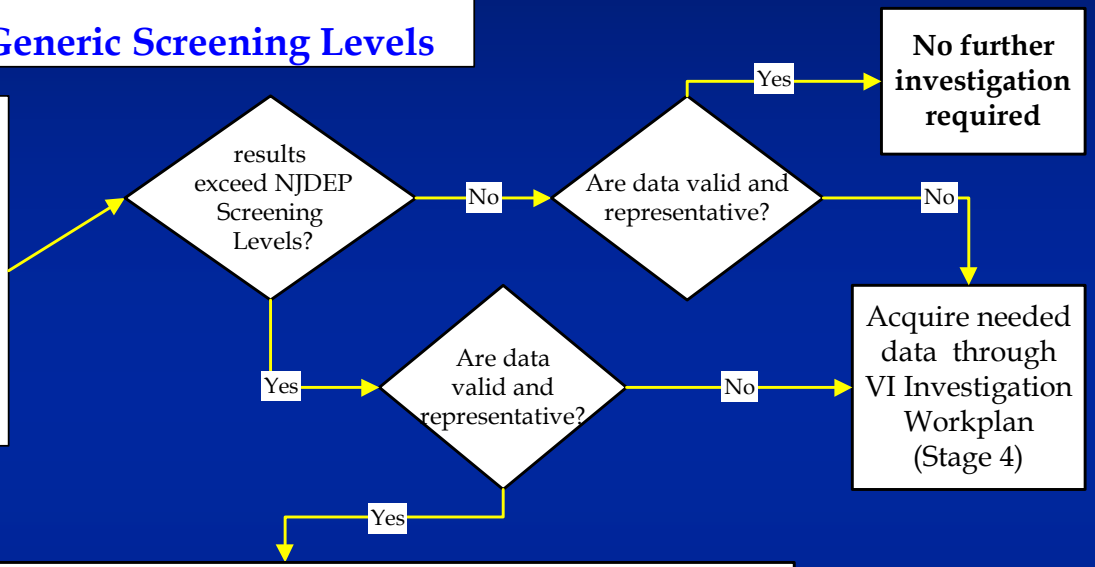
Decision Flow Chart for Vapor Intrusion Pathway

Remedial Investigation (RI)

Stage 5
Evaluate RI Data using NJDEP Generic Screening Levels

Compare RI Data to:

1) NJDEP Ground Water Screening Levels;
2) NJDEP Soil Gas Screening Levels;
3) NJDEP Indoor Air Screening Levels; and/or,
4) or site-specific screening levels developed consistent with Chapter 5



Appropriate Action Based on Type of Data:

GW data - proceed to Stage 4B and continue GW delineation (if necessary)
near slab soil gas data - Proceed to Stage 4C
exterior soil gas data (for future use) - proceed to Stage 8 (Remedial Action)
sub-slab soil gas data (w/o indoor air data) - proceed to Stage 4C
indoor air data - collect confirmation indoor air & sub-slab soil gas samples
confirming indoor air data - proceed to Stage 8

The option to conduct a site-specific evaluation (Stages 6 & 7) is also available - see Chapter 5 for more information.

Data Valid and Representative?

- Was the sampling plan properly designed, approved by NJDEP, and accurately implemented?
- Were the samples properly collected?
- Is the investigator confident that the sampling equipment was not moved or otherwise tampered with?
- Were the samples validated (QA/QC) and determined to be acceptable?
- Was consideration given to potential background contamination?
- Were any other issues that might impact on the data's usability addressed appropriately?

Site-Specific Investigative Approach (Stages 6 and 7)

- Utilization of alternative soil gas sampling procedures (flux chambers, continuous monitoring, vertical depth profiling)
- Assessment of biodegradation for petroleum hydrocarbons (oxygen levels in subsurface soils, depth to ground water table)
- Development of alternate attenuation factors (with sub-slab or near slab soil gas)
- Implementation of other appropriate site-specific screening options.

Remediation and Monitoring

Stage 8 Determine Appropriate Remedial Action **(RASR & RAW)**

Stage 9 Implement Remedial Action, including Institutional and Engineering Controls **(RA Report)**

Stage 10 Establish a Long-Term Monitoring Program **(O & M)**

Stage 11 Assess Ability to Terminate Remedial Action **(Closure)**

Future Training Opportunities

Vapor Intrusion Seminar

November 30, 9 am - 4 pm, NJDEP Public Hearing Room

This seminar will present an overview to the NJDEP's Vapor Intrusion Guidance document with an emphasis on sampling plan development and implementation, data interpretation, and case studies, primarily dealing with **soil gas sampling**.

Special guest speaker - **Dr. Blayne Hartman** of H&P Mobile GeoChemistry (San Diego, CA)

Register with Karen.Frascella@dep.state.nj.us

VAPOR INTRUSION GUIDANCE: GROUND WATER INVESTIGATION

Tracy Grabiak

New Jersey Department of Environmental Protection

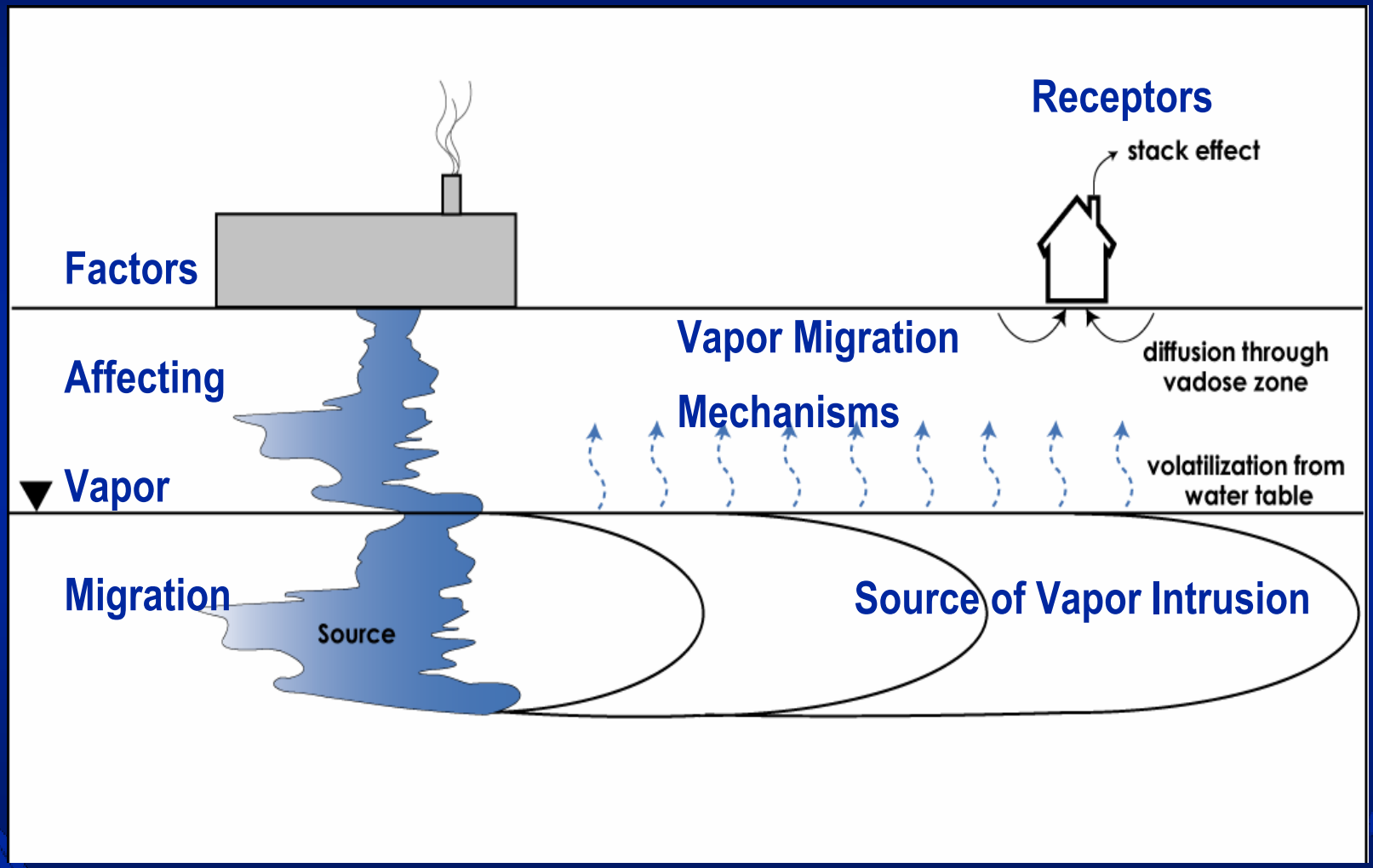
tracy.grabiak@dep.state.nj.us

November 1, 2005

NJDEP Vapor Intrusion Guidance Document (2005)

- [x] Conceptual Site Model
- [x] Development of Screening Levels
- [x] Investigative Procedures
- [x] Petroleum Hydrocarbons & Biodegradation
- [ ] Background Indoor Air Contamination
- [x] Data Interpretation
- [ ] Community Outreach
- [ ] Remedial Action

CSM - Issues to Be Considered



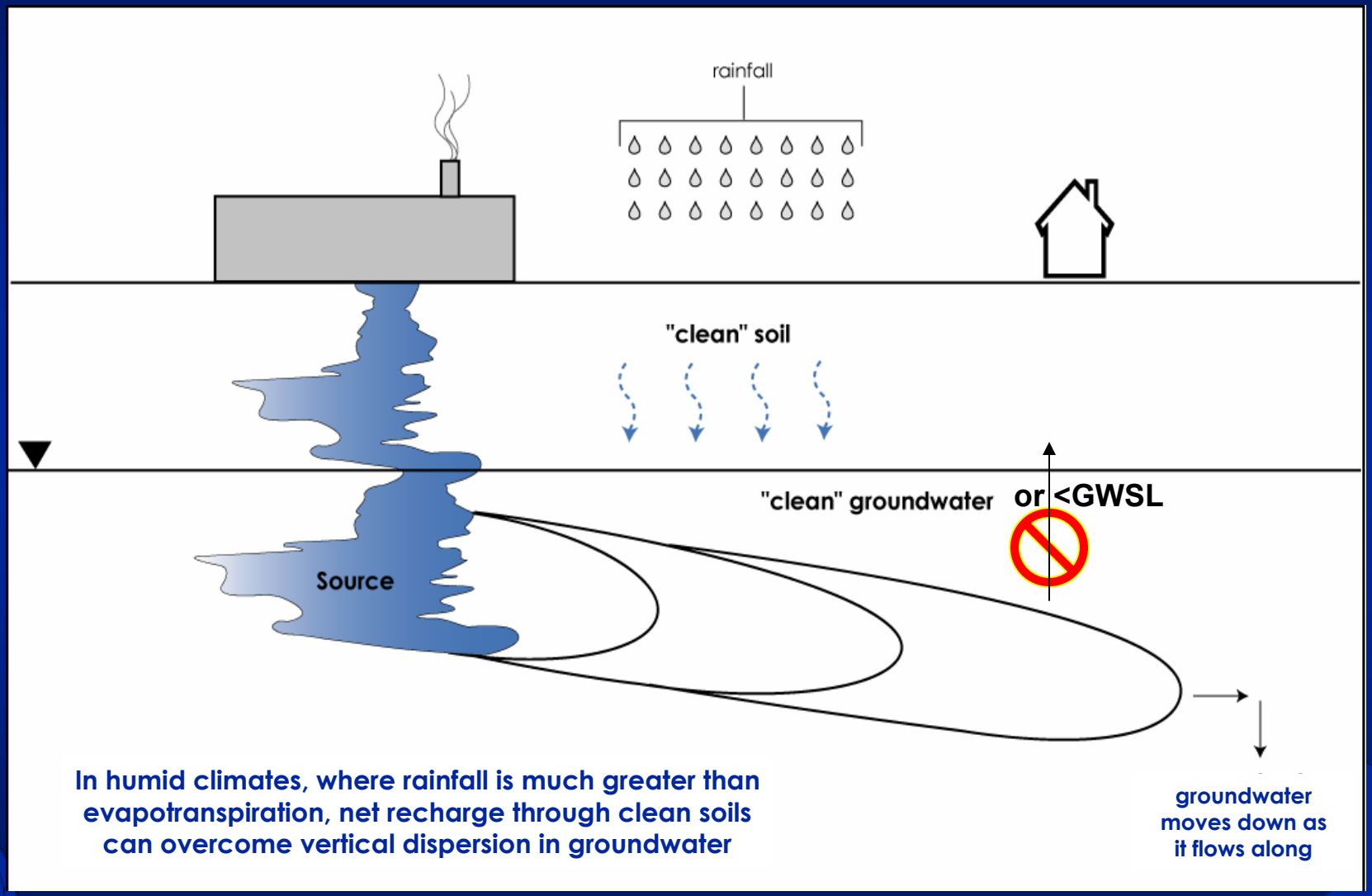
GW Investigation & Sampling Procedures (Section 6.2)

- Saturated Zone Features Affecting Vapor Intrusion
- Use of Pre-Existing Ground Water (GW) Data
- Obtaining New Ground Water Data to Evaluate the Vapor Intrusion Pathway

Saturated Zone Features Affecting VI
(Section 6.2.1)

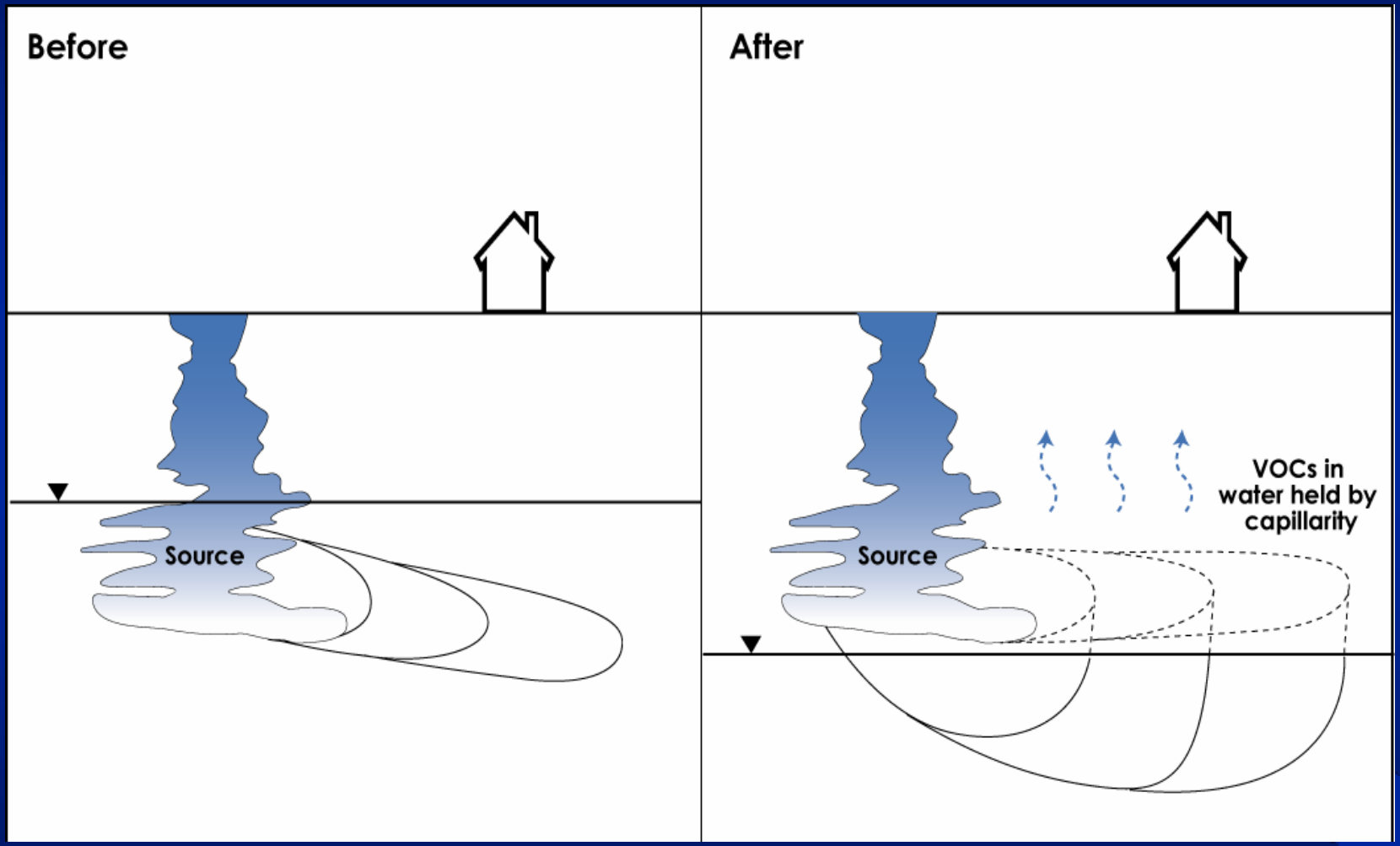
- Clean Water Lens
- Depth to Saturated Zone and Stratigraphy
- Fluctuations in Depth to Saturated Zone
- Complex Hydrogeologic Settings
- Proximity to Preferential Pathways
- Potential for Contaminant Degradation

Clean Water Lens



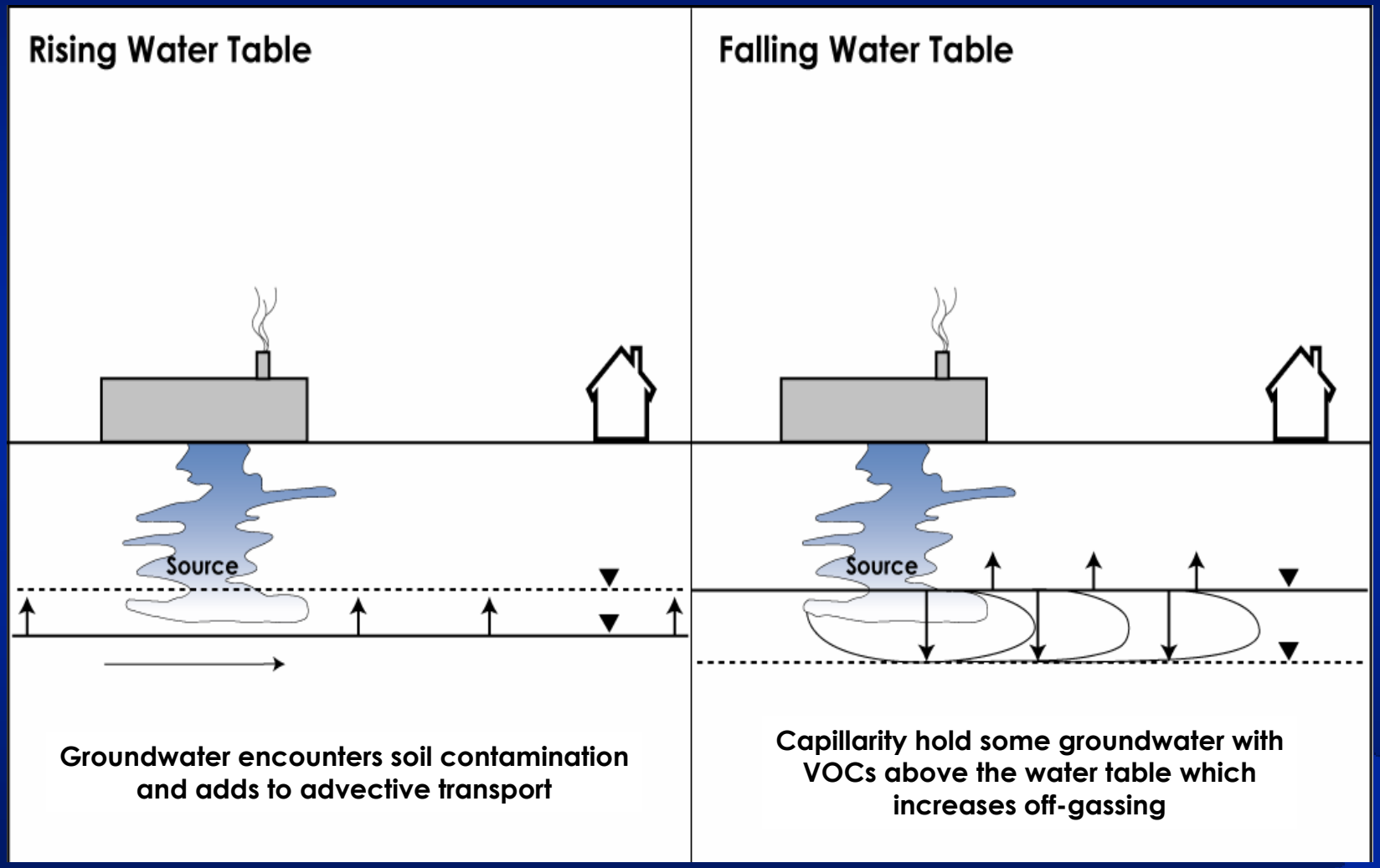
Source: McAlary 2003

Falling Water Table



Source: McAlary 2003

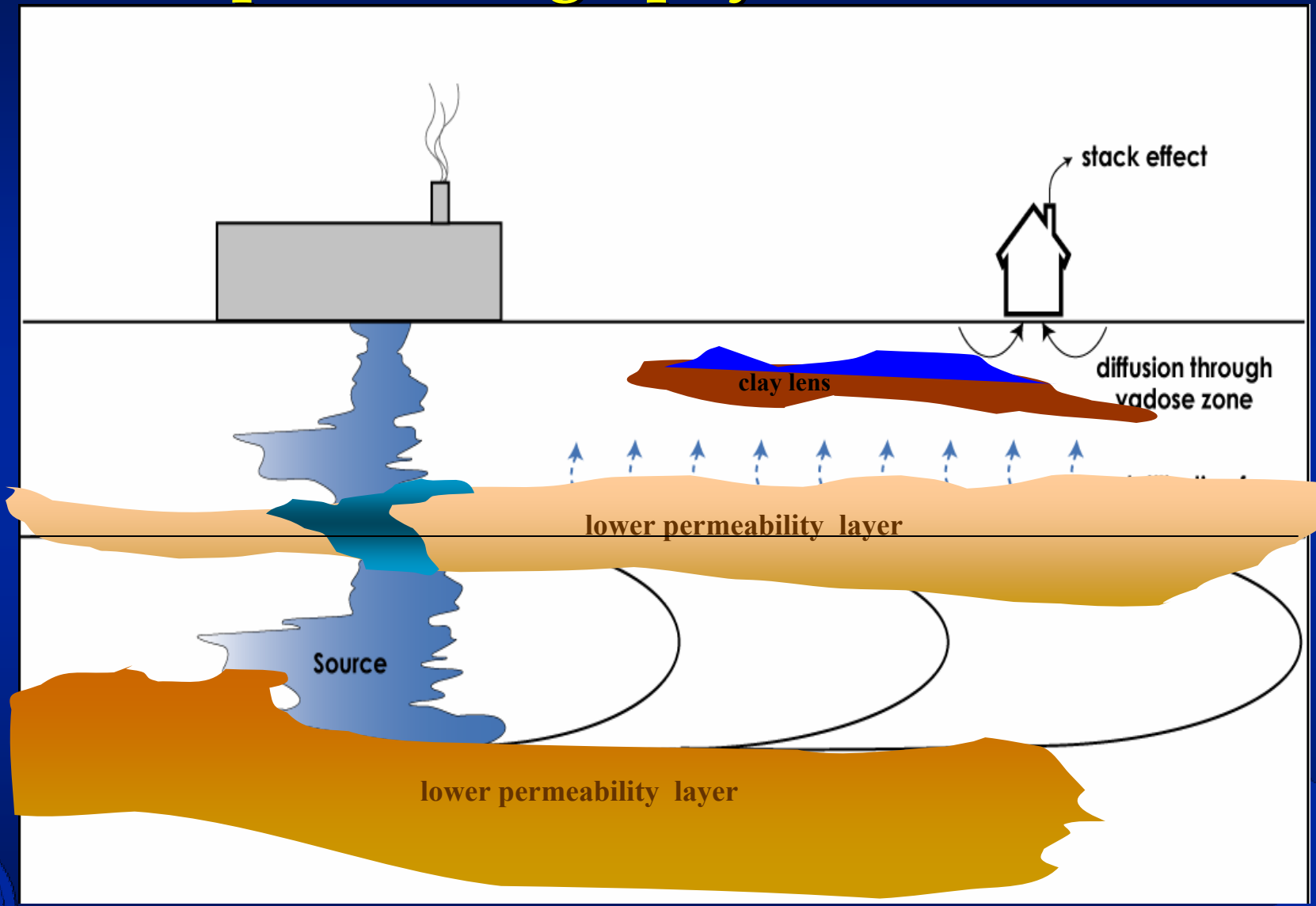
Water Table Fluctuations



Source: McAlary 2003

Saturated Non LNAPL Features

Complex Stratigraphy



Application of GWSL

(Section 4.2.1)

GWSL should not be used if, at time of sampling:

- Water table (WT) is < 2 feet below building foundation
- WT is at 2 ft. below foundation *AND:*
  1. seasonal high WT reaches foundation
  2. WT is in fill directly under building, or
  3. if no fill, top of capillary fringe expected to reach foundation.

     ⇒ For 3rd scenario, can field determine soil texture and use Table 4-1 to predict capillary fringe height

Application of GWSL (continued)

(Section 4.2.1)

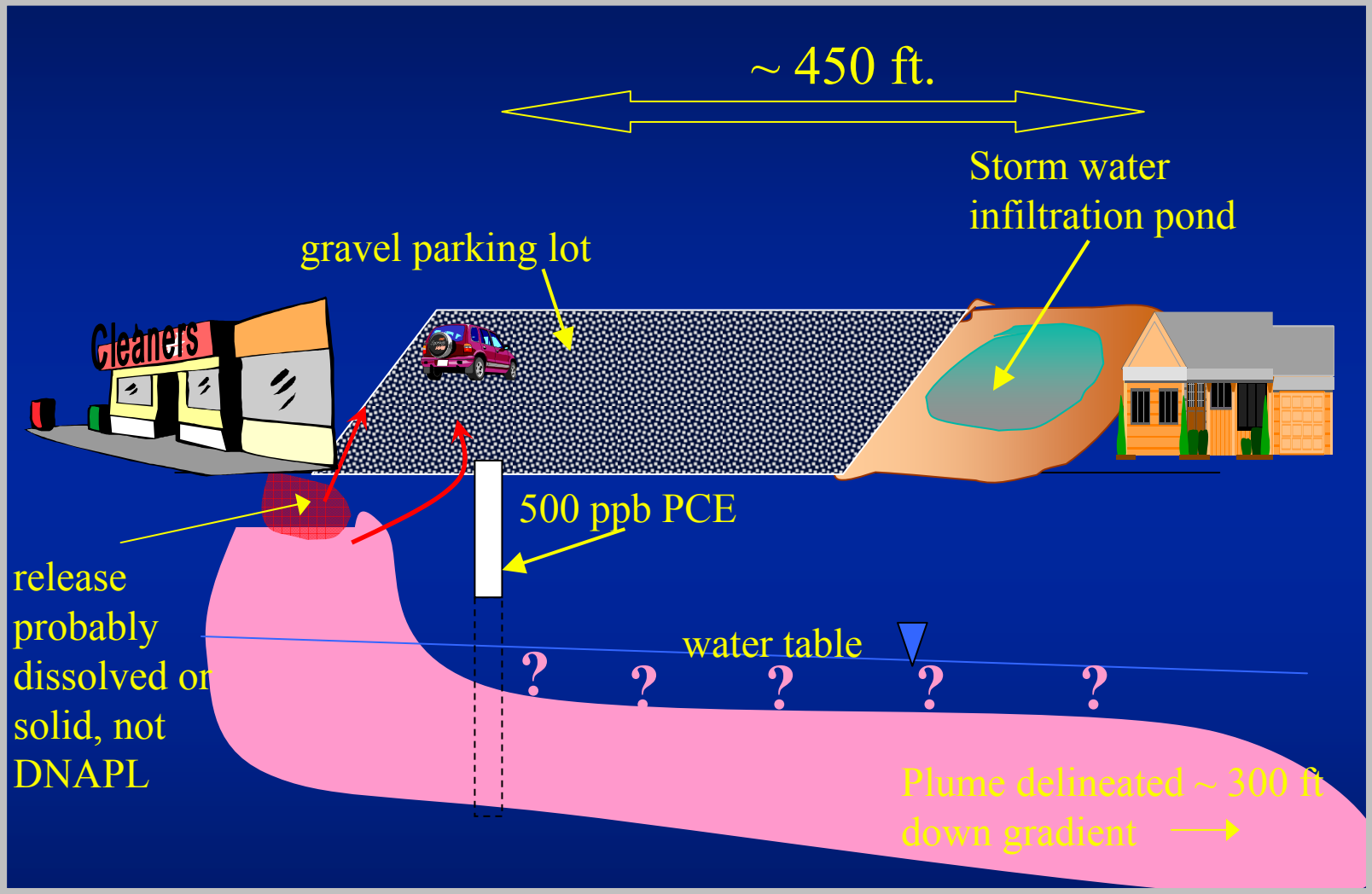
GWSL should not be used if:

- **first water is in massive, competent bedrock with very discrete fractured zones *AND***
- **the building foundation is directly on bedrock (no fill is in between)**

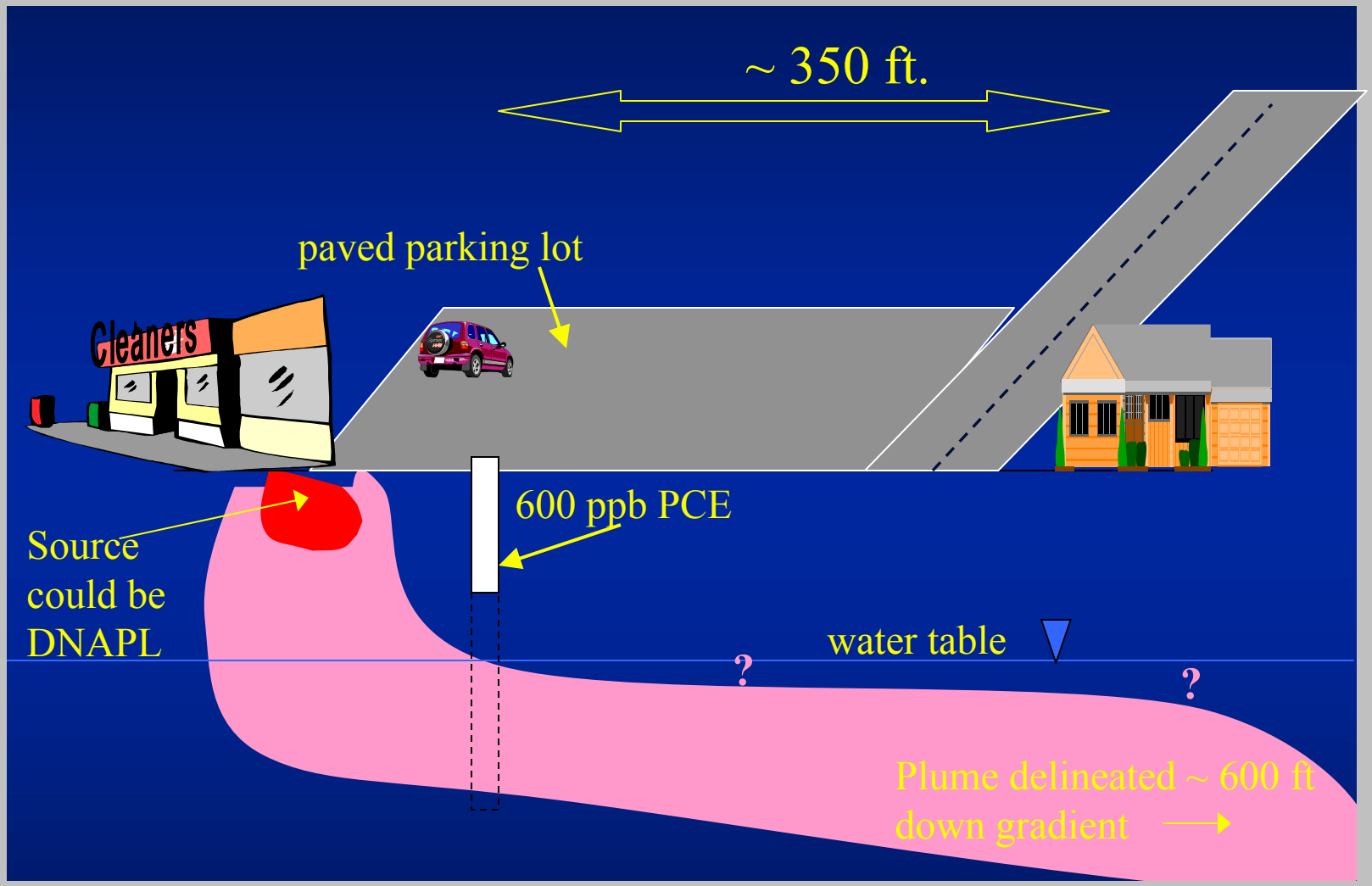
Use of Pre-Existing Ground Water Data
(Section 6.2.2)

- Consider site specific CSM issues
  - Clean water lens likely below receptors ?
  - Concentration and type of VOCs present ?
  - Existing data points near enough to receptors ?
  - Soil/geology suggests soil gas sampling next?
- Are data from water table wells with water column thickness (vertically) of about 10 ft. or less?
- What sampling method was used?

Example 1 - Collect new ground water data? Yes.



Example 2 - Collect new ground water data? **Probably not.**



Obtaining New Ground Water Data
(Section 6.2.3)

Main Objective - sample interval close to the water table

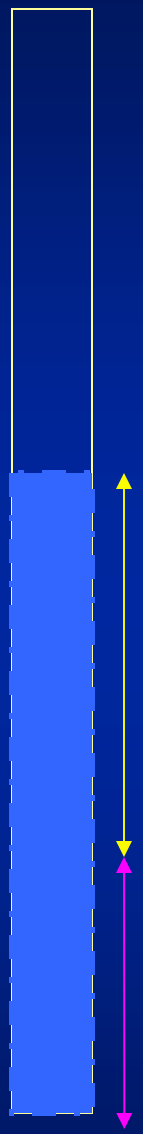
- Ground Water (GW) Sampling Location
- Sampling Depth Intervals
- Direct Push and Alternative GW Sampling Methods
- Monitoring Well Sampling Methods
- Installation of New Monitor Wells
- Ongoing GW Monitoring

Ground Water Sampling Location

- as close as possible to structures due to:
  - 30 ft. & 100 ft. distance criteria
  - non-isotropic distribution & heterogeneity
    - steep concentration gradient, horizontally (especially if side gradient) or vertically
    - buried stream channels, highly fractured zones, etc.
- consider changes in surface cover/infiltration in choosing locations

Obtaining New Data

Sampling Depth Intervals



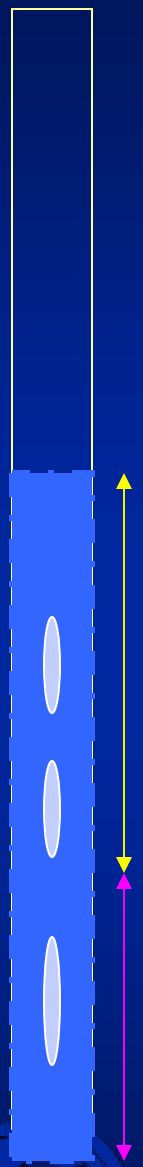
- Existing wells:
  - Screened across water table (WT)
  - Vertical thickness of water column in well ~10 ft. or less
- New WT wells - 5 to 10 ft. screen (unless ...)
- Perched zones - sample if possible
- Vertical profile - possible "exit ramp"
  - May be warranted if clean water lens, use SS option, or use discrete interval sampling methods
  - At least two samples in 0 to 6 ft. interval below WT (bwt)
  - If expect drop in WT, one sample from 6 to 10 ft. bwt
- Profile in at least one boring or well

Obtaining New Data

Direct Push Technology & Alternative ...

- DPT OK instead of wells for evaluating VI
- good for vertical profiling, can get discrete interval sample from defined depth
- rapid sampling in multiple locations horizontally
- sample intervals? 0-3 & 3-6 ft bwt
  - also one sample from 6 to 10 ft. bwt if WT likely to drop by ~4 ft. or more
- accurately map & document sampling locations
- mark boring locations in field if possible

Monitoring Well Sampling Methods for VI



- **PDBS: use 2005 FSPM (but alter as *indicated below*)**
  - **not for MTBE, acetone, styrene, MIBK**
  - **bag length ~20 inches**
  - ***two, potentially three, bags in 0 to 6 ft. interval bwt***
  - ***one bag in central portion of 6 to 10 ft. bwt***
- **LFPS: if water column > 10 ft. not recommended**
  - **can differ from FSPM if data quality objective (DQO) VI only**
    - **set pump intake at ~1.5 to 2 ft. bwt**
    - **purge 2x sampling array volume (tubing & pumps only)**
- **Other discrete interval well sampling methods**
- **Volume-averaged purge & sample? Not for <u>new</u> data**

Obtaining New Data

Installation of New Monitor Wells

- Short screens, preferably 5 ft., but up to 15 ft OK if place so water column is about 10 ft.
  - Longer screen if: long term monitoring; large WT fluctuation likely; and/or multiple DQOs
- If water table in transition zone between overburden and bedrock, deviation request needed
- If first water in bedrock but shallow bedrock is highly fractured/weathered, wells OK for VI
- If first water in massive, competent bedrock with discrete fractured zones, wells probably not most reliable indicator of VI risk (soil gas…)

Obtaining New Data

Ongoing Ground Water Monitoring

- Initial VI investigation may indicate longer term monitoring needed to evaluate changes in conditions that can change VI risk
  - If plume hasn't reached receptors but CSM says it could
  - If vertical profiling indicated VOC could off-gas to vadose zone if water table drops slightly
  - If implementing a remedial action may change conditions affecting VI pathway
- Wells probably best but could use DPT if vertical profiling important & frequency can be low
- Include ongoing evaluation of VI in RAW

Ground Water Data Interpretation

(Section 7.2)

If exceed GWSL, further investigation needed :

- evaluate CSM and data specifics to decide on next step
- further GW delineation horizontally or vertically
- monitor GW to evaluate changes over time
  - can statistically analyze data if exceedances are minor and sporadic
- soil gas investigation could be next step
- in some situations may also immediately initiate indoor air sampling

GW Data Interpretation (continued)

(Section 7.3)

Guidelines for interpreting vertical profile data:

- If no vertical changes update CSM & continue RI
- > or = 6 ft. thick clean water or <GWSL lens
  - If exists all year, no more VI RI. If not likely to persist, include monitoring or general reevaluation in RAW.
- 3 to 6 ft. thick < GWSL lens
  - If exists all year, VI risk low but do ongoing GW monitoring
  - if not persistent, more VI RI & ongoing monitoring
- < 3 ft. thick lens
  - more VI RI needed (probably soil gas sampling), more rigorous monitoring requirements in RAW

Soil Gas Investigation

William S. Hose

bill.hose@dep.state.nj.us

New Jersey Department of Environmental Protection

October 2005

Soil Gas

- What is it?
  - Soil gas is atmospheric gas located in the airspace between soil grains, i.e. soil pore space.
- Why is it of concern?
  - Volatile organic compounds that are contaminants in soil or ground water will also be prevalent in soil vapor and can migrate to a receptor.
- How do vapors migrate?
  - There are two primary transport mechanisms, diffusion and convection.

Primary Factors Affecting Vapor Migration

- Soil permeability
  - One of the most important factors in the movement of vapor through soil is soil permeability. In general the smaller the grain size the less permeable the soil unless secondary porosity (i.e. fractured clays) increases permeability.
- Soil moisture content
  - The presence of moisture in soil decreases the rate of vapor intrusion by decreasing soil airspace and inhibiting vapor movement. Thus soil gas sampling after a significant precipitation event where the ground is saturated is not recommended.
- Vapors migrate fastest through the coarsest driest materials

Evaluating Soil Gas Concentrations

- Soil gas sampling is conducted one of two ways:
  - Active collection.
    - Involves pulling a sample through a temporary or permanent probe to a collection or analytical device.
    - The Department's VI Guidance Document focuses on active soil gas collection.
  - Passive collection.
    - Involves collecting contaminants on a sorbent material or collecting vapor from the ground surface via an emission isolation flux chamber.
    - The use of sorbent material is limited to field screening only.
    - Flux chambers may be utilized with prior approval by the Department with justification why its use is more appropriate for the application proposed.

Soil Gas Sampling Locations

- Within the VI Guidance Document, soil gas concentrations are evaluated in one of three locations:
  - Exterior
    - Samples collected beyond the 10 foot perimeter from the receptor slab.
  - Near Slab
    - Samples collected within the 10 foot perimeter from the receptor slab.
  - Sub-Slab
    - Samples collected beneath the receptor slab.

Exterior Soil Gas Sampling

- Primarily a screening tool for rapid identification and delineation of volatile organics in the subsurface.
- Not acceptable as an exclusive determinant in the assessment of the VI pathway unless evaluating future use scenarios when no existing structures are present.
  - Why?...Potential false negatives due to differing soil types and moisture content away from the receptor.

Near-Slab Soil Gas Sampling

- May be acceptable as an exclusive determinant in the assessment of the VI pathway with the Department's prior approval.
- May be useful in evaluating background contribution to indoor air samples.
- Conditions of acceptability include:
  - Access for sub-slab sampling denied by target receptor.
  - Samples collected at a depth corresponding to a range of 2 to 5 feet below the depth of the receptor slab and a minimum of 5 feet below the ground surface.
  - Samples collected at least one foot above the capillary fringe.
  - Samples are collected from at least two sides of the receptor structure for a single family residence (1500 ft^2).

Sub-Slab Soil Gas Sampling

- Department preferred location for a stand alone assessment of the VI pathway when the source of the vapors is contaminated ground water beneath or in close proximity to the receptor slab.
- Particularly useful in evaluating background contribution to indoor air samples.
- Acceptable when:
  - seasonal high water table is two feet or greater from the base of the sub-floor.
  - The water table does not extend into the fill material directly under the building foundation.
  - The capillary zone does not reach the building foundation.

Soil Gas Sampling Techniques

- Exterior and Near-Slab Sampling
  - Soil vapor probes with retractable tips driven manually or hydraulically a desired depth and retracted to expose an airspace. In general a minimum of 5 feet from ground surface.
  - Small diameter inert tube inserted through the center of the vapor probe and connected to the drive point.

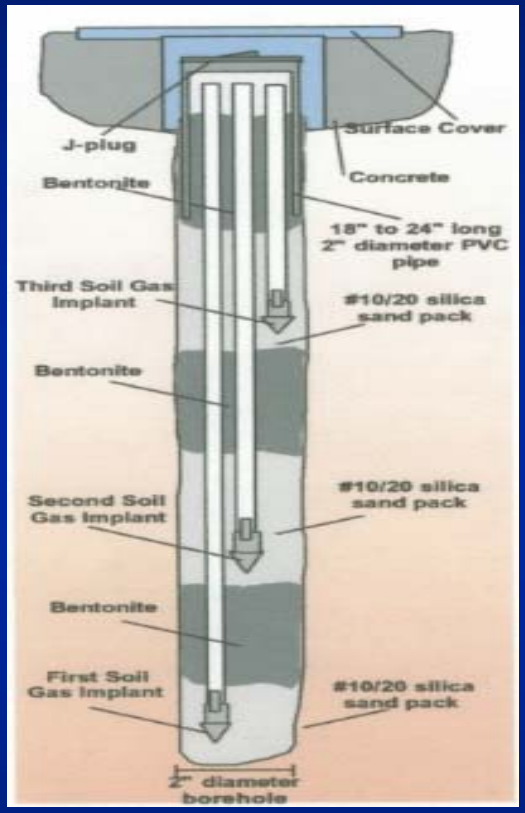
Soil Gas Sampling Techniques

- Exterior and Near-Slab Sampling (continued)
  - Annular seal maintained by soil against probe rods or alternatively the rods are withdrawn and a bentonite seal is utilized. The surface seal is verified by the use of a tracer compound such as iso-propanol, butane, helium, or difluoroethane.
  - The vapor probe is then purged by drawing three volumes of air through the probe and connecting tubing.
  - Samples are withdrawn primarily by 1-liter or 6-liter stainless steel canisters for offsite laboratory analysis or syringes or tedlar bags for onsite analysis at a maximum of 200 milliliters/minute.

Soil Gas Sampling Techniques

- Exterior and Near-Slab Sampling (continued)
  - For exterior and near-slab sampling, the number and location(s) of the samples will be determined based on the end use of the data, i.e. a field screening use will be based on professional judgement and the intent of the study.
  - Exact locations will dictated by site conditions and the location of the contaminant plume.
  - Sampling frequency for exterior or near-slab samples is also based on the end use of the data. Near-slab stand alone determinations may require more than one sampling event.

Soil Gas Sampling Techniques



Nested Exterior Soil Gas Sampling Point
(Courtesy H&P Mobile Geochemistry)

Soil Gas Sampling Techniques

- Sub-Slab Sampling
  - Two basic methodologies:
    - permanent sample points
    - temporary sample points
  - Permanent sampling points involve the emplacement of stainless steel tubing and fittings through which repeated samples can be withdrawn.
  - Temporary sampling points utilize Teflon or metal (or similar) tubing to extract a sample without a permanent point.

Soil Gas Sampling Techniques

- Sub-Slab Sampling (continued)
  - For both methods a hole is drilled through the slab approximately 3 inches into the sub-slab material to create an open cavity.
  - An annular seal must be maintained by non-volatile emitting non-shrinking material such as cement grout for permanent points or modeling clay, beeswax, plumbers putty, etc. for temporary points.

Soil Gas Sampling Techniques

- Sub-Slab Sampling (continued)
  - The vapor probe is then purged by drawing three volumes of air through the probe and connecting tubing.
  - Samples are withdrawn primarily by 1-liter or 6-liter stainless steel canisters for offsite laboratory analysis or syringes or tedlar bags for onsite analysis at a maximum of 200 milliliters/minute.
  - Samples should be collected from as close to the center of the slab as possible, use utility closets or utility rooms to minimize damage to carpeting or tile.

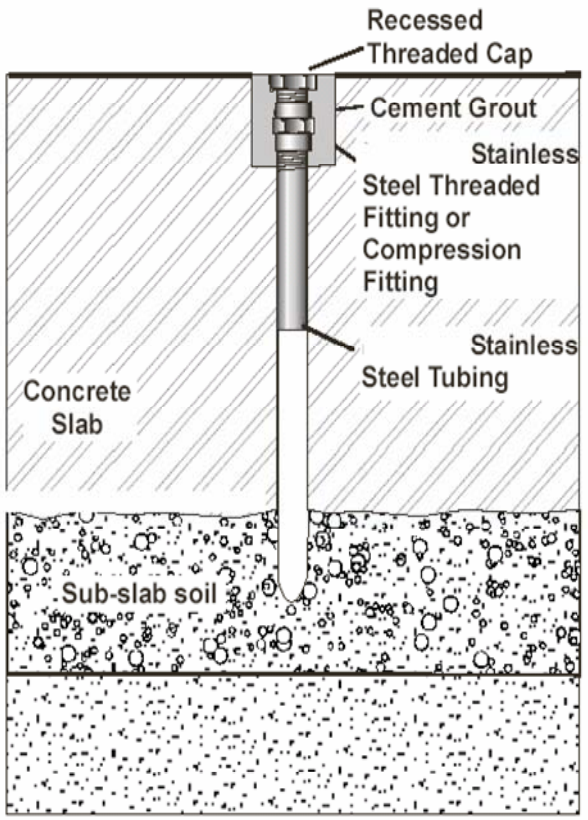
Soil Gas Sampling Techniques

- Sub-Slab Sampling (continued)
  - One sample point for a typical single family home (1500 ft^2) is considered sufficient. Larger structures may require additional points; however, the decision on the number of sub-slab sample points should begin with an evaluation of the Conceptual Site Model.
  - Confirmation sampling may be necessary if sub-slab sampling is used as a stand alone determination of the VI pathway. A single round of data is considered sufficient if the initial round is an order of magnitude below the appropriate screening level.

Soil Gas Sampling Techniques

General Schematic for Installation of Sub-Slab Vapor Probes

(DiGiúlio et al., 2003)



Soil Gas Sample Analysis

- Selection of an analytical procedure for sample analysis is based on the end use of the data.
- Samples for stand alone evaluations of the vapor intrusion pathway should be analyzed for volatile organics via TO-15 or TO-17 by a laboratory certified by the Department for those methods.
- Samples for field screening may be analyzed for target compounds via USEPA SW-846 Method 8260B. Determinations for future use will required usage of a laboratory certified in this method.

Soil Gas Data Evaluation

- Soil gas data are generally used in comparison with other data sets to determine patterns or differentiate site related compounds from other sources.
- Sub-slab and with prior approval near-slab data can be used for stand alone determinations of the VI pathway. In these instances and when the data is collected in concert with IA samples the near slab and sub-slab data are compared to the Soil Gas Screening Level (SGSL) which utilizes an attenuation factor of 0.02 or 50 times to evaluate the possibility of the VI pathway being complete.

NJDEP VAPOR INTRUSION GUIDANCE: INDOOR AIR INVESTIGATION

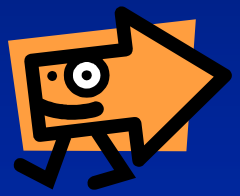
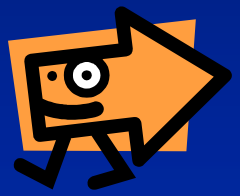
John E. Boyer

New Jersey Department of Environmental Protection

john.boyer@dep.state.nj.us

November 2005

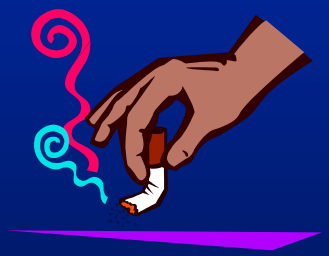
General VI Investigative Procedures

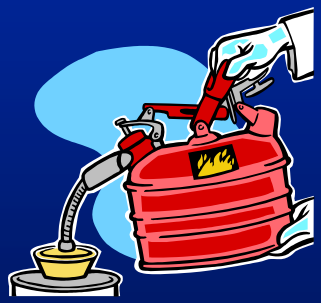
Ground Water  Soil Gas  Indoor Air

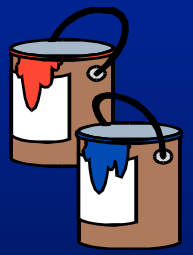
- Recommend collecting indoor air and sub-slab soil gas samples concurrently, but not required
- Consider preferential pathways when designing an investigative approach

Pre-Sample Walkthrough & Building Survey

- Complete the *Indoor Air Building Survey & Sampling form* to identify potential background sources of indoor air contamination
- Conduct walkthrough ideally 1 week BEFORE sampling event
- Remove potential background sources
- Identify sample locations in the basement based on likely vapor intrusion points (sump, utility lines entering structure) and appropriate areas within the living space.
- Discuss *Instructions for Occupants* sheet with the occupants.







Instructions to Occupants - IA Sample Event

- Close windows, doors, and vents
- Do not smoke or use fireplace
- Do not use cleaning products
- Do not use paints or varnishes
- Avoid bringing freshly dry-cleaned clothes into the building
- Do not use hair spray, nail polish, perfume, cosmetics, etc.

When NOT to Collect IA Samples

Source: Mass DEP

Indoor Air Sampling Procedures

For both Method TO-15 & TO-17:

- Collect one sample each on ground floor and basement for typical residential house.
- Collect ground floor samples from breathing zone height and basement (crawl space) samples close to source (sumps, cracks, etc.) .
- Collect air samples over a 24-hour period (minimum of 8 hours).
- Include one ambient (outdoor) air sample per sampling event.
- Determine barometric pressures readings, ambient and interior temperatures

Indoor Air Sampling Procedures (continued)

Method TO-15 Requirements:

- Employs a whole air sample where volatile organic compounds (both polar and non-polar) are concentrated on a solid multisorbent trap, refocused on a second trap, separated on a gas chromatograph column, and passed to a mass spectrometer (operated in SCAN mode) for identification and quantitation.
- Collect indoor air samples using 6 liter stainless steel canisters (Summa®) and analyze for VOCs using USEPA Method TO-15
- Air filters are recommended for canisters to prevent clogging
- All results are to be reported in $\mu g/m^3$ and also in ppbv

Indoor Air Sampling Procedures (continued)

Method TO-17 Requirements:

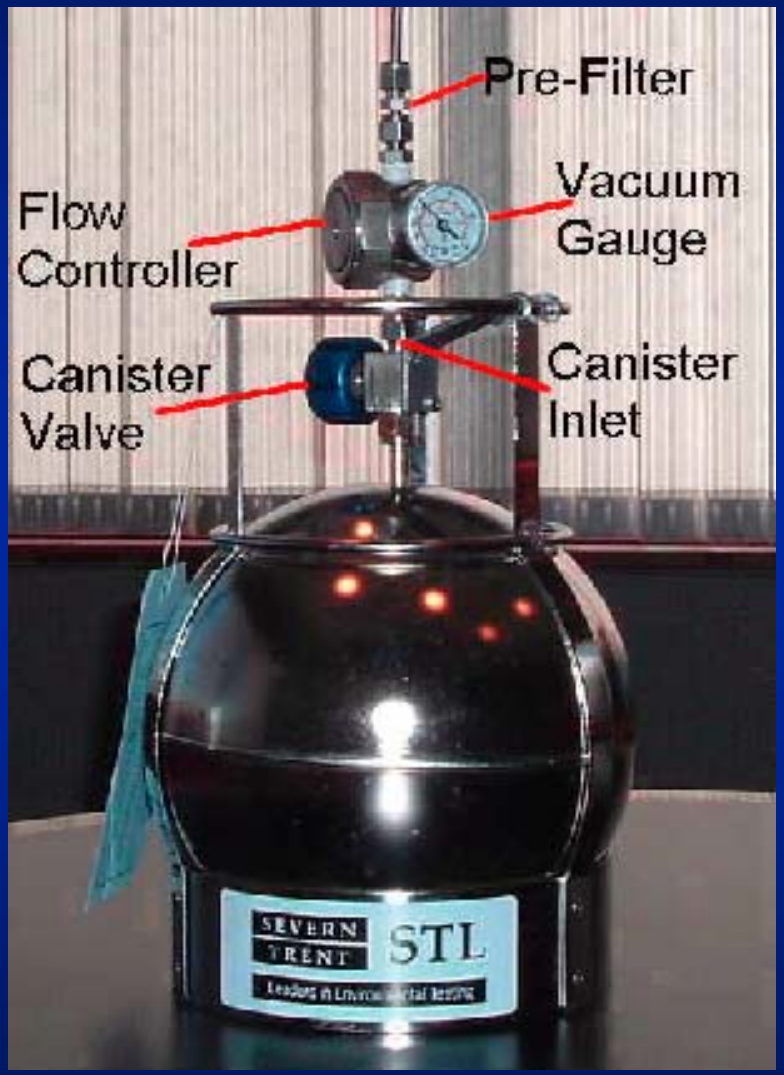
- TO-17 uses sorbent tubes for the collection of air samples
- For each sampling point, collect two sorbent tubes for each sampling point in parallel. The sorbent material in each tube must be the same material.
- The pump rate must be set so that the final calculated reporting limit used by the laboratory shall be less than or equal to 0.5 ppb
- There is a large selection of sorbents that can be matched to the contaminants of concern
- All results are to be reported in $\mu g/m^3$ and also in ppbv

Additional Indoor Air Sampling Procedures

- Full parameter list for initial round(s) of indoor air sampling
- When initial IA results that exceed RAL, confirmation samples should be collected **immediately** to verify these exceedances.
- Avoid collecting IA samples in situations where elevated concentrations are expected based on operations
- Generally, 2 rounds of IA samples is necessary (with 1 round during the worst case months of November through March) **EXCEPTION:** 1 round acceptable when IA results are an order of magnitude below screening levels for COCs.

1- and 6-Liter Stainless Steel Canisters

Typical Canister Components



Quality Assurance Issues

- Utilize lab with NJ Laboratory Certification for appropriate air method
- Full deliverables format with original and summary data packages
- Field and Trip Blanks are NOT required for indoor air samples
- Electronic Deliverables include:
    1) Hazsites Diskette
    2) Electronic data deliverable format
    3) Method TO-15 (or TO-17) Units Conversion Table

Contact Kathy Grimes (ODQ) for further information

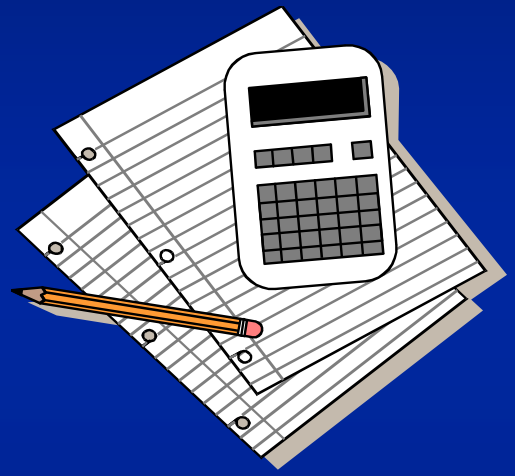
Converting Analytical Results

Formulas are chemical-specific:

$ppbv = (\mu g/m^3 \times 24.45) / MW$

$\mu g/m^3 = (ppbv \times MW) / 24.45$

MW - Molecular weight of the compound



NJDEP
Review and Validation of Vapor Intrusion Data

Kathleen M. Grimes
New Jersey Department of Environmental Protection
Kathleen.grimes@dep.state.nj.us
November 2005

Types of Data

- Primary Focus is Methods TO-15 and TO-17
- Other TO methods and EPA methods

Procedures

- 1St Step Certification Check
- 2nd Step Electronic Deliverables
- 3rd Step Completeness Check of Data Package
- 4th Step Validation

Laboratory Certification

Certification offered by NJDEP Office of Quality Assurance

- Contact Dr. (Zbigneiw) Bernie Wilk at (609) 292-3950
- OQA website http://www.nj.gov/dep/oqa/labcert.html
  - Part III of the Application provides the full list of certified methods and parameters (128 pages)
- General Atmospheric Parameters Types
  - Inorganic Parameters metals
  - Inorganic Parameters nonmetals
  - Organic Parameters
  - Radionuclides

Laboratory Certification

- Soil Gas Oxygen Determination
- Draeger Tube – no certification
- Certification Required for:
  - field GC instrumentation
  - Offsite/Mobile Laboratory Certification for USEPA Method 3C.

Laboratory Certification

- Once OQA certifies a method and the parameter your need is not listed, the following procedures are required.
- If the laboratory is **currently certified** for the method
  - Your **Certified Laboratory** must contact Dr. Wilk at OQA and determine if the compound has recently been added to the list.
  - If not, the laboratory must make the formal request to add the parameter, submit all the required documentation and pay the appropriate fees.
  - OQA will review all documentation, request additional information if necessary and make the determination if certification can be granted

Laboratory Certification

- If the laboratory is **not currently certified** for the method
  - The laboratory must contact Dr. Wilk at OQA and determine if the compound has recently been added to the list.
  - The laboratory must make formal application to OQA for certification for the method and parameter, submit all the required documentation and pay the appropriate fees.
  - An onsite laboratory audit must be conducted by OQA prior to certification being issued.
- Time frame on approvals will vary

Electronic Deliverables

Electronic Deliverables

- Hazresult file
  - File from Laboratory
  - File from Consultant
- Microsoft™ Excel File
- Sample.Txt File

Electronic Deliverables

- Hazresult Deliverables consists of the field sampling information and laboratory information. Required additional fields
  - 2 Additional fields required as specified in Deliverable format
  - UNCCONC" "uncorrected" result value numeric with decimal point
  - UNCUNIT" and will be used for the "uncorrected" results unit value “ppbv
  - "QAQC“populated with the Sample Delivery Group number or analytical batch number

Microsoft™ Excel File

- All data results reported on worksheets
- Nothing is to be revised or changed
- Embedded equations
- Additional compounds are always added at the end must include CAS Number
- No Tentatively Identified Compounds
- Headers are to be completed

Sample.Txt File

- Sample information used by Office of Data Quality
- Tracking purposes
- The sample.txt file and Excel™ spreadsheet files can be included on one diskette or CD-ROM
- Data not accepted for review until electronics are properly submitted

Review/Validation of Data

- Field Test Data Sheets for TO-15 and TO-17 **(new)**
- Completeness Check of Deliverables
- Validation of Data

TO-15 Field Test Data Sheet

- Laboratory initiates the data sheet and assigns flow controller to a canister.
- Sampler required to complete entries in
  - General information
  - Sampling information
  - Temperature, pressure, sampling period, canister pressure start and stop
- Laboratory finalizes the data sheet upon receipt of the canisters.

TO-17 Field Test Data Sheet

- Entire Form completed by the sampling personnel
- Site information and sampling locations
- Adsorbent Tube information
- Field Audit Check
- Pump model and serial number
- Sampling information
  - Ambient temperature, pressure
  - Flow rate, sampling period

Completeness Check

- Follow Deliverable format for TO-15 or TO-17
- For all other methods full deliverables required. Follow style of the two standardized formats
- Bound package, prefer single sided original data package.
- Easier to validate

Common Problems

- Missing pages
- Poor photocopy
- Chain of Custody (external and internal)
- Clean Canister Certification
- Addition of Make up air to canister upon receipt to over pressurize the canister

  Causes " Non Detects" to be above the required reporting limits
- Inability to meet Reporting Limits based on Method Detection Limit Studies

Common Problems

- Dilutions documentation
- NJDEP requires documentation of dilutions by 2 analytical runs
  - Based on screening results
  - To meet reporting limits will need to do undiluted and diluted .
  - Grossly contaminated samples will require dilution at the proper dilution level and a more concentrated dilution

Why not call the Lab??

- Burden of correction should not fall on laboratory if consultant's error.
- Laboratory not informed that sampling is being conducted in NJ causing the following:
  - Deliverable format deficiencies
  - Dilution documentation deficiencies
- Consultant reorganizes data package, recopies and loses pages.
- Additional costs incurred to comply with NJDEP requirements.

Data Validation TO-15 & TO-17

- Most data is from Method TO-15
- No formal SOPs
- Certified method requirements
- Follow NJDEP contract requirements
- Guidance document requirements

Validation

- Canister Documentation (out and back)
- Clean Canister Certification
- GC/MS tuning
- Calibration sequence
- Calibration criteria
- Method blanks, instrument blanks
- Laboratory control samples

Validation

- Sample data review
- Chromatograms, quantitation reports, mass spectra
- Recalculation of results
- Preparation of report

Other TO Methods and EPA Methods

- Laboratory Certification Status
- Does MDL/RL meets needs of NJDEP
- Method Requirements
- Laboratory's SOP approved by OQA

Other Methods

- Sampling procedures will vary
  - New procedures
  - Old procedures
- Full Deliverables
  - Eliminates requests for more information
  - Laboratory's SOP submittal
- Validation against method and SOP

Future Changes

Method TO- 15 Changes

- Development of Low Level Method Requirements for most compounds of RL of 0.2 ppbv December 2005
- Laboratories notified March 2006 with Certification Application cycle
- Revised Deliverable format May 2006
- New Certification effective July 2006
- Guidance Document changes Summer 2006

NJDEP VAPOR INTRUSION GUIDANCE:
DATA EVALUATION

John E. Boyer

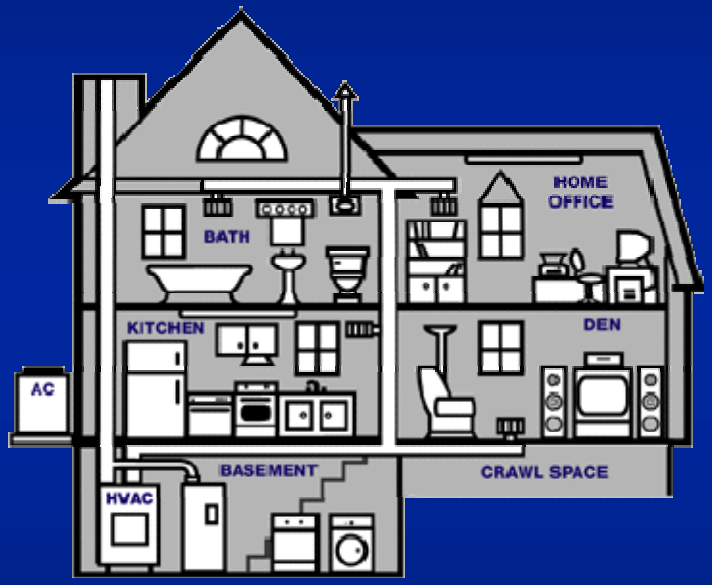
New Jersey Department of Environmental Protection

john.boyer@dep.state.nj.us

November 2005

Sources of Background IA Contamination

- Consumer Activities
- Household Products
- Building Materials & Furnishings
- Ambient (outside) Air
- Laboratory Contaminants



Addressing Background IA Contamination

Multiple Lines of Evidence Approach

Primary Factors

- Site-specific contaminants of concern
- Sub-slab soil gas sampling
- Data Review
- Ambient air sampling

Secondary Factors

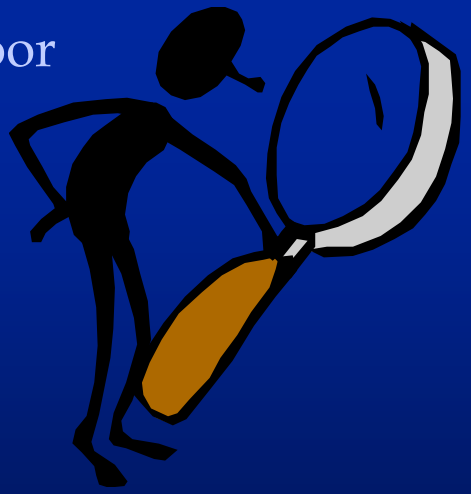
- Building walkthrough and survey form
- Indoor air background databases
- Exterior soil gas sampling

Determine Quality of Indoor Air Data

- review sampling field notes to verify consistency with IA sampling plan
- Verify a NJDEP Certified Laboratory analyzed the samples
- validate/review data for quality assurance/quality control through the Office of Data Quality

Compare Results to Screening Values

- Confirm unit conversions calculated for the results (ppbv verses µg/m^3)
- Compare results to appropriate screening levels (GWSL, SGSL, IASL, or site-specific levels)
- Assess potential contribution from indoor or ambient background sources
- Look for trends in the data



Looking for Trends

Differentiate background from site-related contaminants

- compare sub-slab and indoor air results
- compare ambient air to indoor air results
- compare ground water and indoor air results
- review Building Survey form for potential background sources of contamination

Looking for Trends (continued)

- Compare concentrations from basement and upper level results - is there a trend???
- Compare results between adjacent buildings
- Compare results in buildings with site maps of utility lines and ground water plumes
- Consider factors affecting indoor air concentrations

Decision Flow Chart for Vapor Intrusion Pathway

Remediation Decision Matrix - Stage 8

		Indoor Air Concentrations (for COCs)	
		< IASL	>IASL
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Notes:

* Investigator should consider the potential for vadose zone (soil) contamination and/or preferential pathways as part of the assessment of vapor intrusion before concluding "no further action"

Red Decision Points - investigators should use professional judgement when determining which action is appropriate. Factors to consider include the relative exceedance of the screening level, the ratio of the sub-slab soil gas and indoor air results, building construction, and possible affects of background sources of contamination and sampling errors. (Refer to Chapter 7, *Evaluation of Analytical Results*, for more guidance and information.)

Assessing Remedial Decision Points

Factors to be considered at decision points include:

- the relative exceedance of the screening level
- the ratio of the sub-slab soil gas and indoor air results
- the current building construction (e.g., 1st floor garages, sub-slab vapor barriers, etc.)
- possible effects of background sources of contamination
- sampling errors

Case Example (1)

Chemical	Soil Gas Results Sub-slab	IA Results Basement	IA Results 1st Floor
Benzene	ND	ND	ND
Cyclohexane	14,801.15	123.92	25.47
Ethylbenzene	ND	ND	10.42
4-Ethyltoluene	ND	ND	18.68
Methylene chloride	ND	ND	100.75
MTBE	18,026.58	137.00	50.47
Toluene	ND	ND	45.22
1,2,4-Trimethylbenzene	ND	ND	17.21
1,3,5-Trimethylbenzene	ND	ND	5.90
2,2,4-Trimethylpentane	93,415.13	700.61	158.81
Xylenes *(m & p)*	ND	13.90	38.66
Xylenes *(o)*	ND	ND	16.51

Results in $\mu g/m^3$

Stafford Township, NJ Indoor Air Research Project (NJDEP)

Case Example (2)

Gas Station

Retail Shopping Mall

Tenant 1

Basement
- Acetone - 12,400
- Benzene - 1,447
- MTBE - 7,860

1st Floor
- Acetone - 25,417
- Benzene - ND
- MTBE - ND
- PCE - 79
- THF - 57

Tenant 2

1st Floor
- Acetone - 35
- Benzene - ND
- MEK - 1,690
- MTBE - 2.2
- PCE - 2,281
- THF - 1,010

Tenant 3

1st Floor
- Acetone - 18
- Benzene - 1.1
- MEK - ND
- MTBE - 2.7
- PCE - 460
- THF - ND

Tenant 4

1st Floor
- Acetone - 83
- Benzene - 0.8
- MEK - ND
- MTBE - 1.6
- PCE - 1,322
- THF - ND

All results reported in µg/m³

VAPOR INTRUSION GUIDANCE: COMMUNITY OUTREACH

Heather Swartz

New Jersey Department of Environmental Protection

heather.swartz@dep.state.nj.us

November 2005

Benefits of Community Outreach

Effective community outreach:

- builds trust and credibility with citizens/local officials
- helps prevent roadblocks in the remedial process

Plan your community outreach strategy early

Communicating with the Public

- Local officials - municipal and health officials
- General public - occupants/property owners and other interested parties
- Media - if site becomes high profile

Remember to use non-technical terms and avoid jargon

Public Concerns

- Health effects
- Property values
- Unfamiliarity with the concept of vapor intrusion
- Residents are directly affected, so more frequent contact is needed
- Stigma/confidentiality

Vapor Intrusion Outreach

- arranging sampling appointments
- collecting samples
- reporting findings
- facilitating remedial actions
- holding public meetings

Arranging Sampling Appointments

Step 1: Introductory letter

- Send several weeks before sampling event
- Explain reason for sampling and provide general information
- For rental properties, send to occupant and owner
- Include access agreement if necessary

Give local officials a list of occupants/ property owners contacted

Arranging Sampling Appointments

Step 2: Phone call to occupant

- Give at least two weeks notice
- Be prepared to discuss sampling details and when they will get their results
- Review "Instructions for Occupants – Indoor Air Sampling"
- Review "Indoor Air Building Survey and Sampling Form"

Follow-up appointments just require a phone call

Collecting Samples

Make sure someone is available to answer the occupants' questions

Reporting Sampling Results

NJDEP officially notifies occupants/property owner of their results

NJDEP may provide verbal notification of their results first if:

- contaminant(s) of concern exceed Rapid Action Levels
- high levels of background contamination
- more than two months since sampling occurred

Written Notification

Written notification consists of:

- cover letter that explains the findings in non-technical terms
- table that clearly summarizes the analytical results

Inform property owner of Property Disclosure Requirements (if vapor intrusion is occurring)

Outreach During Remedial Actions

- Scheduling installation of remedial system
- Relaying property owner/occupant's concerns to appropriate individuals
- Ensuring owner/occupant's issues or concerns are resolved whenever possible

Completed remedial systems should be as inconspicuous as possible

When a Public Meeting is Needed

- The earlier in the process the better
- Meet as often as needed

Possible Meeting Formats:

- Local council meeting
- Formal presentation with question/answer period
- Open house or “public availability session”

Additional Information

- **USEPA guidance**: *Risk Communication* – Seven Cardinal Rules of Risk Communication

  www.epa.gov/superfund/tools/pdfs/37riskcom.pdf

- **NJDEP report**: *Establishing Dialogue & Planning for Success: A Guide to Effective Communication Planning*

  www.state.nj.us/dep/dsr/pub.htm

NJDEP Office of Community Relations

Website: www.nj.gov/dep/srp/community

Toll-free Phone Number: 800-253-5647

Local Phone Number: 609-984-3081

VAPOR INTRUSION GUIDANCE: REMEDIAL ACTION

William S. Hose

New Jersey Department of Environmental Protection

bill.hose@dep.state.nj.us

Remedial Action (Chapter 10)

Decision Flow Chart for Vapor Intrusion Pathway

Remediation Decision Matrix - Stage 8

Sub-Slab Soil Gas Concentrations (for COCs)	Indoor Air Concentrations (for COCs)	
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Objective: To eliminate the pathway between the source (i.e., groundwater and/or soil contamination) and the receptors.

Primary Goal: Remediate the Source of the Vapor Contamination.

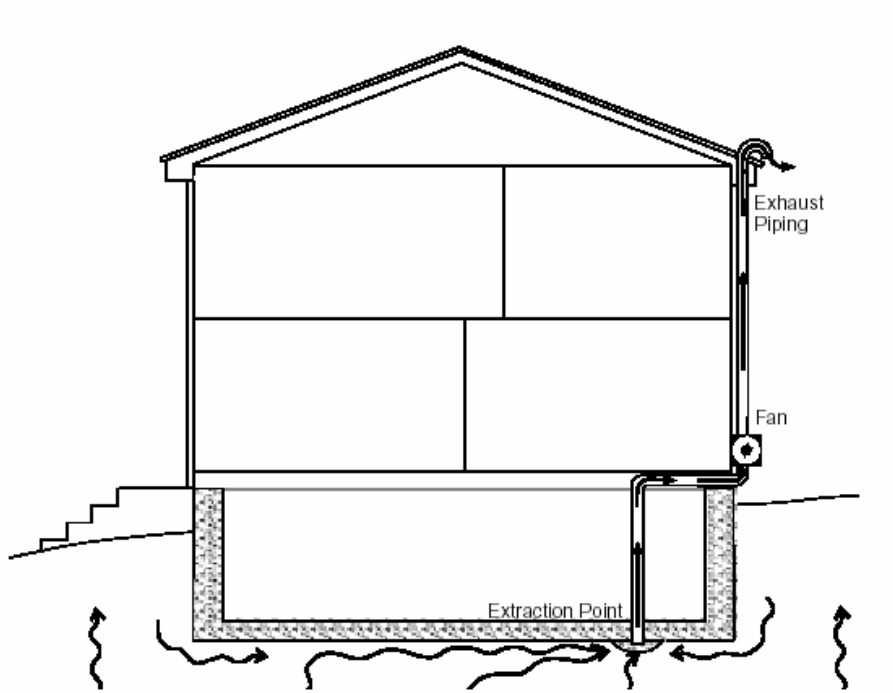
Remedial Action Techniques

- Seal openings and cracks in floors, walls, etc.
- Cover exposed soil and sump pits
- Install a vapor barrier
- Pressurize the building (HVAC)
- Install Soil Vapor Extraction (SVE) System
- Subsurface Depressurization Systems

Subsurface Depressurization Systems

- The remediation systems typically utilized in residential homes.
- System design depends on the building's construction.
- Only active systems may be utilized in existing buildings.

Subsurface Depressurization Systems



A subsurface depressurization system prevents vapor intrusion by directing hazardous vapors in the soil to the exterior of the building.

Subsurface Depressurization Systems

- Subsurface Depressurization Systems should contain:
  - Pressure Gauge (manometer)
  - Audible Alarm
  - Label w/purpose of the system, name, address and phone # of the entity to contact for repairs, etc.

Remedial Action Implementation

Qualifications: Consult a NJ Certified Radon Mitigation Business or licensed Professional Engineer for the design, installation, monitoring & maintenance of the remedial system. Certify that remedial system will eliminate/address VI pathway.

Permits: Obtain necessary permits prior to installation of the system.

- An Air Permit is required from NJDEP for use of Depressurization Systems in certain dwellings, contact Regional Air Enforcement Office.

Pre-Construction Considerations

If a property designated for redevelopment has the potential risk for vapor intrusion, proactive remedial measures should be implemented into the design of structure.

- Vapor Barrier
- Vapor Barrier with Passive Depressurization System
- Active Depressurization System

Institutional and Engineering Controls

Not Necessary: For remedial systems provided official notification of the property owner/occupant is provided. Notification requires informing the property owner of the Property Condition Disclosure requirements as per N.J.A.C. 13:45A-29.1.

Seller is required to answer the following per N.J.A.C. 13:45A-29.1:

Question # 78: Have you received any written notification from any public agency or private concern informing you that the property is adversely affected, or may be adversely affected, by a condition that exists on a property in the vicinity of this property? If "yes," attach a copy of any such notice currently in your possession.

Question # 82a: If "yes" to any of the above, were any actions taken to correct the problem? Explain.

Institutional and Engineering Controls

Necessary:

- For undeveloped properties that contain source concentrations above the generic screening levels (GWSL or SGSL), if NFA is requested.

- For sites where the Nonresidential screening levels are used.

- For sites that adjust the building parameters to generate an approved site-specific GWSL.

Verification Sampling

- Sample IA 2-4 weeks after remedial system is operational.
- Generally, 2 rounds of IA samples is necessary (with 1 round during the worst case months of November through March) **EXCEPTION:** 1 round acceptable when IA results are an order of magnitude below screening level for COCs.
- System modifications require additional sampling.
- If using a depressurization system verify that a negative pressure extends beneath the structure of concern.

Monitoring & Maintenance

Monitoring & Maintenance Plan required for all Remedial Actions

Monitoring & Maintenance Plan requires:

- Quarterly monitoring to assess effectiveness
- Semi-annual maintenance inspections
- Repairs as needed to maintain effectiveness
- Submit results to NJDEP periodically

Remedial System Termination Sampling

Once the investigator concludes that the VI source has been remediated such that the VI pathway is not complete, a proposal to cease operation of the remedial system may be proposed to the Department.

- Indoor Air and Sub-slab Soil Gas Sampling Recommended

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Questions?