Learning from the States…
Commonwealth of Massachusetts

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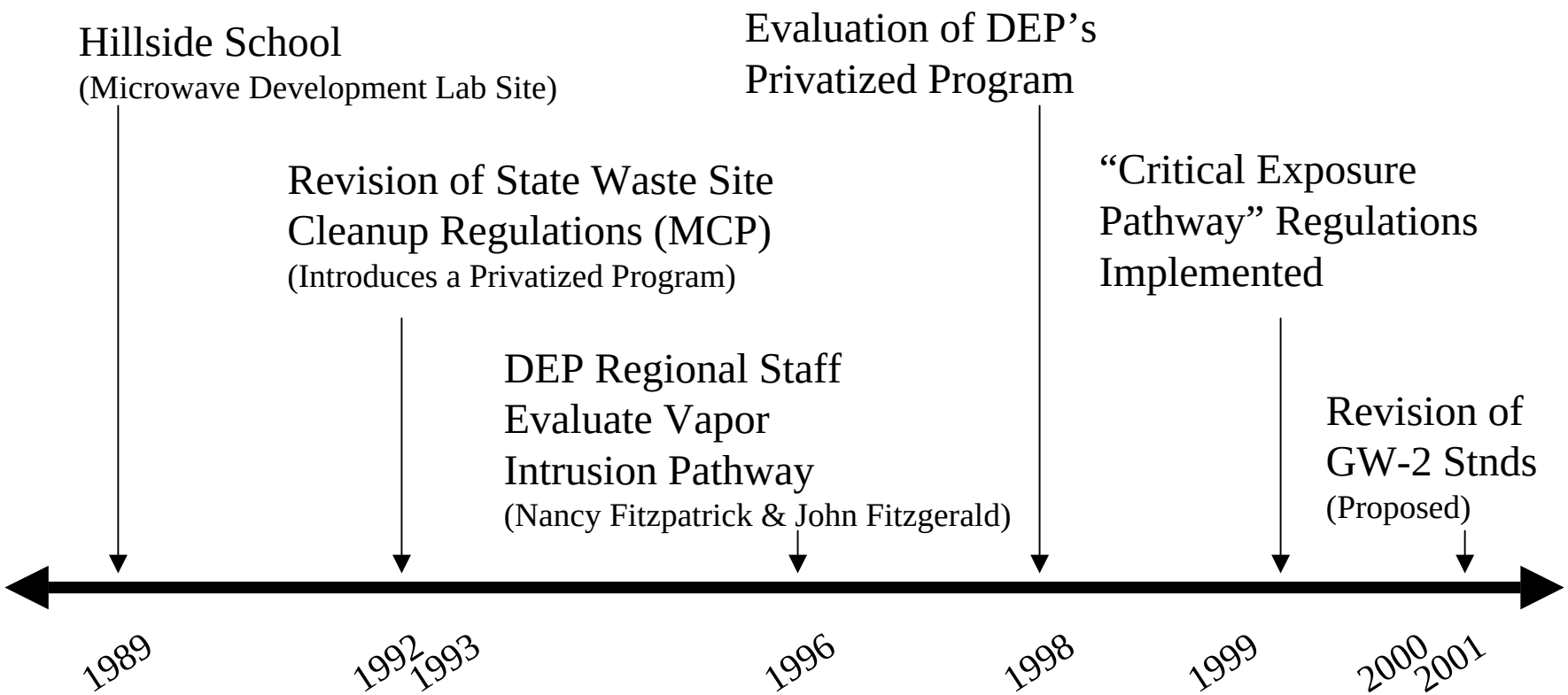
Timeline for MADEP Concerns with the Groundwater/Indoor Air Pathway



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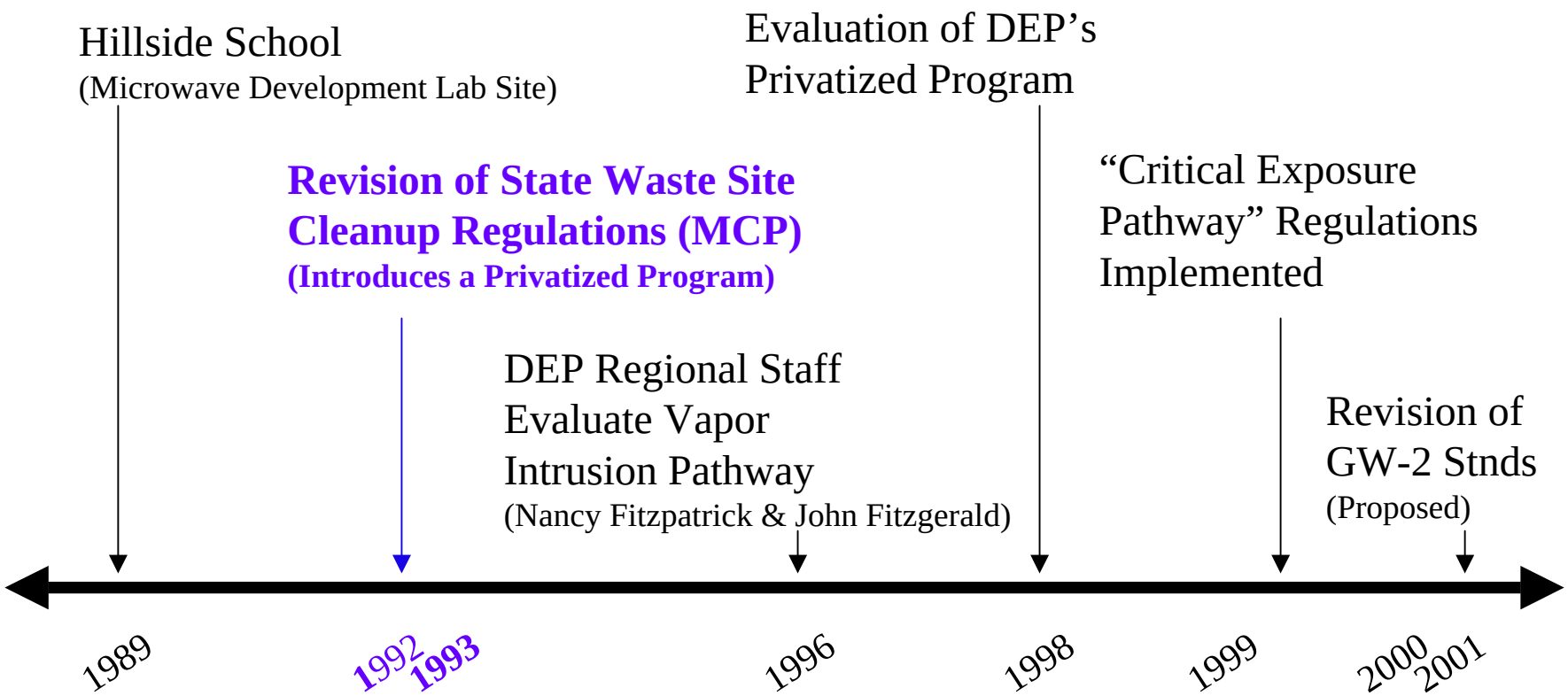


Key Features of the Massachusetts Contingency Plan

- Privatized process: Licensed Site Professional (LSP) oversees work
- Remediation to level of “No Significant Risk” or “Background” (where feasible)
- Audit program reviews *X* % of work

Risk Characterization in the Massachusetts Contingency Plan

(310 CMR 40.0900)

3 Options to Assess Risk:

- Generic Soil and Groundwater Standards (Method 1), 3 categories each

  Risk Limits: Chemical Specific Risk Levels of 1×10^{-6} (cancer), Hazard Index = 0.2

- Modification of Method 1 Standards (Method 2)

- Site-specific Risk Assessment (Method 3)

  Risk Limits: Cumulative Cancer Risk = 1×10^{-5}, Cumulative Noncancer Risk = HI = 1

Groundwater Standards

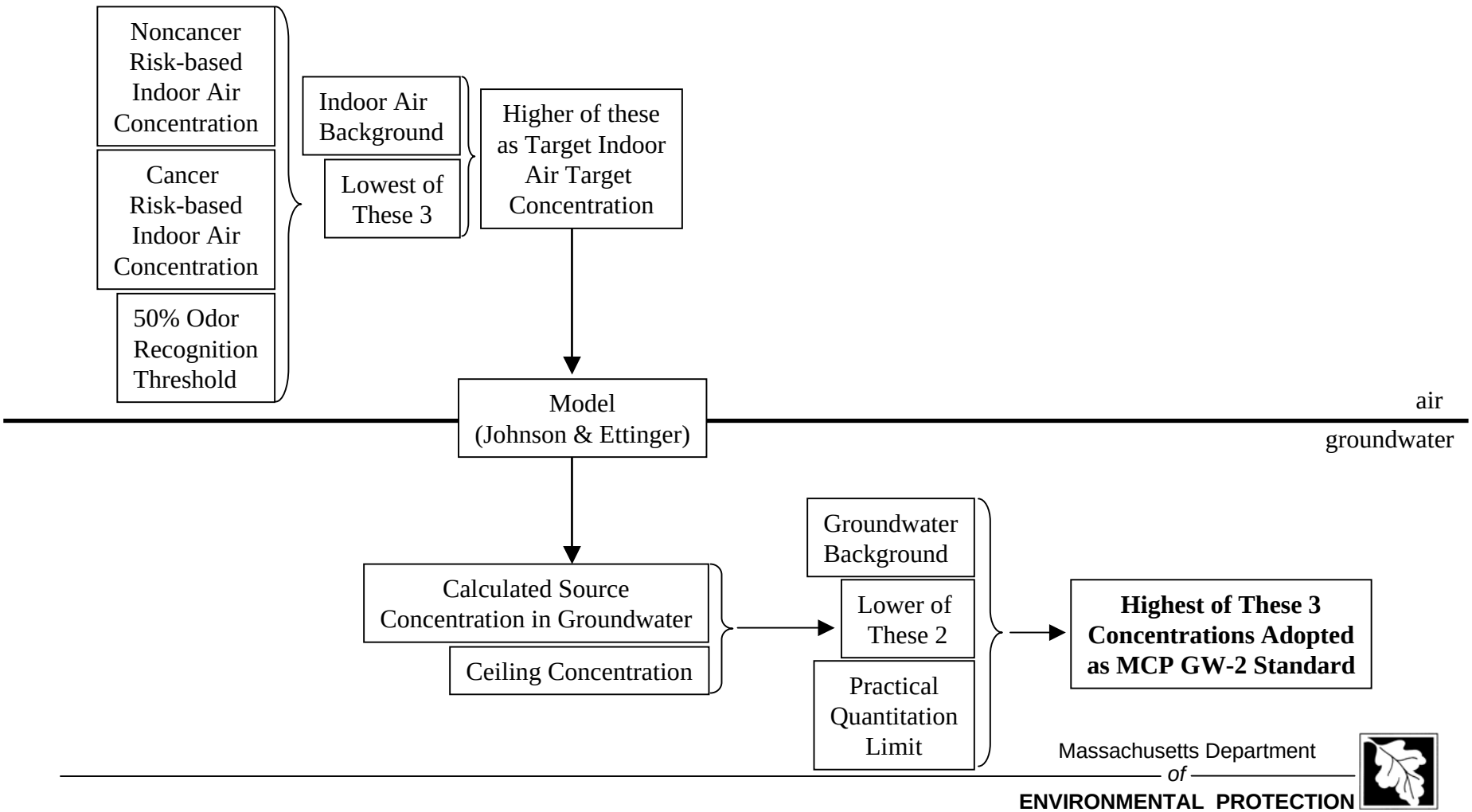
- GW-1: current or future drinking water source

- GW-2: source of indoor air contamination

  "Groundwater shall be defined to be in category GW-2 if it is located **within 30 feet of an existing occupied building or structure**, and the average annual depth to groundwater in that area is **15 feet or less**. Category GW-2 groundwater is considered to be a potential source of vapors of oil and/or hazardous material to indoor air." (310 CMR 40.0932(6))

- GW-3: source of surface water contamination

GW-2: Groundwater -> Indoor Air



GW-2 Derivation

- Noncancer risk-based concentration:

$$[OHM]_{air} = 0.2 \times RfC$$

- Cancer risk-bsaed concentration:

$$[OHM]_{air} = 10^{-6}/UR_{air}$$

- Attenuation Factor, $\alpha = 5 \times 10^{-4}$, applied to all chemicals with an additional adjustment factor, d, applied by DEP:

$$[OHM]_{gw} = [OHM]_{air} / (\alpha \times d \times H \times C)$$

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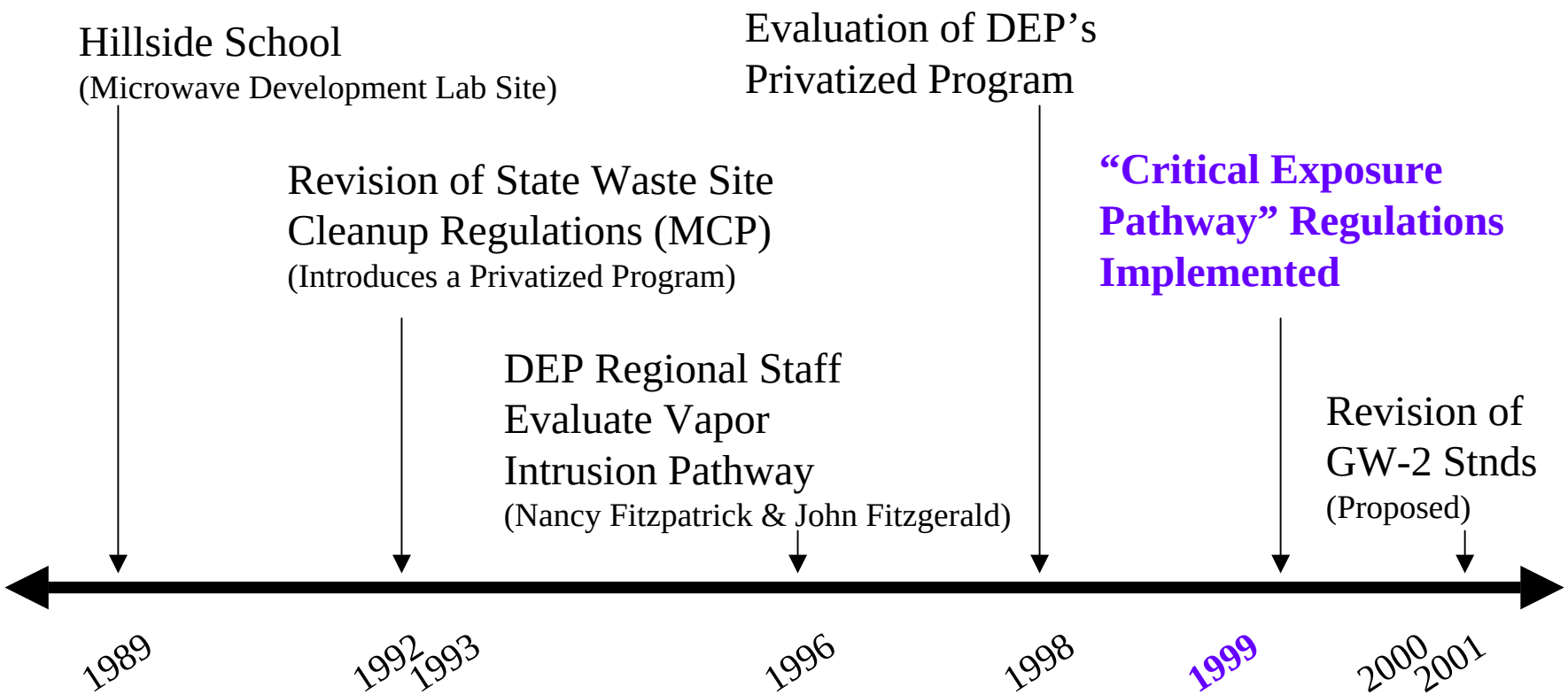

1998 Evaluation of MCP

Program is generally working, but there are areas to be addressed

Among conclusions:

- GW-2 Standards may not be sufficiently protective in some cases
- Focus on current buildings may not be sufficiently protective
- Uncertainty/variability in pathway calls for alternative approach
- Soil -> Indoor Air pathway often overlooked

DEP Introduces
Critical Exposure Pathways
(310 CMR 40.0006 & 40.0414)

…[R]outes by which OHM(s)…are transported, or likely to be transported, to human receptors via:

(a) vapor-phase emissions…in the living or working space of a pre-school, daycare, school or occupied residential dwelling; or

(b) ingestion, dermal absorption or inhalation …from drinking water supply wells located at and servicing a pre-school, daycare, school or occupied residential dwelling.

Concept (simplified):

- "Substantial Release Migration" (impacts to indoor air/water supply within 1 year) requires notification to DEP

- "Immediate Response Action" (IRA) is implemented to contain/remove OHM

- All *IRA*'s must eliminate, mitigate or prevent *Critical Exposure Pathways*, where feasible…regardless of risk posed.

FY2001 Revisions to Standards

- All Numerical Standards, not just GW-2, under revision
- GW-2 evaluation to include chemical-specific modeling of vapor intrusion using USEPA Johnson & Ettinger model spreadsheets.
- Regulations also to include trigger levels of VOCs in soil to address applicability of Method 1 soil standards.

GW-2: Driving Force for Remediation?

- Current Standards
  - GW-2 is lowest standard (of GW-1, GW-2 and GW-3) for 5 of 112 chemicals
  - In non-drinking water areas, GW-2 is the lower (of GW-2 and GW-3) standard for 32 of 112 chemicals
- FY 2001 Revisions
  - GW-2 may be lowest standard (of GW-1, GW-2 and GW-3) for 20 of 116 chemicals
  - In non-drinking water areas, GW-2 may be the lower (of GW-2 & GW-3) standard for 57 of 116 chemicals

What we've learned…

- Majority of documented vapor intrusion cases related to "classic" chlorinated VOC plumes
- Vapor intrusion associated with non-chlorinated VOCs primarily observed at sites with NAPL and/or vapor migration along preferential pathways (i.e.,utility lines, faulty plumbing)

Site Characteristics

- Shallow water tables
- Significant [VOCs] in groundwater and/or soil gas
- Permeable soil
- Proximity to source
- Presence of non-permeable surfaces between source and receptor

Fresh Water Lens Phenomenon

- Large, unpaved areas between source & receptor (ofetn at base of slope) that allow infiltration of precipitation
- Creates lens of “clean” water in upper portion of water table
- Increases distance for liquid-phase diffusion & limits transport to air phase

Building Characteristics

- Basements
- Earthen Floors
- Fieldstone foundations, multiple cracks, sumps
- Negative pressure “stack effects” induced by heating systems; “worst case” winter months

Stoughton, MA

- Residential homes with basements
- Very shallow water table
- 580 ug/l 1,1,1-TCA measured in sump water (GW-2 Standard 4,000 ug/l)
- Imminent Hazard levels of chlorinated VOCs measured in indoor air
- Various venting systems installed

Burlington, MA

- Residential homes with basements
- Relatively shallow water table
- Gasoline plume > GW-2 Standards
- Significant [BTEX] measured in soil gas adjacent to sewer lines connecting to homes
- Gasoline odors in home, faulty plumbing

North Adams, MA

- Residential homes, most with earthen floors and/or fieldstone foundations
- SRM investigation of TCE plume emanating from old landfill
- Water table 7-13 feet bsg, coarse sand
- Synoptic gw, soil gas, indoor air data collected prior to venting systems

TCE Data - North Adams, MA

- June 1997
  - 350 ug/l in groundwater
  - 11,000 ug/m3 in soil gas (HC = 0.004)
- Home #6 (dirt floor, wet)
  - 330 ug/m3 in indoor air (AC = 3E-2)
- Home #7 (cement floor & walls, sump)
  - 13.44 ug/m3 in indoor air (AC = 1.2E-3)

GW to SG Partitioning Data

- 2,000 - 2,300 ug/l TCE in groundwater
- 52,000 - 170,000 ug/m3 in soil gas
  - Hc partitioning range 0.026 - 0.074
- 120 ug/l TCE in groundwater
- 53,000 ug/m3 in soil gas
  - Hc partitioning = 0.44

Indoor Air/Soil Gas ACs

- Home #5 (dirt floor, water)
  - 8,800 ug/m3 in soil gas (Dec 1996)
  - 140 ug/m3 in indoor air (Jan 1997)
  - AC = 1.6E-2
- Home #16 (concrete floor?)
  - 15,000 ug/m3 in soil gas (Oct 1997)
  - 6 ug/m3 in indoor air (Nov 1997)
  - AC = 4E-4