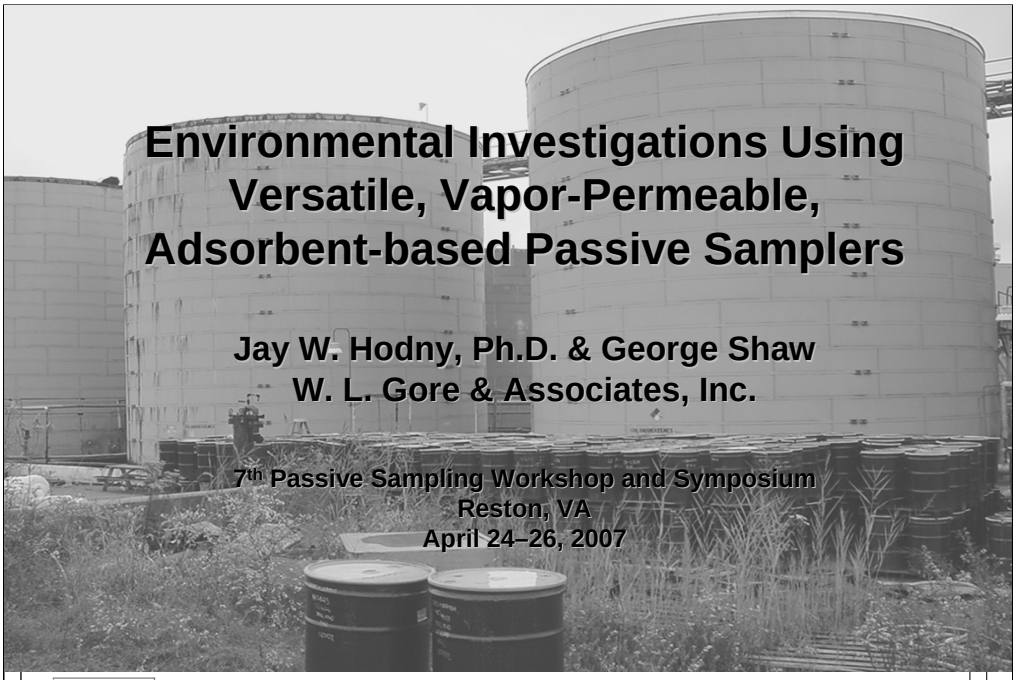

# Environmental Investigations Using Versatile, Vapor-Permeable, Adsorbent-based Passive Samplers

**Jay W. Hodny, Ph.D. & George Shaw**
**W. L. Gore & Associates, Inc.**

**7th Passive Sampling Workshop and Symposium**
**Reston, VA**
**April 24–26, 2007**



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## Outline

- Introduction
- Environmental investigations
  - Passive sampling – soil gas, subslab soil gas, air
  - Common applications
  - Benefits
- GORE™ Module
  - What it is and how it works
- Example
- New advances
  - Concentration reporting – air, water
- Examples

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## Do you prefer an informative picture before an operation?

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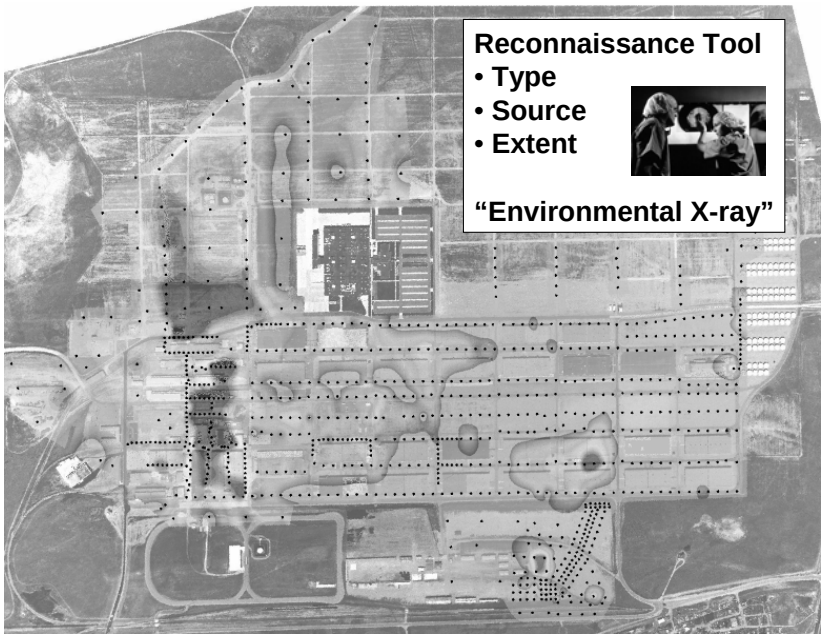
## Do you prefer an informative picture <u>before</u> remediating?



**Reconnaissance Tool**
- **Type**
- **Source**
- **Extent**



**"Environmental X-ray"**

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## Common Applications – Passive Sampling

- Site assessment (Conceptual Site Models)
- Vapor intrusion
- Remedial optimization
- Property transfer - Brownfields
- Monitoring
  - Long-term GW
  - Remediation
- Pipeline integrity

*** - partial list**

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## Benefits – Passive Sampling

- Rapid, inexpensive, unobtrusive installation & retrieval
  - Minimal operator & field sampling error
- Time-integrated sampling
  - ppt sensitivity
  - Sensitivity to broad range of compounds VOCs, SVOCs, PAHs
  - Minimizes sampling variability
- Virtually any soil and moisture condition
- No forced extraction of vapor
- No mechanical parts
- No energy required

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Limitations

Mercury and vapor concentration, no longer a limitation.

## Comparison

- **Active** soil gas and subslab soil gas
  - – Forced withdrawal of vapor
  - – Complex setup
    - Potential for error

Courtesy of ZEBRA Environmental Corporation

- **Passive** soil gas and subslab soil gas
  - – No forced withdrawal of vapor
  - – Simple setup
    - Minimal error

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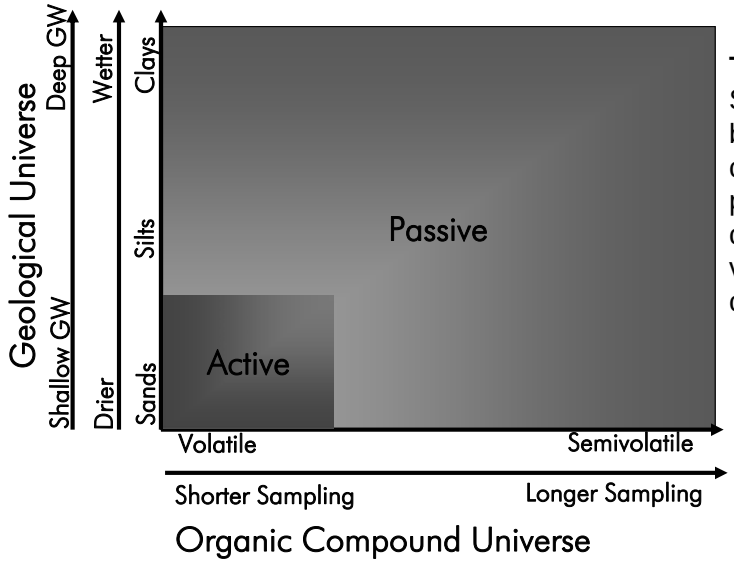
Limitations

Mercury and vapor concentration,  no longer a limitation.

## Why Passive Sampling?




**Time-integrated:** Sensitive to a broader range of compounds, present in lower concentrations, in virtually any soil condition.

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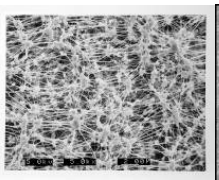
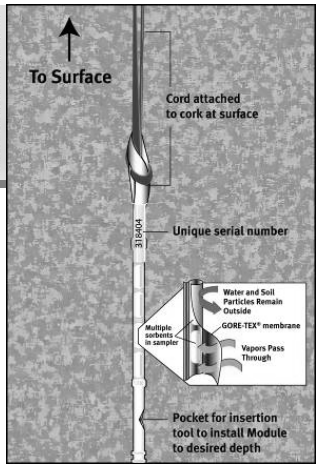
# GORE™ Modules

## GORE-TEX® Membrane






1) **GORE-TEX® Membrane**
   - Chemically-inert, waterproof, vapor permeable
2) **Engineered sorbents**
   - Hydrophobic
   - VOCs, SVOCs, PAHs
3) **Sample analysis**
   - EPA 8260/8270 or TO-15
   - Duplicate samples

- **Direct detection of organic compounds**
- **Sample integrity protected**

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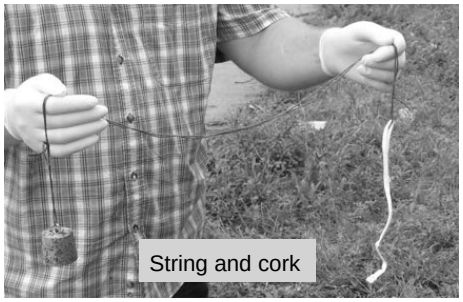
# GORE™ Module



**Subsurface Installation**

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# Installation - Soil Gas, Subslab Soil Gas and Air

## Soil Gas

Slam bar

Hammer drill

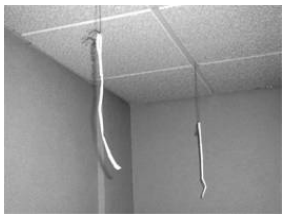
Module insertion

## Subslab Soil Gas

Angle beneath slab

## Air

Crawlspace air



Indoor air

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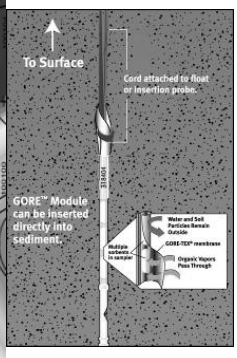
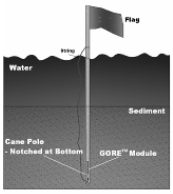
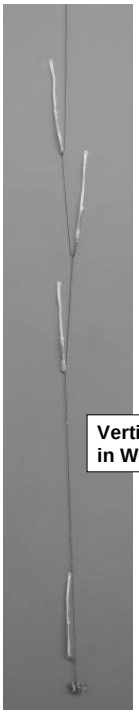
# Installation – Sediment and Groundwater

## Sediment





## Groundwater



**Vertical Profiling in Wells**

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## Remedial Optimization Example

### Manufacturing Facility

**Objective: optimize recovery well placement**

- Chlorinated compounds in groundwater
- 30ft weathered, “tight” clay ($10^{-8}$), fractured bedrock
- Groundwater ~30ft depth
- Geophysical survey lacked resolution
- Active soil gas survey failed
- PETREX survey performed poorly
- 77 GORE™ Modules, 30 x 4ft sample spacing

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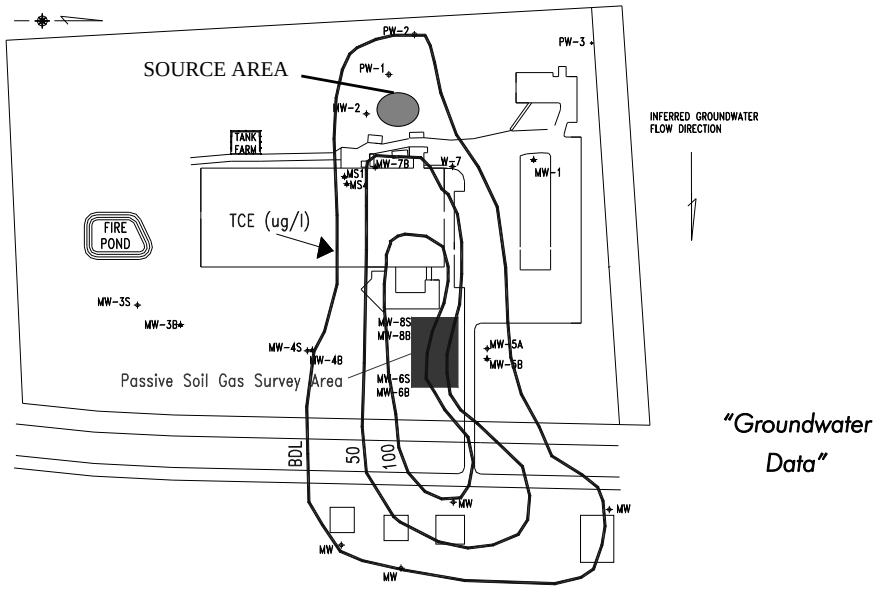
# Remedial Optimization Example




"Groundwater Data"

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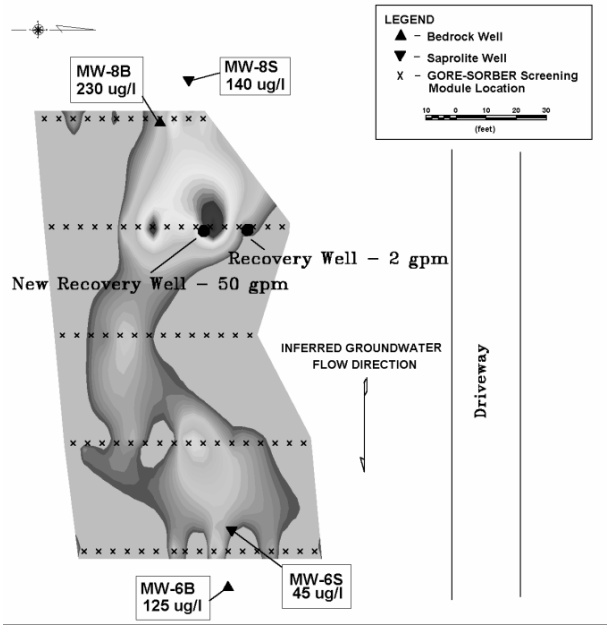
# Remedial Optimization Example




*"Soil Gas Data & New Recovery Well"*

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## Remedial Optimization Example

### Conclusions

- Sample spacing delineated suspect fracture
- TCE in groundwater detected in soil gas
  - Challenging site geology
- Recovery well location optimized
- 25x increase in fluid removal
- 75% increase in TCE removal

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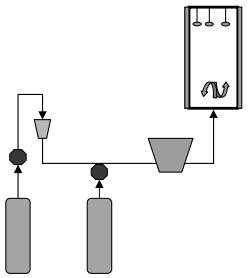
# Calculating Concentrations



- **Quantify (measure) uptake rate**
  - Experimental conditions
  - Varying concentrations, conditions
  - Air, water
- **Exposure period**
- **Quantify (measure) mass desorbed**
- **Soil gas**
  - Eff. Diff.=*ƒ*[total porosity, water-filled porosity]*
    - Johnson-Ettinger VI model terms
    - Millington-Quirk
- **Conc = *ƒ*[volume=*ƒ*(uptake rate, time), mass, soil*]**
- **Approach** – IH methods-solid, sorbent-based diffusion samplers
    - ASTM 6306 (1998); 6246 (1998); 4597 (1987)
    - MDHS 70 (1990); 80 (1995); 27 (1983)

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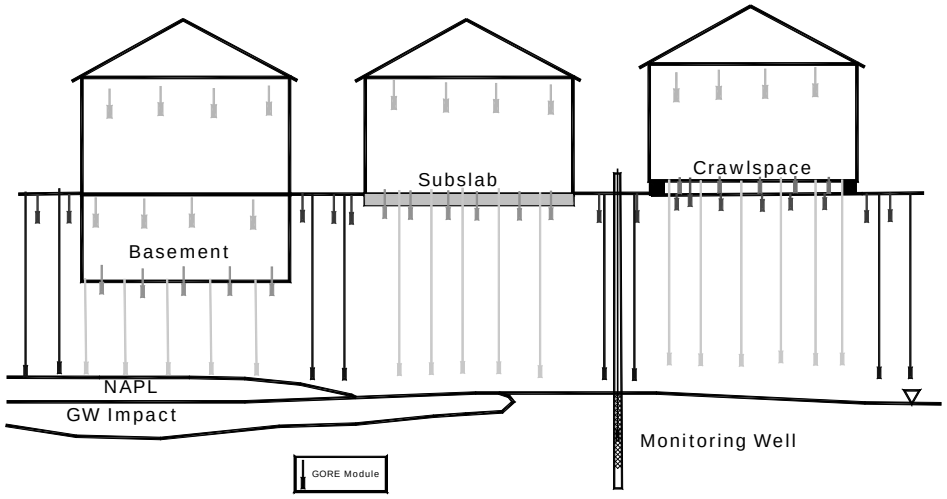
# Vapor Intrusion Investigation

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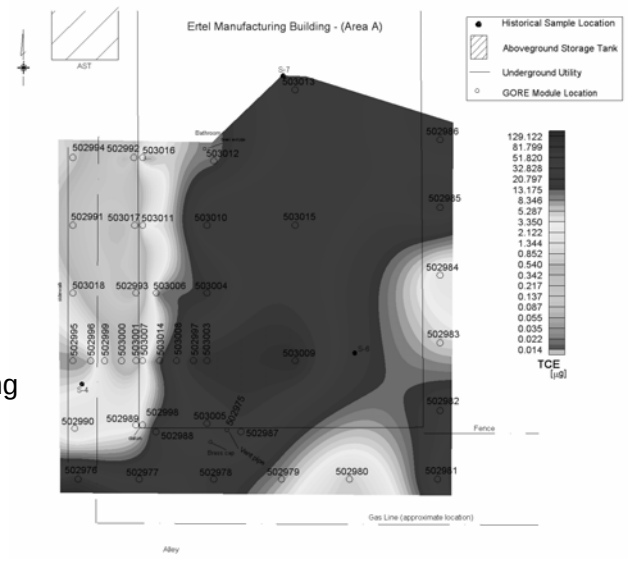
## Vapor Intrusion Concentration Example

Indianapolis site

- US EPA - IDEM
- Objective:
  - "First look"
    - July
    - VOCs, SVOCs, PAHs
  - Guide next sampling
    - July, August
    - "sampling boot camp"

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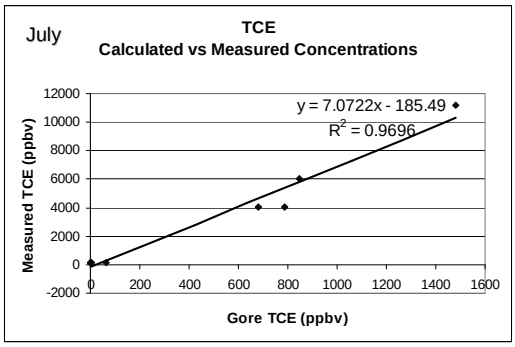
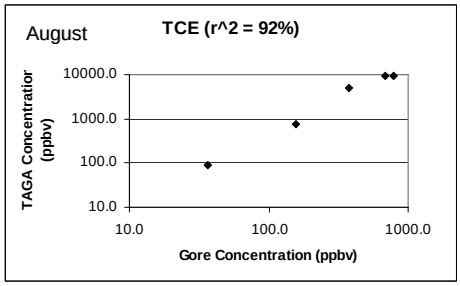
# Vapor Intrusion Concentration Example




- 3 ft sample depth
- Excellent correlation

**Courtesy of Todd McAlary, GeoSyntec Consultants**

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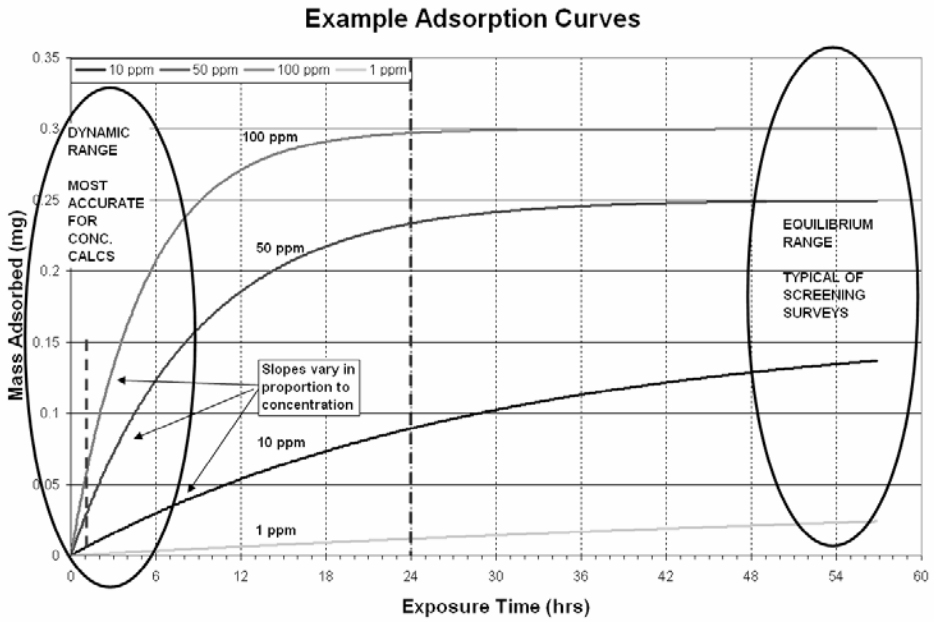
# Vapor Intrusion Concentration Example

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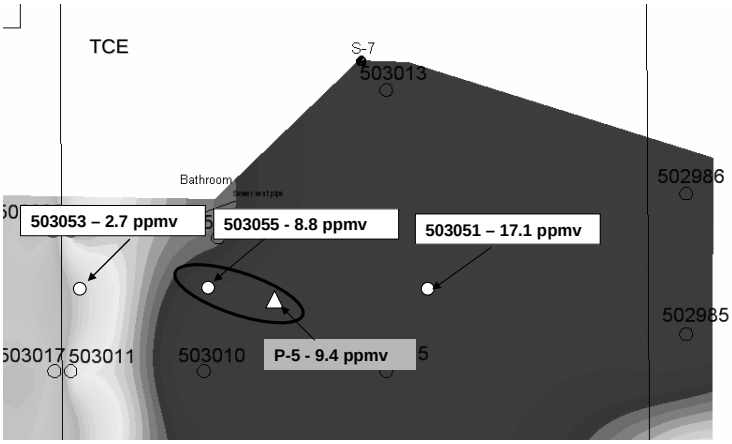
## Vapor Intrusion Concentration Example

- 3 ft sample depth
- One hour exposure
- Correlates spatially
- Matches P5

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## Groundwater Sampling Example

Dry cleaner site – southeast US

- Chlorinated solvents in groundwater
- Shallow water table ~ 8ft.
- Up to four GORE™ Modules per four wells
  - Vertical profile
  - One hour exposure
- Slow purge (peristaltic pump); disposable bailer

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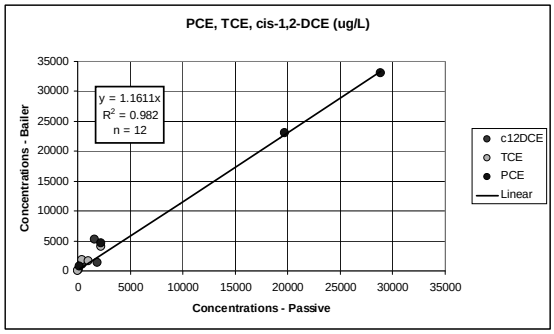
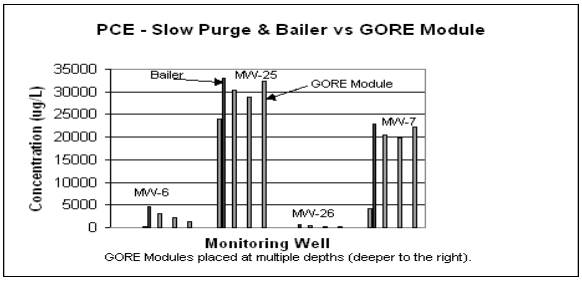
# Groundwater Sampling Example

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## Conclusions

GORE™ Module - versatile, membrane-based passive sampler

- Effective in broad scope of environmental investigations
- Sample virtually any media
  - Air, soil gas, water
- Inexpensive installation, retrieval & operation
  - Minimizes sampling error
- **Concentration reporting**
  - Relatively new capability
  - Sound science
  - Favorable data comparisons

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# THANK YOU!

The authors acknowledge:

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**US EPA**

**IDEM**

**Todd McAlary, GeoSyntec Consultants**

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