



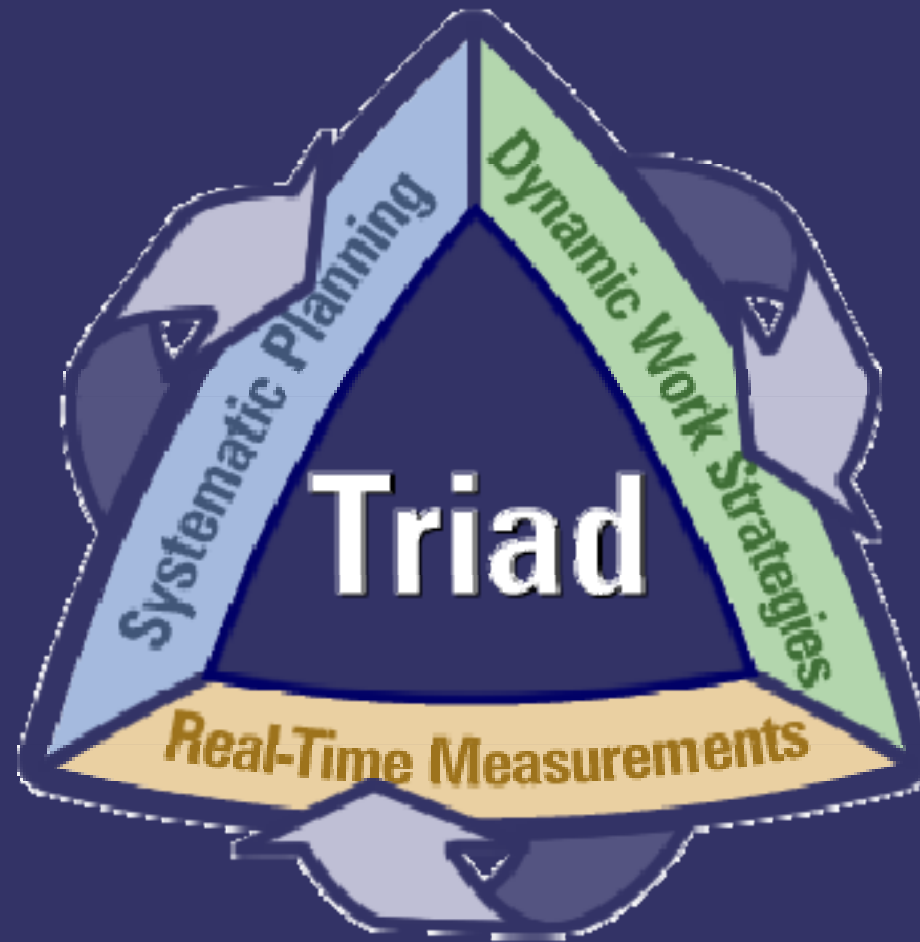
# The Application of Triad Field Methods to Characterize Chlorinated Solvents in Heterogeneous Unconsolidated Deposits

*Michael R. Ravella, R. Joseph Fiacco, Jr.,*

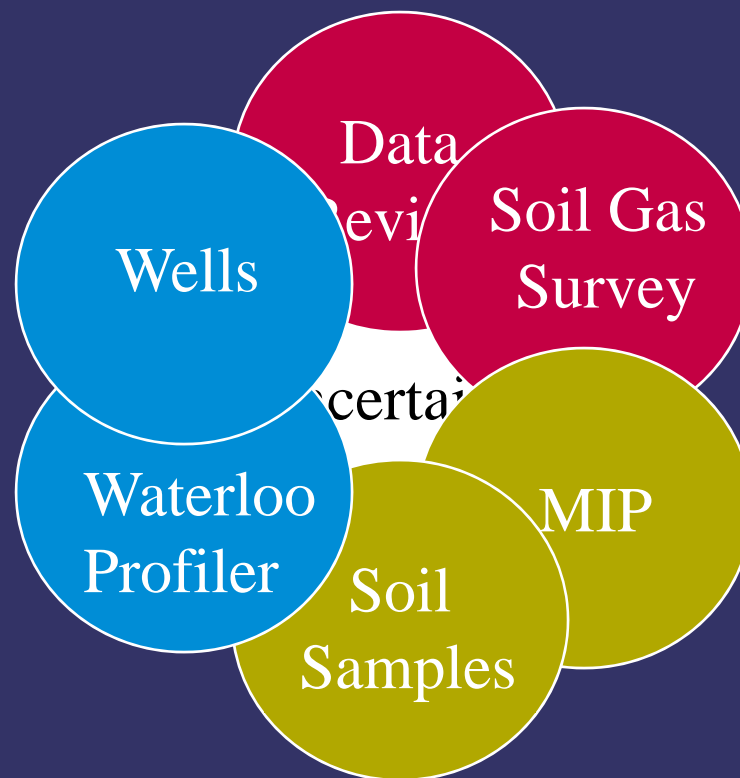
*Jeffrey D. Frazier, Jeremy J. Picard*

*(Environmental Resources Management, Boston, MA)*

# Triad Approach



# Managing Uncertainty



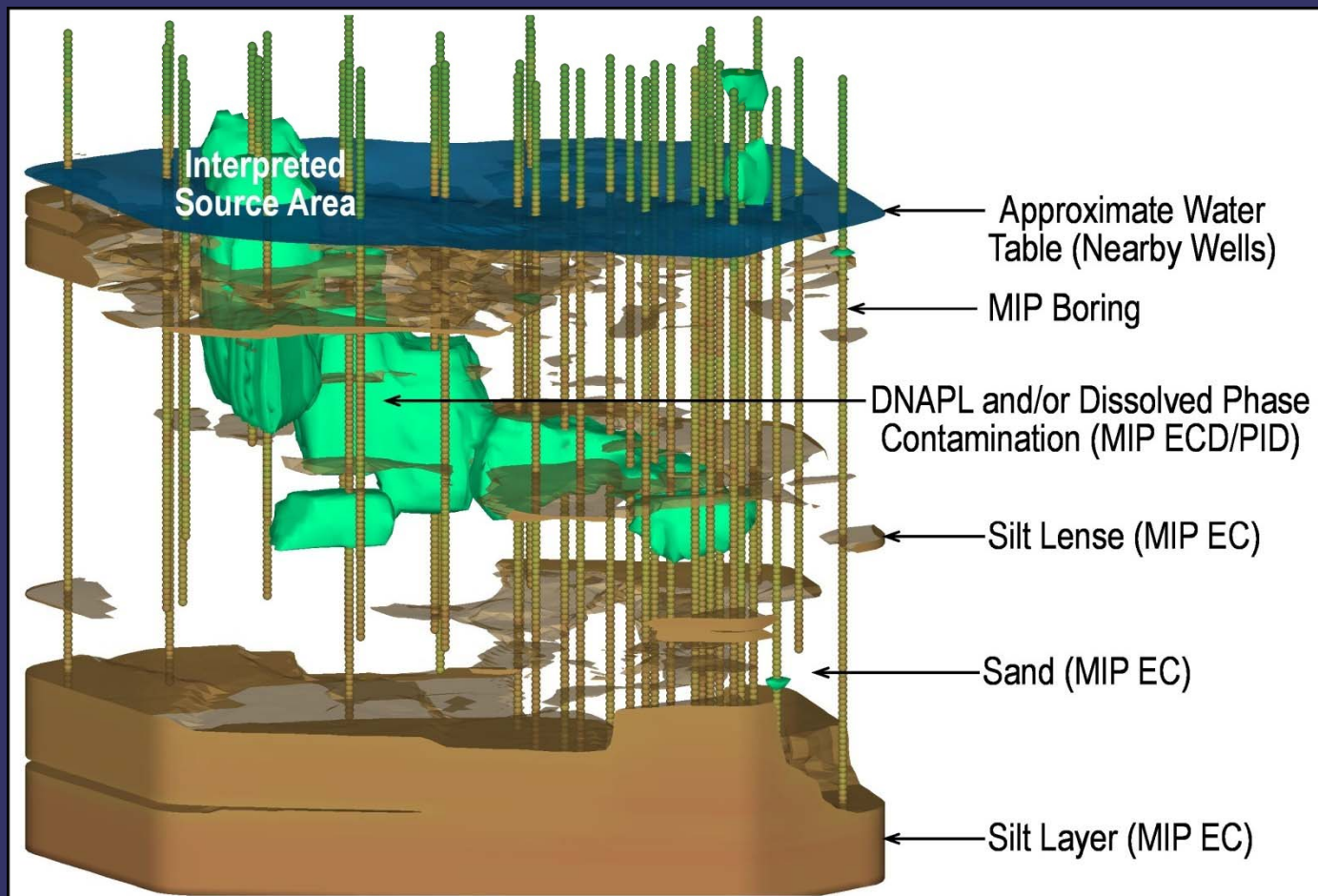
# DNAPL Distribution in Homogenous Sand



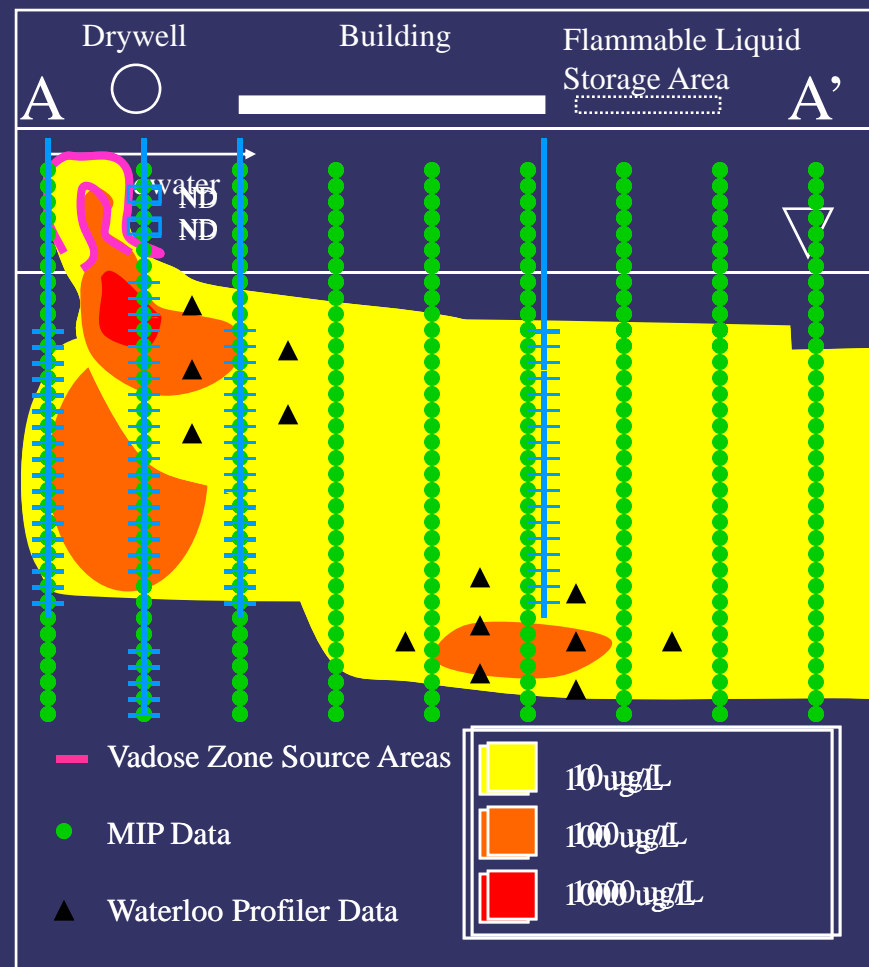
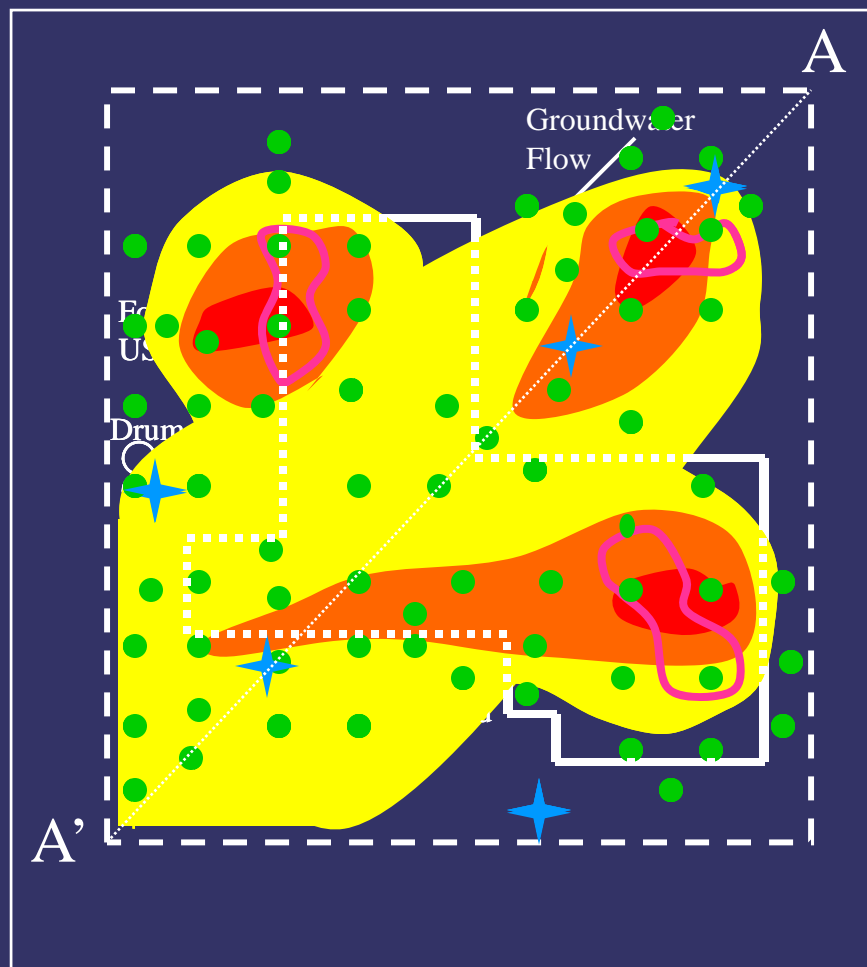
**Source: Poulsen & Kueper, 1992**

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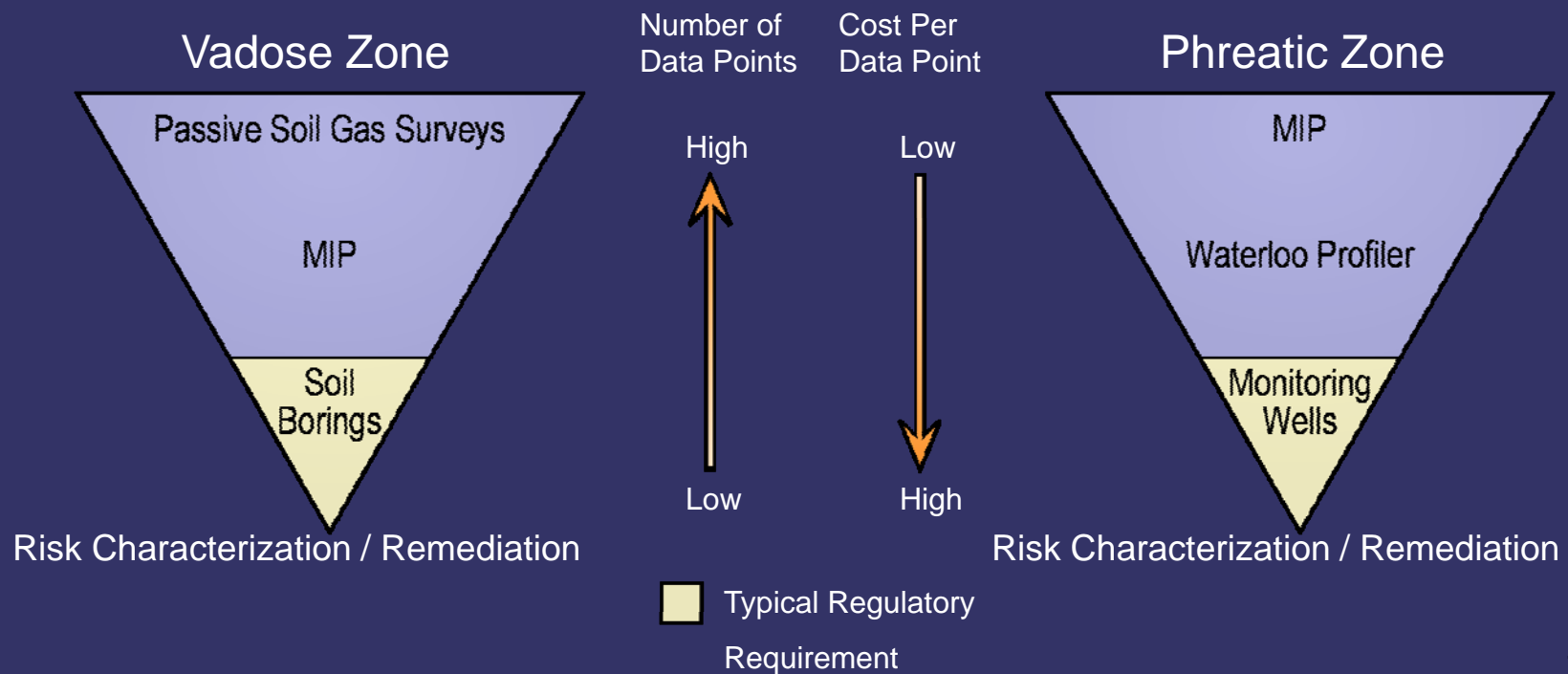
# Vertical Heterogeneity



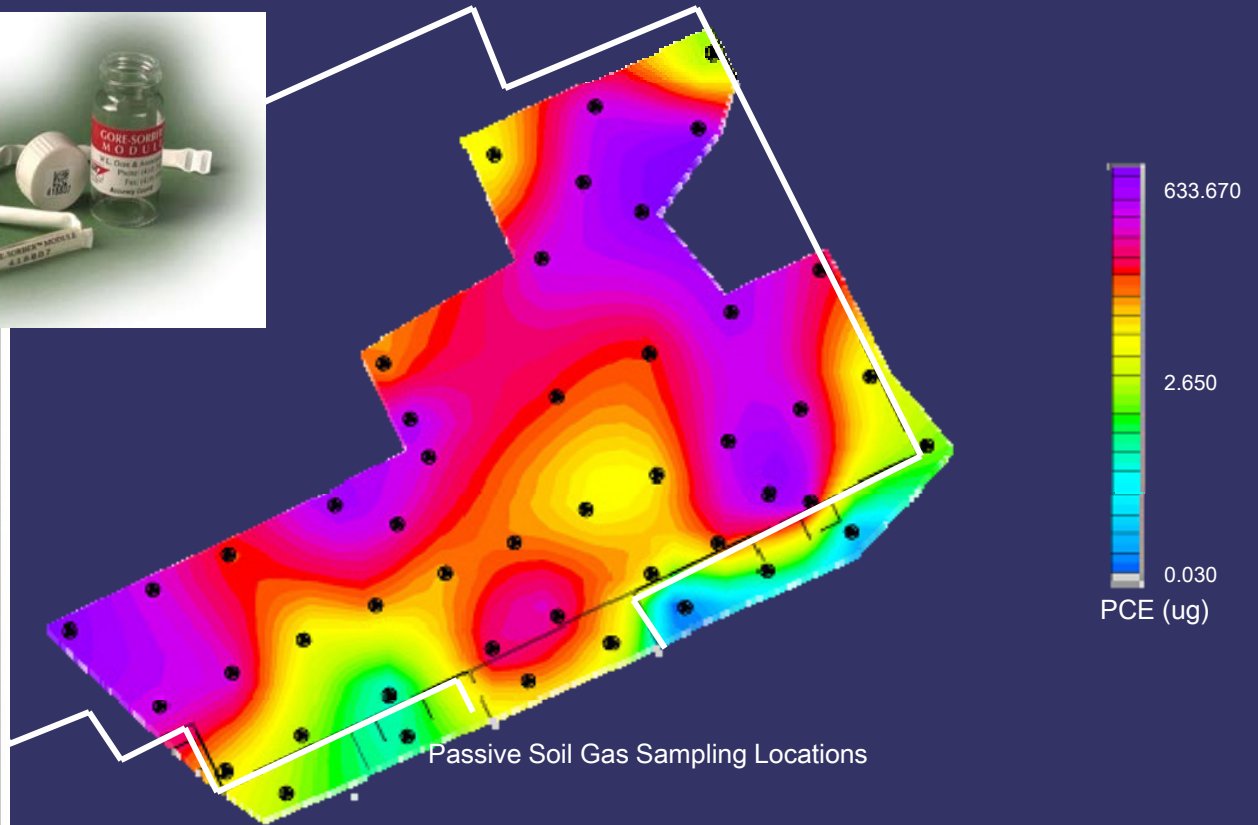
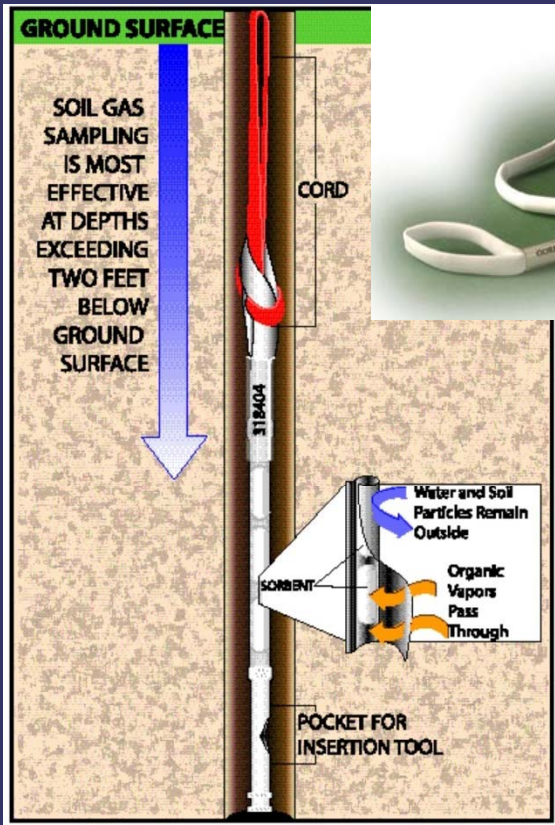
# Data Representativeness



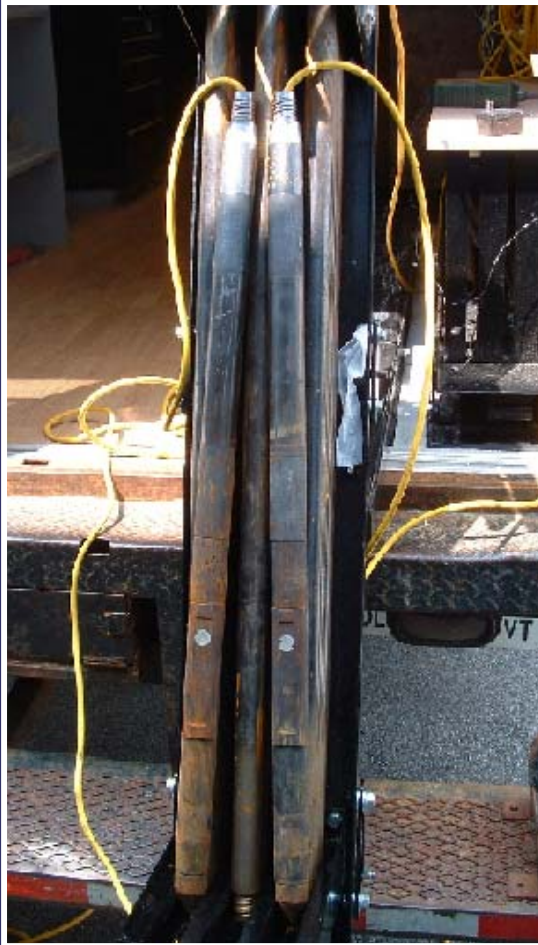
# Collaborative Data Sets



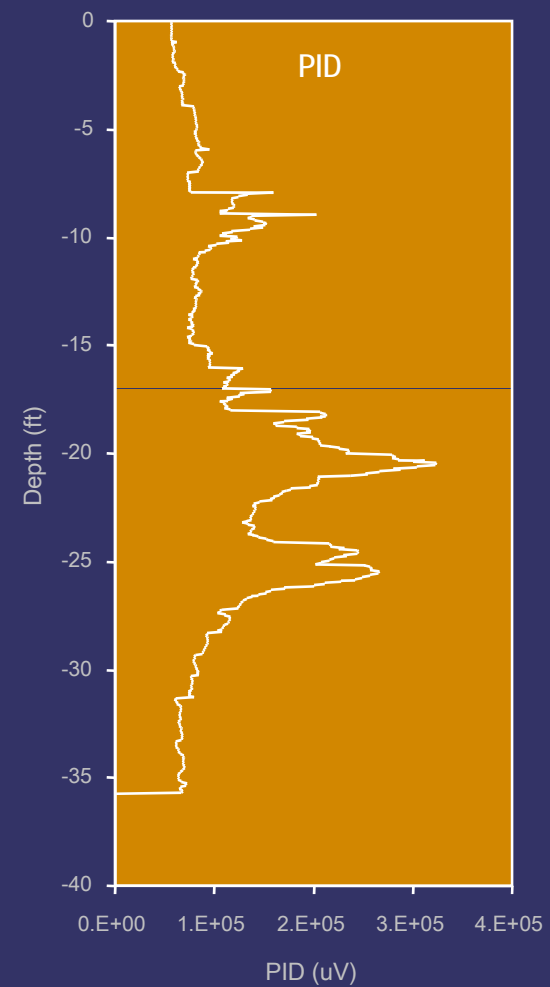
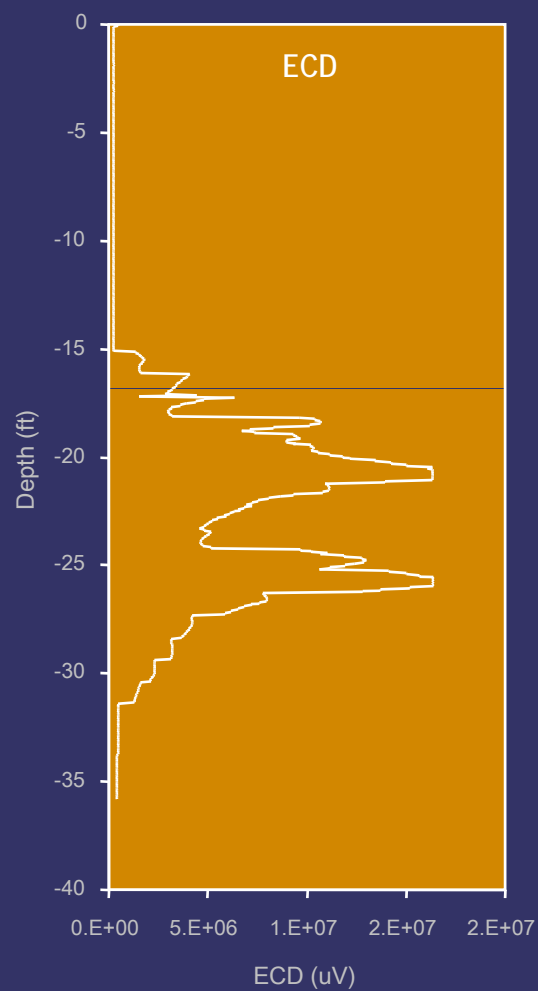
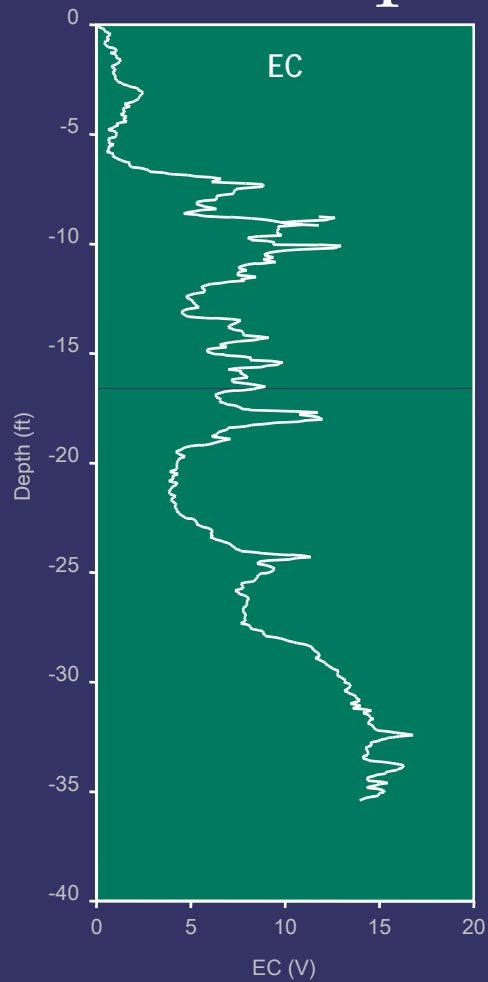
# Passive Soil Gas Surveys

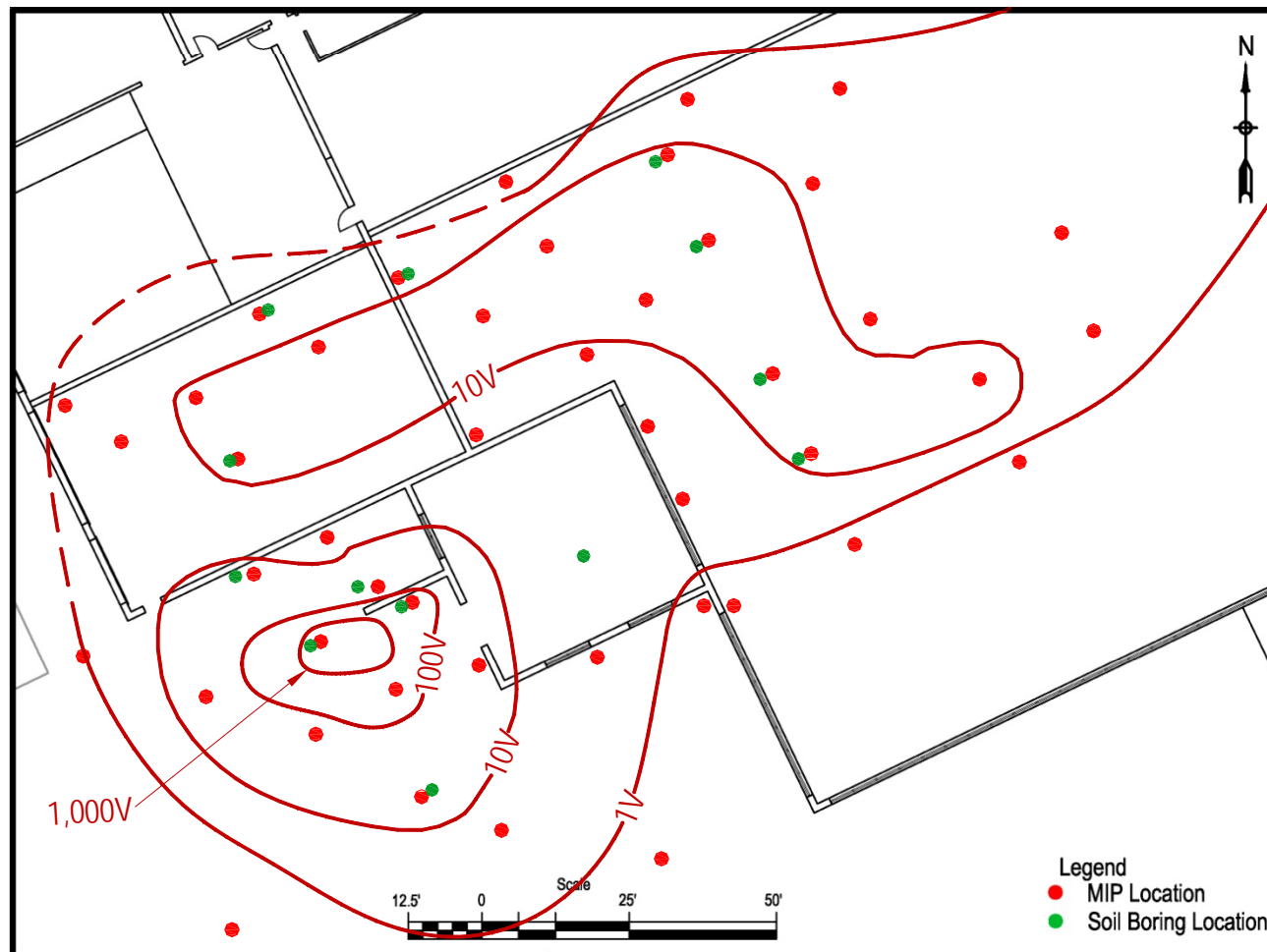


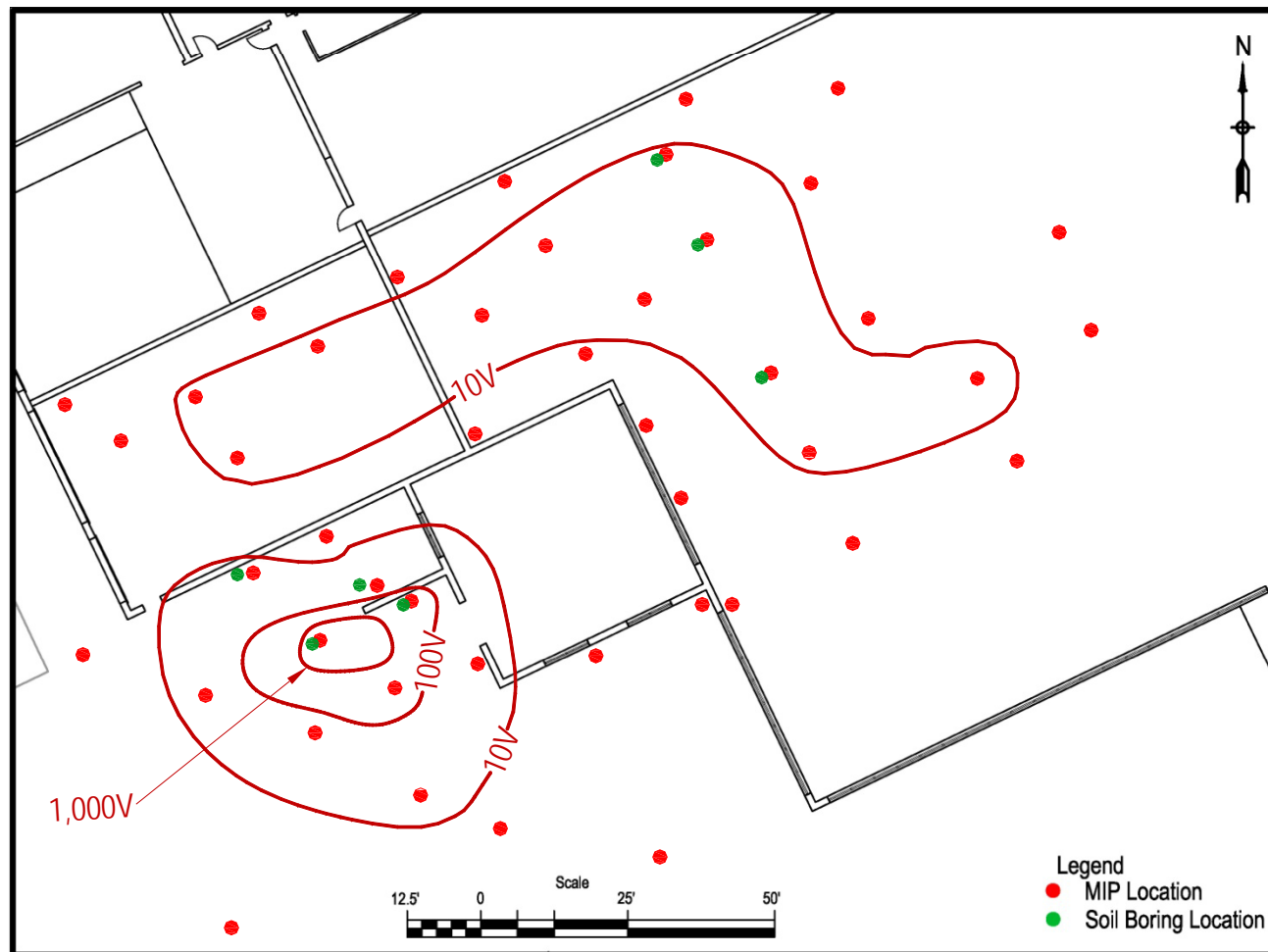
# Membrane Interface Probe (MIP) Hardware

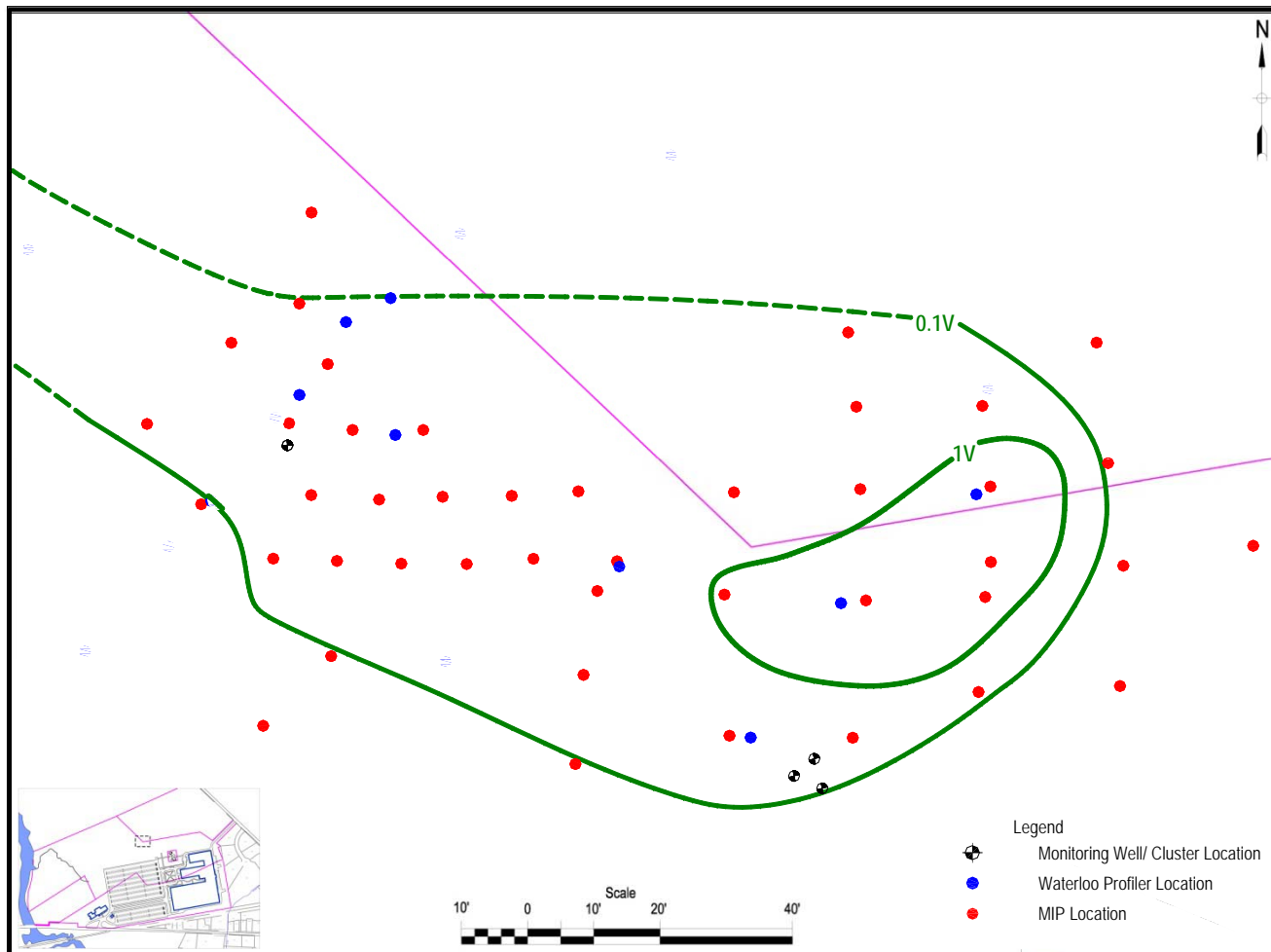


# MIP Output

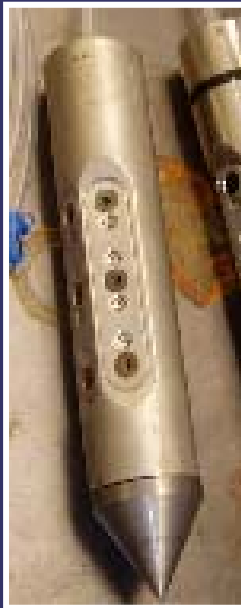




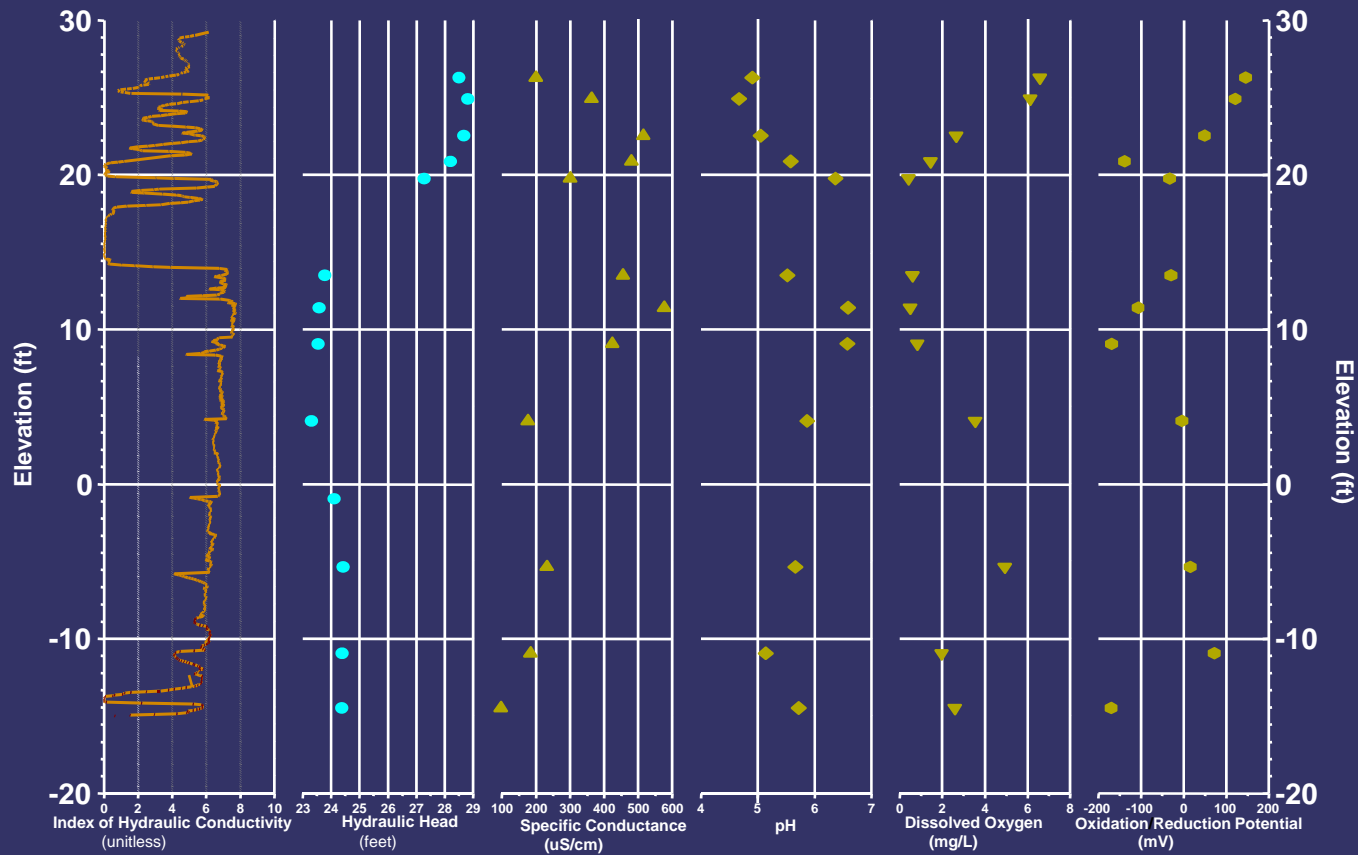




# Waterloo Profiler Hardware



# Waterloo Profiler Output



# MIP v. Waterloo Profiler

	MIP	Waterloo Profiler
Geology		
Hydraulic head		
Relative Hydraulic Conductivity (K)		
VOCs – Vadose Zone		
VOCs – Phreatic Zone		
VOCs – Low K Soil		
VOCs – High K Soil		
VOCs – Speciation		
VOCs – Concentration		

# Systematic Investigation Approaches

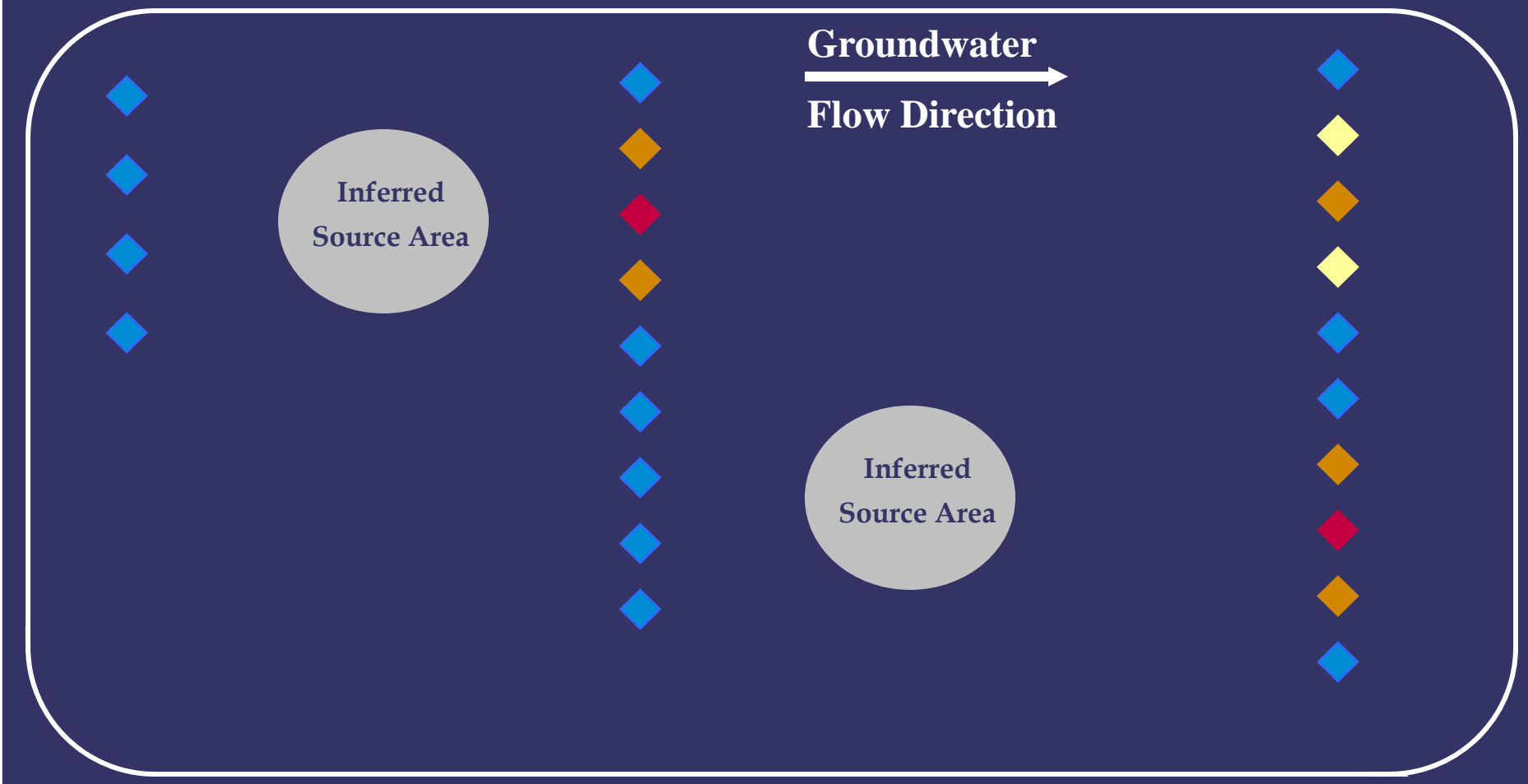
**Groundwater**  
→  
**Flow Direction**

Soil Gas  
Hot Spot

Soil Gas  
Hot Spot



# Systematic Investigation Approaches



# Summary

- **Common Themes**
  - Heterogeneity rules (even in “homogenous” geology)
  - Source area contaminant mass in low K zones
  - Plumes migrate in high K zones
- **Critical Components of Investigation**
  - Development of collaborative data sets
  - Use of real-time measurement technologies
  - Use of appropriate investigation scales