

Sampling Methods and Monitoring Data Variability

Influence on MNA Assessment

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Overview

- Natural attenuation methodology
- Monitoring data examples
- How to handle data variability
- Summary

Natural Attenuation

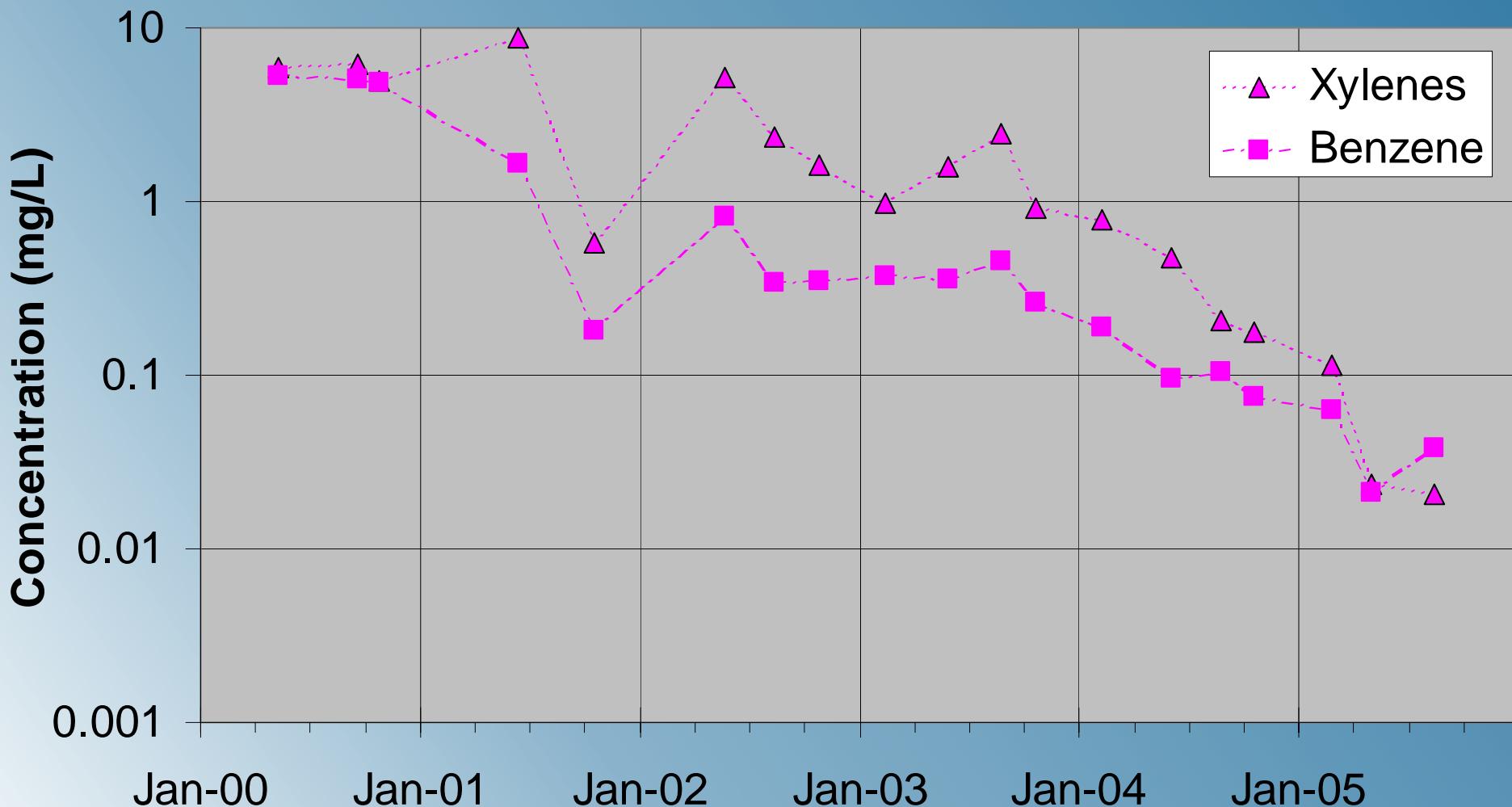
- MNA assessment:

You have your attenuation model,

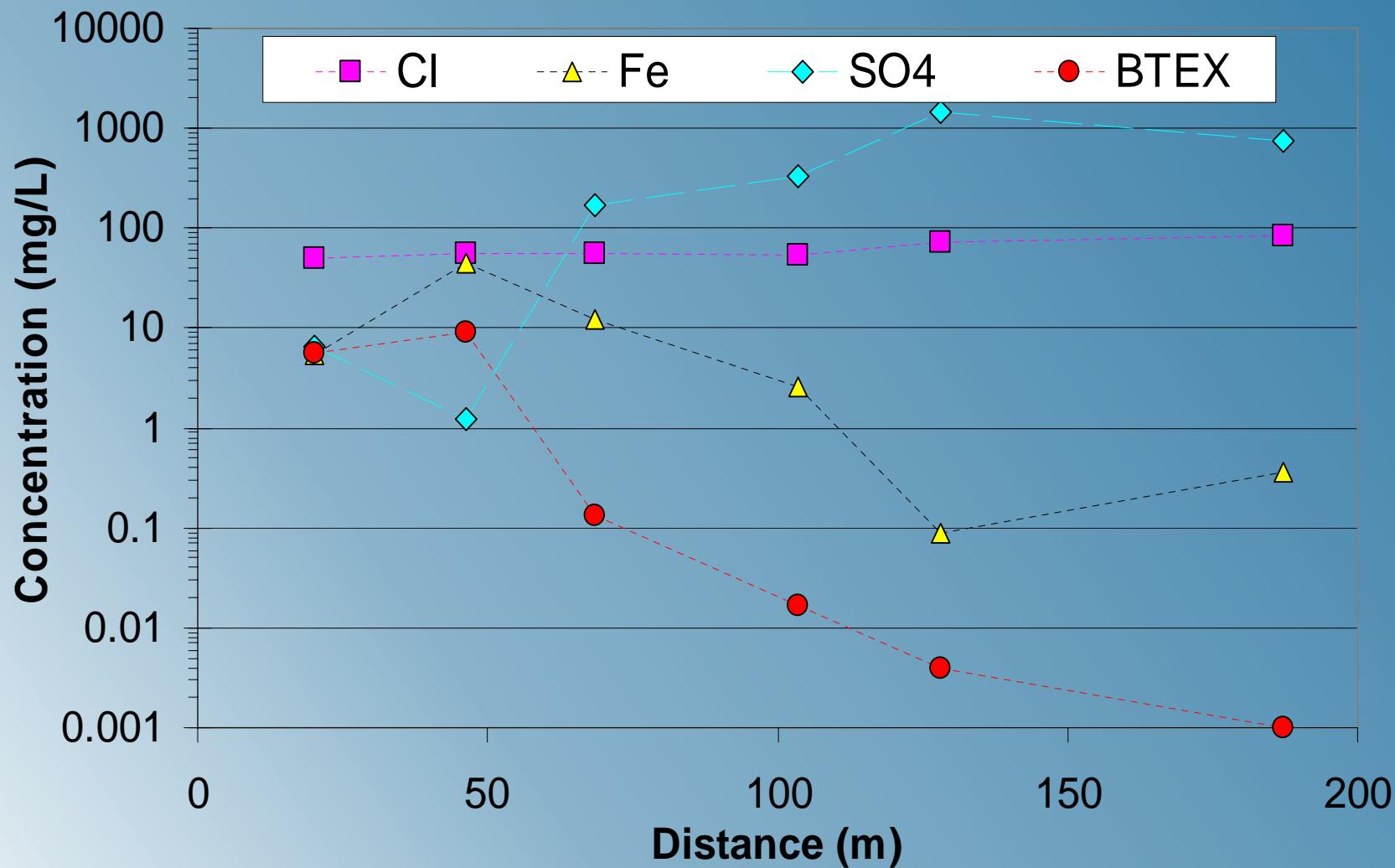
BUT ...

How to deal with monitoring data?

Contaminant Trend



Natural Attenuation Evidence



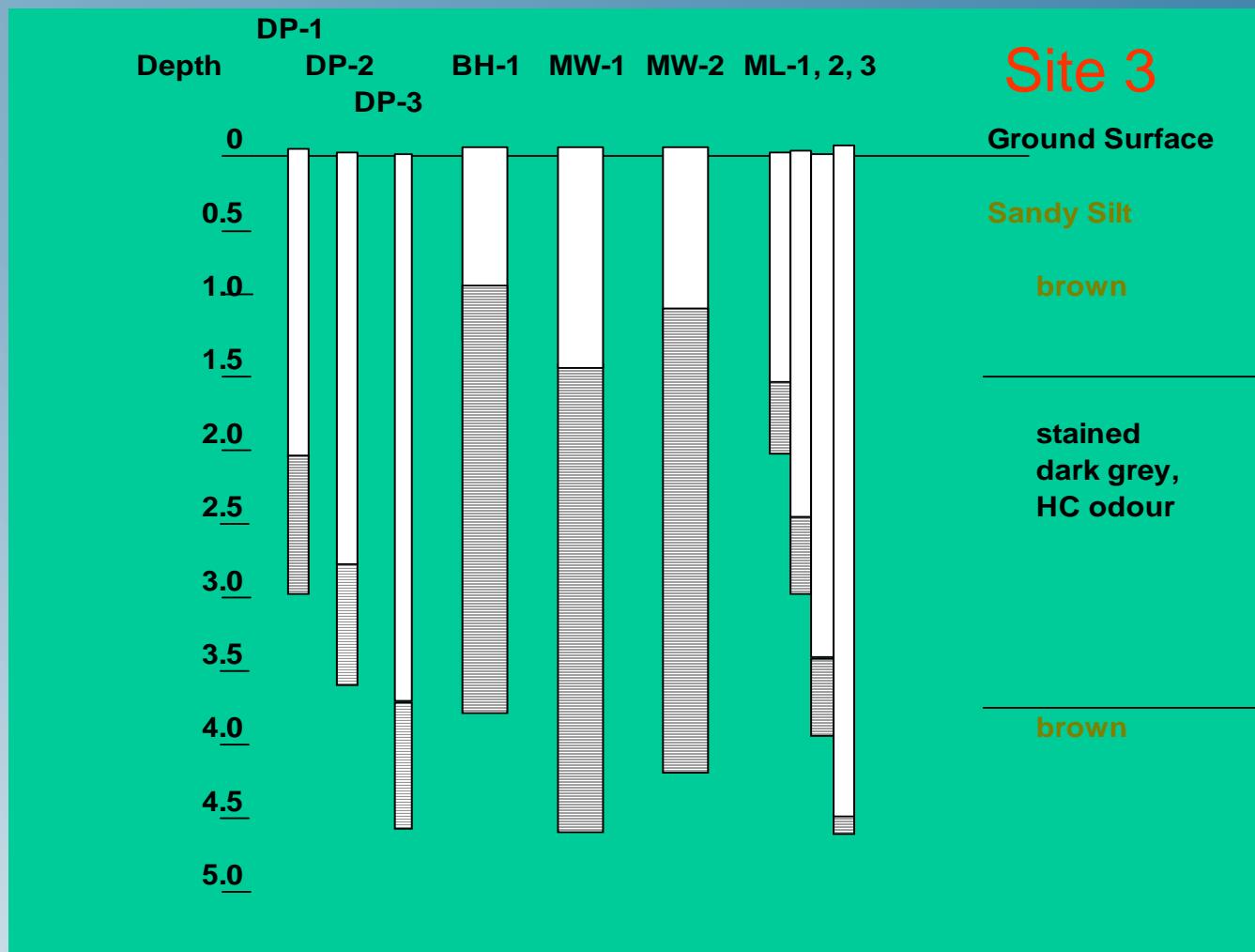
Everyone's Asking ...

- Will NA ever reach the endpoint?
- How long will it take?
- How much will it cost?
- How do I know it is/isn't working?

CORONA Site Examples

- Flare pit plume (partial source removal)
- Condensate leak (minimal source removal)
- Condensate spill (source removal)
 - Multiple monitoring methods
 - Research well nests:
 - 3 direct push, 3 conventional

Research Well Cluster







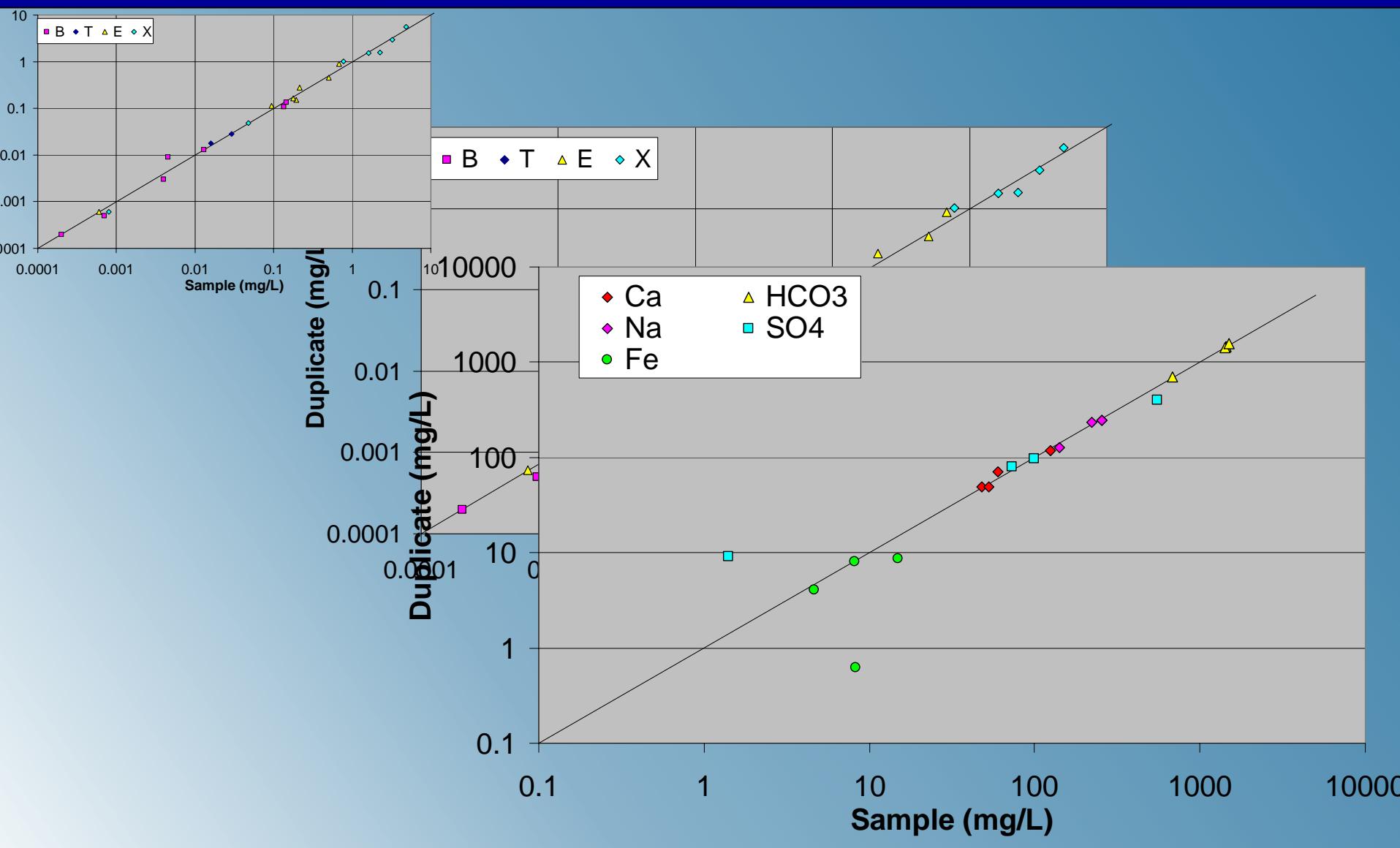
Variability

- Laboratory - analytical
- Sampling methodology
 - purge protocol
 - ‘personal style’
 - equipment
- Spatial: lateral, vertical
- Seasonal
- Others

Laboratory - analytical

- **Spikes and lab duplicates**
 - main ions (NA indicators) $\pm 10\%$
 - hydrocarbons $\pm 20\%$ (BTEX $\pm 10\%$)
- **Field duplicates:**
 - lab analysis, AND
 - handling and storage
 - sampling method
 - sampling technique

Duplicate Samples



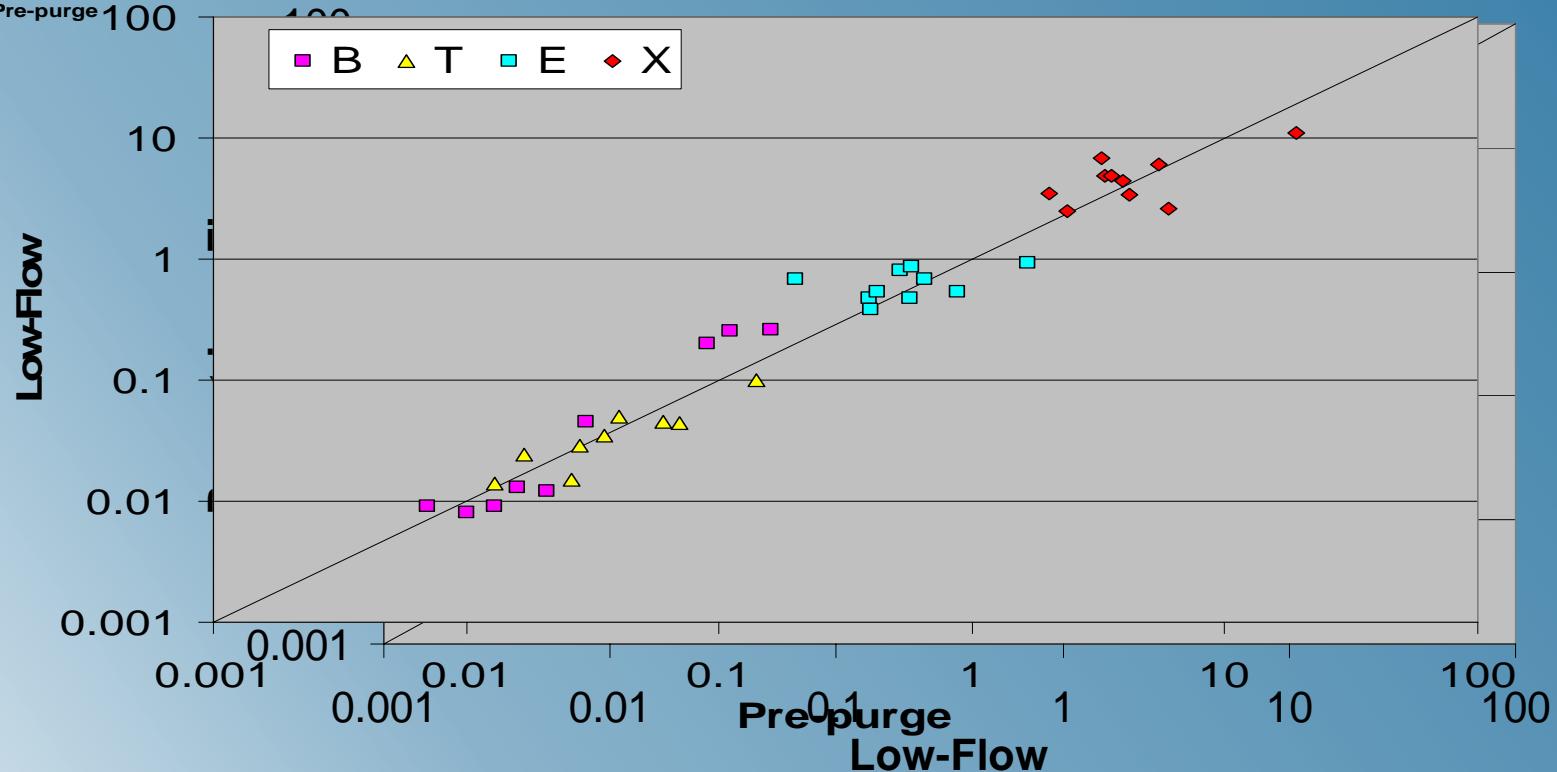
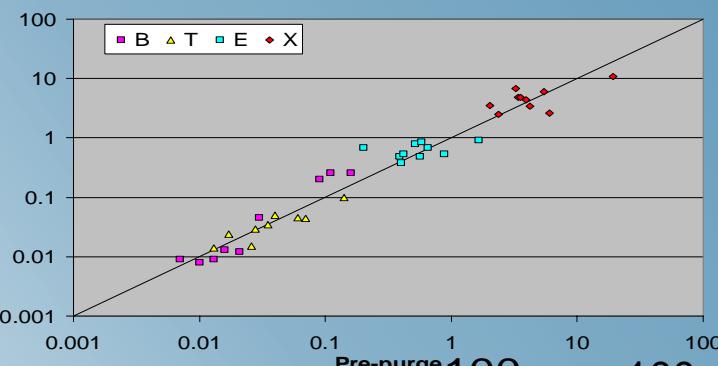
Sampling Methods

- **Protocols**
 - No purge, low-flow purge, conventional purge
- **Dedicated Samplers**
 - Bailer
 - Waterra
 - Peristaltic
 - Passive diffusion: dialysis membrane

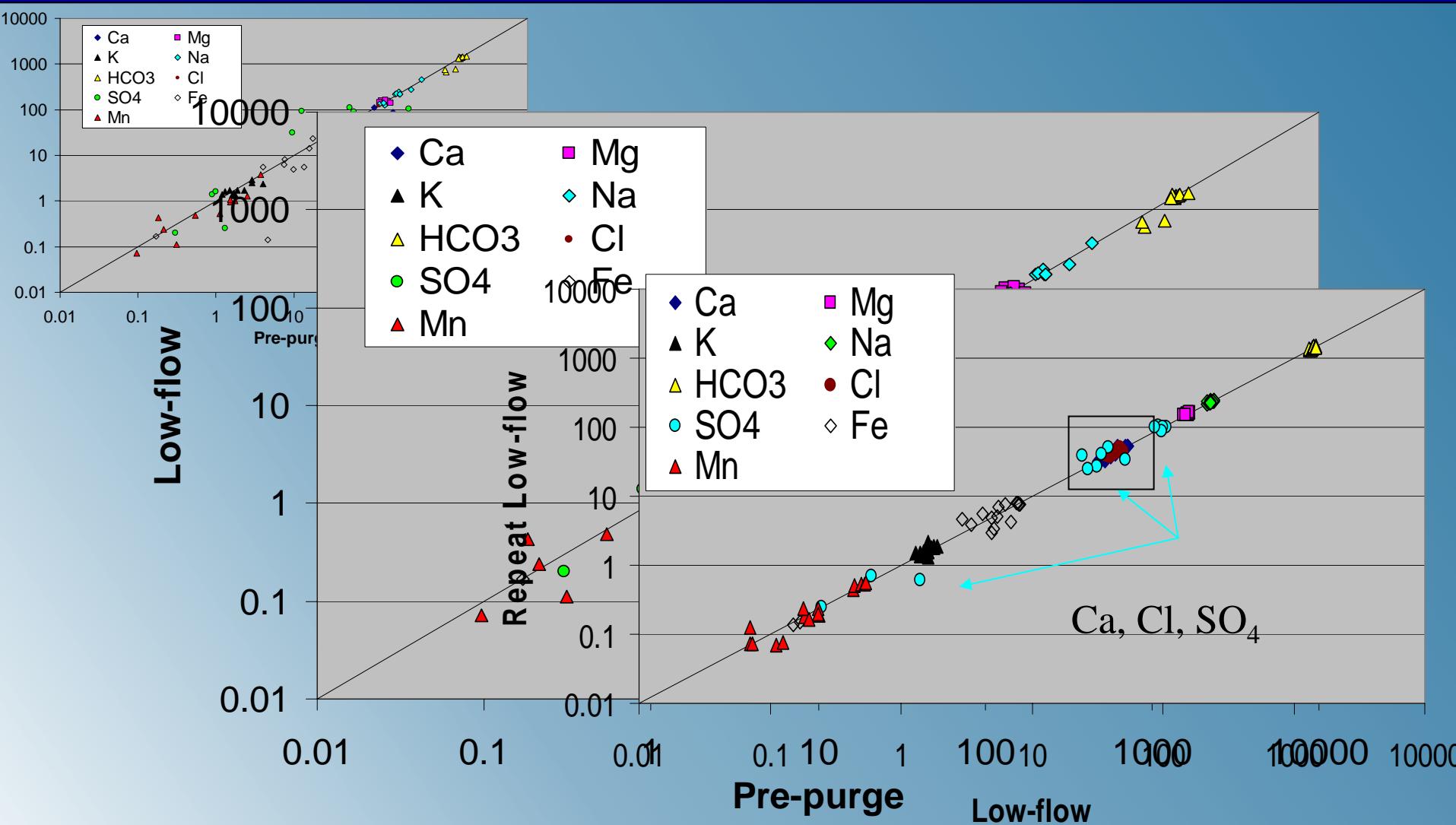
Protocol

- Purge 3 borehole volumes or dry:
 - No issue in high producing wells;
 - Low flow wells
 - excessive oxidation
 - mixing of multiple zones
 - volatile hydrocarbon loss
 - iron oxidation

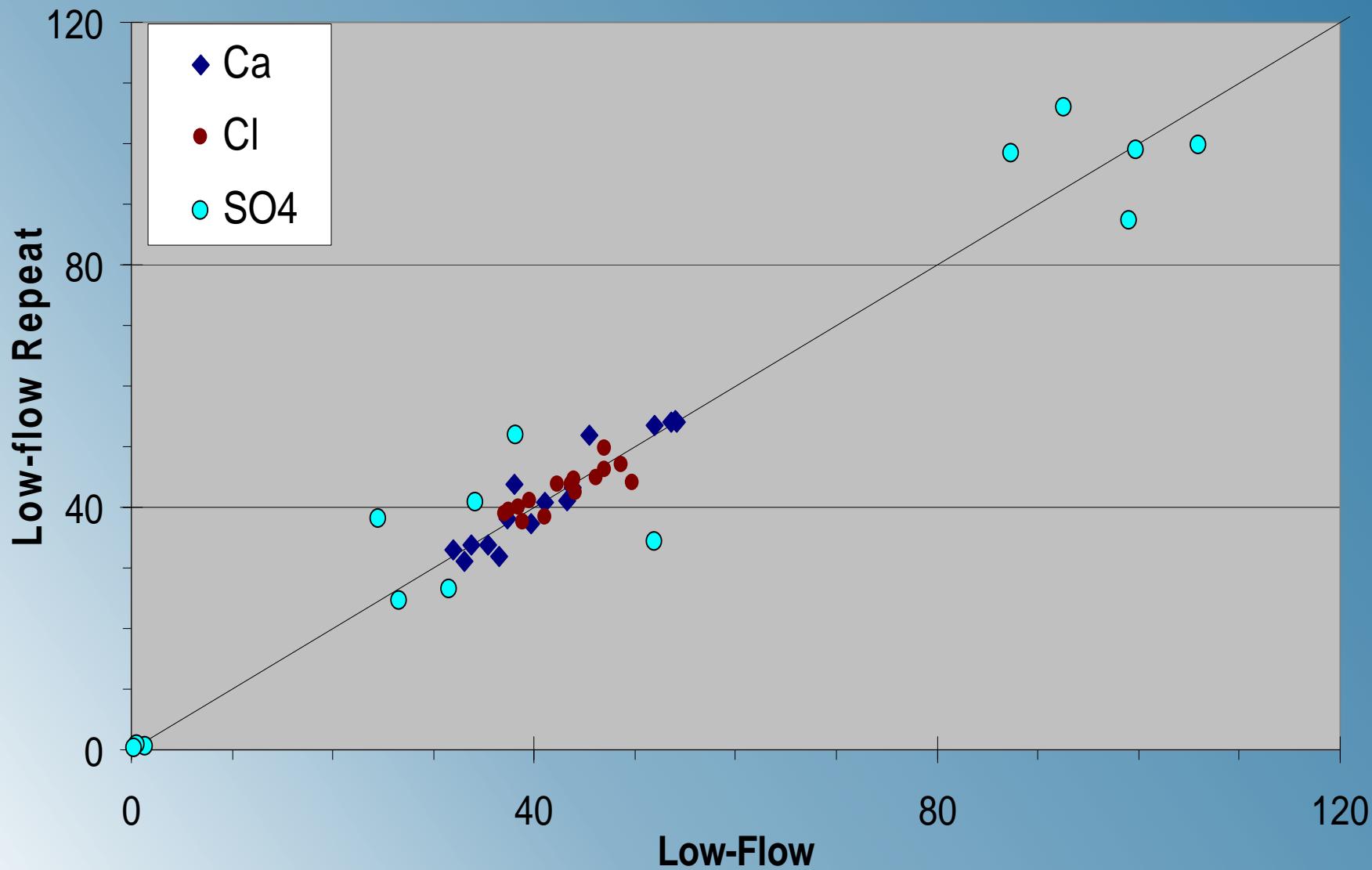
Purging Effect on BTEX



Purging Effect on Ions



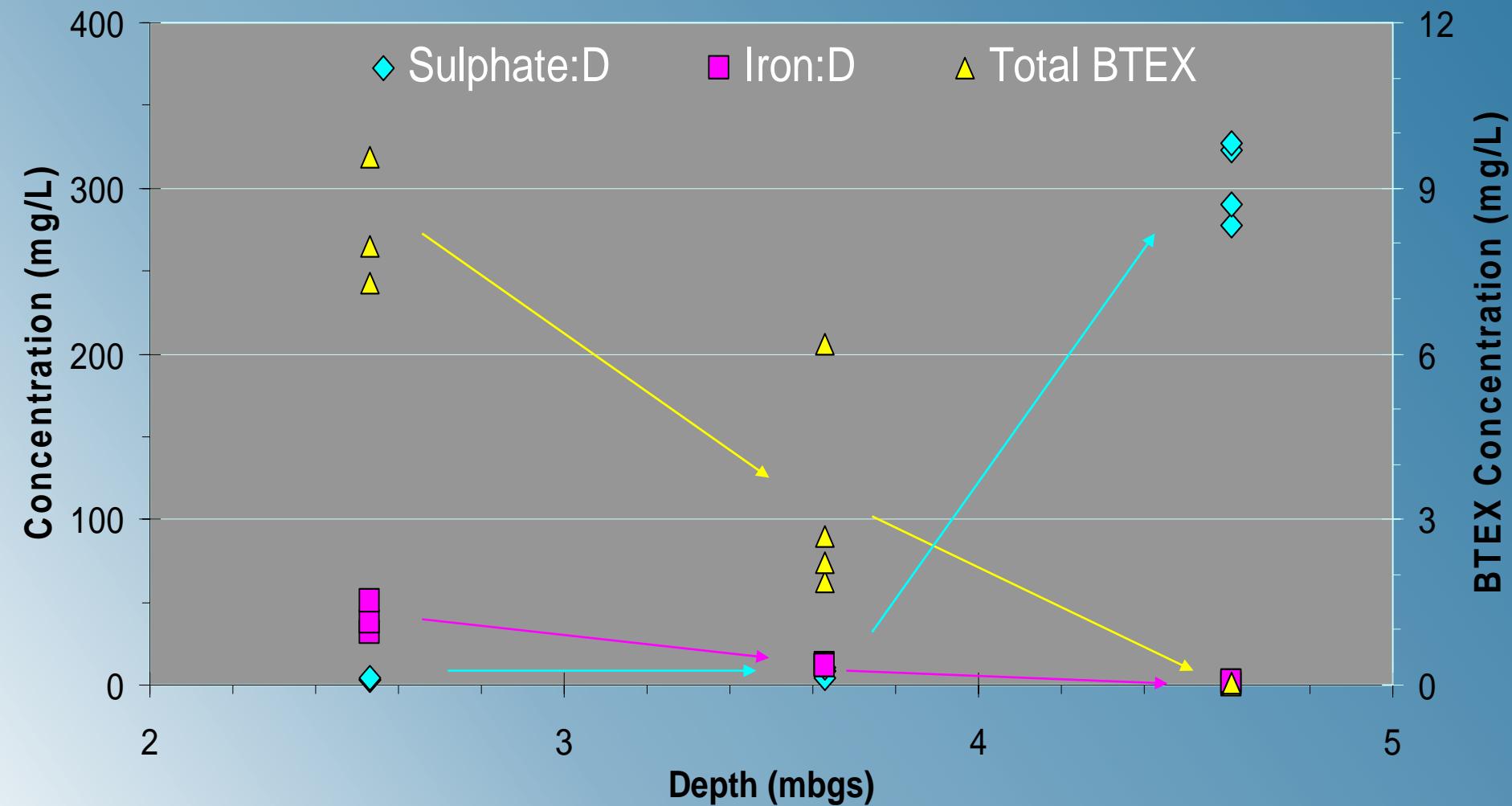
Detail of Low-Flow



Depth Variation

- Current protocol: 3 m screens
- Possible ‘confusing’ effects:
 - mixing of multiple zones
 - geochemical variation

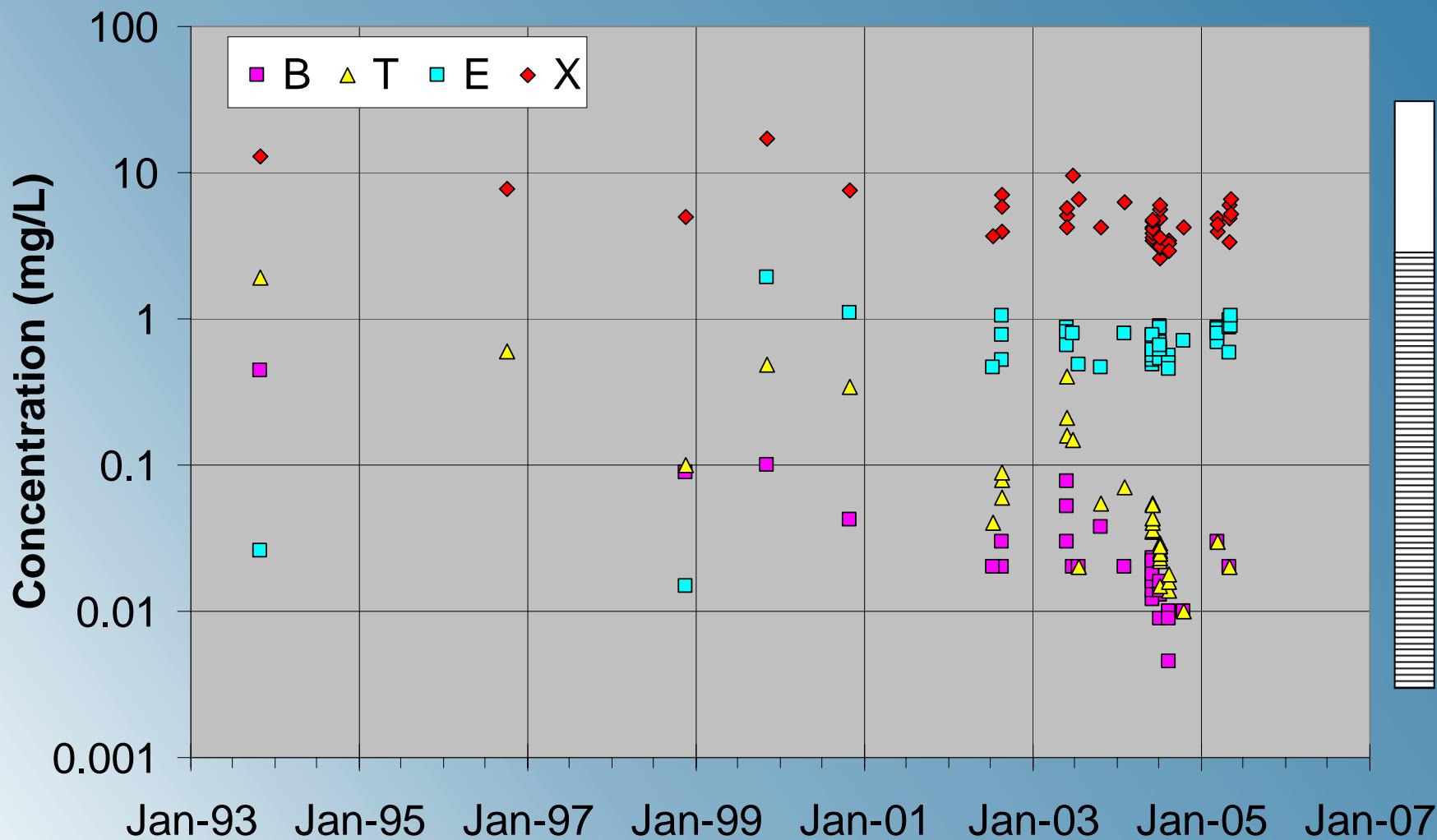
Depth Variation



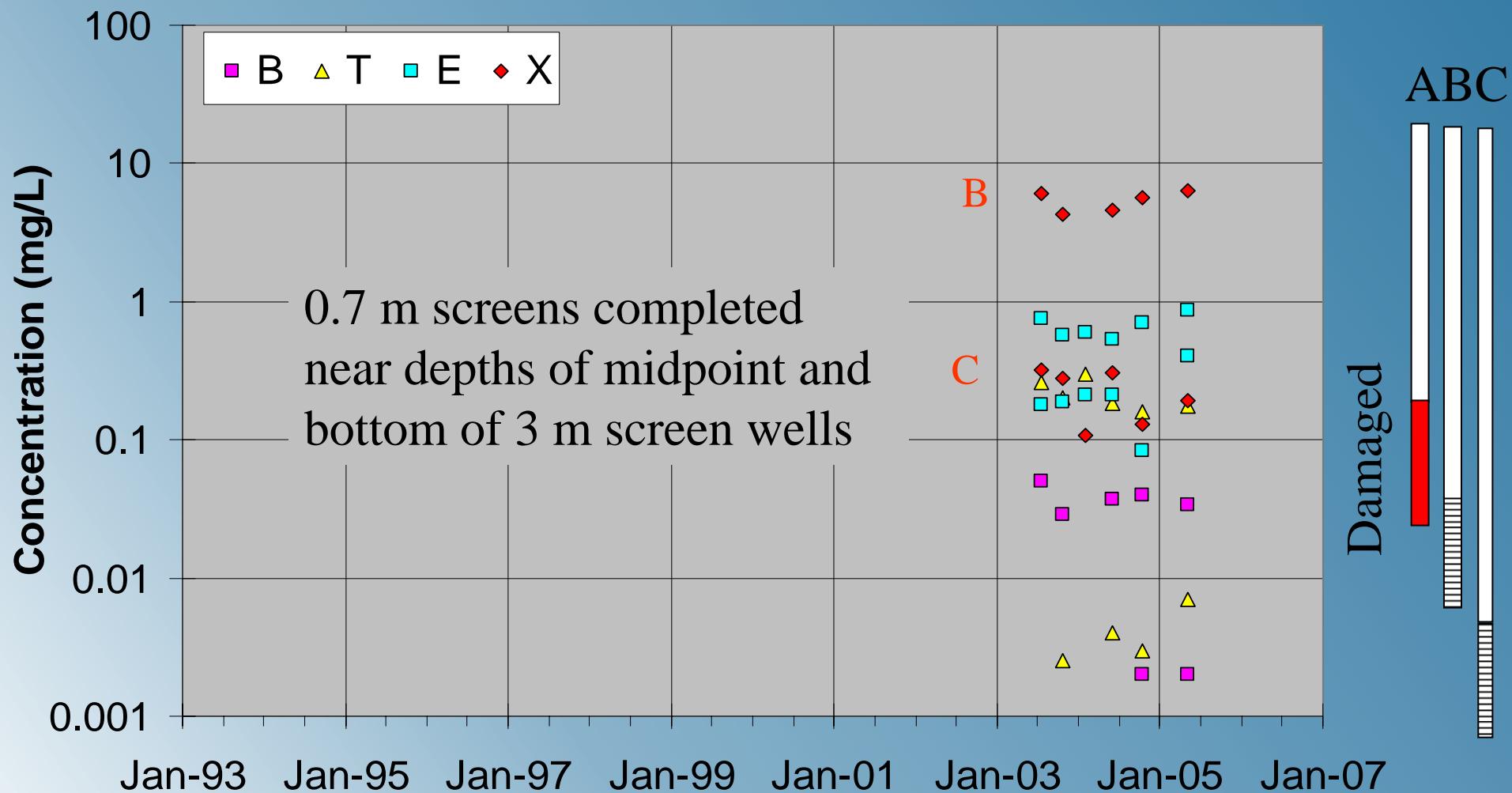
3m Screen Well Variability

- Seasonality
- Water table fluctuation
- Depth-varying mixing effects
- Sampling technique
- Other effects

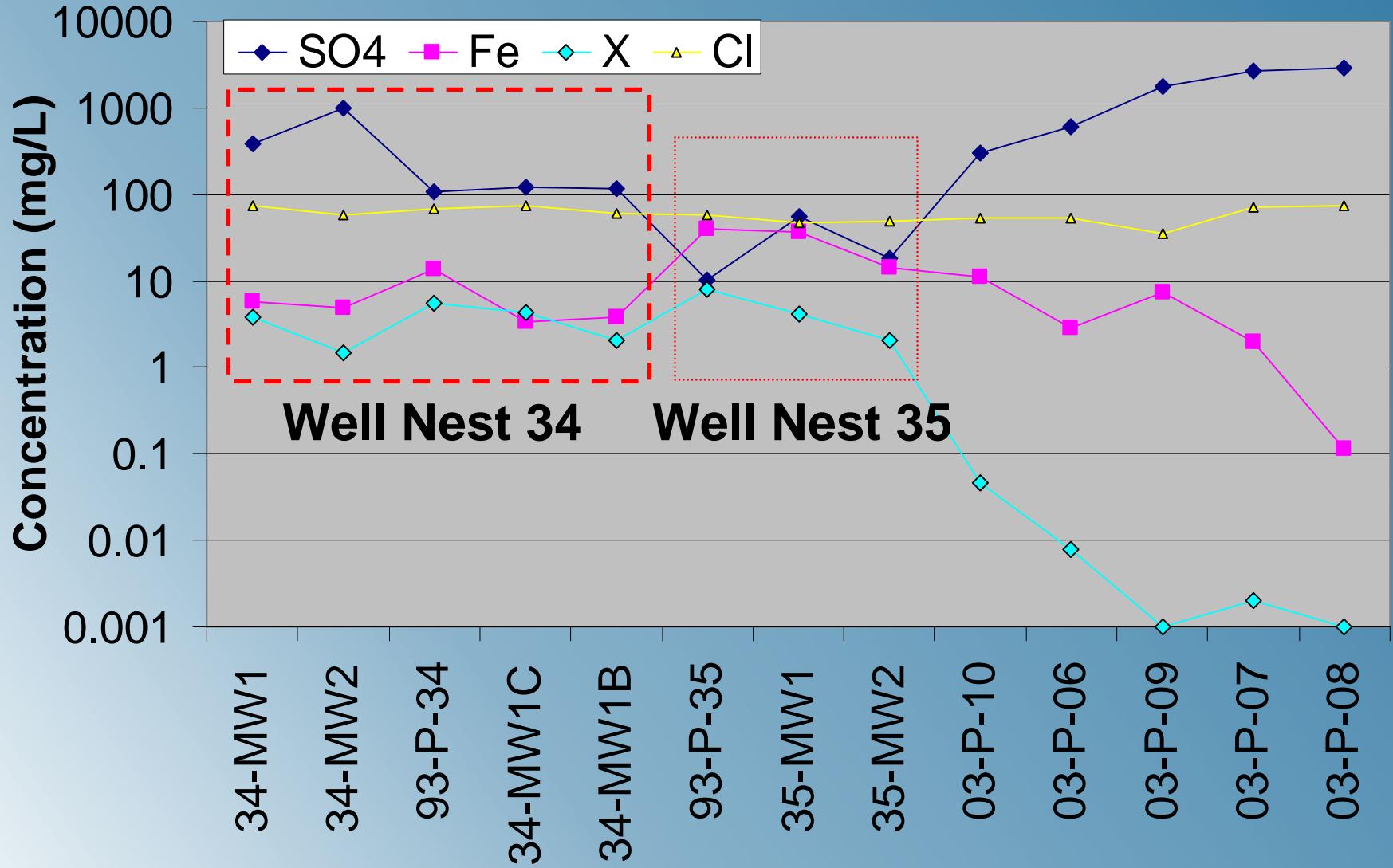
3 x 3 m Screen Replicate Wells



3 x 0.7 m Screen Well Nest



Downstream →

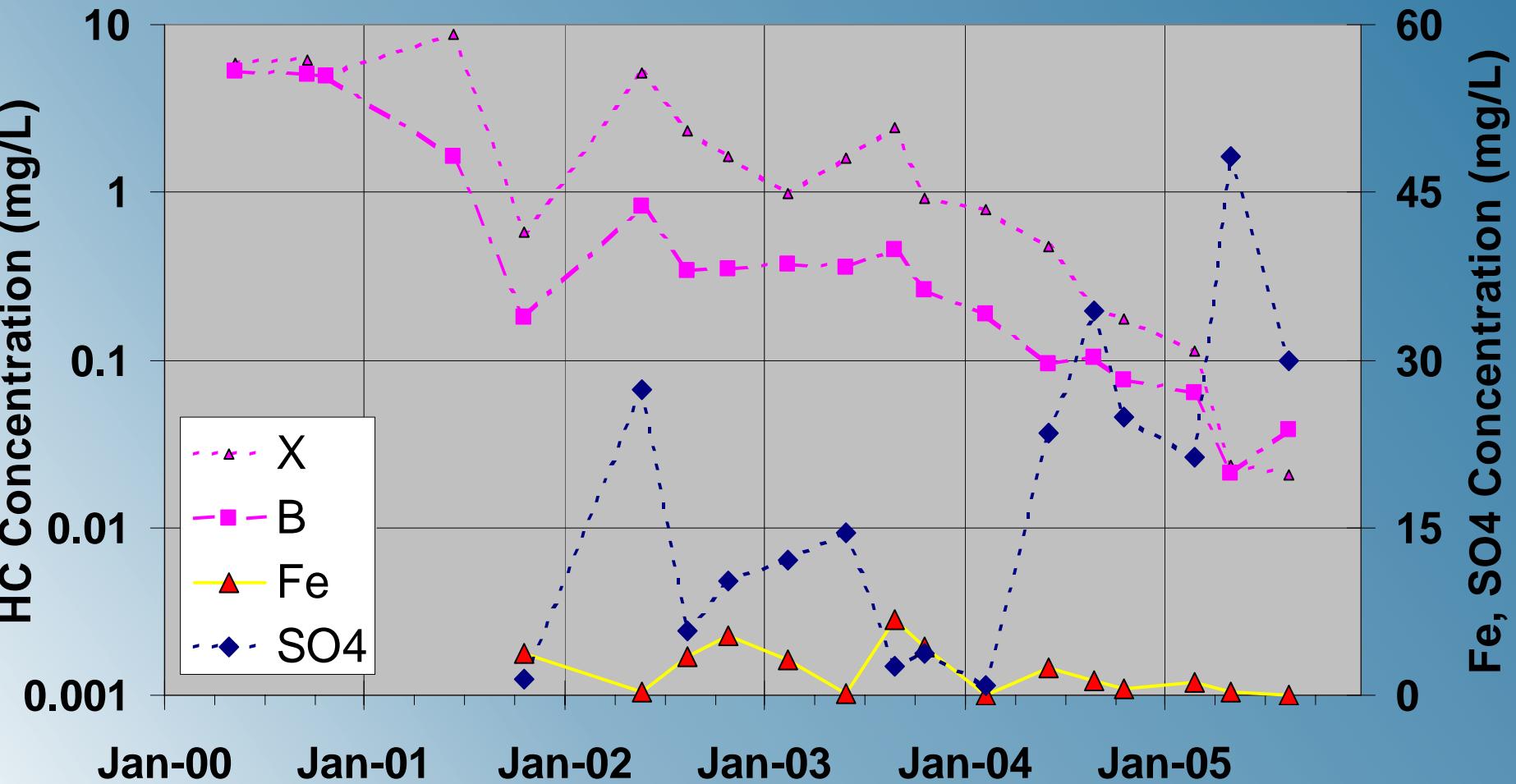


Example Site

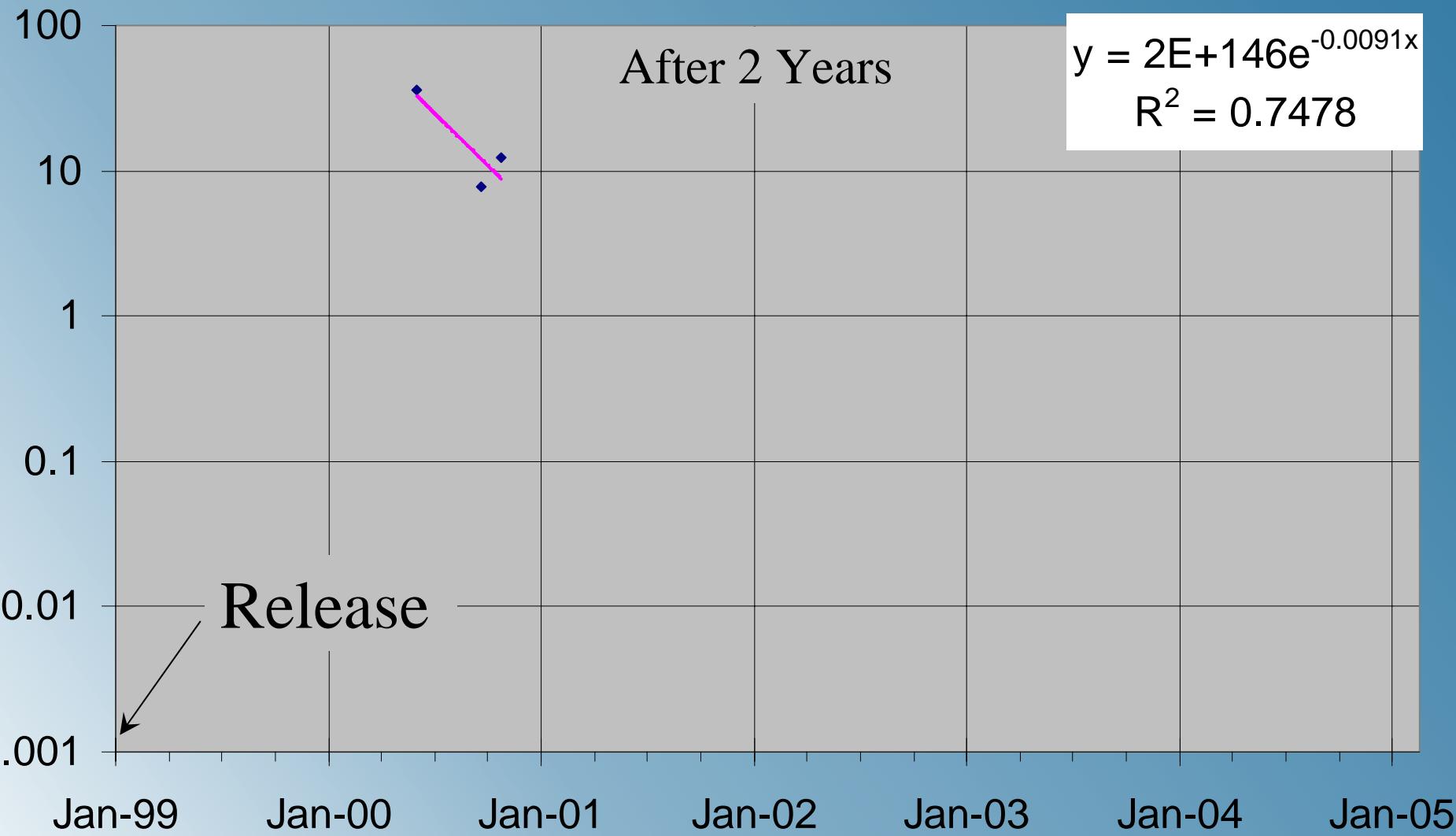
- Winter release of Gas Condensate (>C5 compounds)
- Congested area
 - limited access



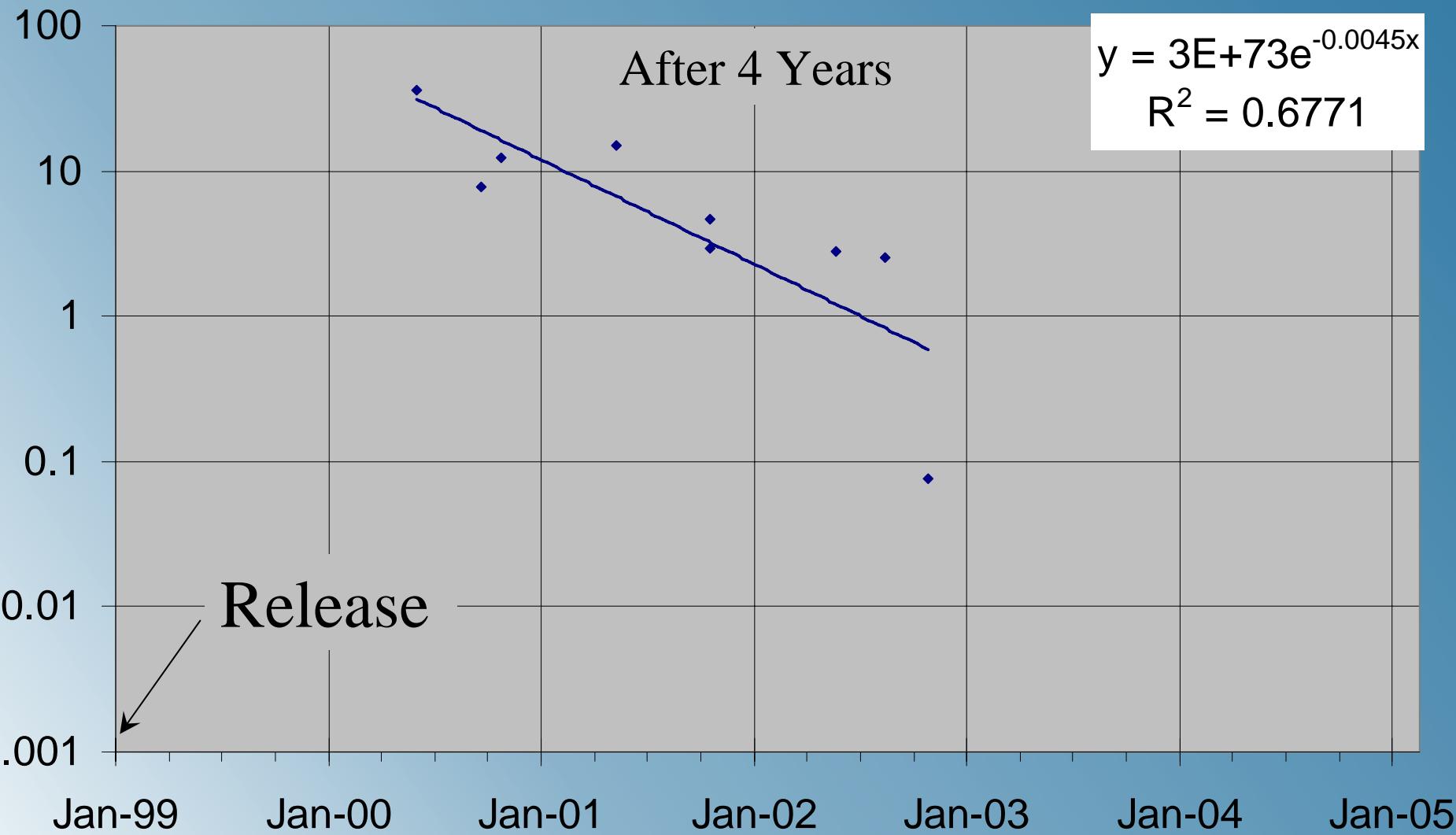
Geochemical Indicators



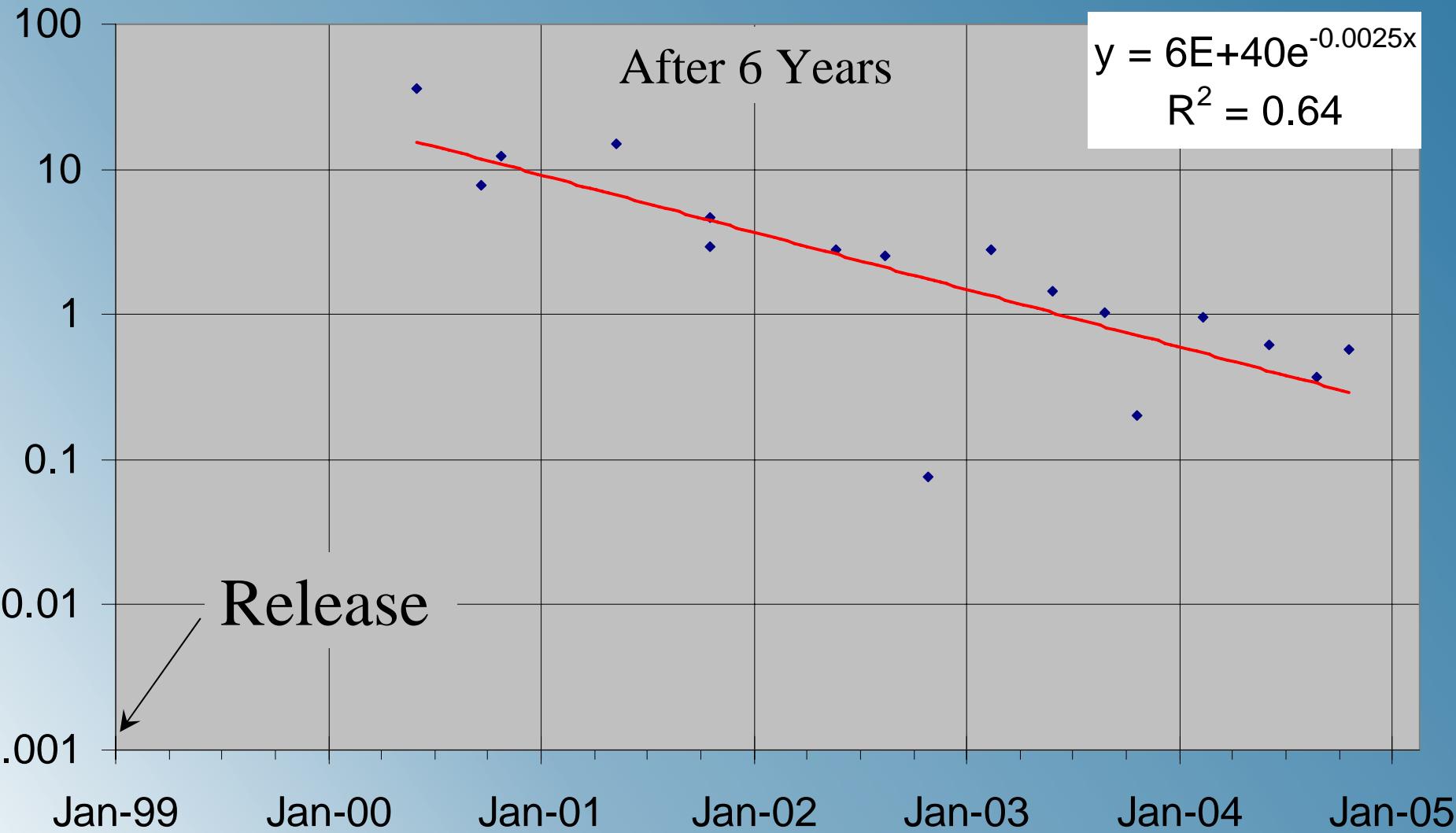
Xylenes (mg/L)



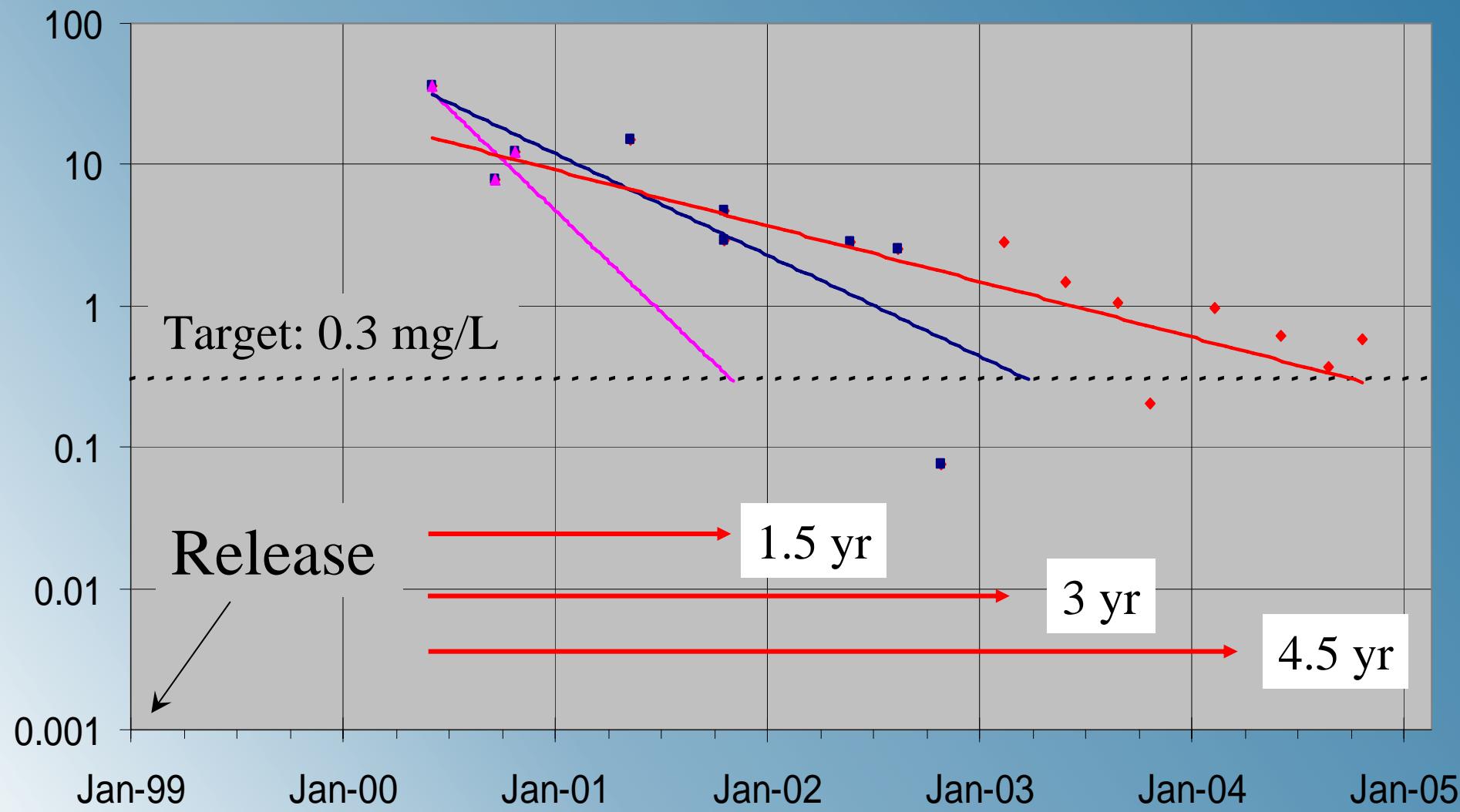
Xylenes (mg/L)



Xylenes (mg/L)



Xylenes (mg/L)



Summary

- Sampling variability can complicate ongoing MNA assessment
- Be aware of causes and magnitude
 - Lateral - spatial variability
 - Depth variability (can be substantial)
 - Seasonal influences
 - Sampling method induced
- High-level inferences valid, but details can get tricky

So What ?

- Expect variability
- Look for ‘order of magnitude’ effects
 - PHC’s,
 - Sulfates & iron sensitive to sampling
- Rely on ‘judgment and experience’
- NA will require source control to reach regulatory endpoints

Acknowledgements

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