Dissolved-Phase Plume Genesis & Life-Span
Part II

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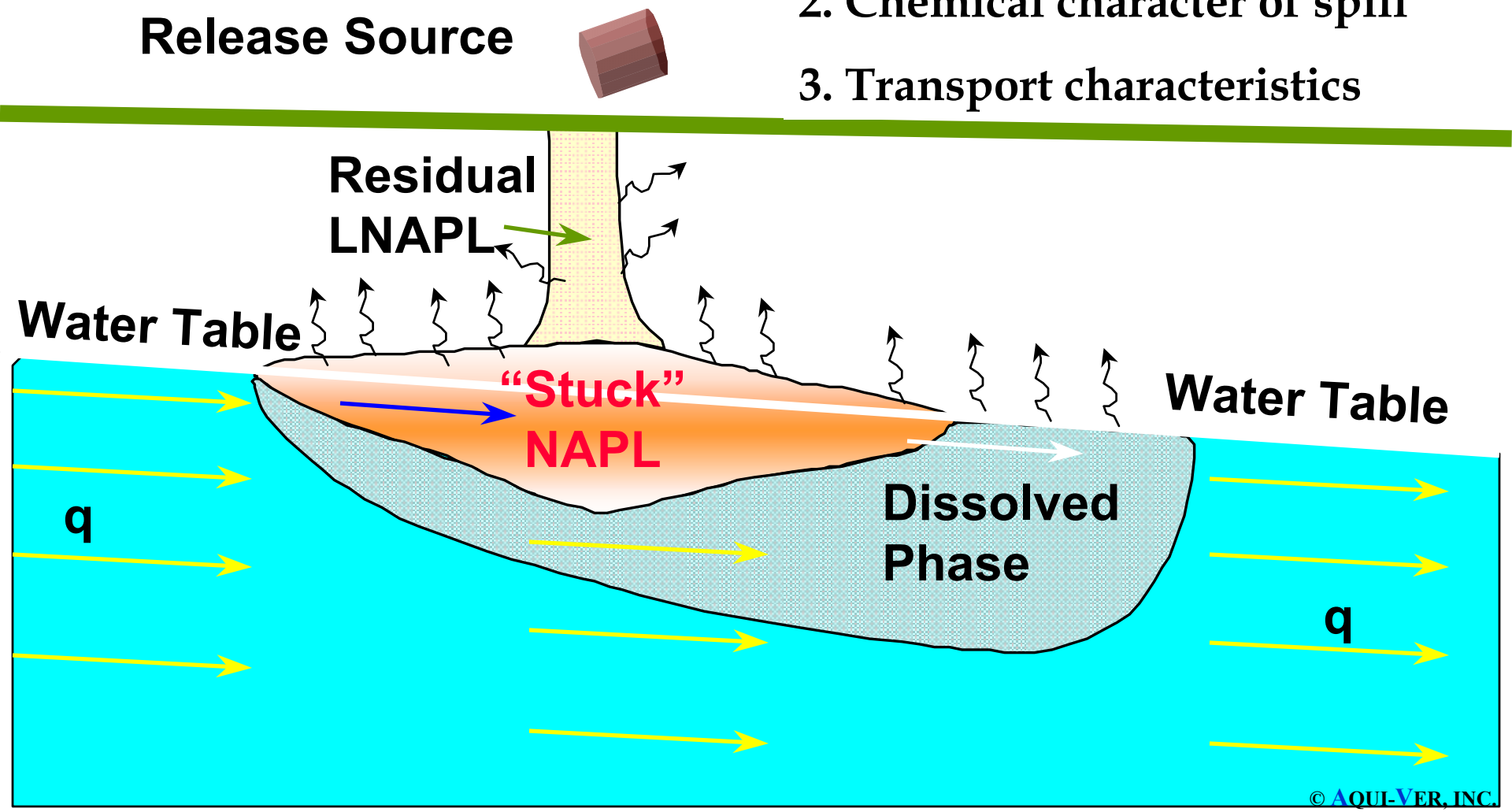
The Scheme; Learn from Theory
(But Expect Complications)

- Theory World - Helpful

- The Real World

Chemical Impacts/Flux Depend on the LNAPL
(when LNAPL is present)

1. Distribution of spill
2. Chemical character of spill
3. Transport characteristics



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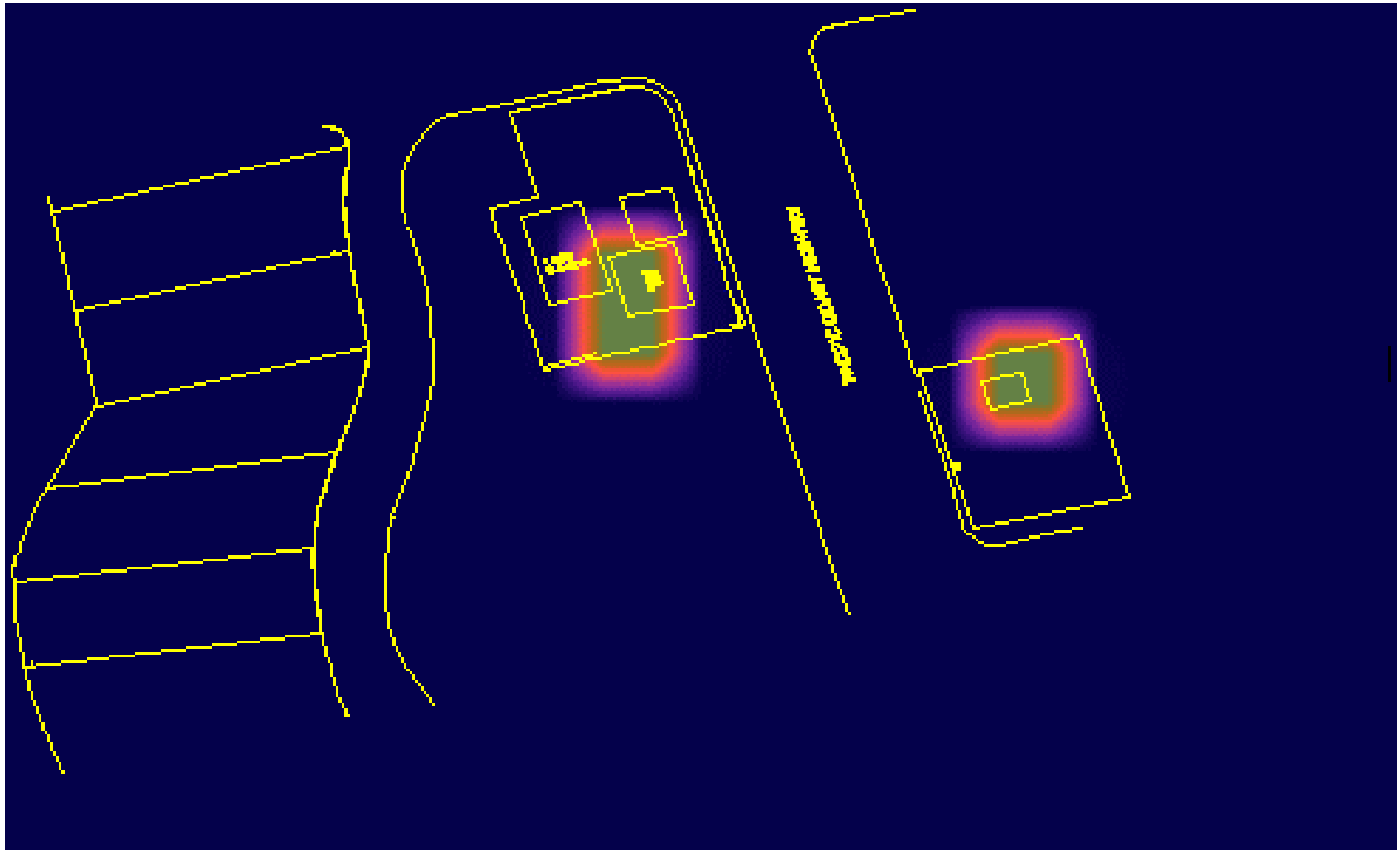
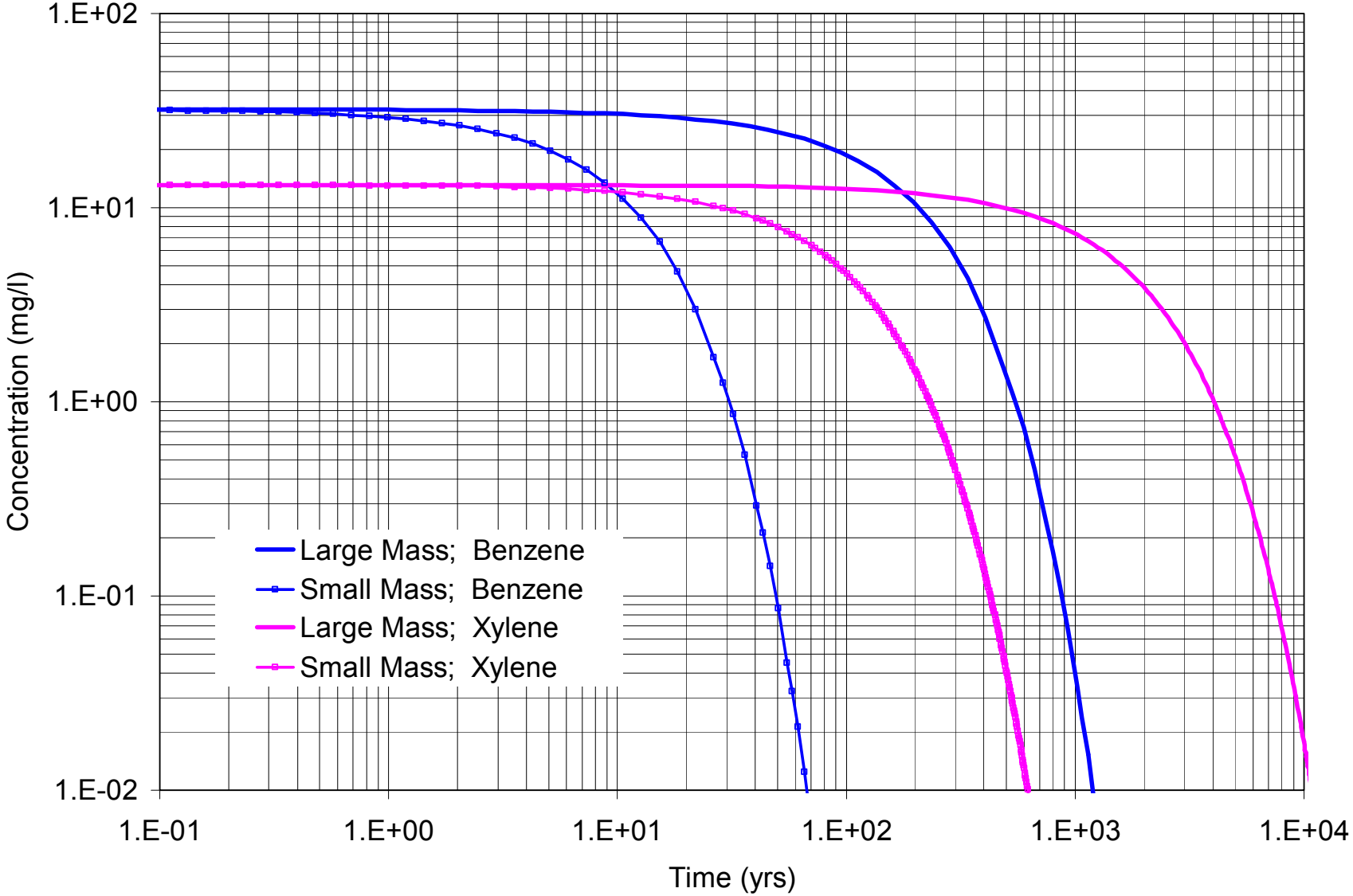
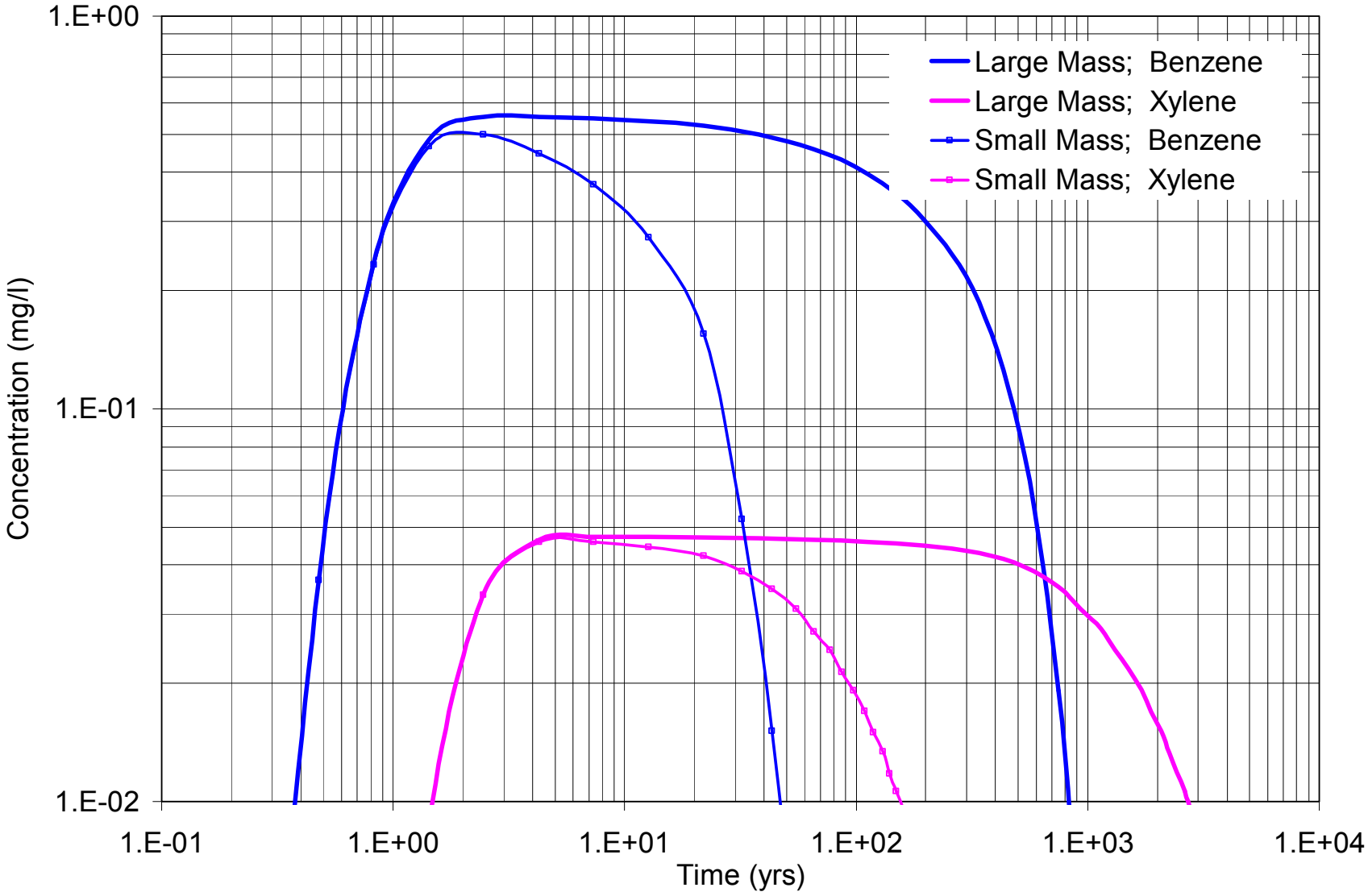
Example Plume Growth Through Time



Different Styles of Plume Source Strength

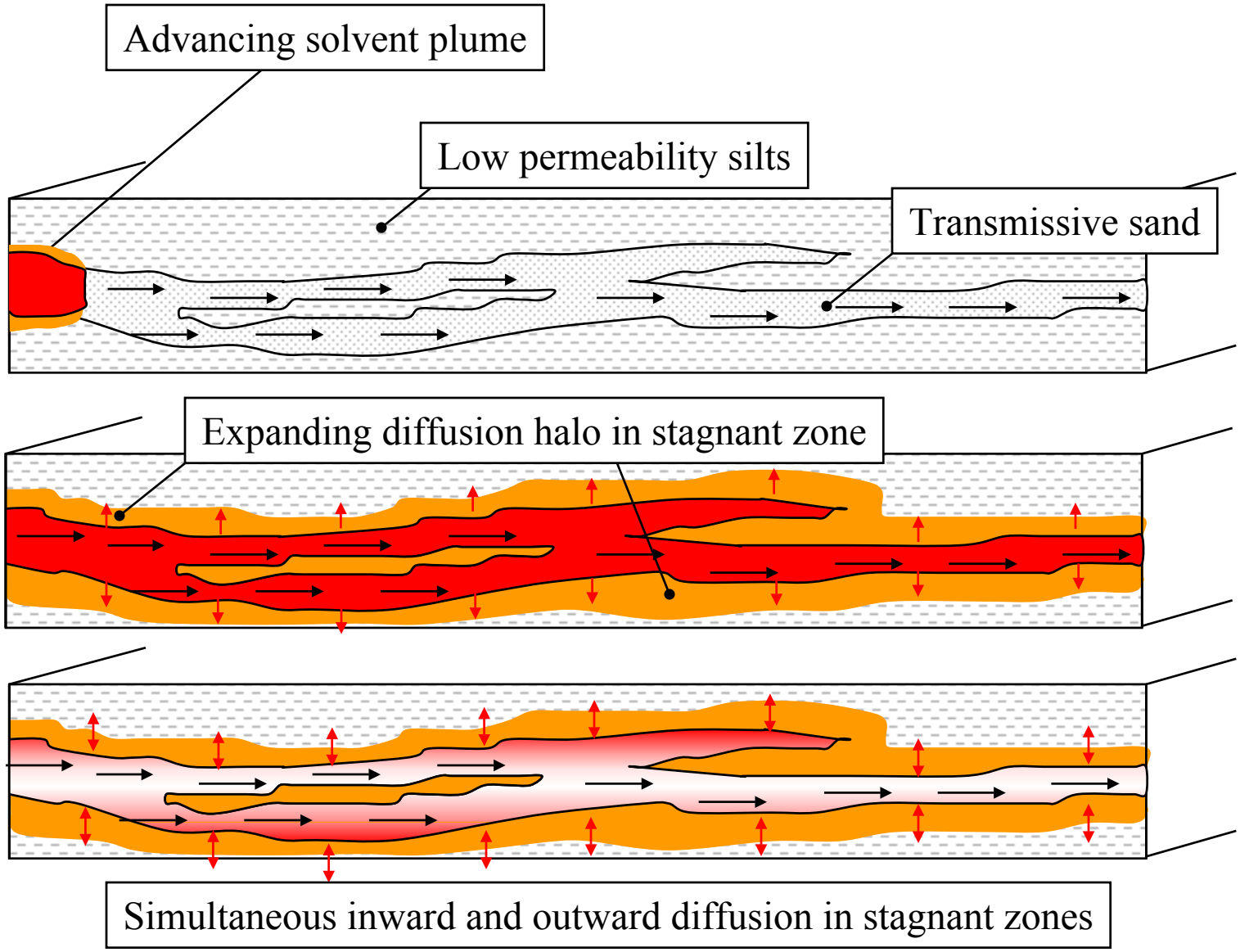


Breakthrough Form Depends on Source Strength



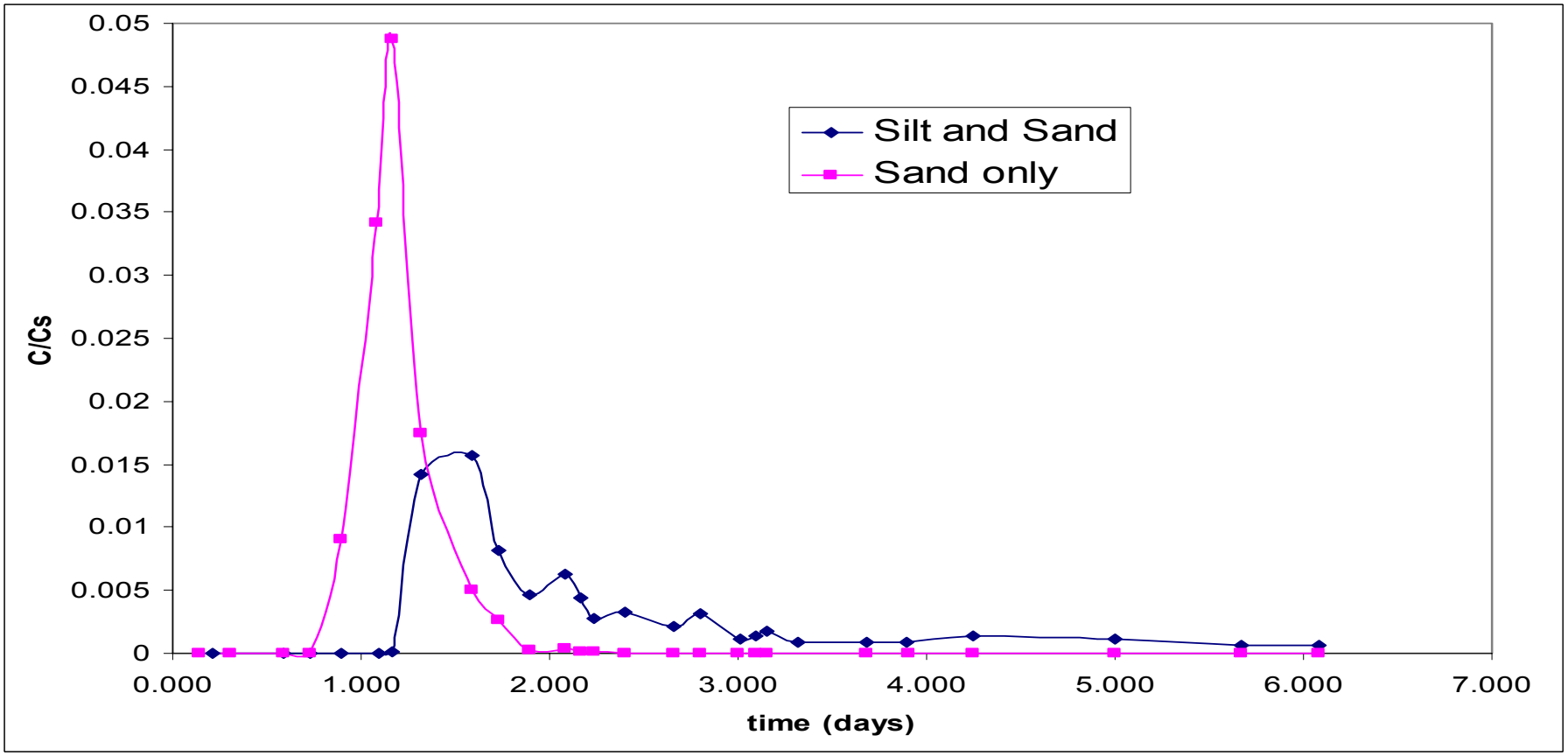
Mass Attenuation by Matrix Diffusion

(e.g. after Parker and Cherry)



MTBE Tank Experimental Results

(Layered System (diffusive) vs. Homogeneous)



(courtesy of Tom Sale, CSU)

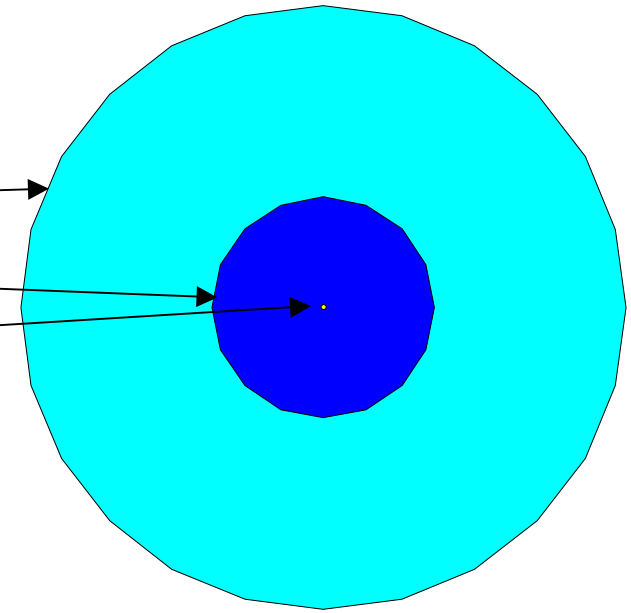
Geology Can Greatly Affect Flux & Timing

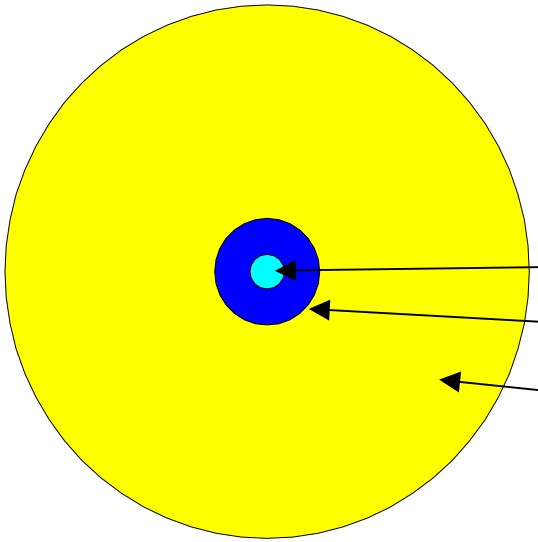
Relative Fluxes:

Coarse-grained soil (SW)

Fine-medium soil (SM)

Fine-grained material





Relative Time to De Minimis:

Coarse-grained soil (SW)

Fine-medium soil (SM)

Fine-grained material

Chemistry Affects Flux Magnitude

(for same LNAPL & geologic conditions)

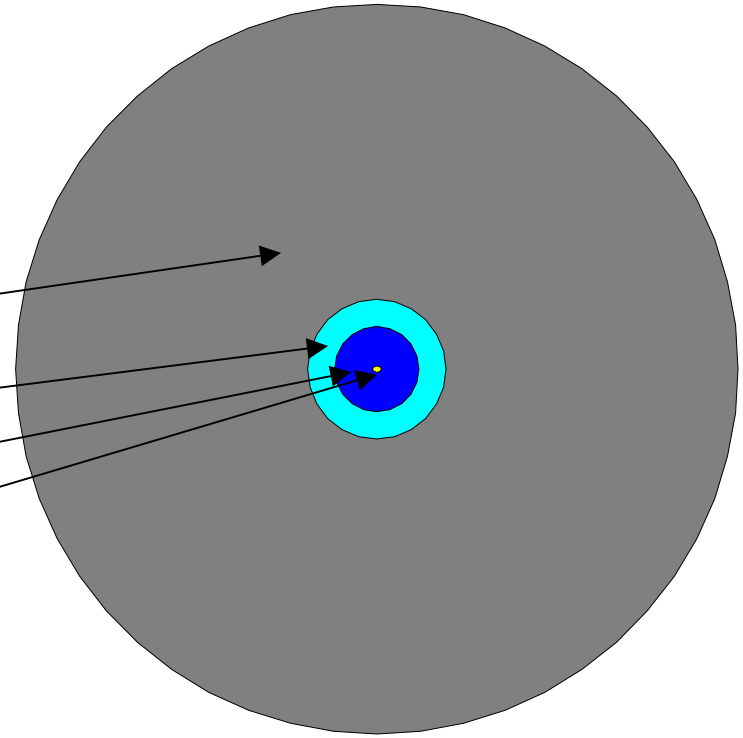
<u>Chemical Compound:</u>

MTBE @ 2%

Benzene @ 2%

Xylenes @ 7.5%

Fluorenes @ 2%

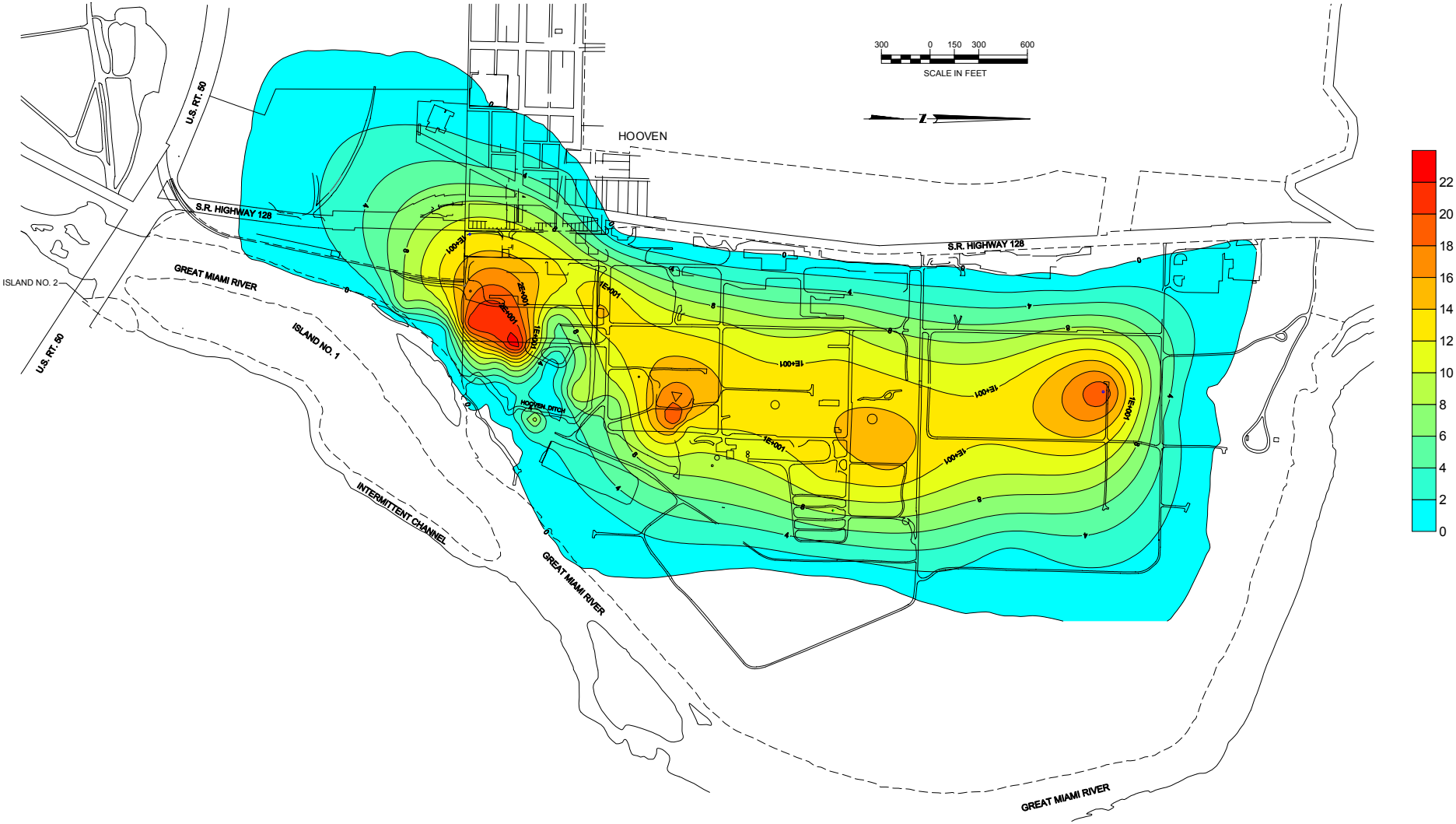


What Can We Draw From Those Things?

- There is a finite mass, it has to deplete through time
  - Ergo, there is a finite & diminishing flux through time
  - Different compounds flux at different rates
  - Heterogeneity affects the form of the mass losses
- Plume conditions should be getting better overall
  - Exception, new &/or ongoing releases
  - Or when transport conditions bring impacts to receptors
- We generally have a lot of groundwater monitoring data
  - It usually reflects the exponential form of the plume
  - These data can be a good story-line for us to learn from
- Key question: what can we learn from this data?
  - Can it help us understand timing & magnitude of impacts?

Quick Site Specific Examples

Total Smear Zone Thickness



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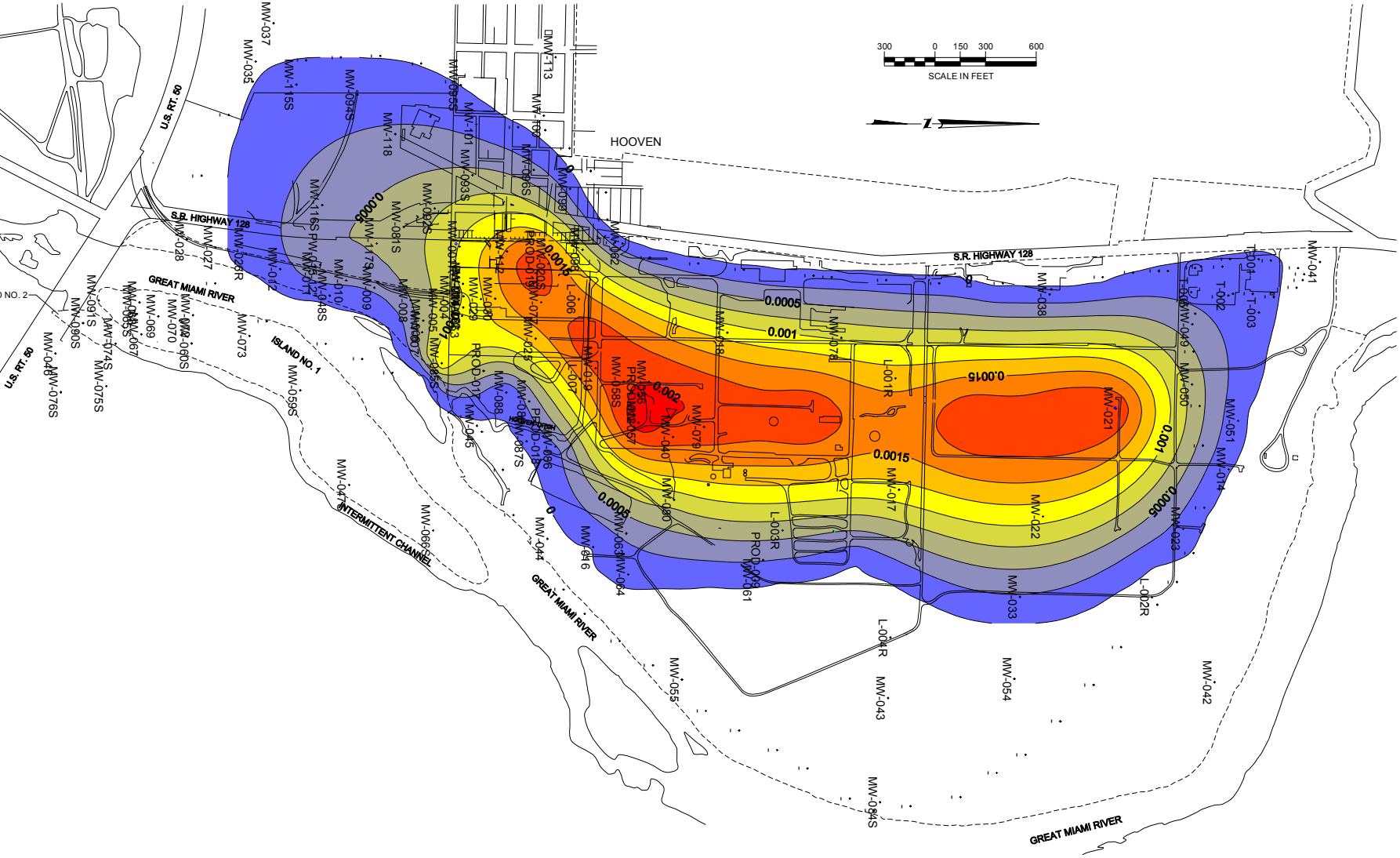
Benzene Mass Fraction in LNAPL



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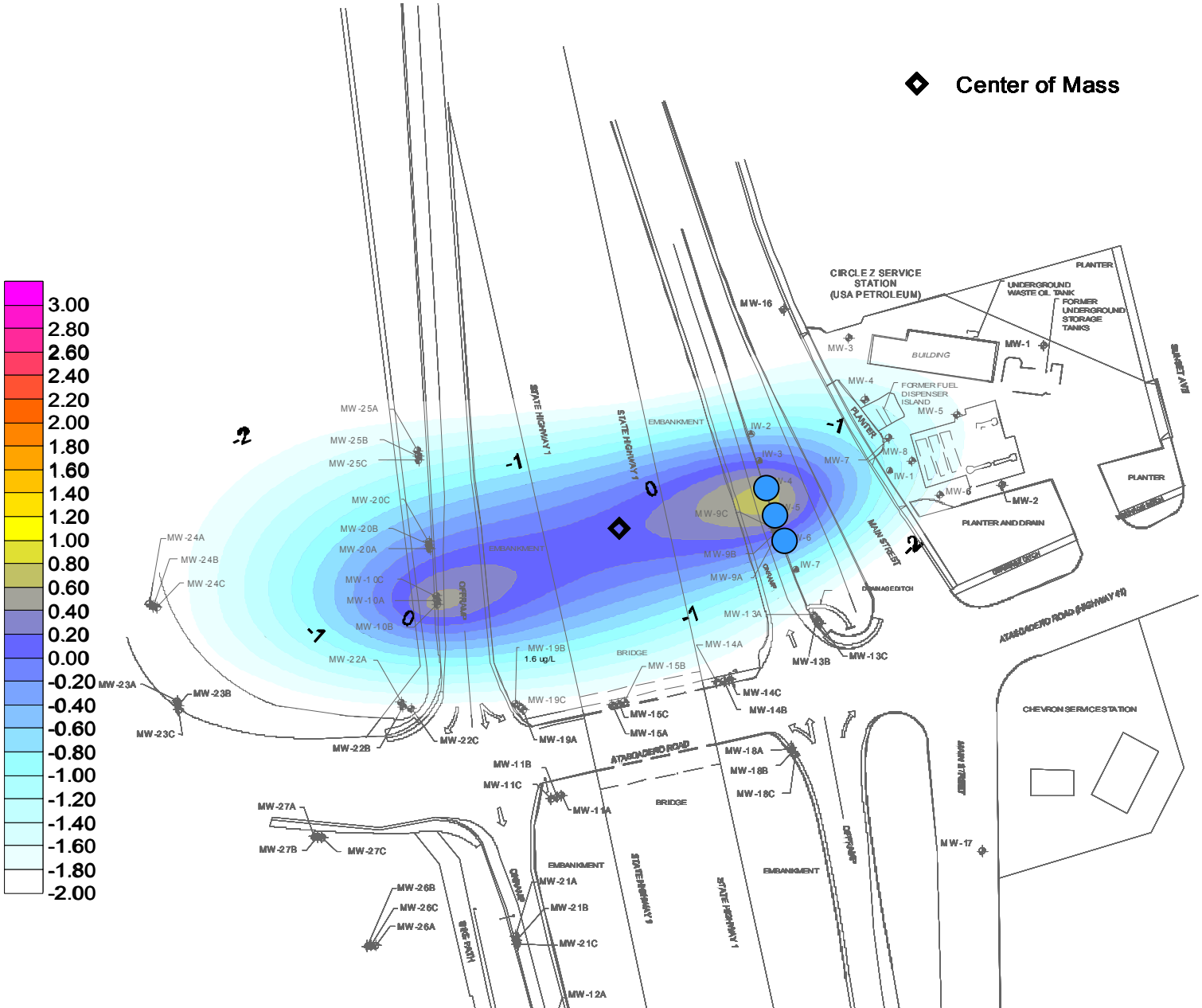
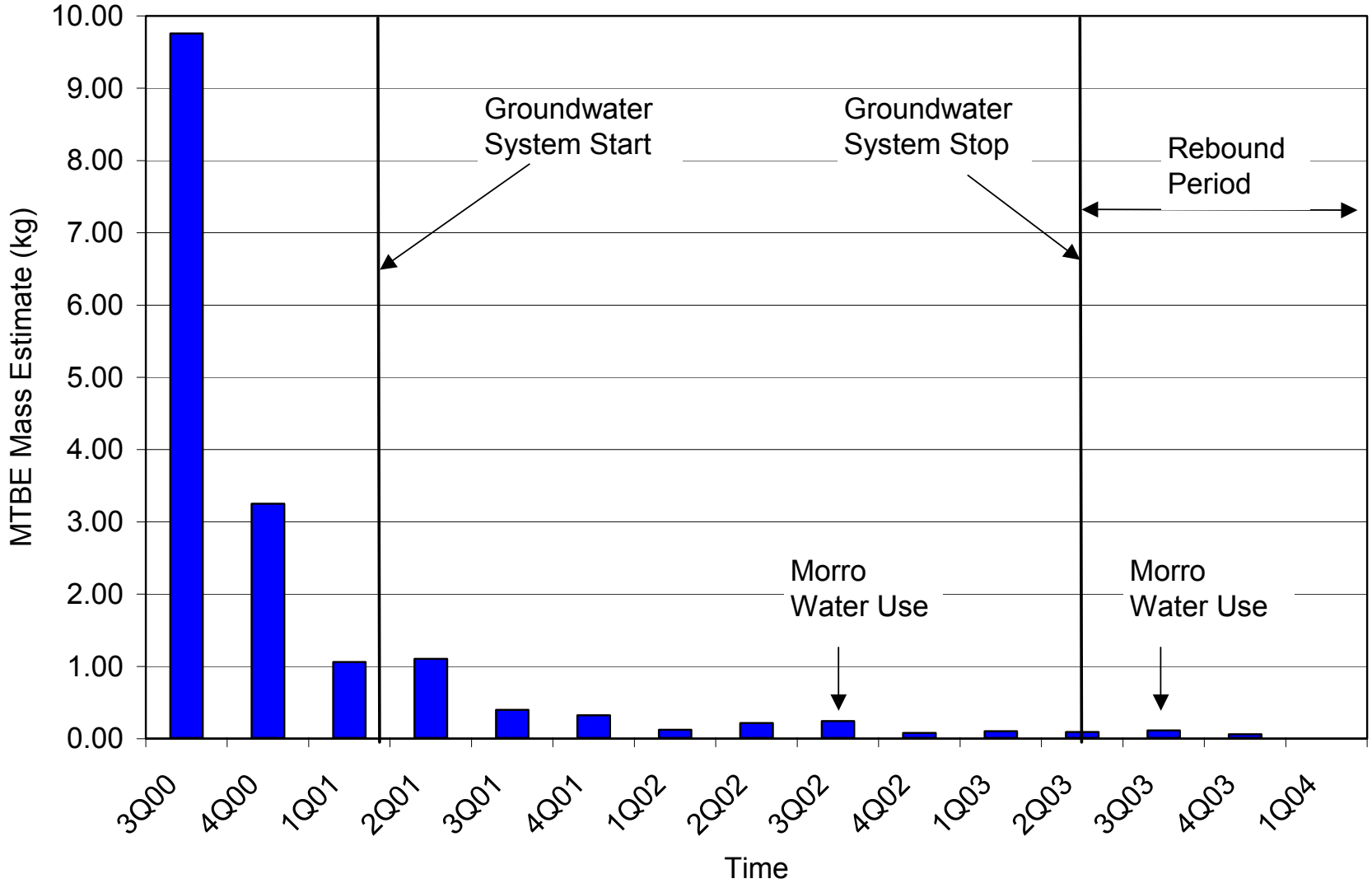
Log MTBE; 3rd Qtr 2000 through 1st Qtr 2004

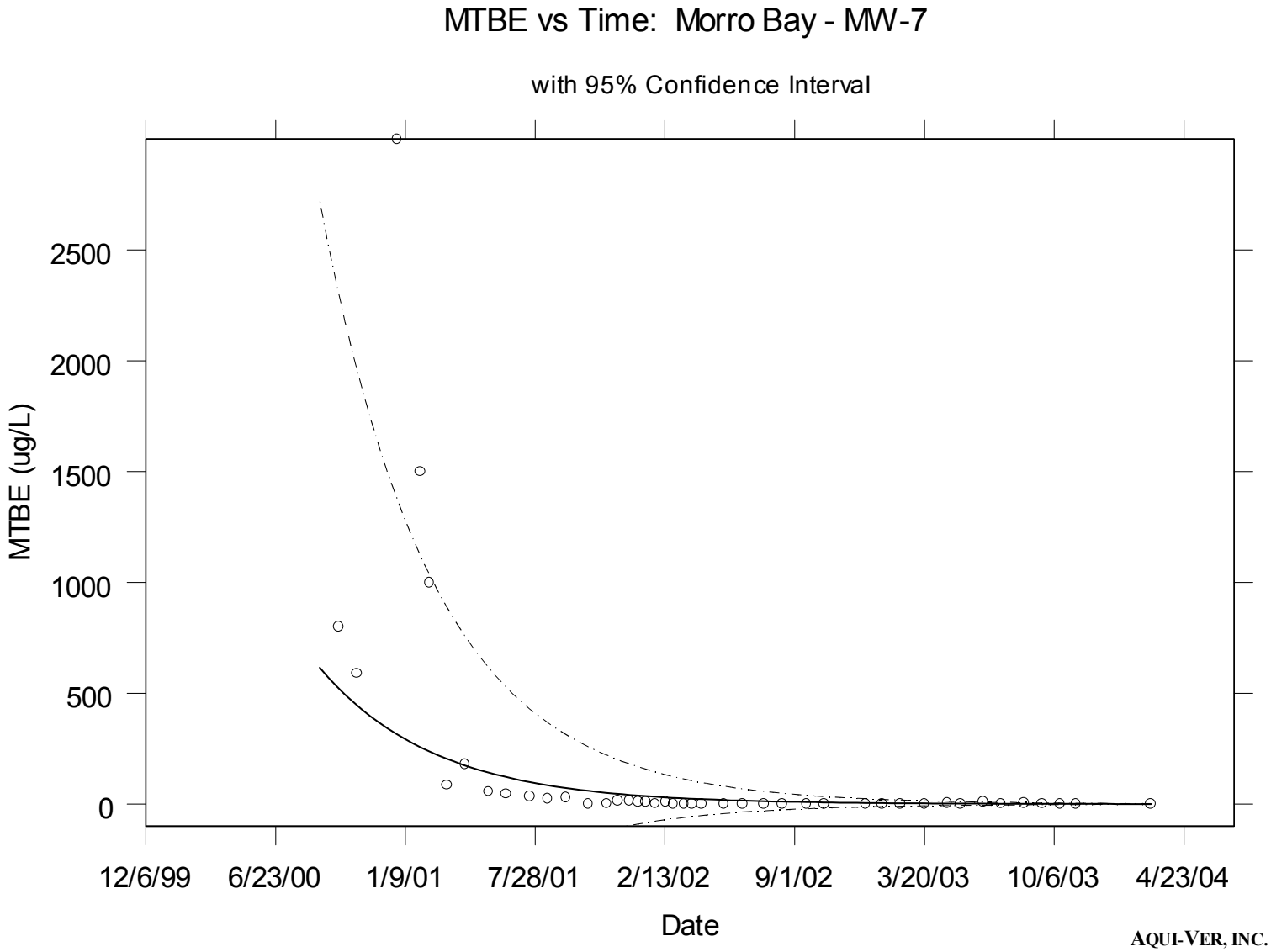


Approximate MTBE Plume Mass vs. Time



Example Decreasing MTBE Trend

(exponential trend allows time to MCL estimate)



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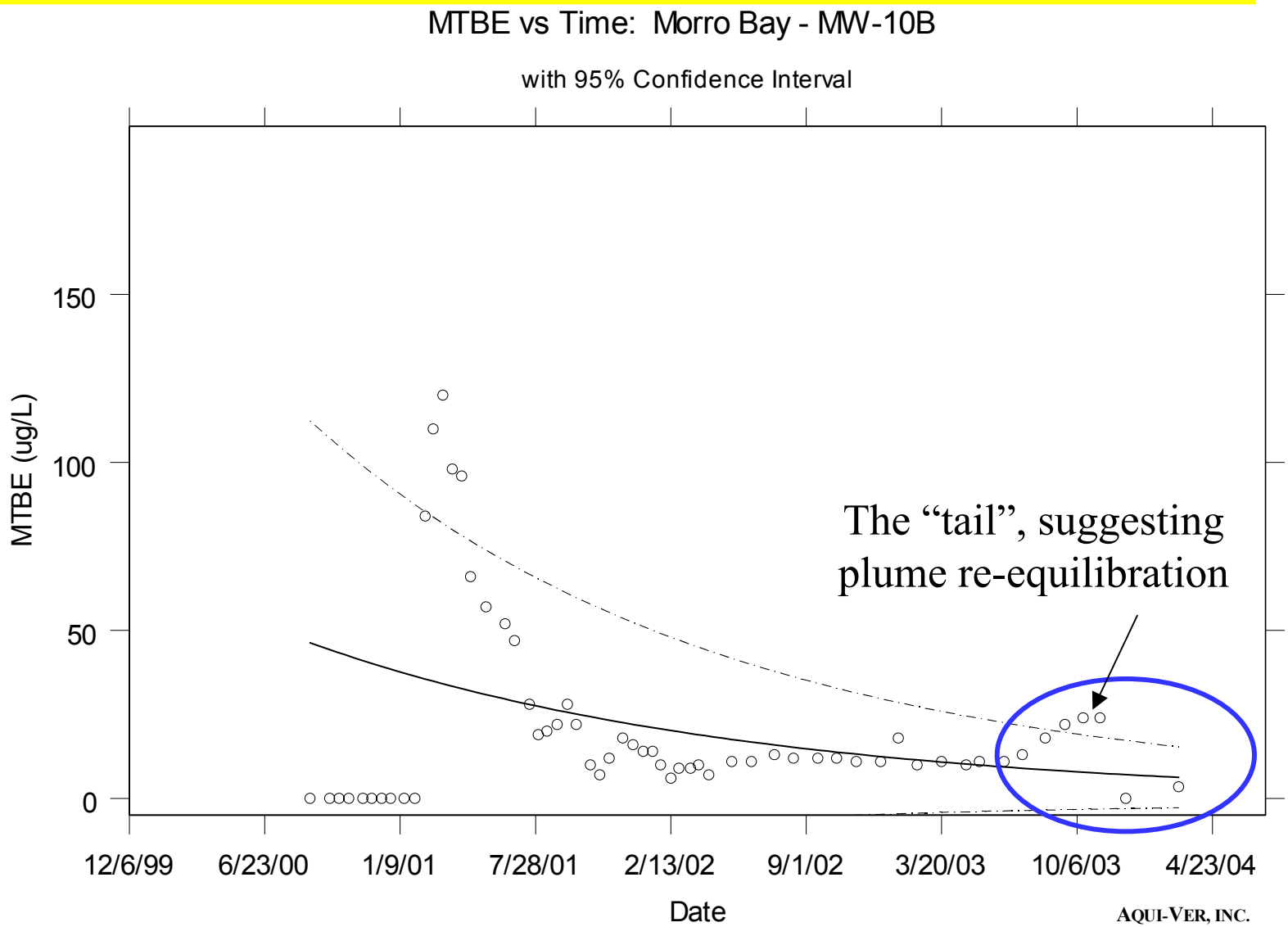
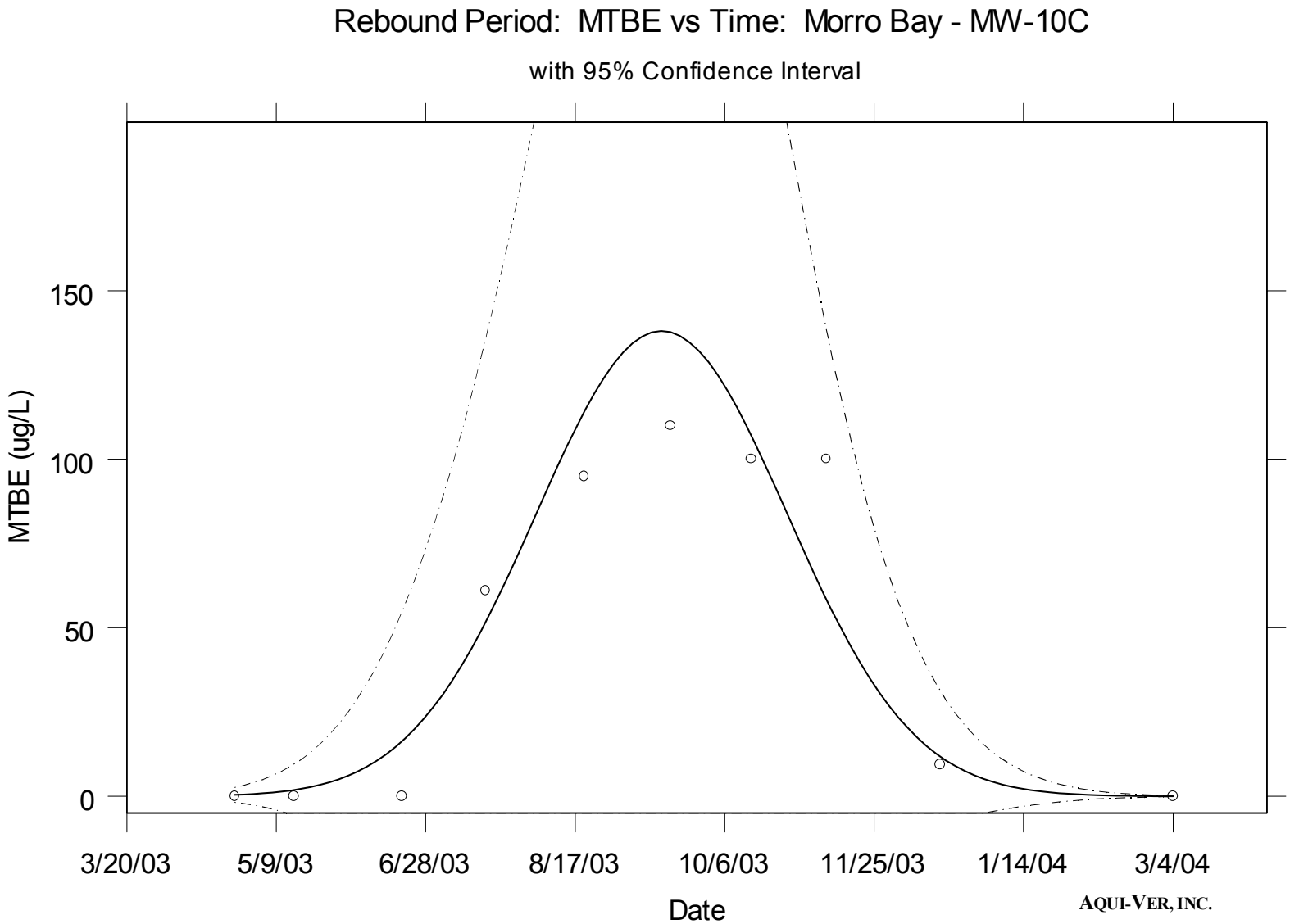
Example Decreasing MTBE Trend with "Tail"



Same Well, Breakthrough During Rebound



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In Summary

- Regardless of whether a model is used or not
  - Use of existing groundwater database can be a big asset
  - Use that reality to guide the CSM context & any modeling
  - Challenge: usually far easier to observe the source term than it is to model &/or estimate the in situ specifics
- Flux is often a good indicator of potential impacts
  - Small flux & large distance to receptors is often safe
  - Large flux & small distances to receptors is often a concern
  - Each chemical in each setting has very different implications
- Need to couple this information with water value & use
  - If water is valuable, but fluxes limited, may be OK
  - If water has low values, may be larger fluxes are OK
  - If water is valued & fluxes are high, maybe best to remediate