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Welcoming Innovation through the Triad Approach

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Uncertainty Permeates Cleanup Decision-Making

- Sediments & soils removal
  - Removed volumes always greater than estimated during design
- GW treatment systems
  - Original goals seldom achieved
  - Never within time frame envisioned by designing engineers
  - Surprises common!
- Common to re-do investigation & remedial work

Triad approach directly addresses uncertainty

3 Primary Best-Practice Elements of The Triad Approach/Framework

Systematic Project Planning

Dynamic Work Strategies

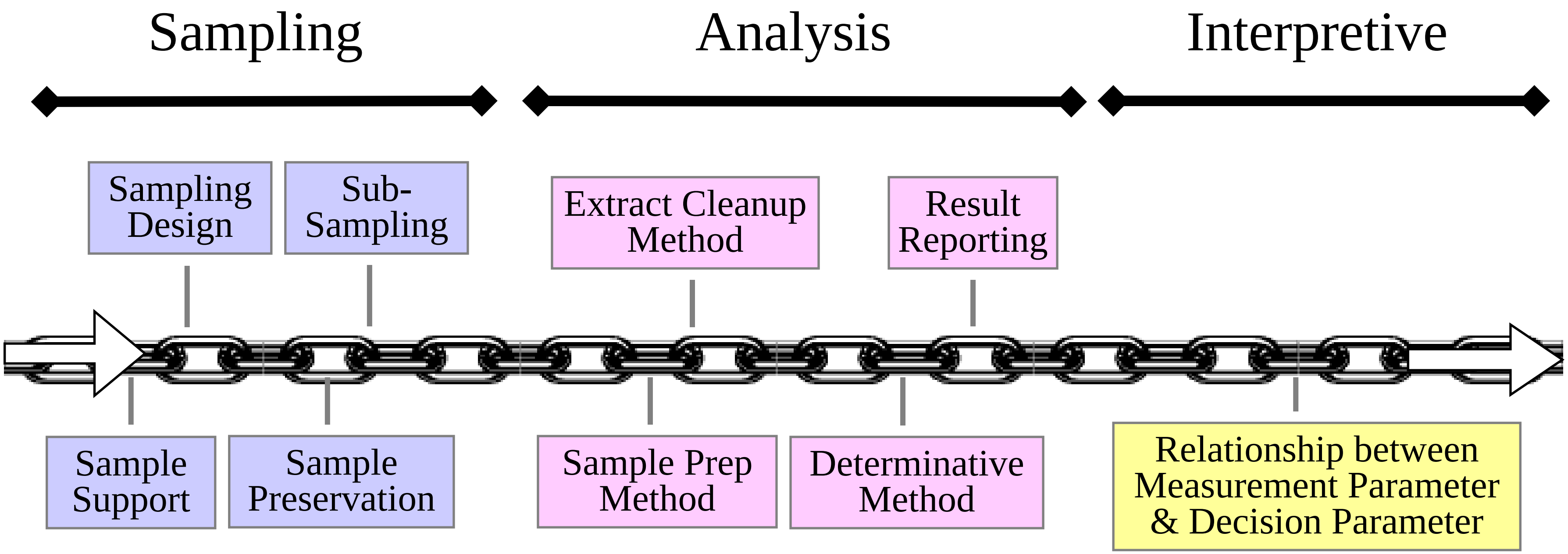
Real-time Measurement Technologies

Managing <u>Decision</u> Uncertainty is the keystone concept that integrates the 3 “how to” Triad elements

Triad Approach Embraces Innovative Tools & Strategies

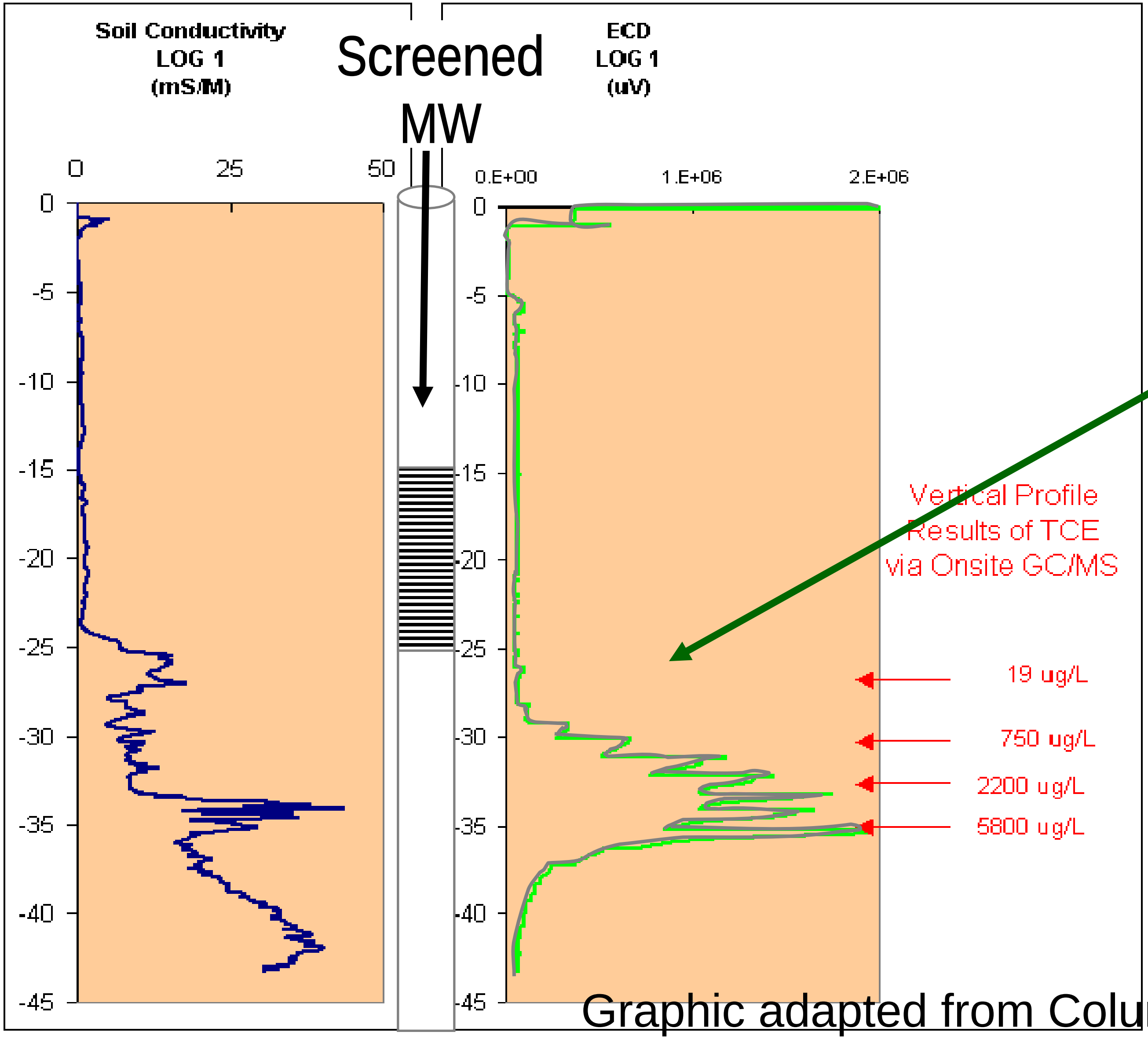
- Triad is a technical framework of best practices for cleaning up contaminated sites.
- The Triad framework
  - builds on 30+ yrs of institutional experience, and
  - exploits advancing science & technologies
  - assumes that intensive planning yields benefits that exceed the considerable effort
- Goals of the Triad framework:
  - **Transparency, consensus** & high scientific confidence in project decisions
  - reduce project lifecycle timeframes & costs

Data Interpretation Must Consider More than Just the Analytical Method



GW sample results & their proper interpretation are highly dependent on “sample support” and sampling design

Advances in Sampling & Measurement Technologies Highlight GW Sample **Representativeness Issues**



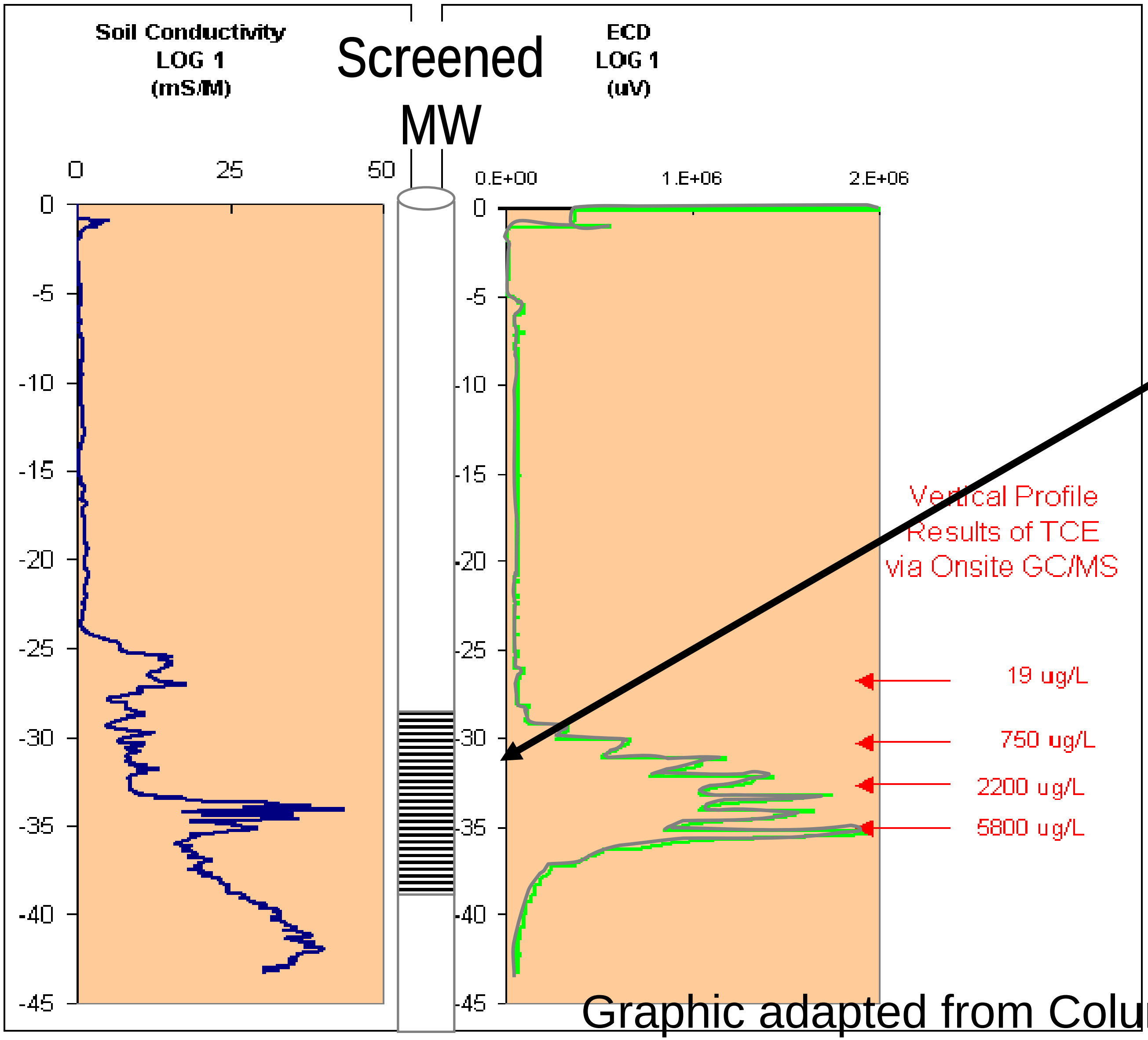
Graphic adapted from Columbia Technologies

Sequence: Slide #1

DP-MIP sensor depth-response log

What TCE conc can be expected from the purged, screened interval sample?

Advances in Sampling & Measurement Technologies Highlight GW Sample **Representativeness Issues**



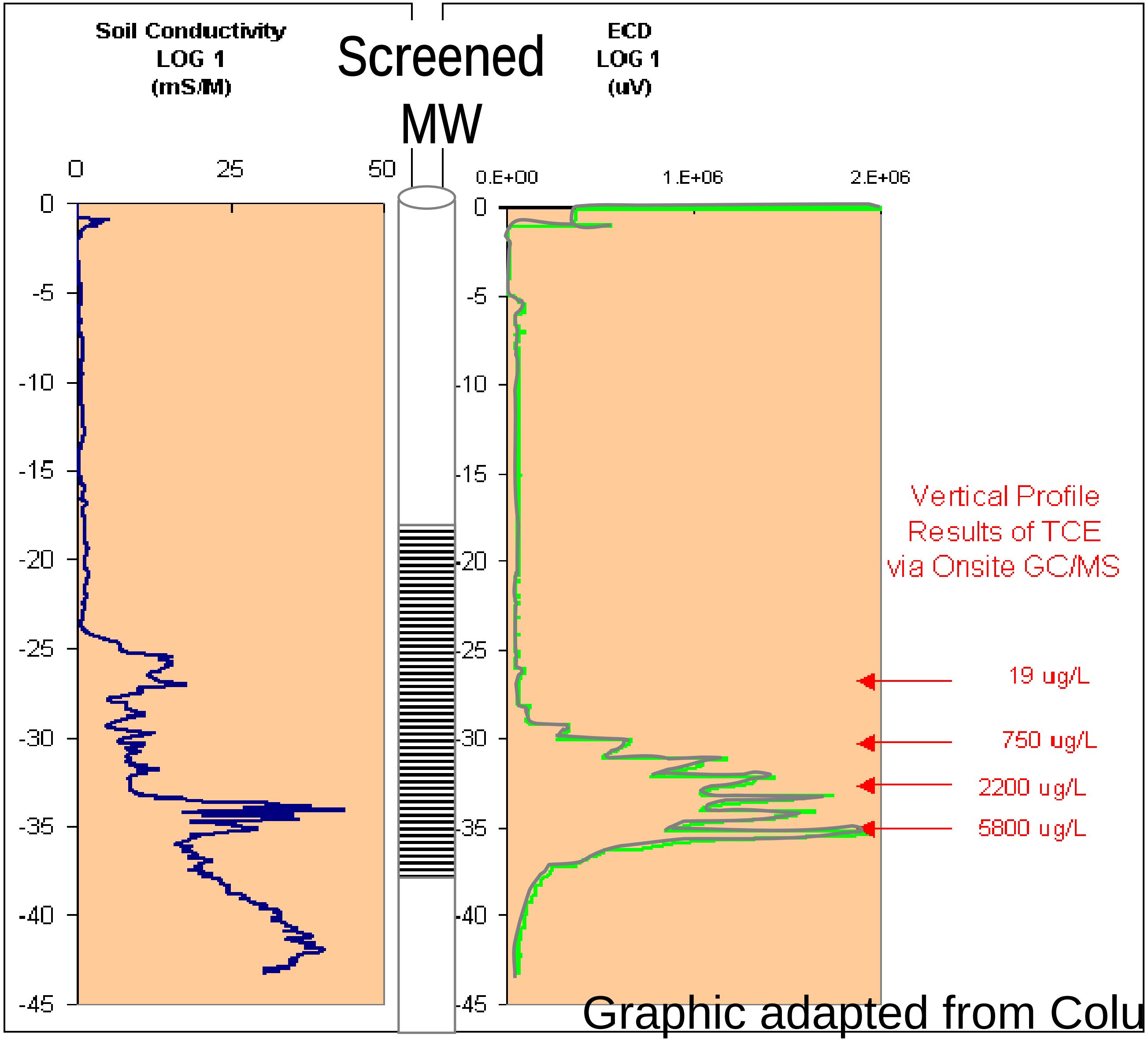
Graphic adapted from Columbia Technologies

Sequence: Slide #2

If the well is screened a few feet deeper…

…NOW, what TCE conc can be expected from the purged, screened interval sample?

Advances in Sampling & Measurement Technologies Highlight GW Sample **Representativeness Issues**



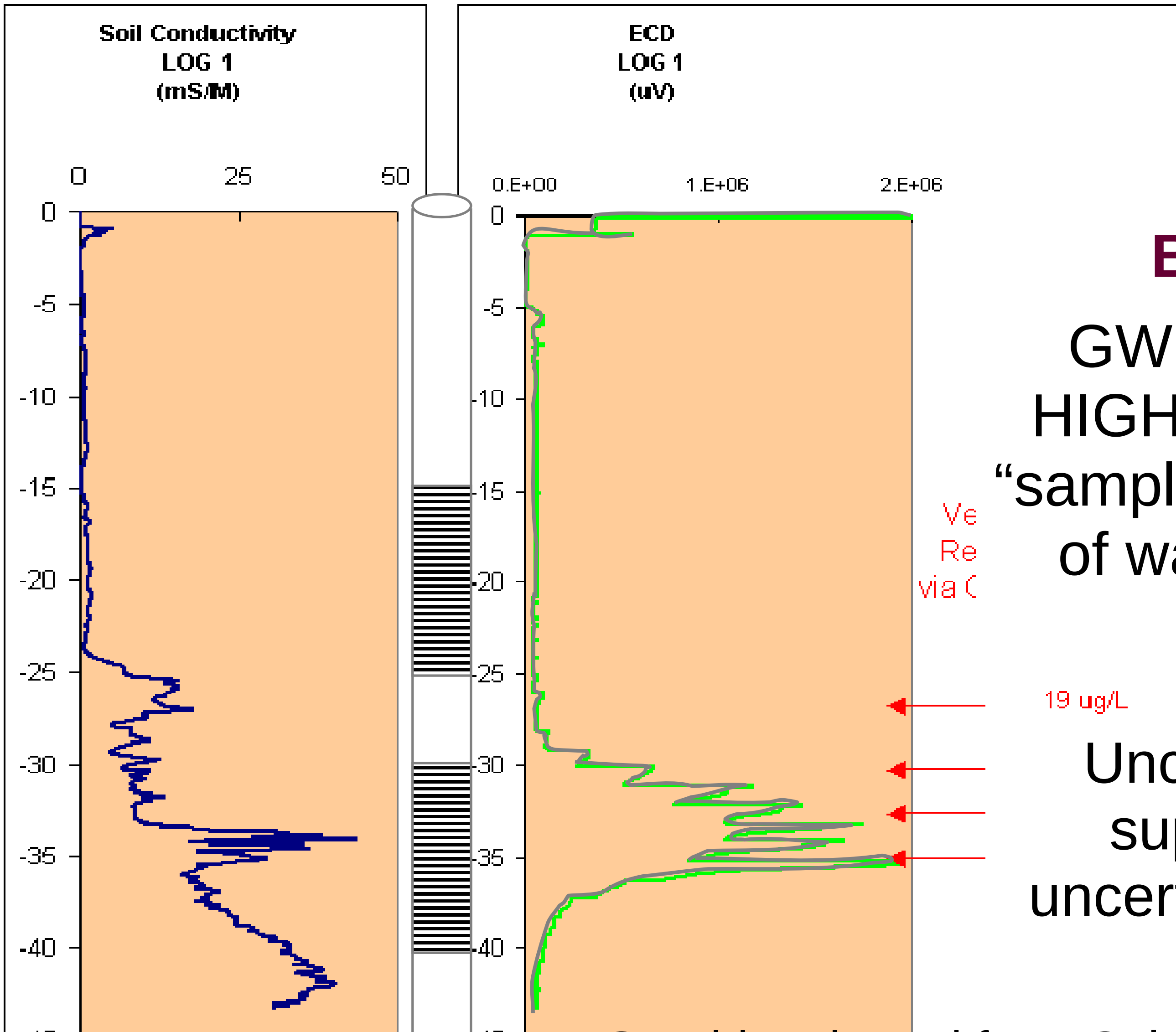
Graphic adapted from Columbia Technologies

Sequence: Slide #3

If the well screen is longer…

…NOW, what TCE conc might be expected?

Advances in Sampling & Measurement Technologies Highlight GW Sample **Representativeness Issues**



Graphic adapted from Columbia Technologies

Sequence: Slide #4

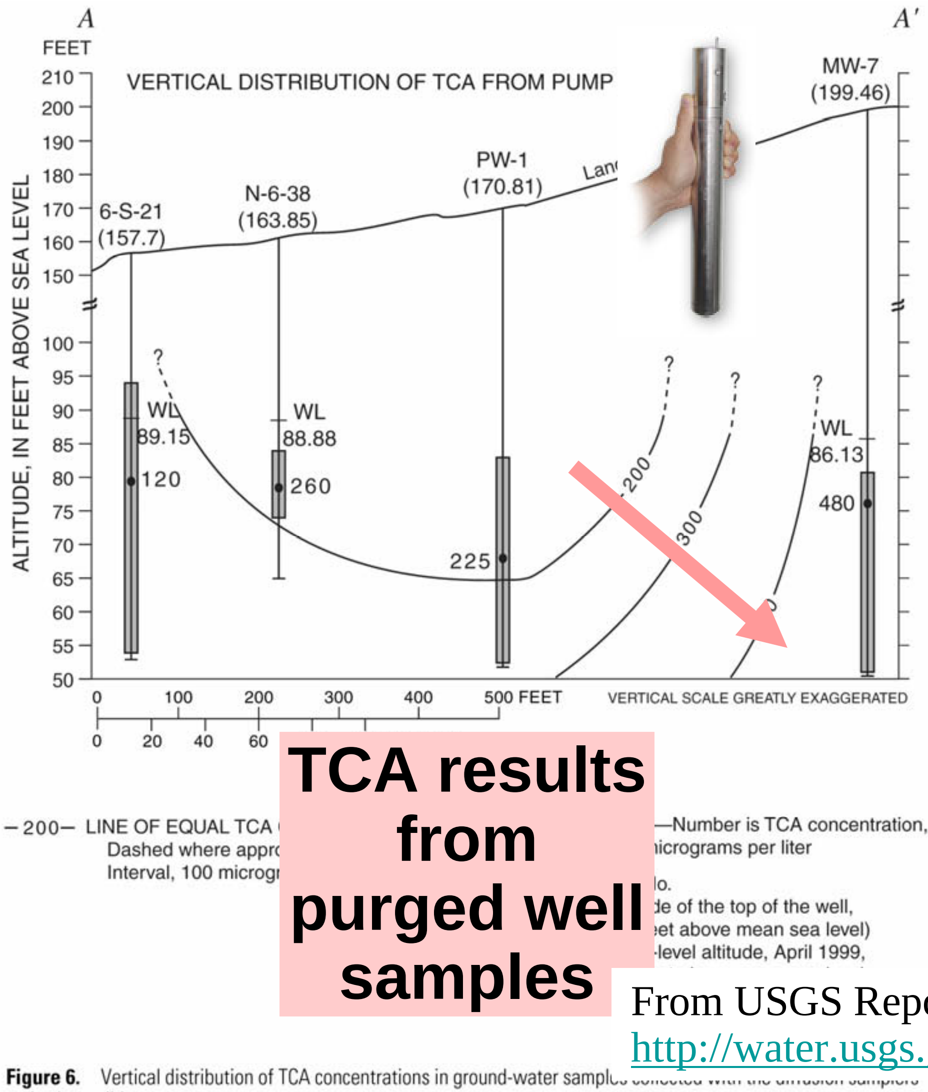
Bottom Line:

GW data results are HIGHLY dependent on “sample support” (volume of water mixed into a single unit)

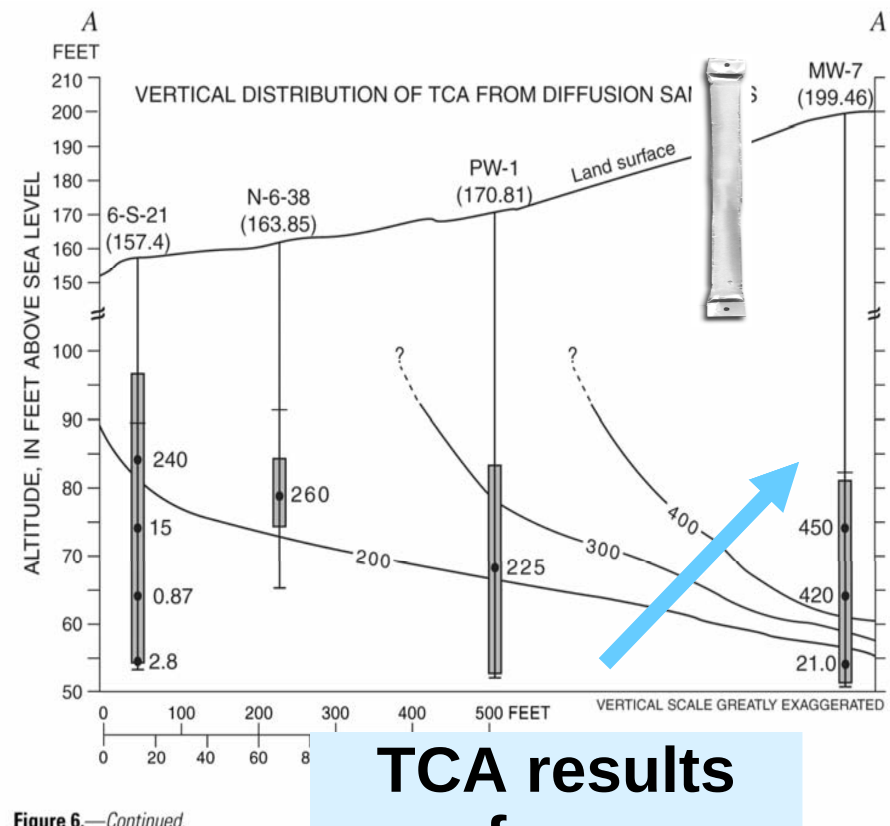
Uncontrolled sample support introduces uncertainty into GW data

Different GW Sampling Scales → Different Results → Different CSMs

same well field…2 different sample collection techniques



TCA results from purged well samples



TCA results from depth-discrete samples

From USGS Report 02-4203 (2002)
http://water.usgs.gov/pubs/wri/wri024203/

Smaller Sample Supports Avoid Mixing Distinct GW Populations & Produce More Accurate GW CSMs

PDB Sampler Data (solid lines) vs Pumped Sample Data (dashed lines)

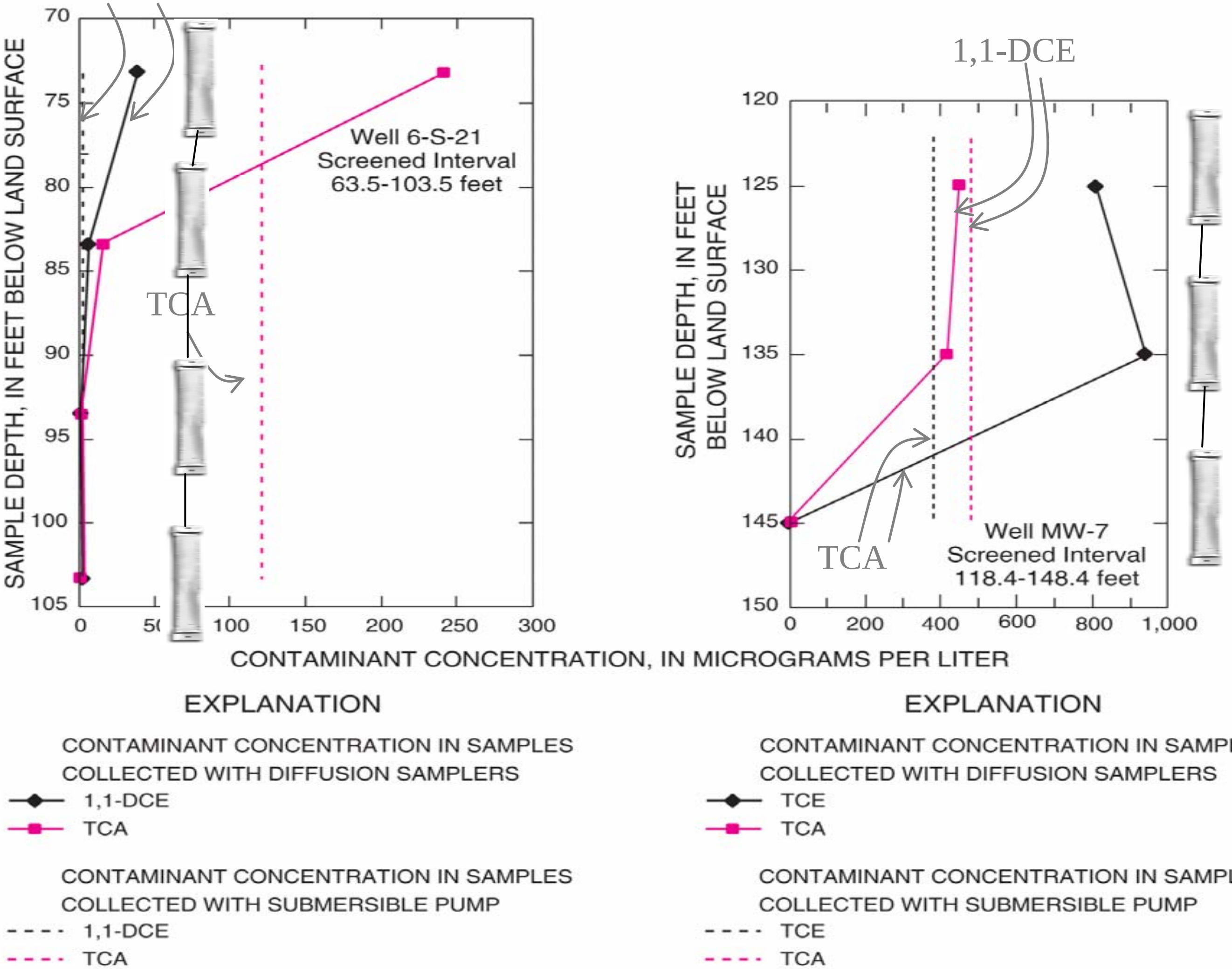
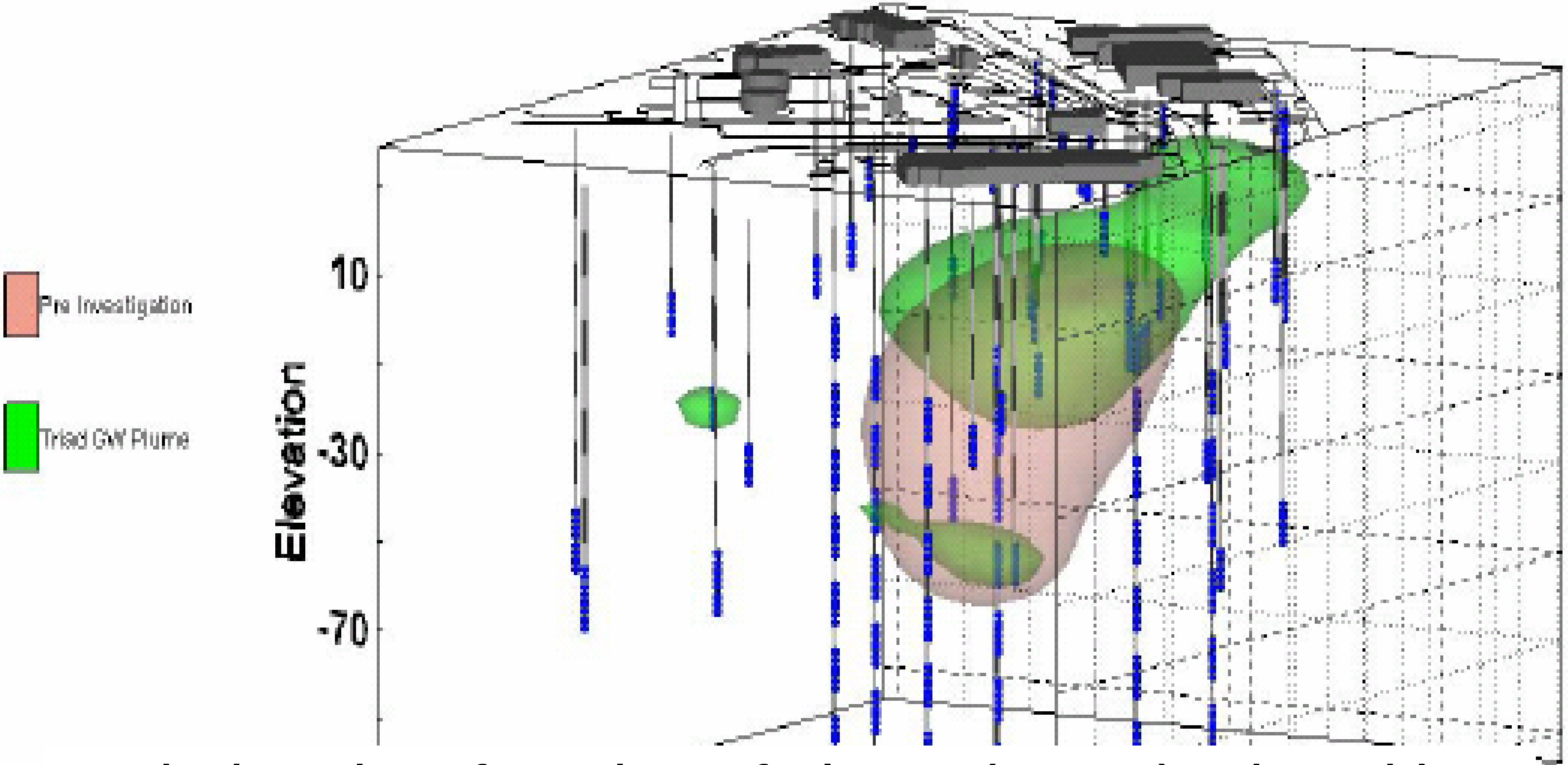


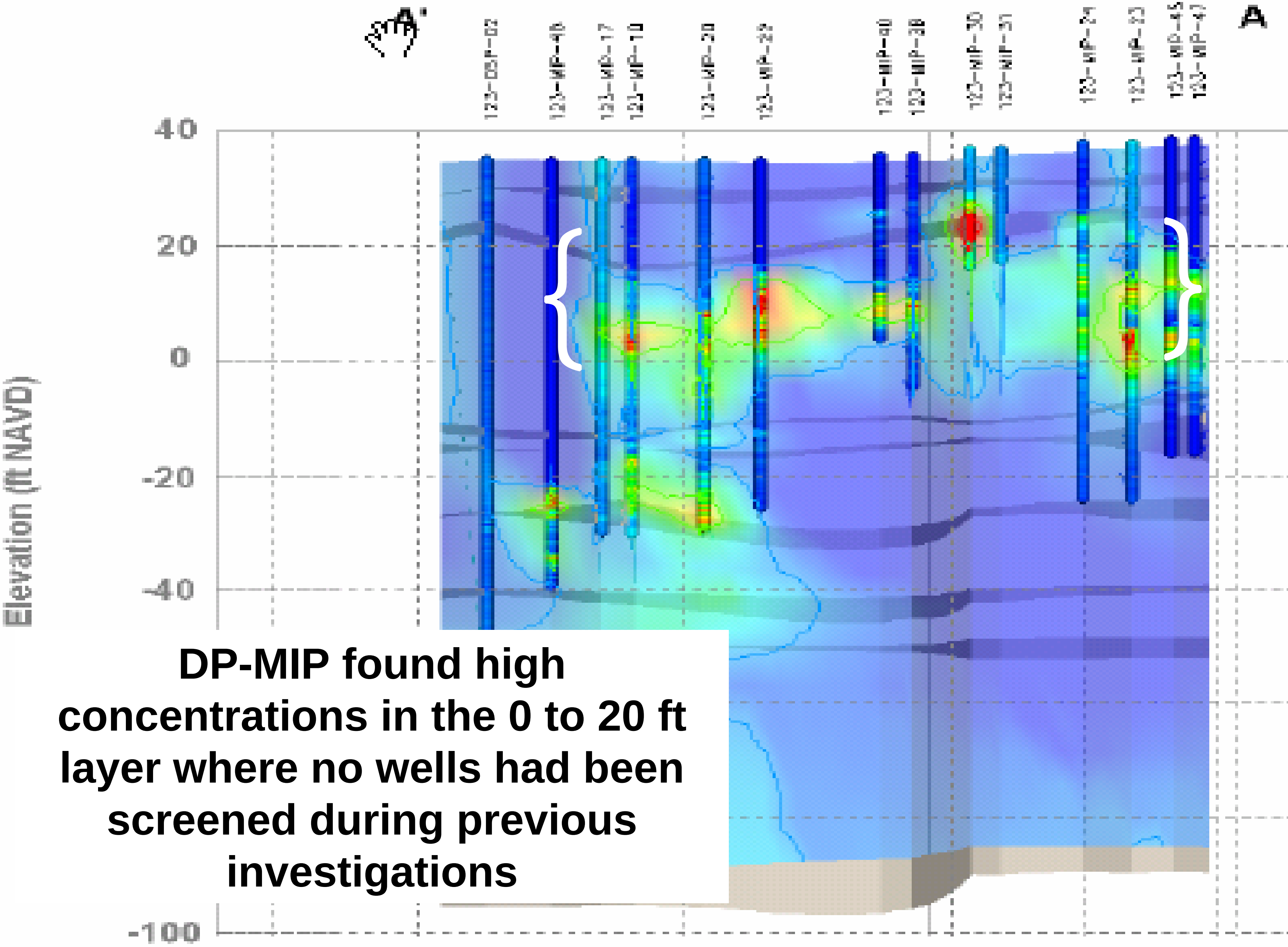
Figure 5. Comparison of selected volatile organic compound concentrations from ground-water samples collected with diffusion samplers and a submersible pump for wells with greater than 20-foot screened intervals in Area 6, Naval Air Station Whidbey Island, Washington.

From USGS Report 02-4203 (2002); http://water.usgs.gov/pubs/wri/wri024203/

Sampling Design: Where (in 3 dimensions) are samples or readings taken?

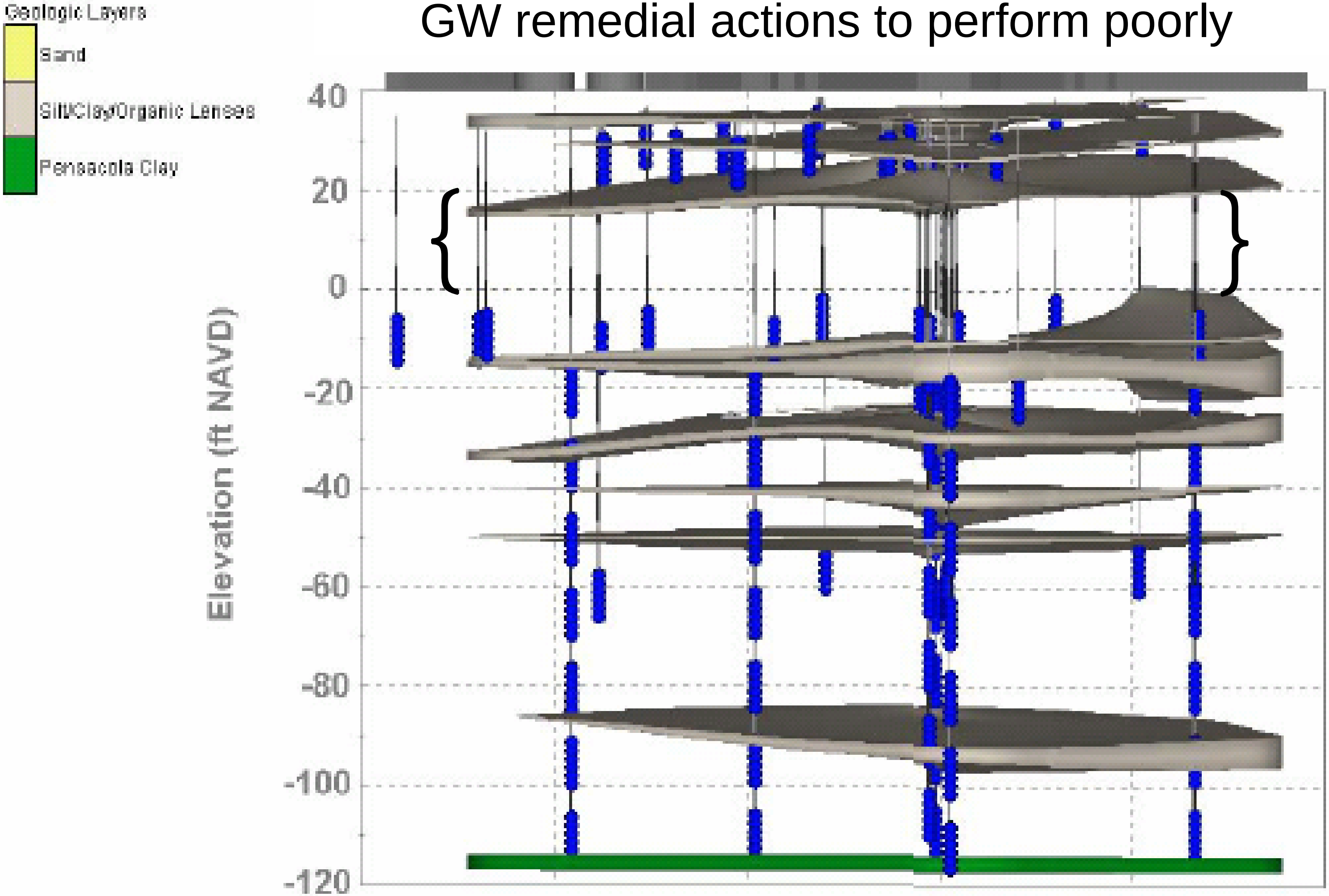


Triad project found ½ of plume (green) missed by 10 years of traditional characterization



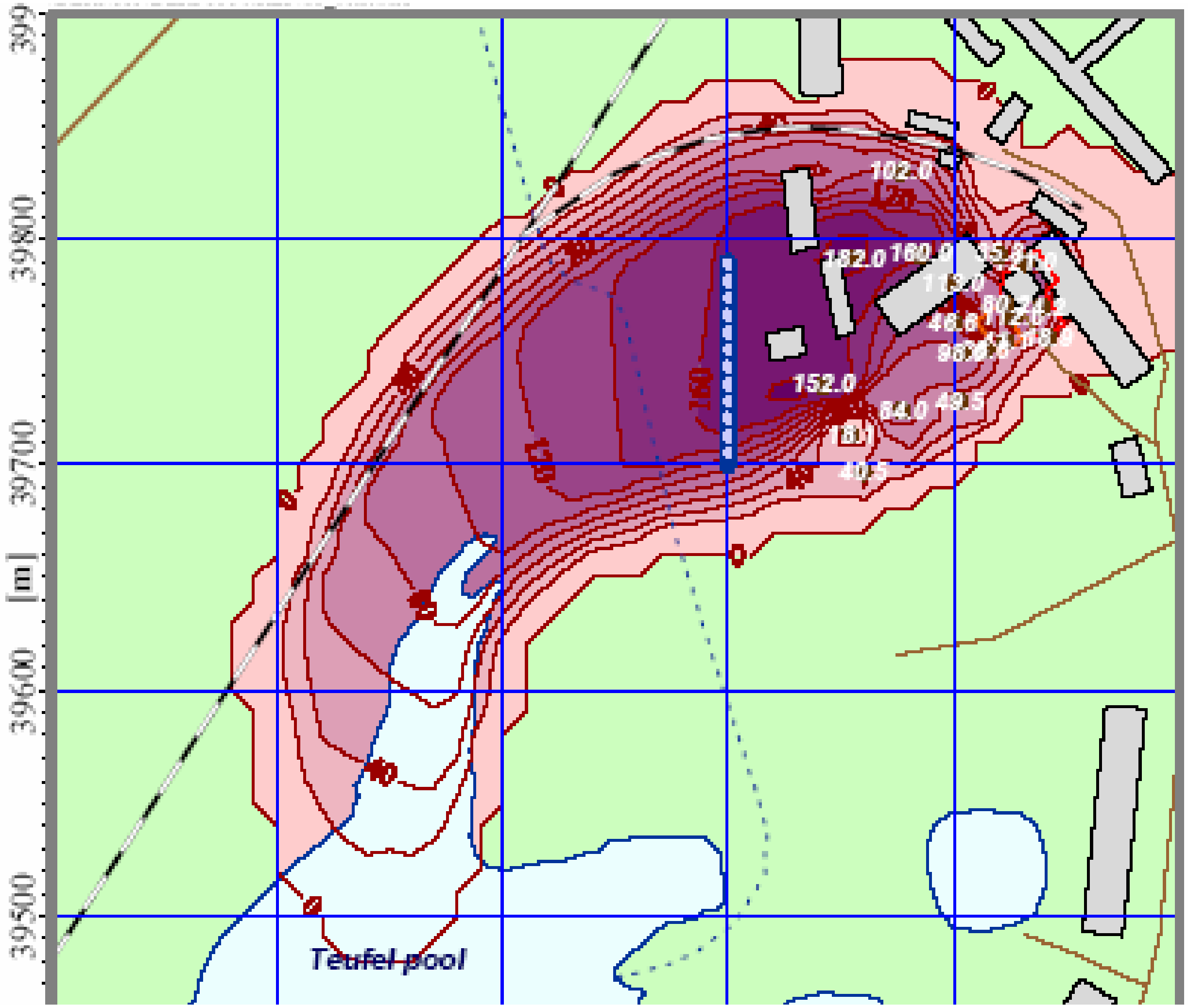
DP-MIP found high concentrations in the 0 to 20 ft layer where no wells had been screened during previous investigations

Missing the "hottest" layer for 10 years caused GW remedial actions to perform poorly



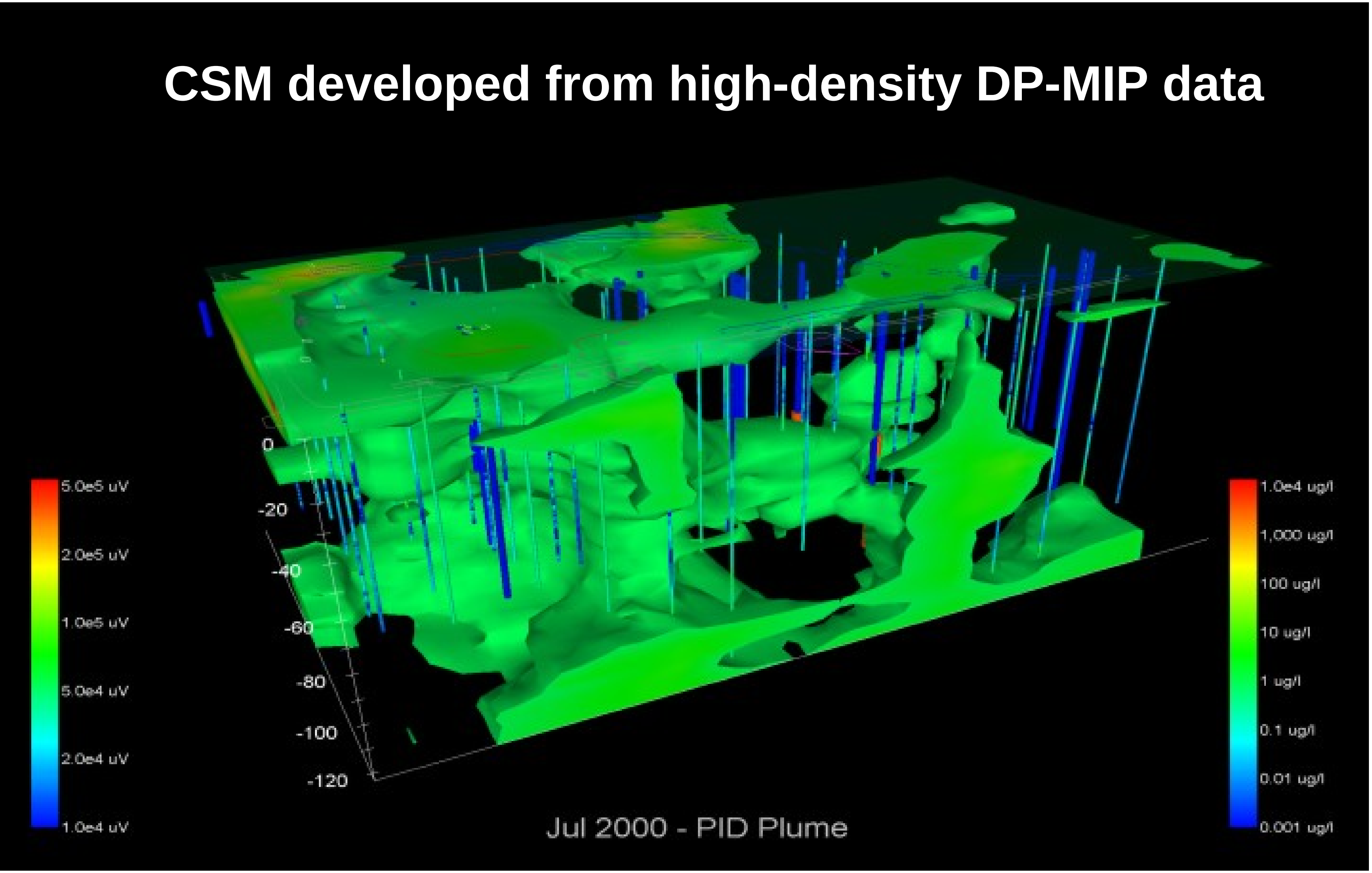
The Biggest Cause of Misleading Data

We can model the plume to be nice & tidy…



…but, successful cleanup depends on a design that can accommodate the actual contaminant distributions…

…and actual distributions are a lot messier than models can predict.



Adapted from Columbia Technologies, Inc., 2003

Mother Nature Can Fool You!

- The complexity of aquifers & the subsurface means that any single test or analytical method provides just a small bit of information
- Interpreting the meaning of that tiny bit in isolation will likely result in decision errors
- Since many physical properties of aquifers affect contaminant behavior, they are important to accurate interpretation of chemical data
- Good science (like a good legal argument) will use a **weight of evidence** approach

Use the CSM as a Scientific Hypothesis

The CSM is the basis of all site decisions about risk, remediation, closure & reuse. It integrates all available evidence & predicts when more is needed.

Iterative CSM maturation process

The Triad Framework assumes that advancing science & technology will be constantly bringing new & better tools to the cleanup community.

The Triad Framework's grounding in **uncertainty mgt** means that any new technologies or scientific advancements that increase the usefulness & accuracy of information are eagerly welcomed!

The Triad initiative works to make regulatory systems more welcoming to beneficial new technologies & strategies!

Progress is often preceded by the need to shatter the assumptions that underlie state-of-the-art (mainstream) thinking and reset default values.

--Daniel Schneck, PhD

Virginia Polytechnic Institute, 2007