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
Managing Decision Uncertainty is the keystone concept that integrates the 3 “how to” Triad elements.
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.
What TCE conc can be expected from the purged, screened interval sample?

Sequence:
Slide #1

DP-MIP sensor depth-response log

Vertical Profile Results of TCE via Onsite GC/MS

- 19 ug/L
- 750 ug/L
- 2200 ug/L
- 5800 ug/L

Graphic adapted from Columbia Technologies
NOW, what TCE conc can be expected from the purged, screened interval sample?

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

Sequence:

Slide #3

If the well screen is longer...

...NOW, what TCE conc might be expected?
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 $\rightarrow$ Different Results $\rightarrow$ Different CSMs

same well field...2 different sample collection techniques

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)

EXPLANATION
CONTAMINANT CONCENTRATION IN SAMPLES COLLECTED WITH DIFFUSION SAMPLERS

- 1,1-DCE
- TCA

EXPLANATION
CONTAMINANT CONCENTRATION IN SAMPLES COLLECTED WITH SUBMERSIBLE PUMP

- 1,1-DCE
- TCA

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

Triad project found $\frac{1}{2}$ 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

Heterogeneity Rules!

You Can't Fool Mother Nature
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.
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
The CSM is the basis of all site decisions about risk, remediation, closure & reuse. It integrates all available evidence & predicts when more is needed.

Preliminary CSM predicts contaminant distributions: Prepare SAP

Develop new SAP to test new predictions

Test predictions: Data confirms or modifies predictions

Mature CSM -- the basis for decisions & subsequent activities

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