Improving Long Term Monitoring: Sampling Variability Reduction / Better Data Trends

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Impact of random error

30% and 10% Random error added/subtracted from Simple Declining Trend graph; trend visible much sooner with less random error
Variations during well purging

What controls flow-weighting *during pumping*?

- Contaminant stratification
- Inflow distribution
- Pump position relative to stratification

What is passive groundwater sampling?

- Rather than actively pumping, passive sampling takes advantage of existing ambient flow in the aquifer to deliver formation water to the well screen and sampling device.

- Dispersion and diffusion of contaminants within the screen zone normally results in a flow-weighted average concentration of contaminants within that zone.

- Sampling from within the well screen without disturbing any stagnant water above or below the intake results in a representative sample without purging the well.
Types of Passive & No-Purge Samplers

- **Diffusion Samplers**: analytes reach and maintain equilibrium via diffusion through membrane or small pores in sampler body.

- **Equilibrated Grab Samplers**: remain in the well before sampling, then collect a whole-water sample when activated.

- **Accumulation Samplers**: rely on diffusion and sorption to accumulate analytes in sampler.
Published in 2007, the ITRC guidance document covers a wide range of passive and no-purge samplers, including the Snap Sampler, PDB samplers, sorptive samplers (e.g., Gore Sorber) and the HydraSleeve sampler.


Published in 2014, the ASTM standard defines passive sampling to exclude no-purge samplers like the HydraSleeve.

http://www.astm.org/Standards/D7929.htm
Passive Flow-Through Concepts

Conditions tested by Britt, 2005 – density contrast, mild heterogeneity

Testing the theory of in-well mixing

How does a well behave between sampling events?

Dye source with gravity feed to injection port

Inflow and residence time yields **flow-weighted mixing**, which can be stratified or relatively homogenized.

- Central entry zone
- Vertical redistribution
Passive wellbore flow conclusions

Field demonstration of in-well mixing

Baffle device installed between samplers to inhibit in-well mixing

Britt, SL and Calabria M, 2008, Battelle Conference Poster
Comparison: Snap Sampler vs Low-flow Purging

Britt, SL, Parker, BL, and Cherry, JA, 2010, A Downhole Passive Sampling System to Avoid Bias and Error in Groundwater Sample Handling, *Environmental Science and Technology*, v.44 p 4917-4923
Snap Sampler System Components

Each well has FOUR components:

- **Well Cap** - 2” (50 mm) or 4” (100 ml)
- **Trigger**
  - Pneumatic, any depth
  - Manual – limited to 40’ (12 m)
- **Snap Sampler Modules**
  - 40ml VOA vial size
  - 125ml/350ml Poly bottle size
- **Bottles**
  - 40ml VOA vial pack (2 bottles)
  - 125ml Poly
  - 350ml Poly
How the Snap Sampler works:

1. Insert vial
2. Load bottle
3. Rotate to set caps

- 40mL VOA vial
- 125mL or 350mL HDPE bottle
The Snap Sampler process

Load... ...Lower... ...Leave...

Return... ...Retrieve... ...Redeploy
Are there differences between passive methods?

Examples from McClellan AFB Study

<table>
<thead>
<tr>
<th>3 vol purge vs:</th>
<th>Y-slope (RECOVERY)</th>
<th>R² (SCATTER)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>1.04</td>
<td>0.90</td>
</tr>
<tr>
<td>PDB</td>
<td>0.75</td>
<td>0.58</td>
</tr>
<tr>
<td>RPPS</td>
<td>0.63</td>
<td>0.70</td>
</tr>
<tr>
<td>HS</td>
<td>0.59</td>
<td>0.50</td>
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</tbody>
</table>

Parsons, 2005, Demonstration of No-Purge Groundwater Sampling Devices, McClellan AFB, Sacramento, CA
Comparison: Snap Sampler vs a “no-purge” method

Snap Sampler 2x higher: 6 (5%)
Snap Sampler 10x higher: 2 (2%)
Purge sample 2x higher: 5 (4%)
Purge sample 10x higher: 0 (0%)

HydraSleeve 2x higher: 3 (2%)
HydraSleeve 10x higher: 1 (<1%)
Purge 2x higher: 53 (37%)
Purge 10x higher: 22 (15%)

Effect of Sample Method: Variability

<table>
<thead>
<tr>
<th>Method</th>
<th>Median Pair-Wise Variability (%)</th>
<th>90th Percentile Pair-Wise Variability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Flow Standard</td>
<td>24%</td>
<td>94%</td>
</tr>
<tr>
<td>Alt. Low Flow (Small Volume)</td>
<td>20%</td>
<td>99%</td>
</tr>
<tr>
<td>Alt. Low Flow (Large Volume)</td>
<td>21%</td>
<td>88%</td>
</tr>
<tr>
<td>Passive No Purge (SNAP)</td>
<td>22%</td>
<td>129%</td>
</tr>
<tr>
<td>Active No Purge (HydraSleeve)</td>
<td>43%</td>
<td>502%</td>
</tr>
</tbody>
</table>
Real world impact on data variation

Data Noise Reduction

Value: Better Decisions

Project site in Los Angeles, site data from 2003 through 2011, unpublished
QUESTIONS?

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