



# Vertical delineation of contamination in aquifers with radiological contaminants

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## The challenge

**The Challenge:** Legacy and newer long-screened wells (LSWs) common at many sites with radiological contamination impede vertical delineation of contamination. This is well known:

- Papers on sampling in LSWs going back to the 1980's (e.g., Tom Reilly)
- Papers on cross contamination (e.g., Sterling et al.)
- Papers on new technologies (you all!)

**A Way Forward:** New approaches and technologies, including some that are well established in other applications.

- Better ways of multi-level sampling
- Better quantification of contaminant mass
- Optimal of extraction
- Optimal emplacement of amendments
- Prevent vertical cross contamination

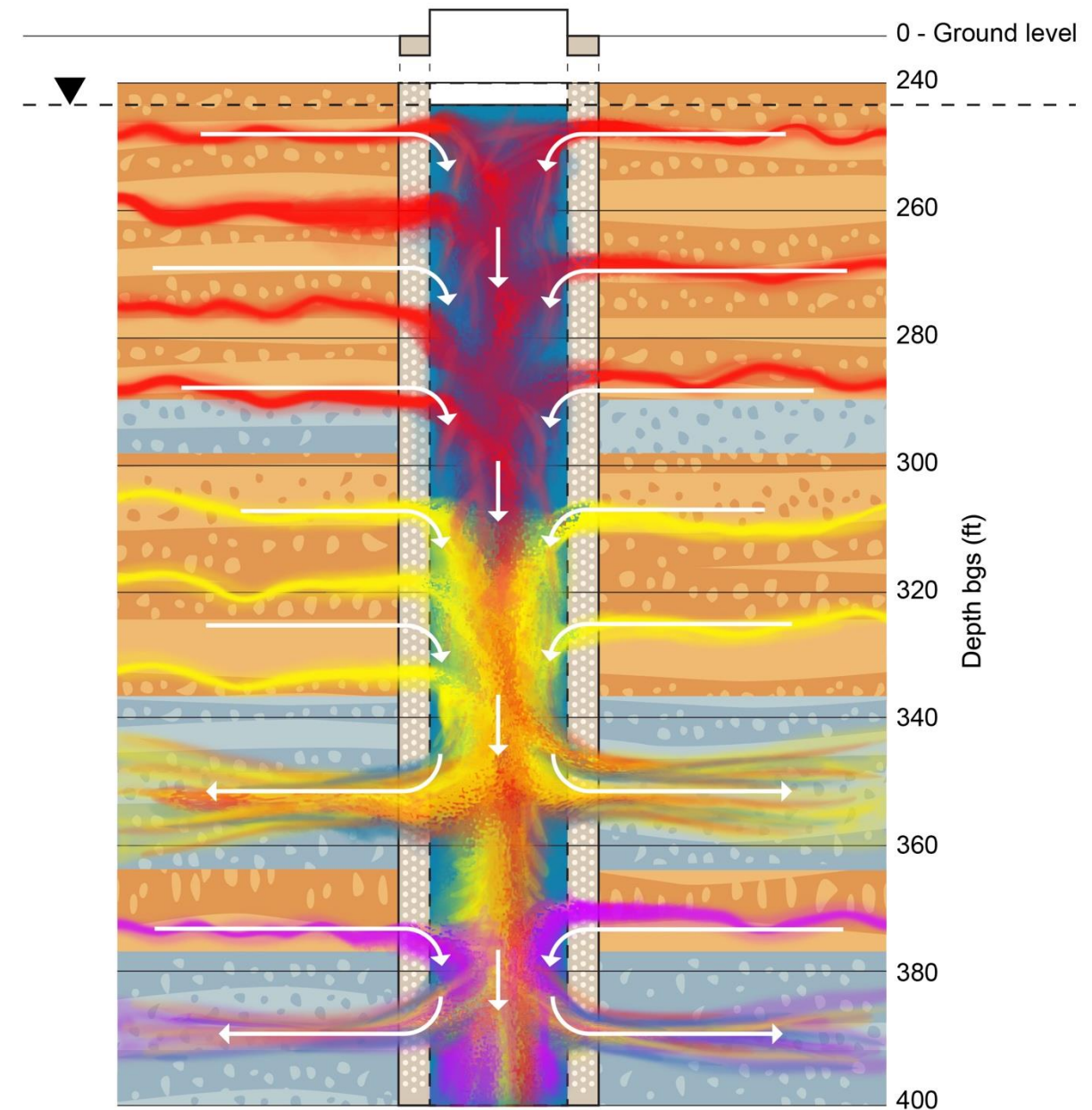
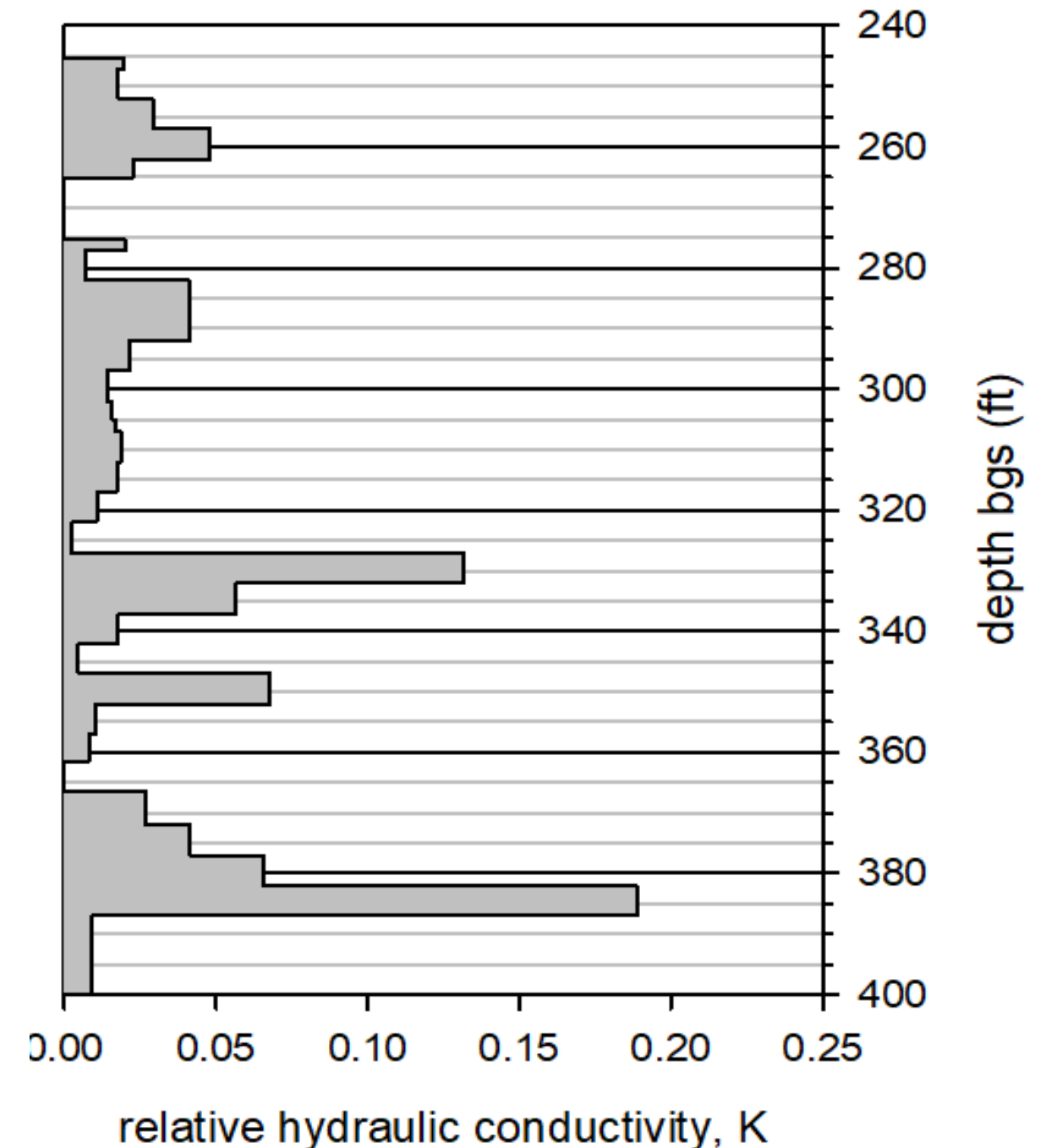


Figure 1. Possible flow patterns and contaminant mixing in a well

## Challenge: Intraborehole Flow

**Intraborehole flow (IBF):** “If a well has an appreciable screen length or open interval, the groundwater inflow distribution during pumping will be a function of the hydraulic head and conductivity distribution across the screened or open interval.” (Poulsen et al. 2018)

*Figure 2. Representation of flow and K profile within a long-screened well at Hanford*



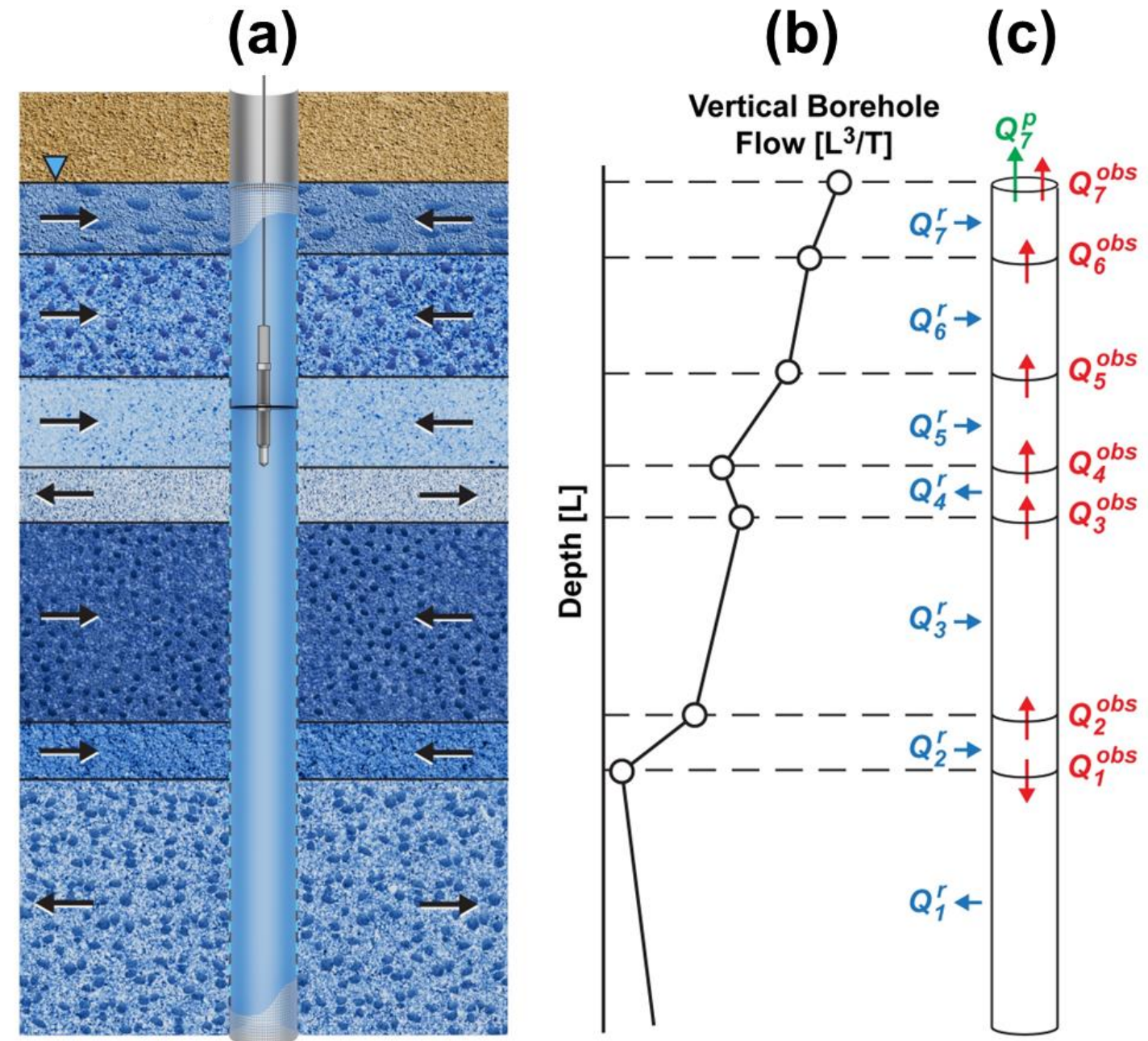
# Approaches

New field and analysis methods:

- Flowmeters
- Fiber optic DTS/DAS
- Geophysical methods
- Dilution/fluid replacement/FEC logging
- Tracer flowmeter & depth dependent sampling

New well design and completion technologies:

- Well liners
- Packer systems





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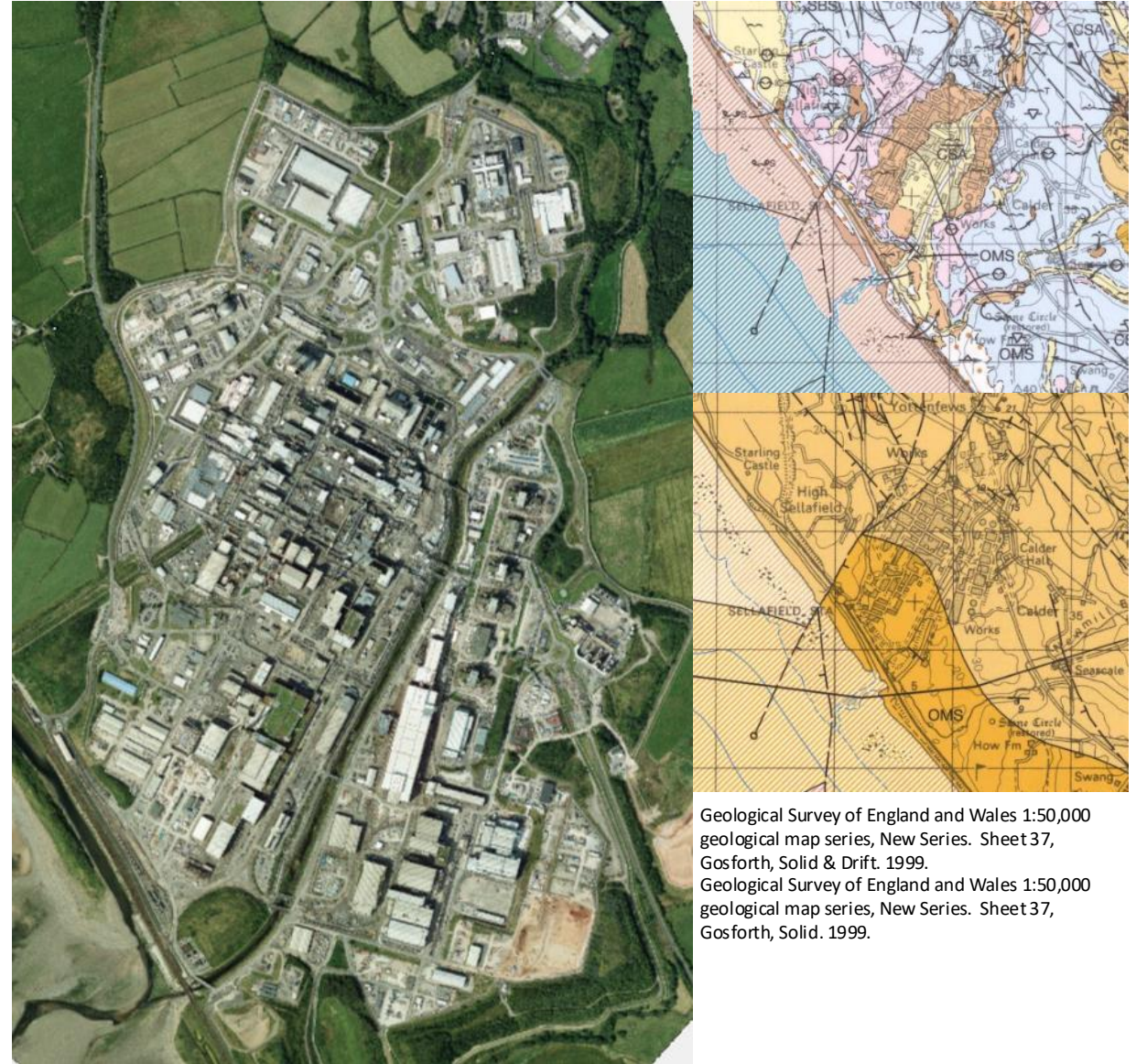
**Thank you**



# Depth specific sampling at Sellafield

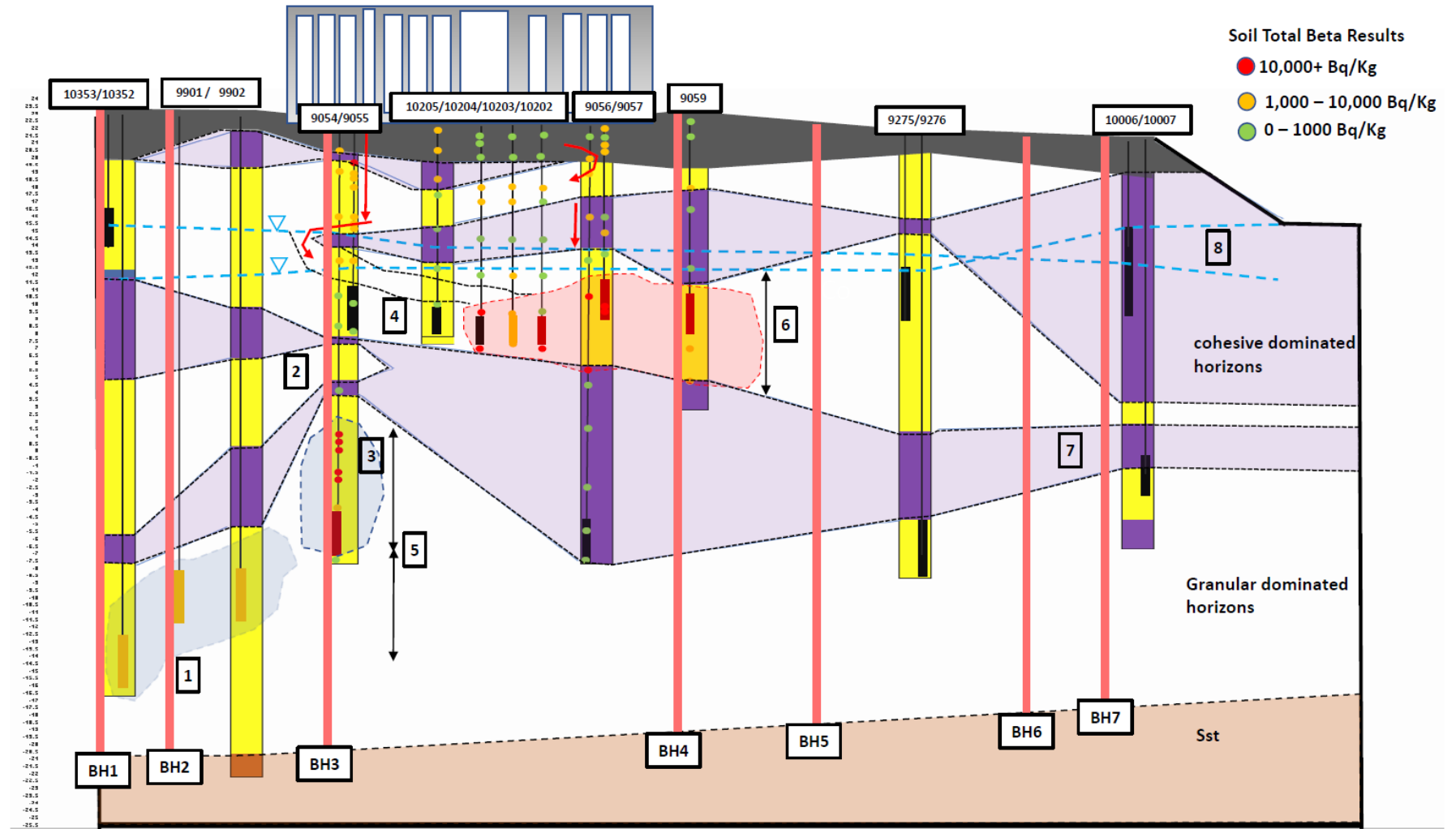
# The Sellafield Context

- Congested site
- Highly complex geology → hydrogeology
- Multiple contamination sources
- ‘Conventional’ monitoring programme
  - Single well piezometers
  - Some nested piezometers and well clusters
- We know we have vertical contaminant heterogeneity
  - Why have we ignored this in our monitoring programme?
  - Some improvement in progress



Geological Survey of England and Wales 1:50,000 geological map series, New Series. Sheet 37, Gosforth, Solid & Drift. 1999.  
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- The Magnox Swarf Storage Silos (MSSS) are the biggest source of contamination
- We know contamination is present at various depths
- We have some good soil contamination profiles
- We have poor vertical groundwater coverage
- We are trying to address this



NB cross section not to scale – illustrative. Geological units inferred by correlating clay/silt rich zones/horizons and sands/gravel rich zones/horizons. Do not represent discrete, continuous strata

# Morwick G360 multi-level system installations



# Improving vertical understanding of contamination

- We know we have complex hydrogeology, incl. vertical flows
- We know we have a complex vertical distribution of contamination
- We know we don't know enough about the dynamics of groundwater contamination
- Investigation is expensive and difficult (contamination and built environment challenges)
- Budgets are limited
- How can we do better?
- Does it matter?