Quality Management of site investigations

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Background

- All site investigations are associated with uncertainties

The acceptable uncertainties depend upon:

- The objectives of the investigations &
- The risk associated with errors.

- The goal is a sufficient but not excessive investigation quality ("fitness for purpose").

Quality management

- To define the relevant quality ("fitness for purpose")
- To set up a plan for how this quality can be obtained
- To ensure that the quality aimed for is reached

Presentation

The presentation introduces:

- **A methodology for evaluation of groundwater monitoring uncertainty**
- **A methodology to assess soil gas investigations**

Groundwater case

- **An important drinking water resource for the city of Århus has been identified as at risk for deterioration of the quality due to intensive drinking water abstraction. A program is to be established in order to monitor the trend in water quality development.**
- **The methodology was developed to allow planning of groundwater monitoring and control with defined quality objectives**
- **The basic principles can be found in the guidelines for groundwater monitoring related to the EU groundwater directive (in preparation)**

Specifics

- Groundwater body: 2 km x 2 km x 10 m, starting 20-30 m below the surface.
- Glacial outwash sand with Miocene sands and clays below and glacial till above
- Several local aquifers and aquitards
- Natural quality of the groundwater is anaerobic with sulphate and reduced iron, without nitrate, hydrogen sulphide and methane
- Threat is oxygen intrusion as the result of the water abstraction and groundwater table draw down.

Investigation

- 9 wells sampled during surveillance monitoring
- 6 wells now available for sampling
- Aim: monitoring of one well twice per year
- Objective: 95% probability of recognising a 20% quality deterioration
- Target parameter: Dissolved iron (sensitive to aquifer oxidation: decreasing iron with increasing oxidation
- Supporting evidence: redox potential
- Oon-line indicators of sampling stability: Oxygen, pH, electrical conductivity and redox potential
- General groundwater quality parameters: sodium, calcium and chloride
- Only the two key parameters, dissolved iron and redox potential are discussed here.

Key parameters, surveillance monitoring (9 wells)

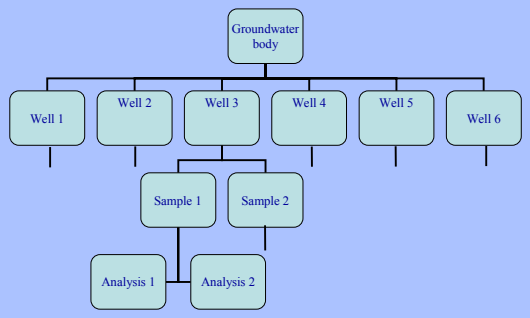
	Redox potential	Dissolved iron
	mV	mg/L
Mean	-123	1.11
Relative standard deviation	27%	56%
Main cause of uncertainty	Oxygen impact during sampling and on-line measurement	Filtering

Data Quality Objects

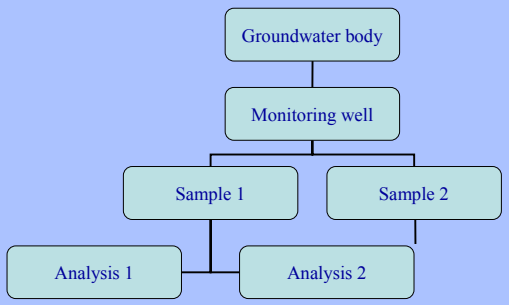
Meeting the monitoring objective requires:

- A measurement uncertainty including both sampling and analysis of not more than 10% (comparison of two means each for two samples, 95% confidence interval, two sided test) corresponding to an expanded measurement uncertainty of 20%.
- Control of systematic errors through comparison of results

Validation study



Quality control programme



Analysis of data

Calculation of uncertainties was done using:

- The range method (ISO 3085), http://www.samplersguide.com
- Analysis of variance (ANOVA) using ROBAN version 1.01 (University of Newcastle upon Tyne)

No great difference in results

Results

- Validation

	Analyses	Sampling	Between-target
Redox potential	5.2 %	15 %	14 %
Dissolved iron	2.1 %	10 %	35 %

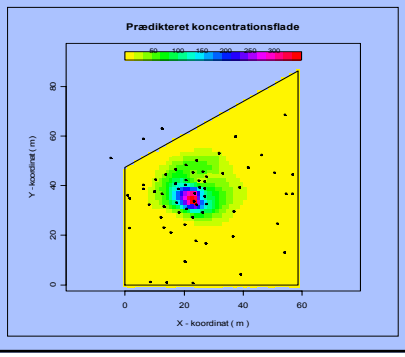
- Quality control

	Analyses	Sampling	Between-target
Redox potential	18 %	3.8 %	23 %
Dissolved iron	2.5 %	3.6 %	9.9 %

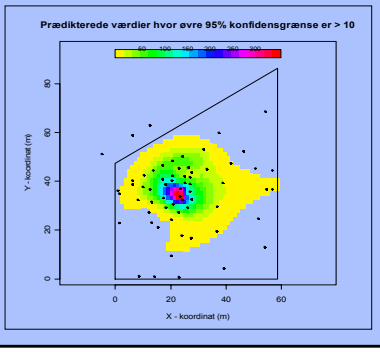
Pore gas case

- Site contaminated with chlorinated solvents
- Aim:
  Assessment of plume
  Assesment of excedance of criteria
  Assessment of uncertainty related to investigation
- Tool: Statististically based program developed for the Danish EPA

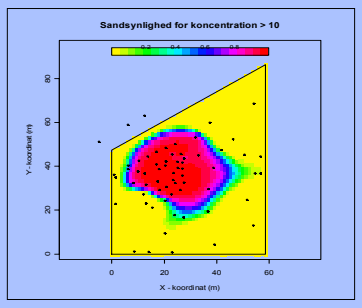
Predicted poregas concentrations



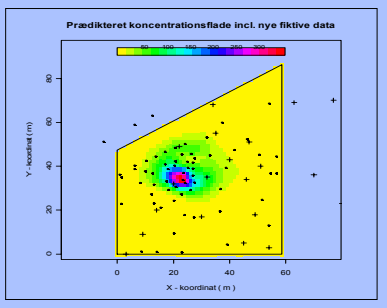
Predicted values > criteria (95% confidence)



Propability for concentration > criteria



Suggested new sampling points



Summary

- To be able to assess the quality of your decision on a contaminated site, you must set Data Quality Objectives
- To be able to do so, you must know something of the variability of the analysis the sampling and the heterogeniety:
  Use must have some data and they must be collected and anaysed in an appropriate fashion
- Uncertainty is not the problem; it is not knowing the uncertainty or addressing the uncertainty that is the problem