

Uncertainty from sampling groundwater

A triplicate approach

Christian Grøn, DHI

Mogens Wium, GEO

Lærke Thorling & Birgitte Hansen, GEUS



The quality chain



Define the required measurement quality from the purpose

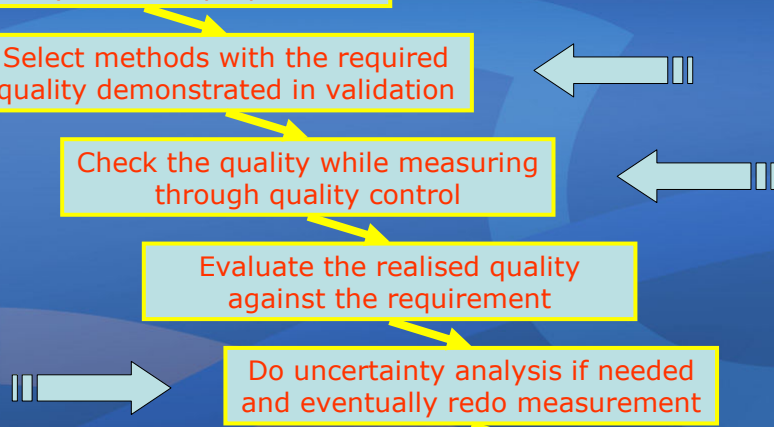
Select methods with the required quality demonstrated in validation

Check the quality while measuring through quality control

Evaluate the realised quality against the requirement

Do uncertainty analysis if needed and eventually redo measurement

Report measurements with quality information



Sampling for groundwater monitoring



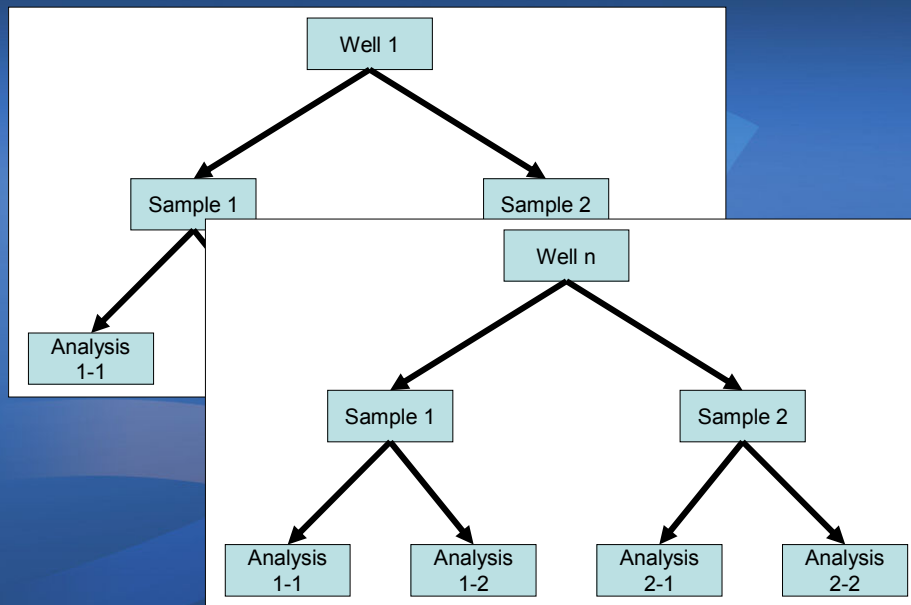
Profile_2

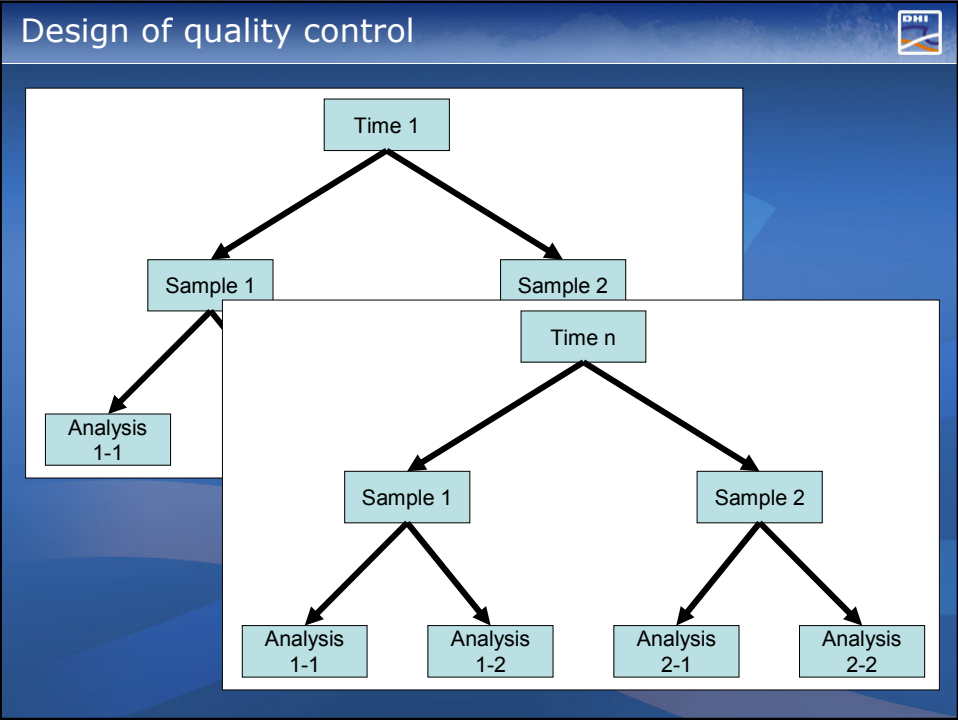
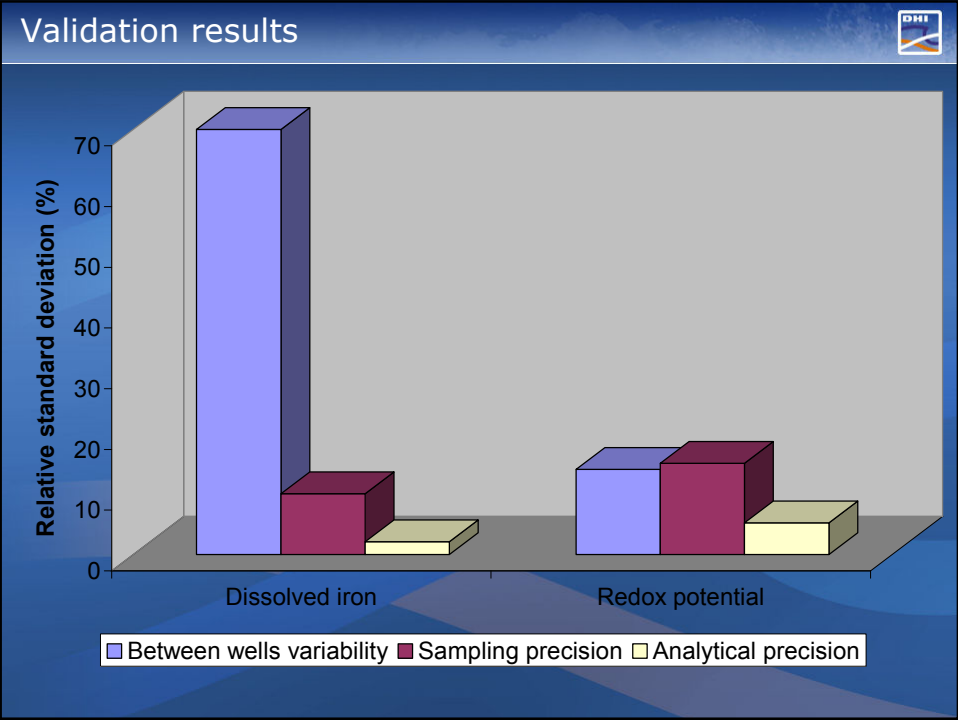
Monitoring of **dissolved iron** and redox potential

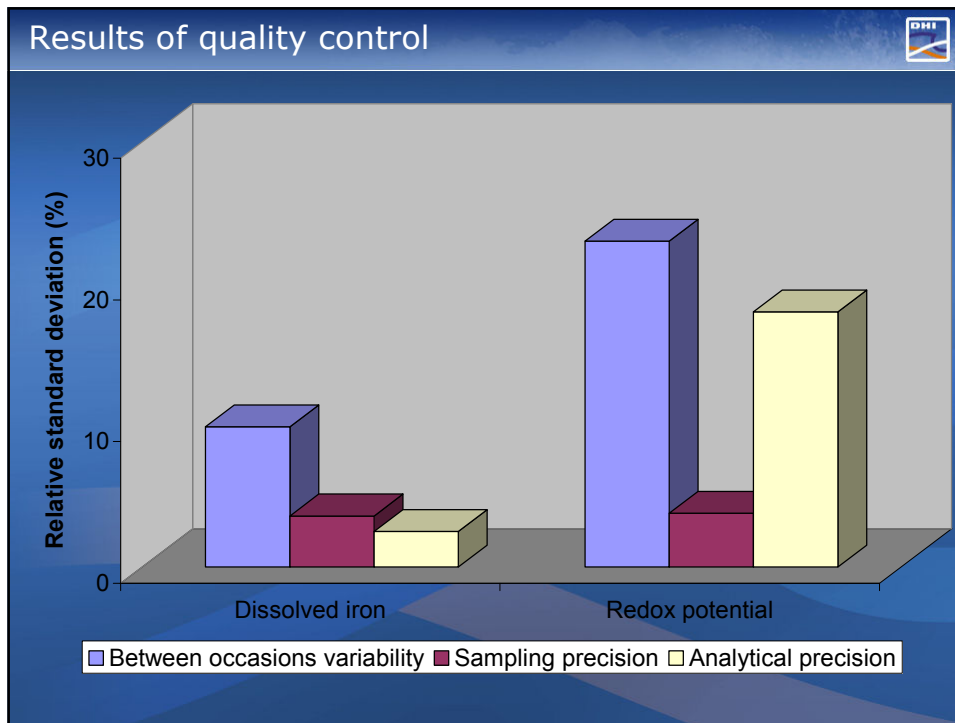
The purpose required 10% RSD

Profile_1, Map scale=5000, Vertical exag

Design of validation

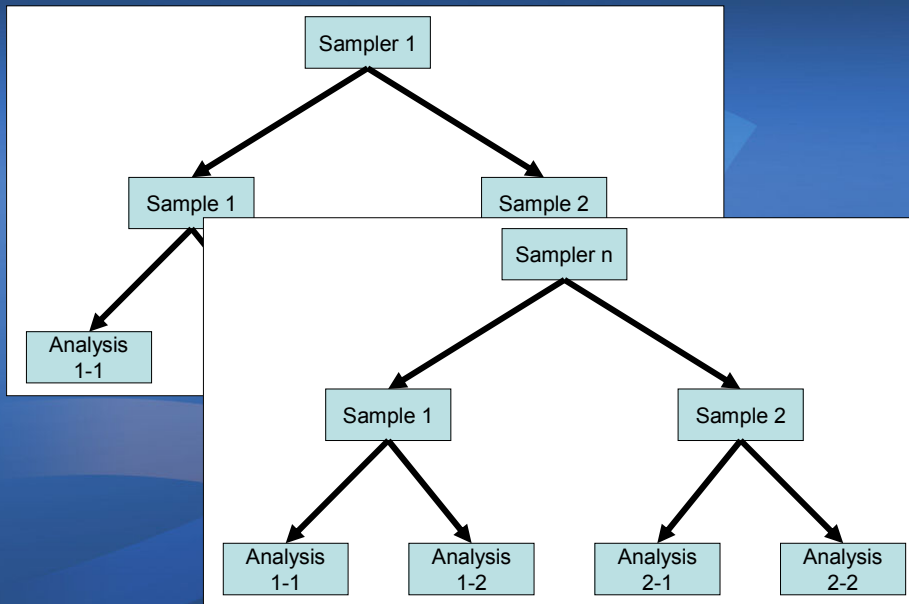




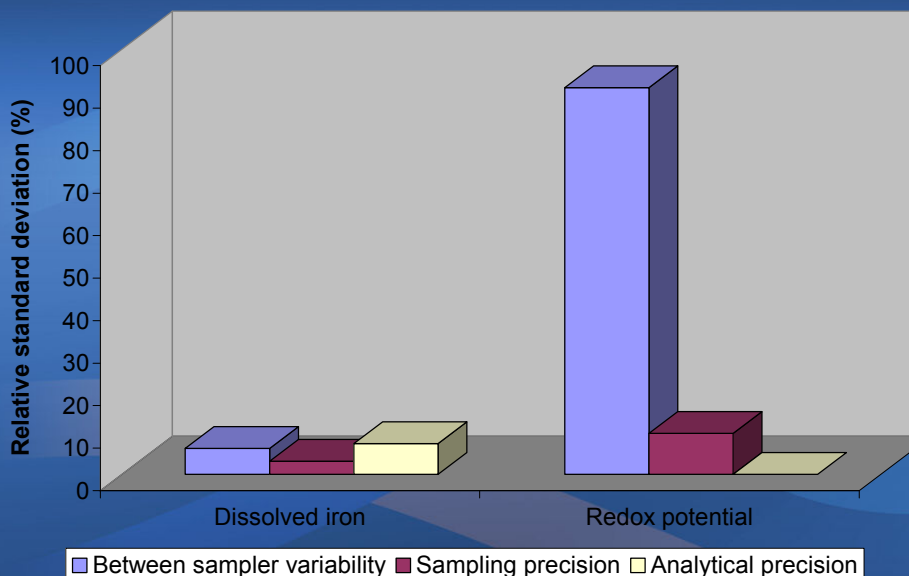


- ### Sampler proficiency test
- Organized at an other location
 - 8 sampler teams
 - Sampling of groundwater from one well
 - Pump installation and well purging prior to sampling was done by the organizers
 - Sampler teams applied their own sampling procedures
 - Field filtration for dissolved iron
 - Samples were sent to one laboratory for analysis of iron
 - On-line monitoring of redox potential

Design of sampler proficiency test



Sampler proficiency test results



Conclusions for the groundwater investigations



% RSD	Between wells variability	Between occasions variability	Between samplers variability	Sampling precision	Analytical precision
Dissolved iron	70	9.9	6.1	3.1-10	2.1-7.2
Redox potential	14	23	91	3.8-15	0-18

Dissolved iron

- Total measurement uncertainty from one well including variation over time, systematic errors and random errors was 12-17%
- Uncertainty requirement was 10%
- Increased number of samples or improved methods are the cost efficient points of improvement
- The quality requirement is attainable with a realistic additional effort

Conclusions for sampling uncertainty in general



- Tools are readily available for estimating and controlling sampling precision
- Tools are gradually emerging for estimating and controlling sampling trueness
 - Availability of proficiency tests and method studies needs to be increased
 - Sampling reference sites need to be established
 - o For sampling uncertainty to be controlled at the same level as analytical uncertainty
- Training of the sampling community is required
 - In order to include sampling QA in measurements
- Awareness rising with the measurement users is required
 - In order to gain acceptance of the increased costs
 - In order to provide uncertainty requirements and to include measurement uncertainty in data evaluation
- QA approval resembling laboratory accreditation (ISO 17025) needs to be established, e.g. sampler certification (ISO 17024 and NT ENVIR 08)
- There is a long way to go but we know the direction

Thanks for your attention!



chg@dhi-group.com
+45 45 16 95 70
www.samplersguide.com
www.sampler-education.dhi.eu
www.samplercertification.com