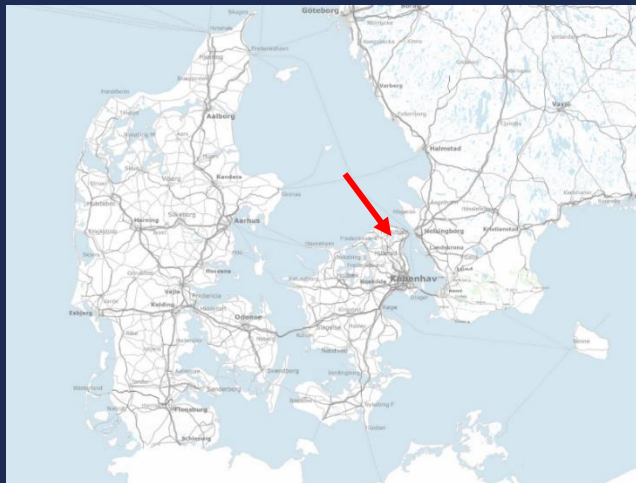


1

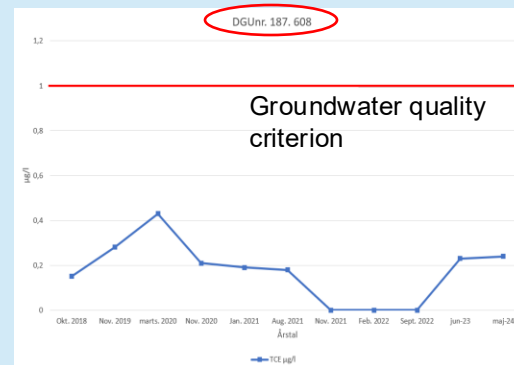
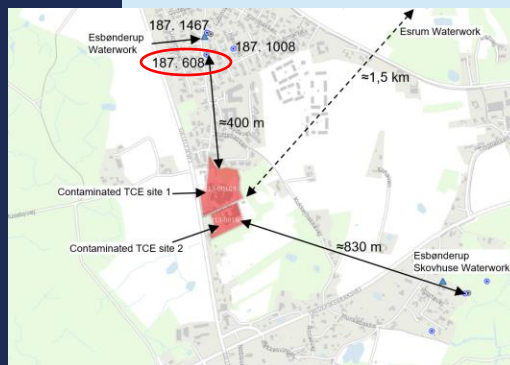
Bo Tegner Bay, COWI
NORDROCS September 15, 2026

Background

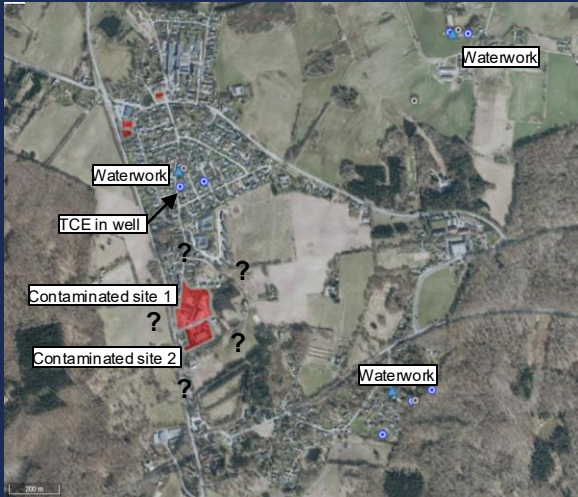


Location

- Two Sites with high TCE contamination located in the northern part of Sealand
- Located nearby 3 waterworks
 - Esbønderup Waterworks
 - Esrum Waterworks
 - Esbønderup Skovhuse Waterworks
- Since 2018, TCE has been detected in abstraction well DGUnr. 187.608 at Esbønderup Waterworks

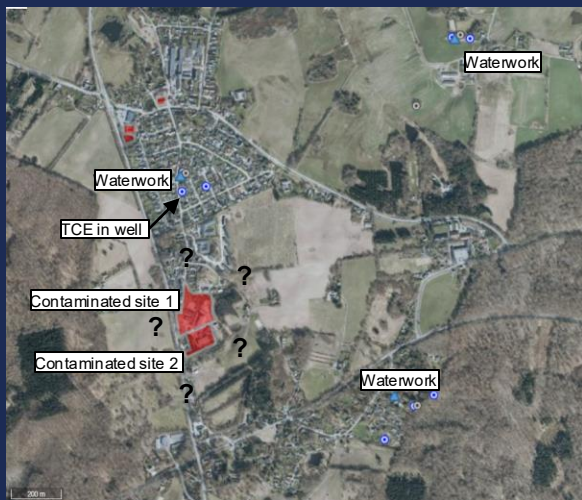


Challenges



- Two sites. High TCE contamination
- No plume detected in surrounding aquifers – is it missing or just not found yet?
- Complex groundwater flow
- Complex geology

Purpose



Overall purpose with investigation

- To investigate the contaminant migration from the two sites and determine whether one or both sites are responsible for the TCE detected in the drinking water well ?
- If not.....where does the contamination from these sites migrate to, and does it pose a risk to other nearby waterworks?

Purpose with Geophysics investigation

- To support the ongoing effort to characterize the geological conditions in order to improve the interpretation of contaminant leakage from the two sites
- To support decision-making of placing new boreholes in the pursue of tracking down the possible contaminant plume

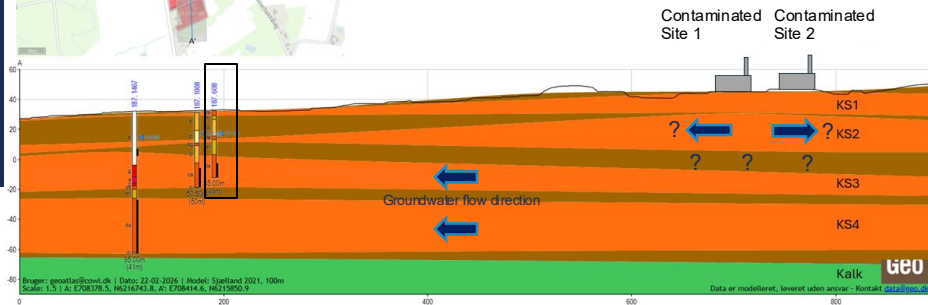


Geological Setting

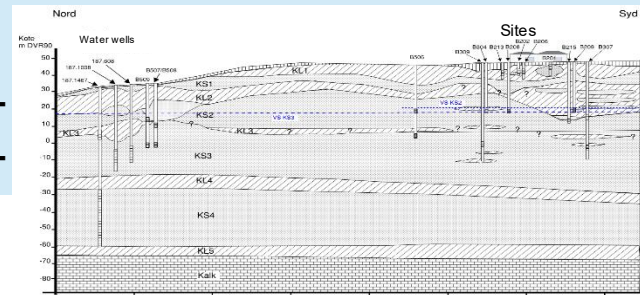
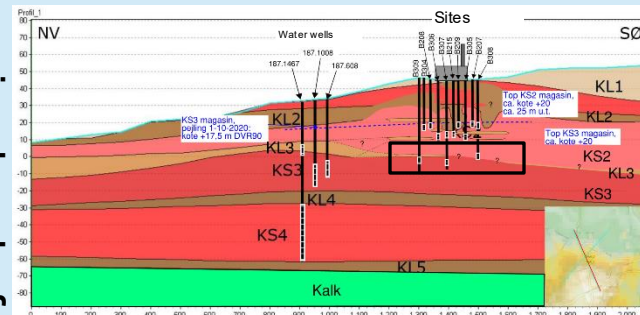
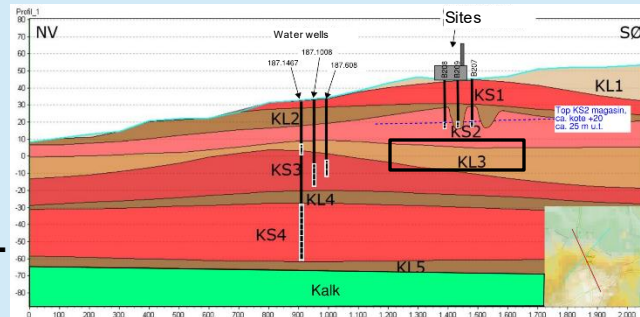


Esbønderup Waterworks, 3 wells:
Groundwater abstraction from "KS3" sand aquifer:
DGUnr. 187. 608
DGUnr. 187. 1008

Groundwater abstraction from "KS4" sand aquifer:
DGUnr. 187. 1467



Multiple conceptual models



Increasing level of knowledge
Increasing level of complexity

Groundwater flow direction

Challenges:

- Multiple sources and a possible groundwater divide in the KS2 aquifer between the two sites
- Which direction will the contamination migrate?



Why Geophysics?

Boreholes:

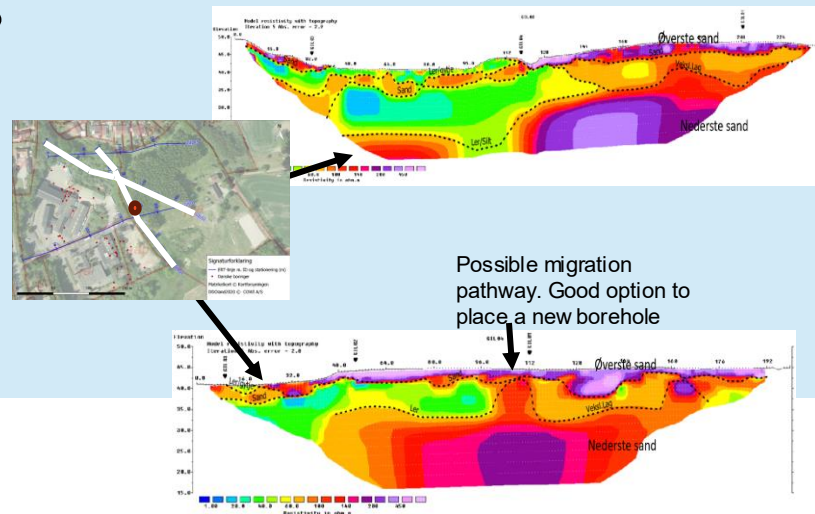
- Expensive
- Time-consuming
- Disturbing the surroundings (residents, environment)



Use geophysics to place boreholes smarter – not replace them

Geophysics:

- Cover large areas
- Quick
- Non-intrusive



Geophysical methods used



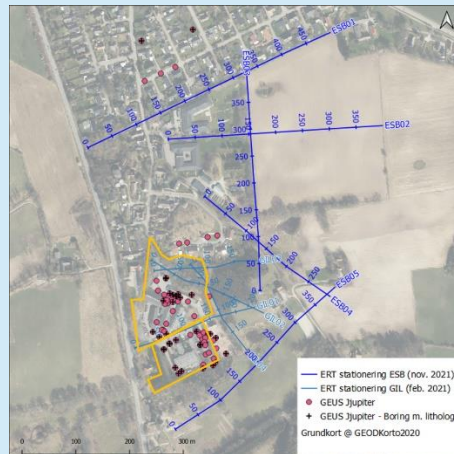
DCIP. Foto: Bargheer Geophysics



tTEM. Foto: Bargheer Geophysics

ERT/DCIP and tTEM

2021



ERT lines around the sites

2024/2025

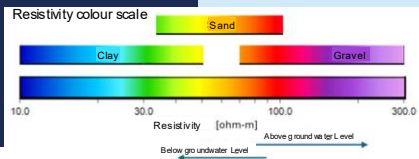
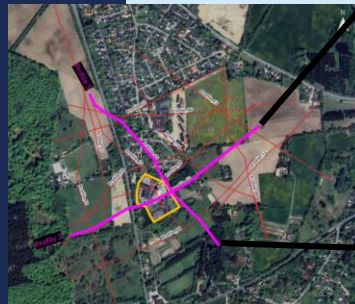


Overview of the investigated area. Red shows tTEM survey lines, yellow shows tTEM data used in the inversion, and green shows DCIP survey lines.

Metode	Measures	Depths of impact
ERT	Resistivity	20–60 m
DCIP	Resistivity + chargeability	20–60 m
tTEM	Transient elektromagnetik	40–120 m

Geophysical Investigations

- tTEM and DCIP provide high-resolution data on deeper geological structures and possible contaminant migration pathways
- The data can help identify where additional boreholes are needed and support verification of the geophysical interpretation.
- Limitation: small-scale geological variations, such as thin sand layers in clay, may not be detected
- Profiles 3 and 5 indicate thrust clay slabs within the sand aquifer → Key Finding



Results - profiles

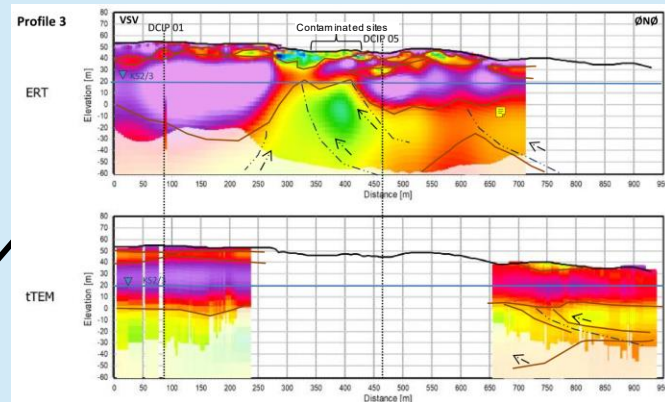


Figure: Bettina Olsen, DMR

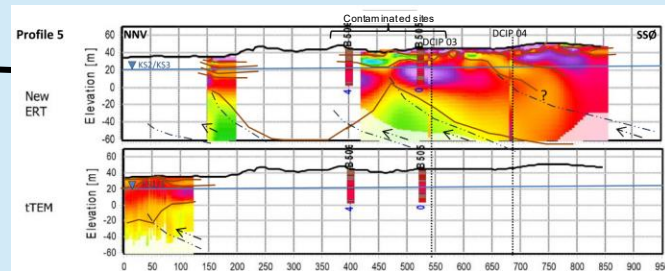
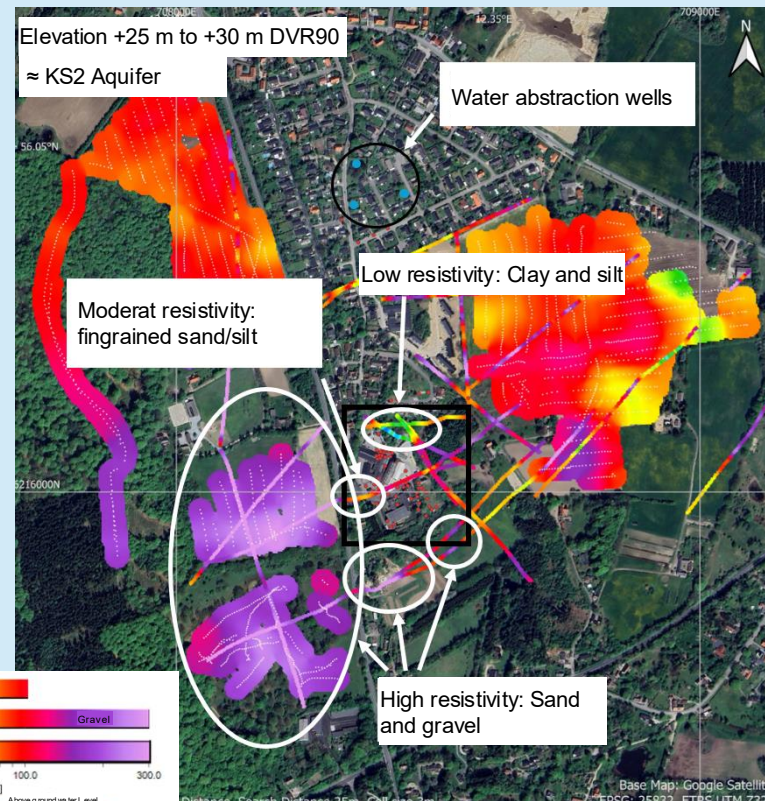
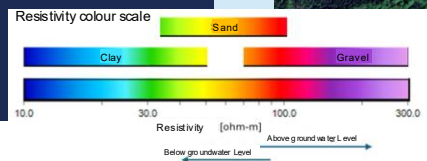


Figure: Bettina Olsen, DMR

Results

- **North of contaminated site 1:** Low-resistivity deposits interpreted as **clay/silt** → may explain the **lack of contaminant migration** in this direction
- **South and across a large area to the west:** High-resistivity deposits interpreted as **sand and gravel** → **potential pathway for contaminant migration**
- **The two major sandaquifers KS2 and KS3** are assessed to be **hydraulically connected** beneath **contaminated site 2** and in several surrounding areas



Average resistivity map, elevation +25 m to +30 m DVR90

Interpretation

- Thrust clay slabs derived from the terminal moraine form hydraulic barriers between the two sites
- This explains the divergent groundwater flow in KS2 aquifer and the presence of a groundwater divide
- The geological setting may promote contaminant migration in multiple directions

Interpreted profile

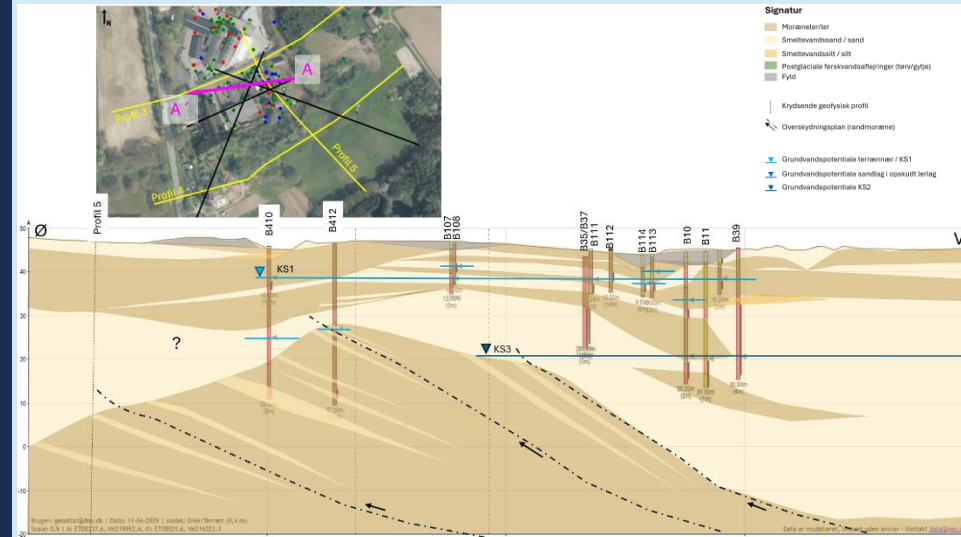
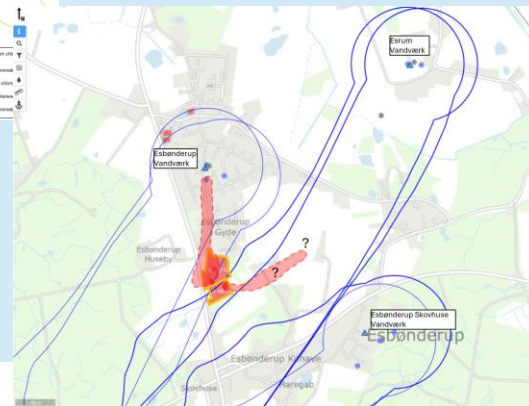
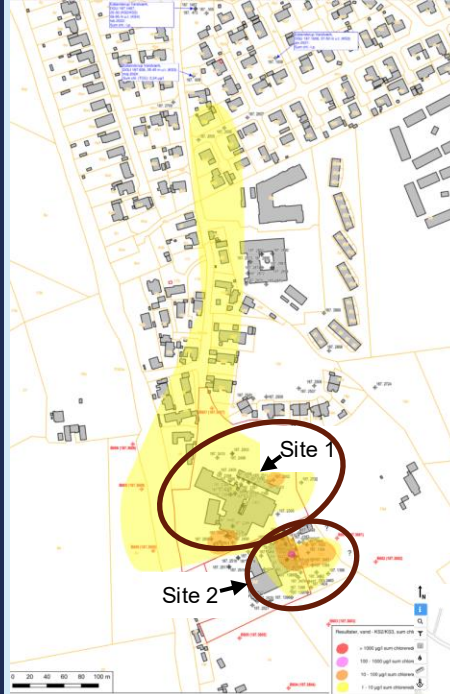


Figure: Bettina Olsen, DMR

Key Findings

- Geophysics guided the optimal placement of nine deep boreholes drilled in October–November 2025
- Local potentiometric maps were established for KS2 and KS3
- A groundwater divide between Site 1 and Site 2 was confirmed
- The geological model was validated by the geophysical data
- Thrust clay slabs create hydraulic barriers and control migration pathways
- The results indicate site-specific migration risks in multiple directions, including potential risk to nearby waterworks
- TCE detected in abstraction well DGUnr. 187.608 most likely originates from Site 1



13 Bo Tegner Bay, COWI
NORDROCS September 15, 2026

- Geophysics can strengthen the geological model
- Geophysics identifies geological structures and possible migration pathways
- Geophysics can not stand alone, but supports targeted placement of boreholes

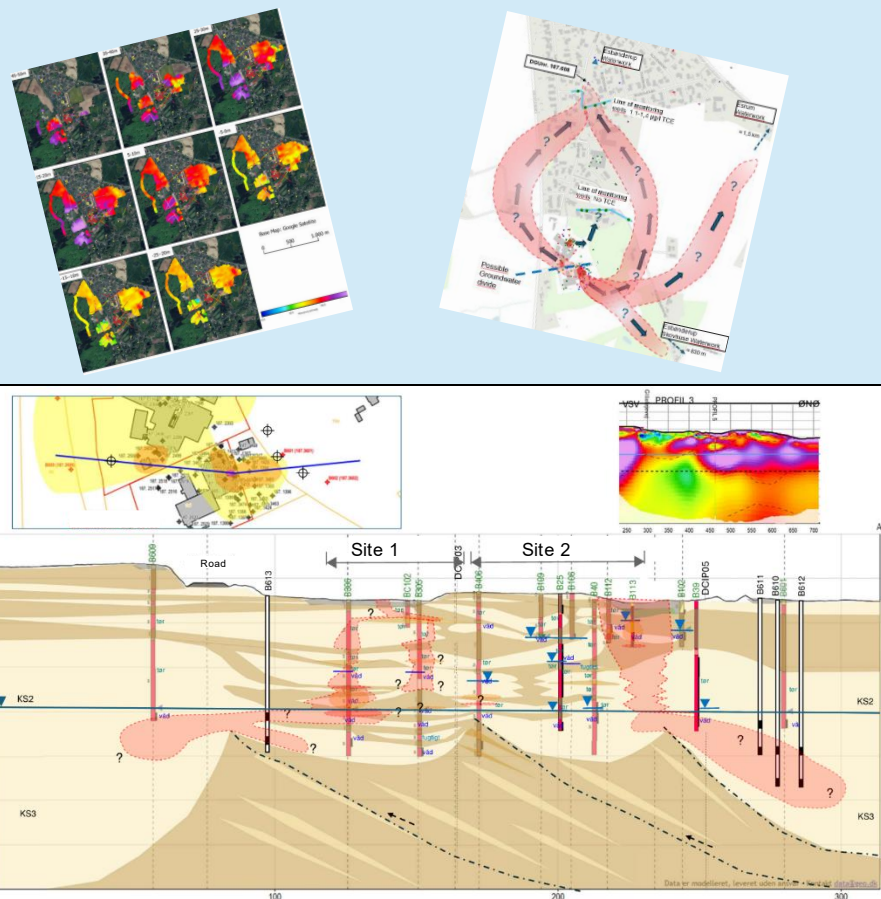


Figure: Bettina Olsen, DMR (modified by COWI)

Thank You for Your Attention

I will be happy to answer any questions

