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Hedwigepolder: a pioneering project exploring the strength of tidal sand

GWF2024 - Geotechnical Engineering and Design Practices for Sustainable Infrastructure Development

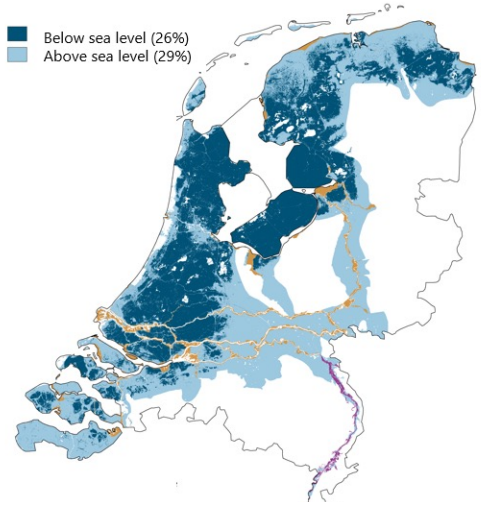
By Niels Walrave, MSc

Introduction

Niels Walrave - Fugro

Consultant Flood Defences

Expertteam on Sustainable Geotechnical Engineering



Netherlands

>55% flood prone

Levee reinforcement programme (HWBP)

2050: 1,100 km

Faster, cheaper & less impact

HWBP
voor sterke dijken

Deltares

waterschap Hollandse Delta

Vlaanderen
is mobiliteit & openbare werken

Partners

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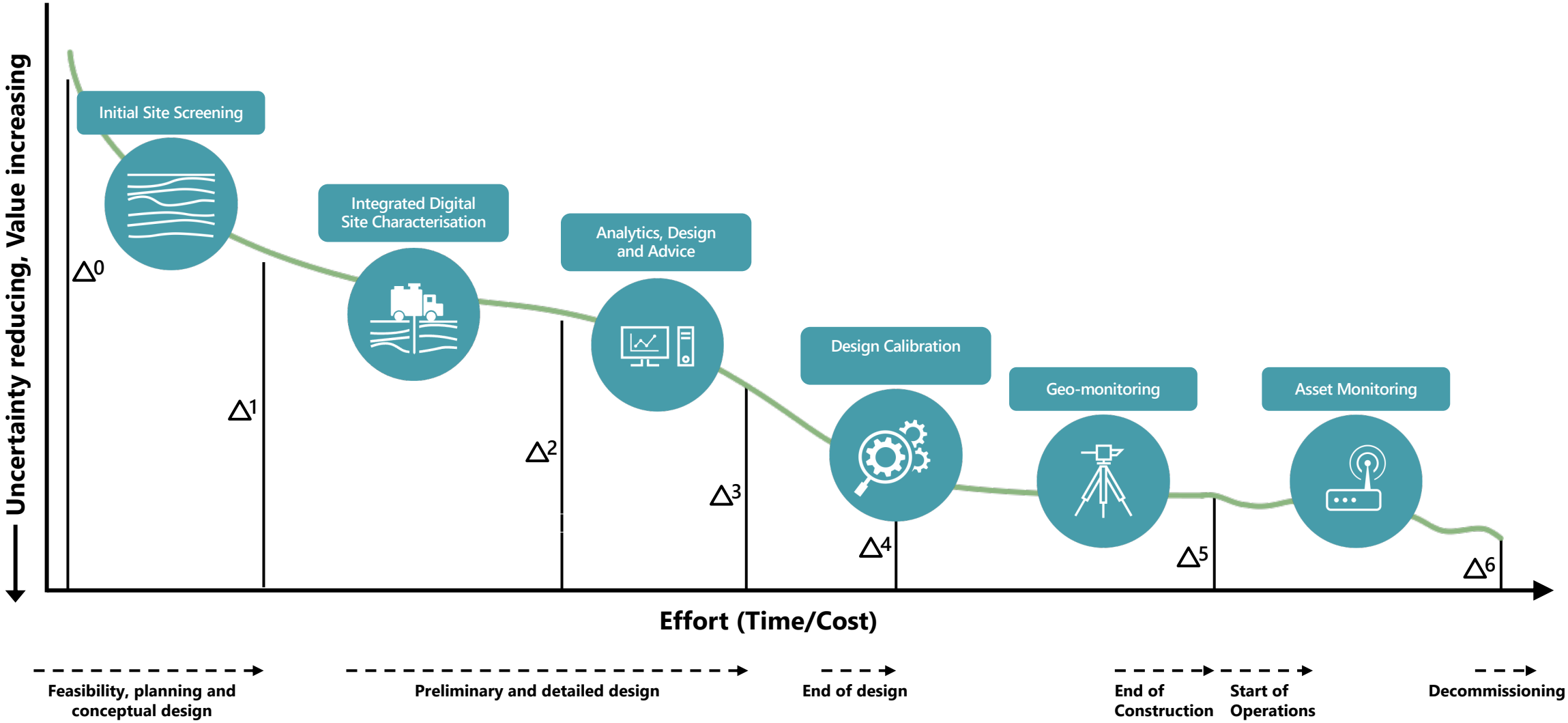
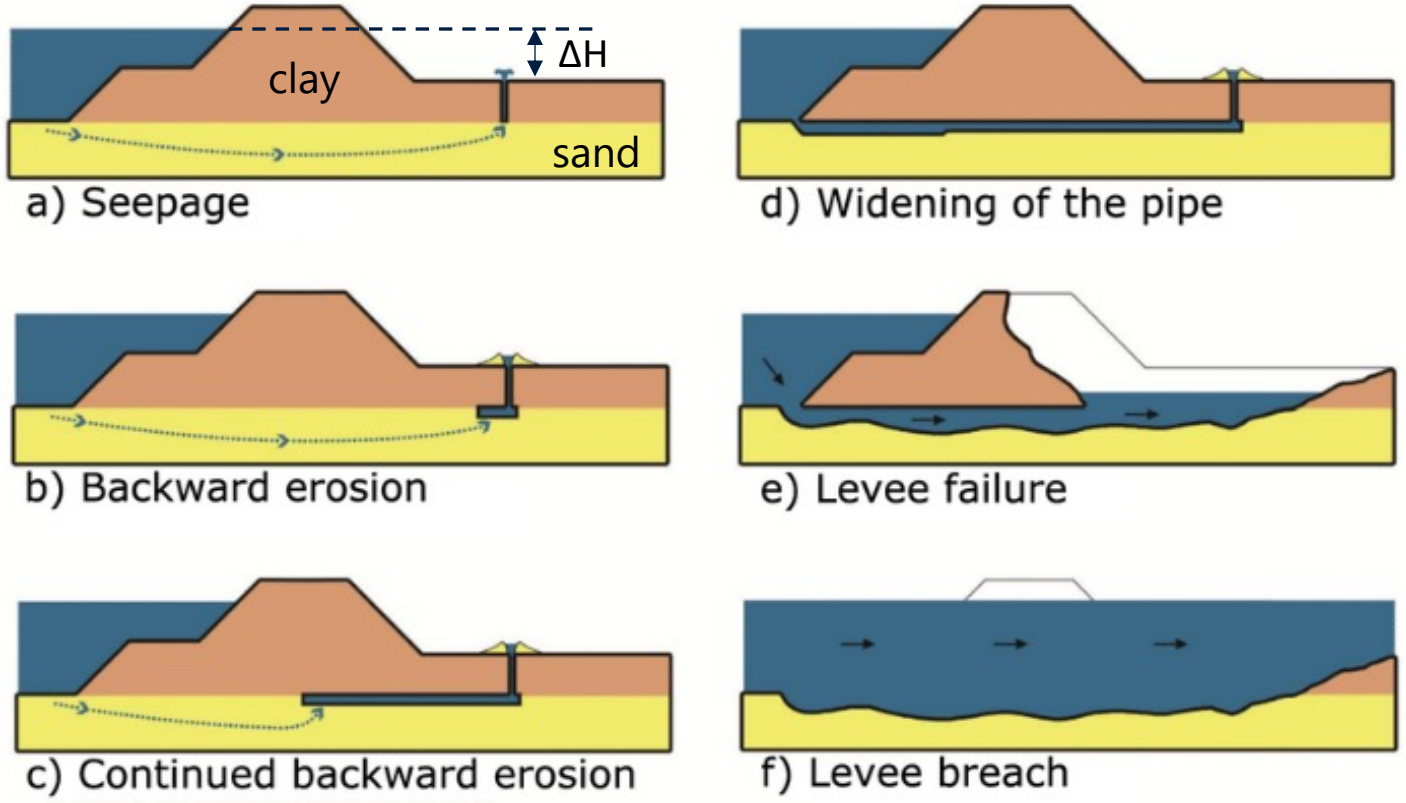
Geo-Risk Management Framework



Backward Erosion Piping (BEP)



Dutch design rule BEP based on homogeneous, river sand

Hypothesis: tidal sands are more resistant to BEP, mainly due to fines
→ Let's experiment!

Design of the field test

- BEP experiments on different scales:
  - small & medium in laboratory
  - 2 full scale in Hedwigepolder

- Area =13 m x 20 m
- ΔH_{max} = 10 m
- Ditch – Infiltration tubes = 10 m

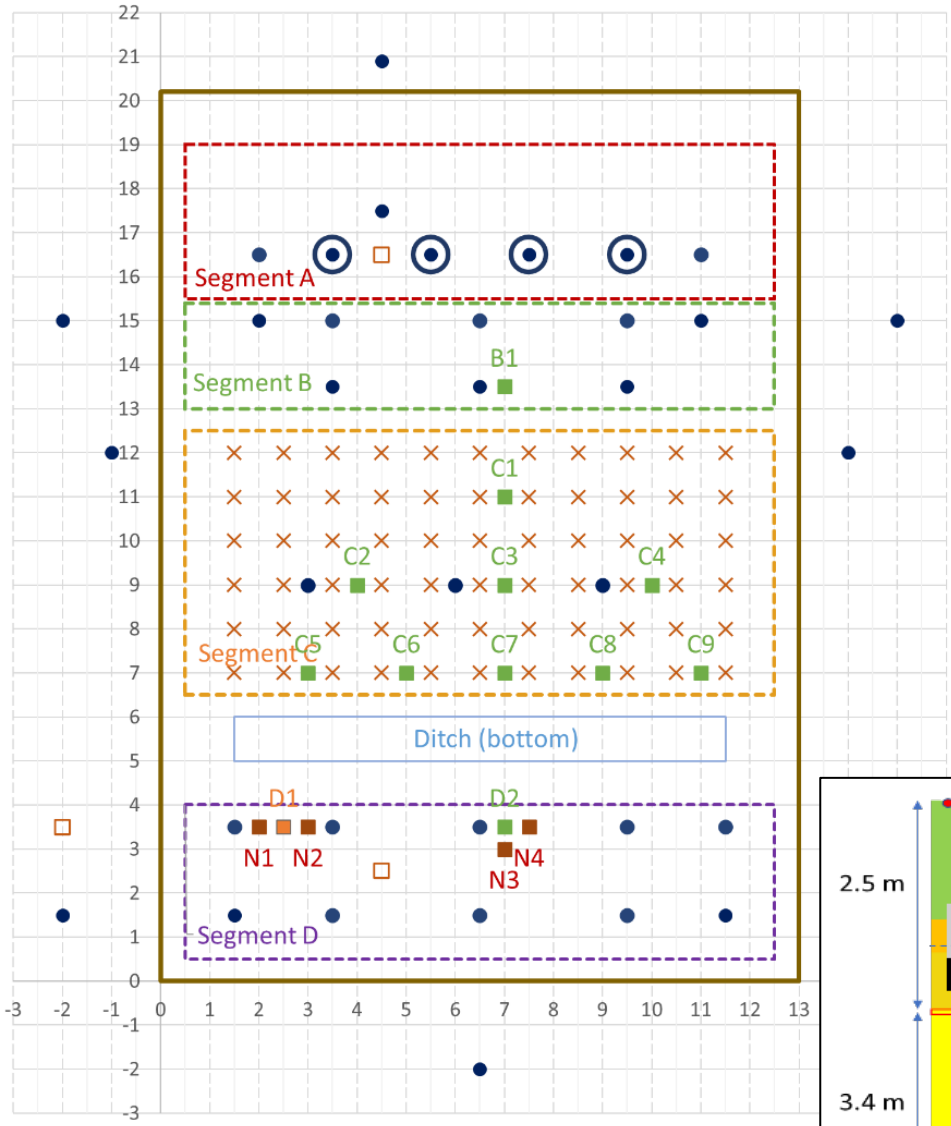
- Water levels incrementally raised in tubes to allow for head difference in confined natural tidal sand layer

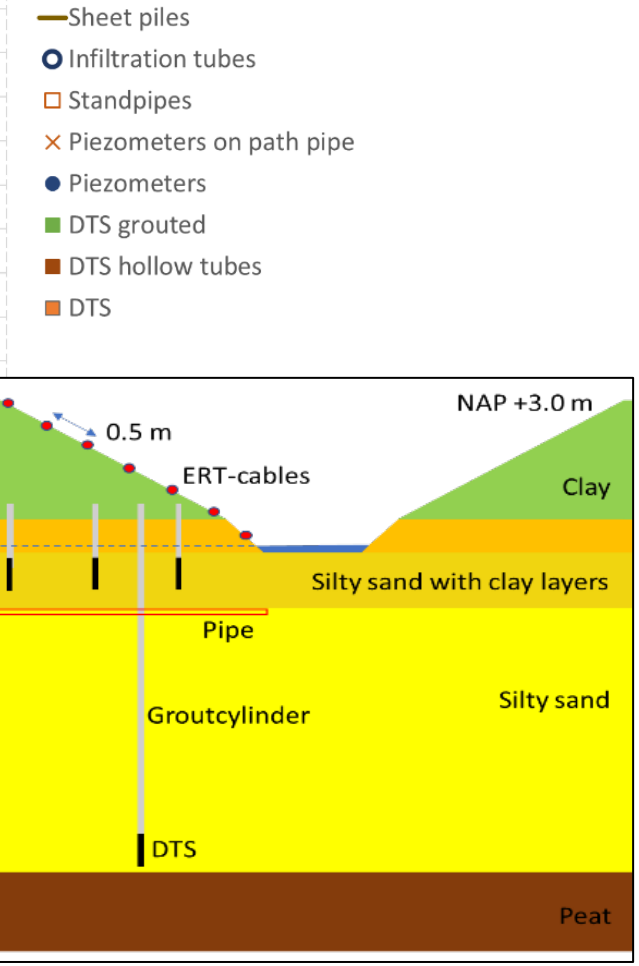
Multi-monitoring approach

- 206 piezometers
- 6 standpipes
- 16 Active DTS locations
- 7 ERT lines
- Thermal imaging at exit
- Discharge, precipitation, temperature (air, water)

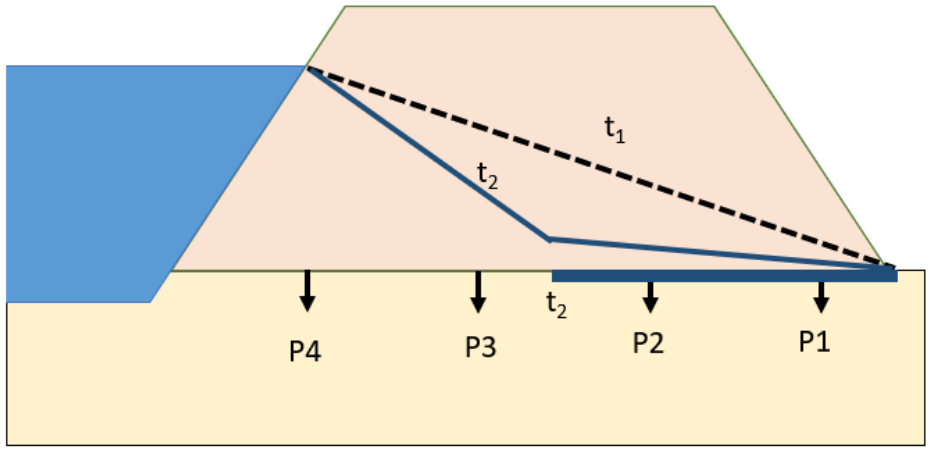
VirGeo®: real-time data management

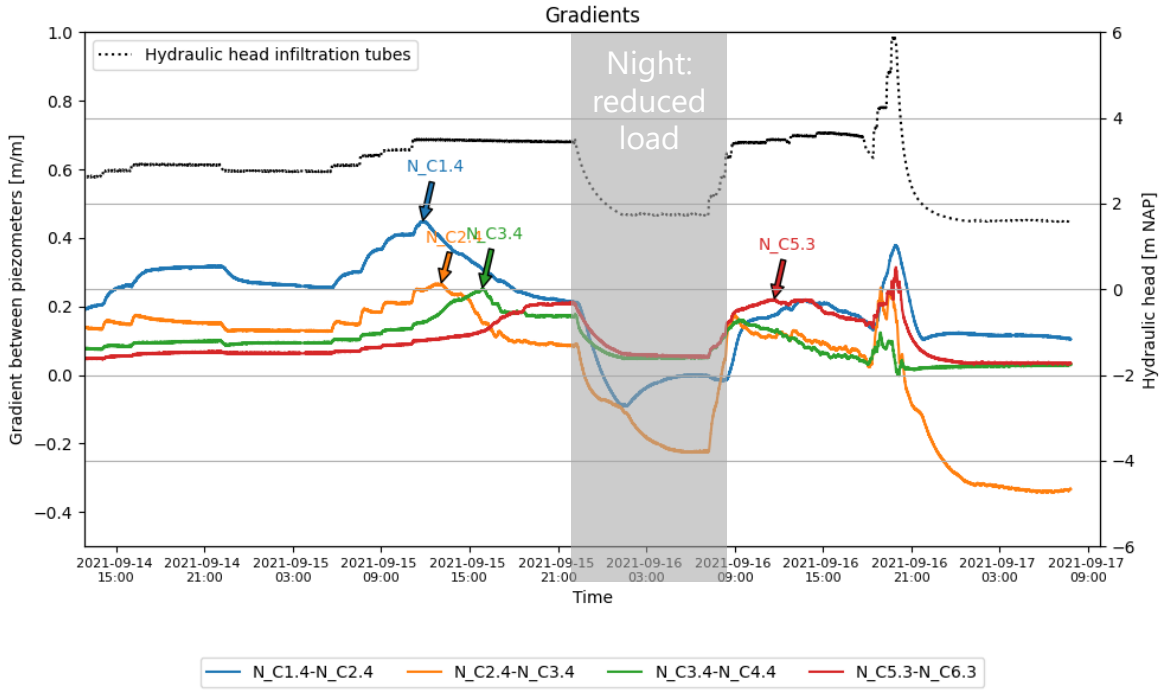
Aim: information to steer experiment and data for further analysis, test ERT/DTS for pipe detection

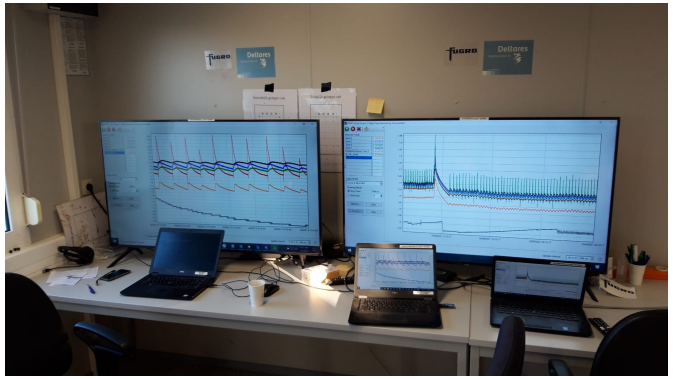




Piezometers: pipe location and growth rate







Live data used to steer and adjust the experiment

Thermal imaging (IRT)

Temperature differences of water, used to confirm:

- location exit points
- check for leakages

IRT confirms exit point locations and situation with no significant leakages

Groundwater ~13.0 °C

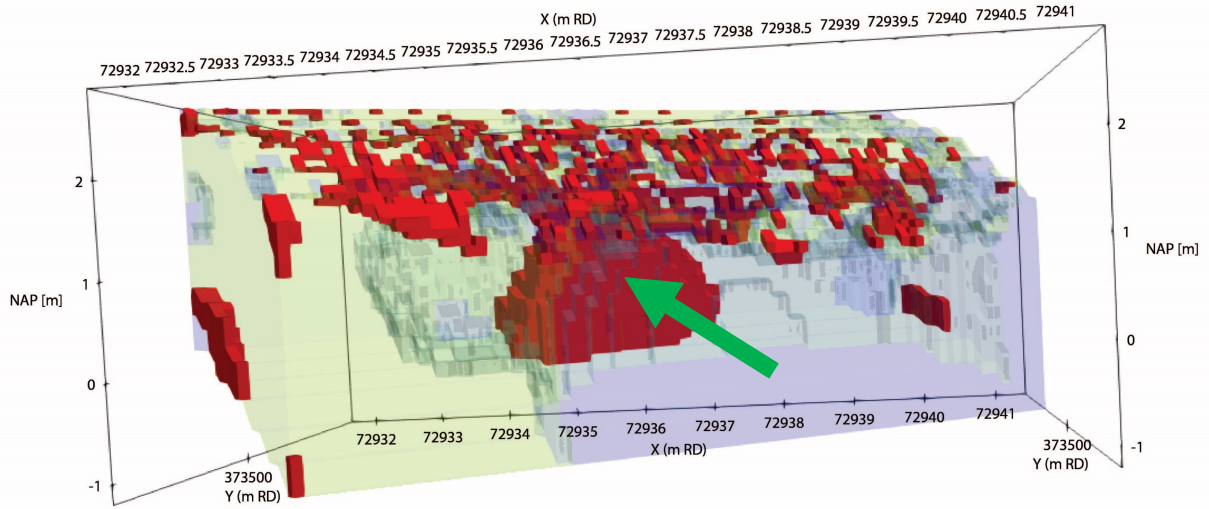
Ditch water ~ 10.7 °C

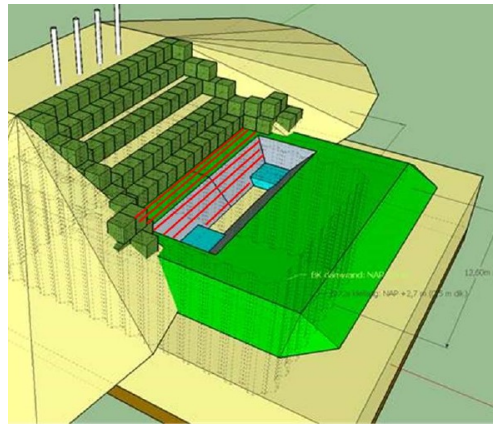
ERT

- 270 electrodes along 7 lines
- Spacing 0,25 m
- Ground level -2,7 m

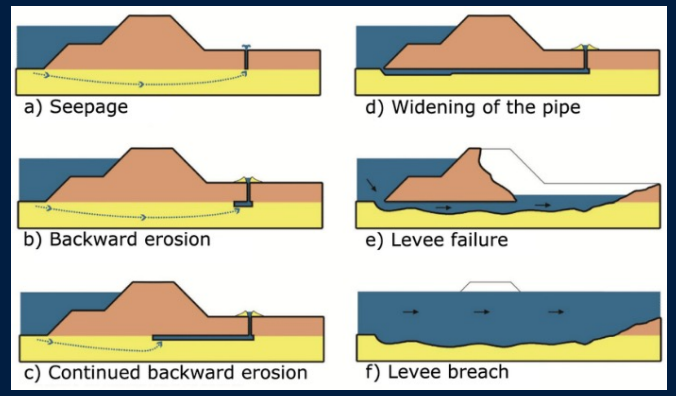
- Vertical resolution ~ 3 – 20 cm

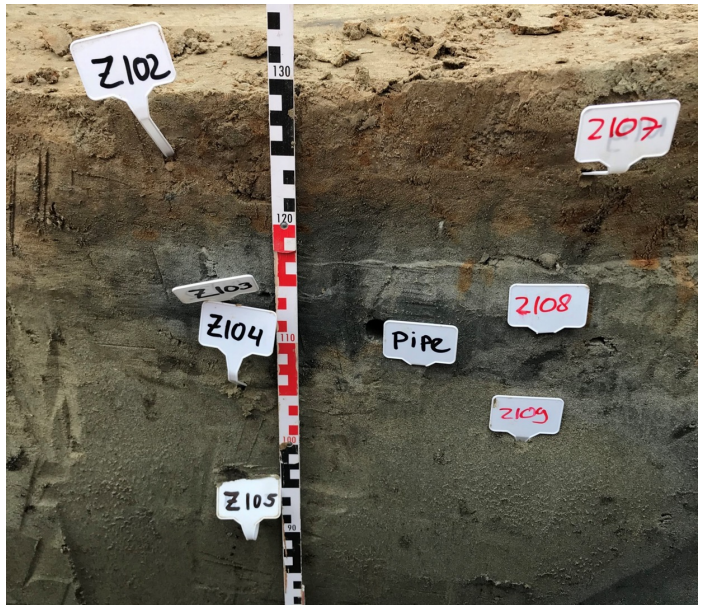
- Increase in resistivity measured at location of pipe





CSI – validation of monitoring results





Outcome – did it pay off?

Experiments do pay off!

- For a project scope from 7 km BEP to 0 km
- Less complex reinforcement
- Less environmental impact:
  - no piping embankments or seepage walls
  - less material needed
  - less transport
  - less emissions
- Nationally: 5-10 M€ investment over the last 6 years >significant cost reduction
- And, not always mentioned, it is also fun to conduct an experiment!



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