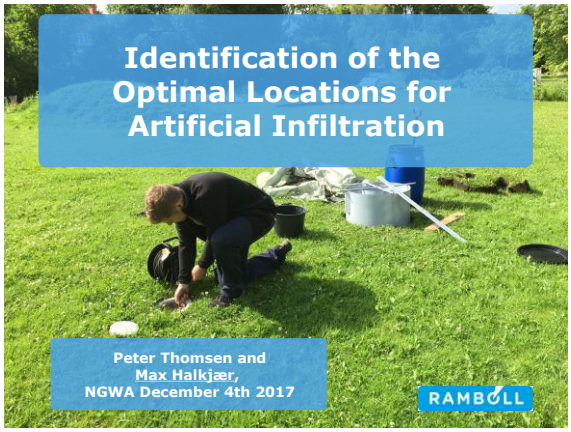
Identification of the Optimal Locations for Artificial Infiltration



Peter Thomsen and
Max Halkjær,
NGWA December 4th 2017

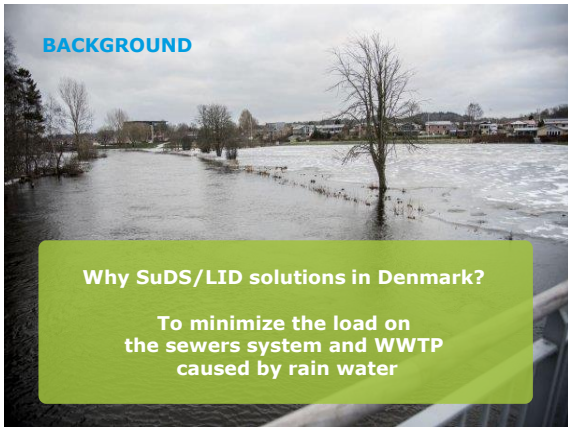
RAMBØLL

CLIMATE CHANGE ?

Rain 900mm ~ 2.7 ft per year

Since 2010:
100 year event every second year
and a 1000 year event

BACKGROUND

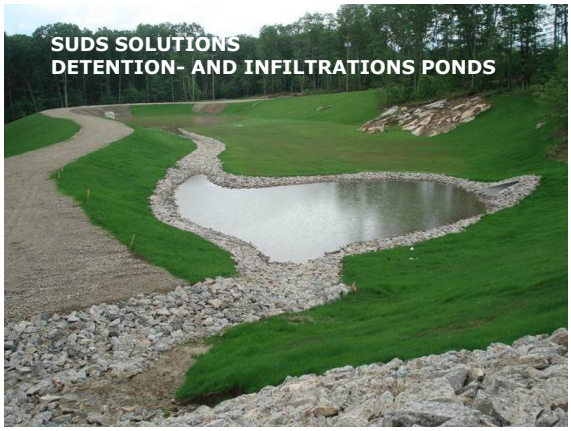


Why SuDS/LID solutions in Denmark?

To minimize the load on
the sewers system and WWTP
caused by rain water

SUDS SOLUTIONS – INFILTRATION TANK

SUDS SOLUTIONS
DETENTION- AND INFILTRATIONS PONDS



STORM WATER MANAGEMENT

BISHAN PARK
SINGAPORE/SG

After: It's an iconic landmark for the City of Singapore, an accessible stream integrated in an urban park

Case 1: SPARK an Urban Renewal project

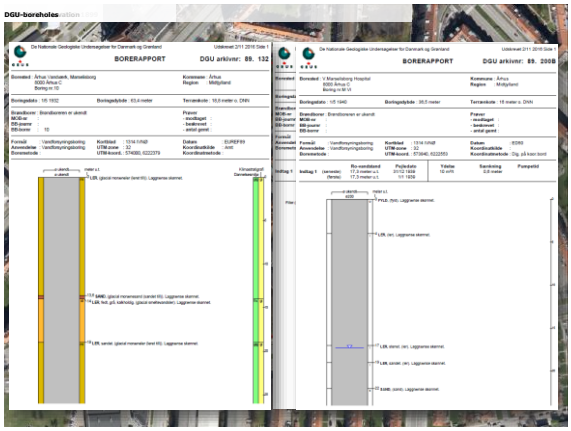
Marselisborg Hospital build in 1913

Combined sewerage system (except 4 buildings)

Scope: Local infiltration of rainwater combined with retention basins

Holistic approach:
- **Recreational park (10,000 visitors/week in the area)**
- **Area to be used for Rehabilitation purposes**
- **Climate adaptation**

DGU-boreholes



Task: Map the unsaturated zone

Concept for assessing potential for infiltration in the unsaturated zone includes:

- **Detailed geophysical mapping**
- **Boreholes**
- **Infiltrations tests**

DUALEM 421 – Geophysical tool

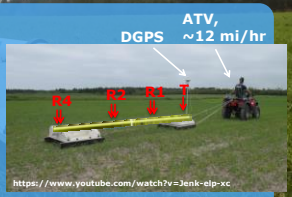
Ground conductivity Meter

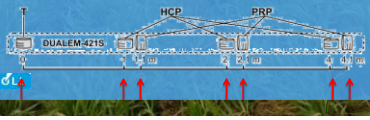
Type 421

Depth of investigation 15-30ft

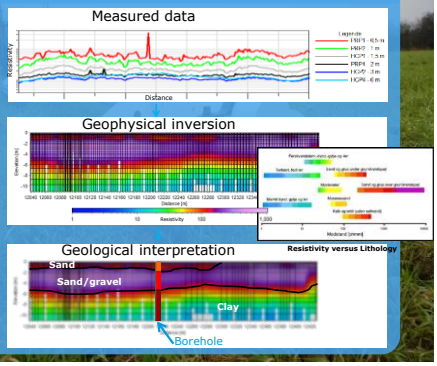
Production: up to 50 mi/day

Line Spacing 3 to 30ft

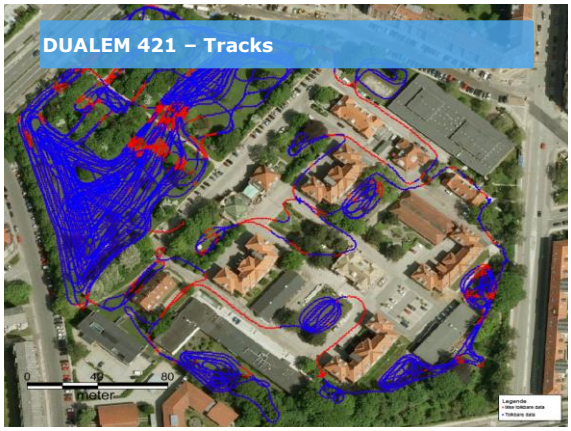


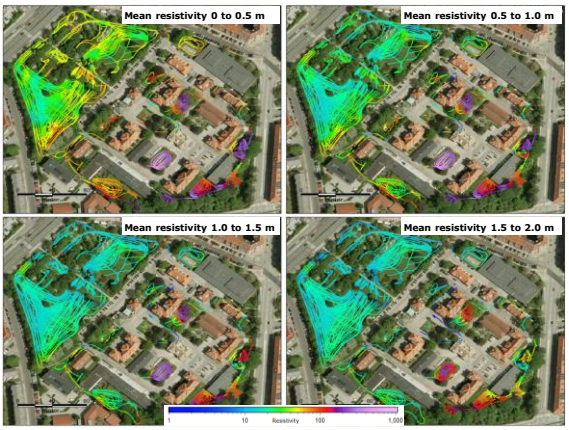


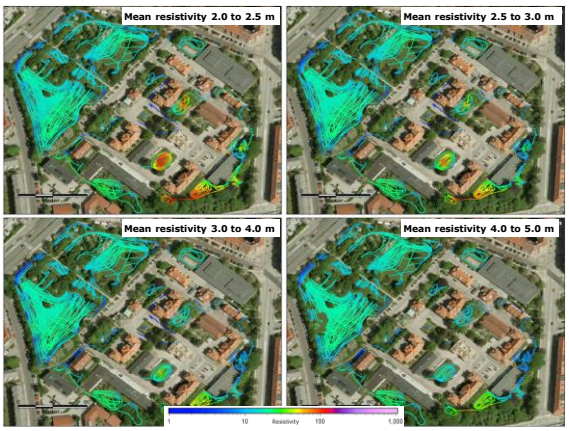
DUALEM 421 – Data

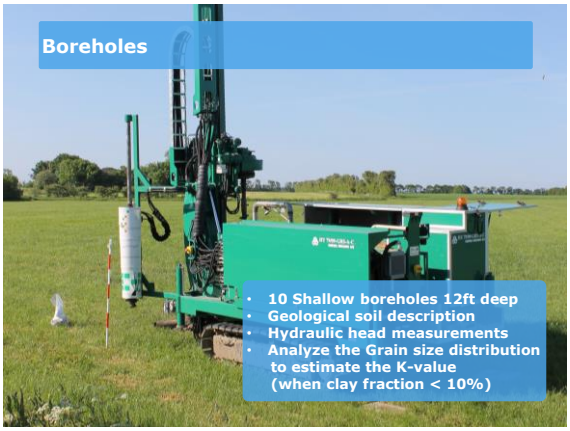


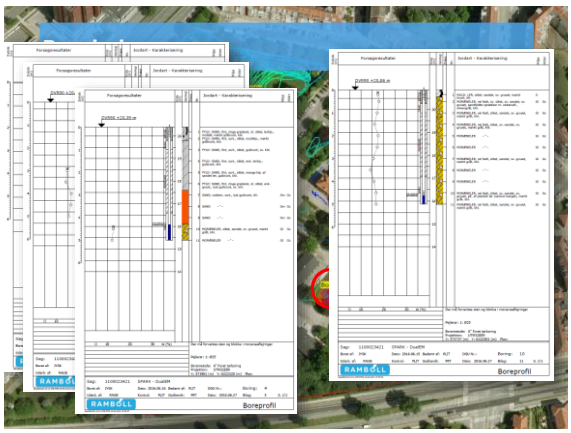
DUALEM 421 – Applications


DUALEM 421 – Tracks
0
40
80
meter

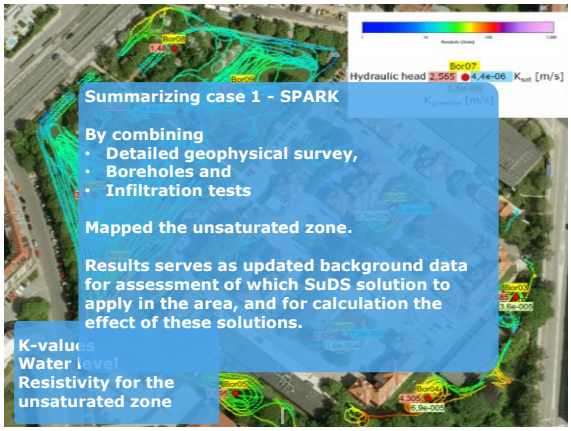

Mean resistivity 0 to 0.5 m
Mean resistivity 0.5 to 1.0 m
Mean resistivity 1.0 to 1.5 m
Mean resistivity 1.5 to 2.0 m
Resistivity


Mean resistivity 2.0 to 2.5 m
Mean resistivity 2.5 to 3.0 m
Mean resistivity 3.0 to 4.0 m
Mean resistivity 4.0 to 5.0 m
Resistivity

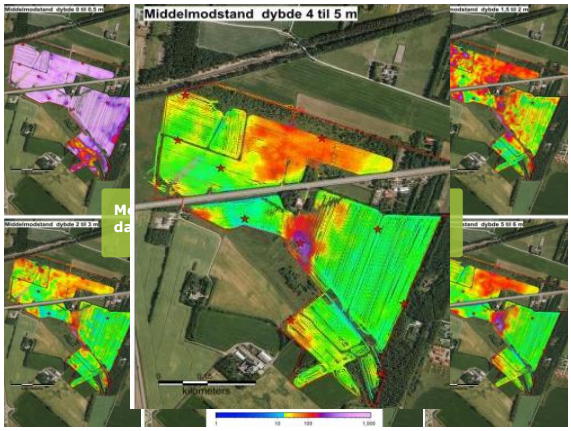

Boreholes
• 10 Shallow boreholes 12ft deep
• Geological soil description
• Hydraulic head measurements
• Analyze the Grain size distribution to estimate the K-value (when clay fraction < 10%)

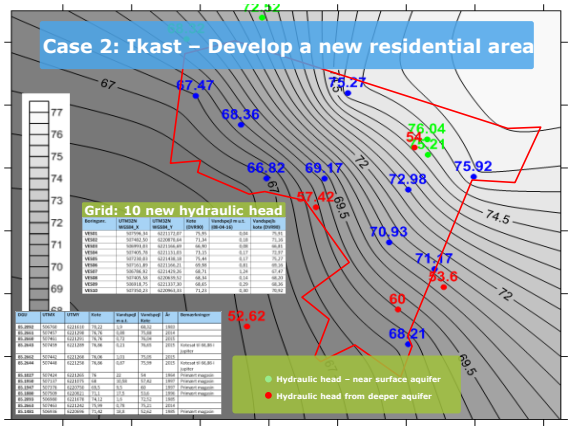

Boreprofil
Boreprofil

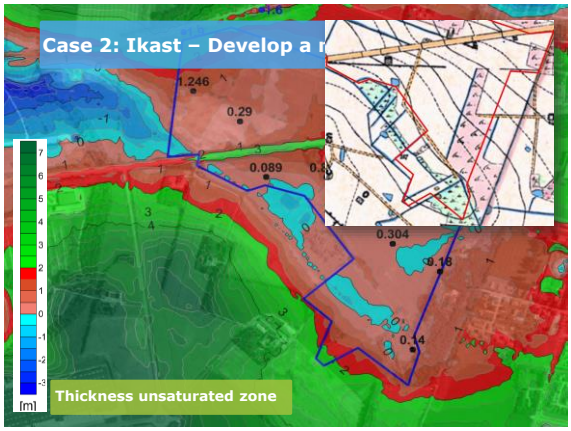

Infiltration tests – Double-ring infiltrometer

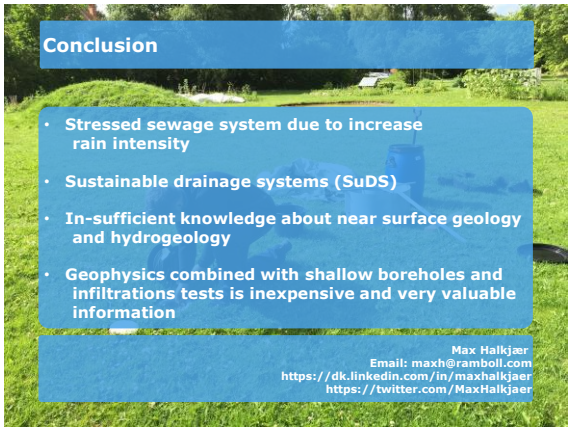

Hydraulic head
Bor07
Summarizing case 1 - SPARK
By combining
• Detailed geophysical survey,
• Boreholes and
• Infiltration tests
Mapped the unsaturated zone.
Results serves as updated background data for assessment of which SuDS solution to apply in the area, and for calculation the effect of these solutions.
K-value
Water level
Resistivity for the unsaturated zone


Case 2: Ikast – Develop a new residential area
• Area 48 hectars
• DUALEM Distance between lines 10 ft
• 100 miles
• 10 boreholes


Middelmodstand dybde 4 til 5 m


Case 2: Ikast – Develop a new residential area
Grid: 10 new hydraulic head
67.47
68.36
66.82
69.17
72.98
75.92
70.93
71.17
68.21
52.62
Hydraulic head – near surface aquifer
Hydraulic head from deeper aquifer


Case 2: Ikast – Develop a
1.246
0.29
0.089
0.304
0.16
0.14
[m]
Thickness unsaturated zone


Conclusion
• Stressed sewage system due to increase rain intensity
• Sustainable drainage systems (SuDS)
• In-sufficient knowledge about near surface geology and hydrogeology
• Geophysics combined with shallow boreholes and infiltrations tests is inexpensive and very valuable information
Max Halkjær
Email: maxh@ramboll.com
https://dk.linkedin.com/in/maxhalkjaer
https://twitter.com/MaxHalkjaer