KRÜGER VEOLIA

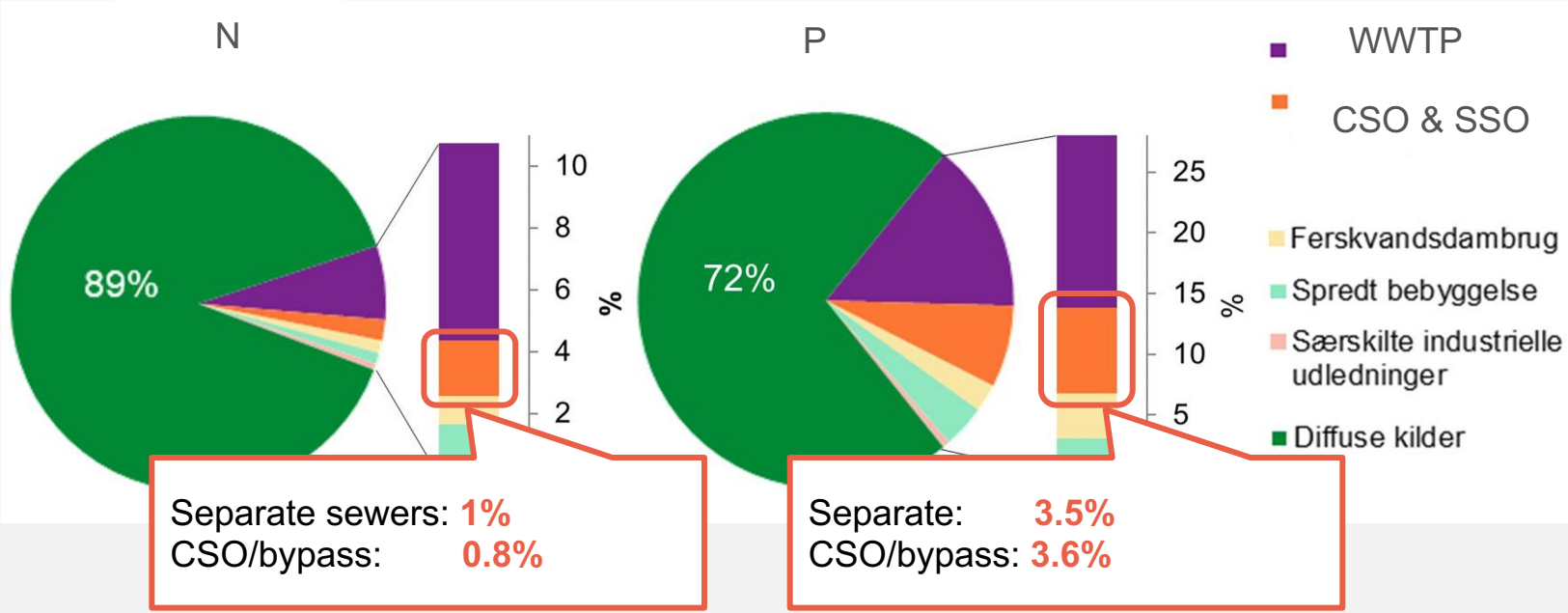
Overløb

Travel time for in sewer treatment

Ole Mark
Head of Innovation

WATER TECHNOLOGIES

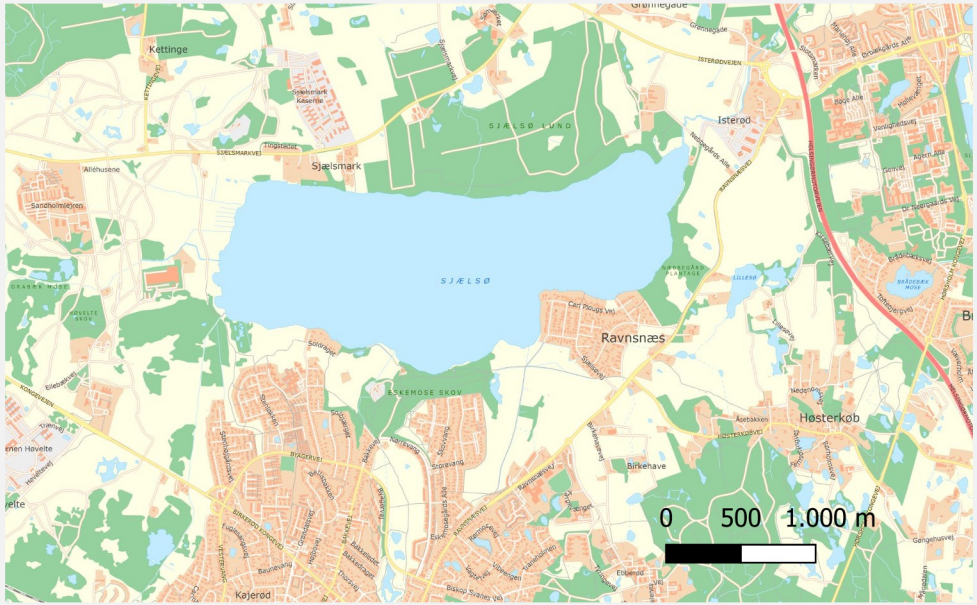
The problem
CSO contribution of N and P



Kilde: Vezzaro, L., Arnbjerg-Nielsen, K., Mikkelsen, P.S. (2022) Hvidbog om udledning af vand fra byer. https://www.danva.dk/media/8839/hvidbog-om-udledning-af-vand-fra-byer.pdf

Problem

Overflow conttribution of N and P ud - Locale scale



Example: Sjælsø ~ 283 ha

Target P: 435 kgP/year

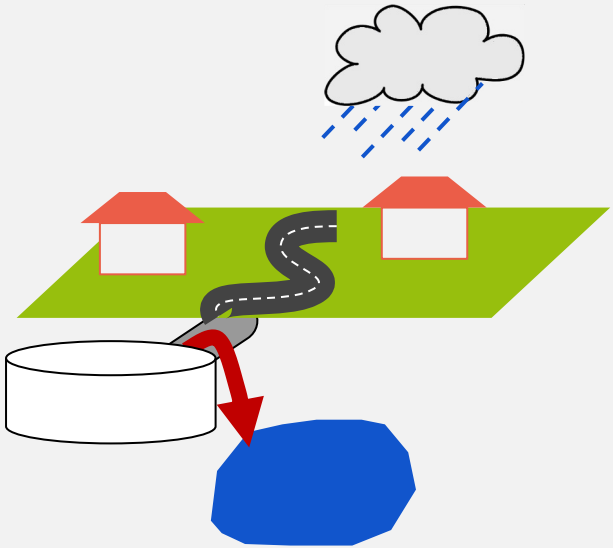
Load in 2016: approx 1000 kgP/year

Excess load: **approx 550 kgP/year**

P – from overflows must be removed

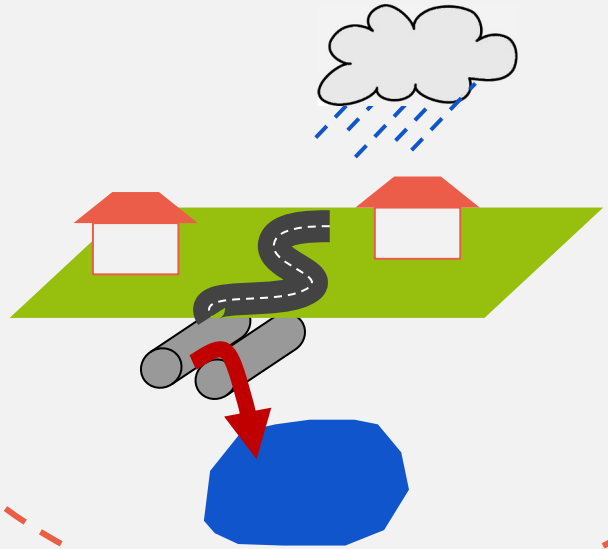
How to reduce overflow ?

Basins



Separate sewers

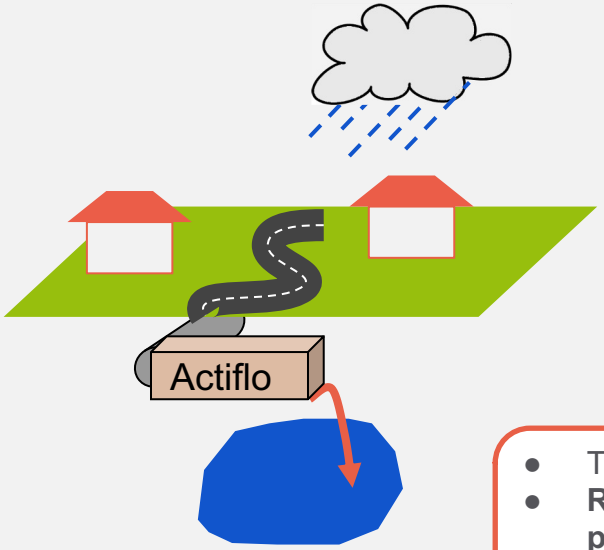
Potentially: a magic bullet – which removes overflows
Demands huge investments and takes a looooong time

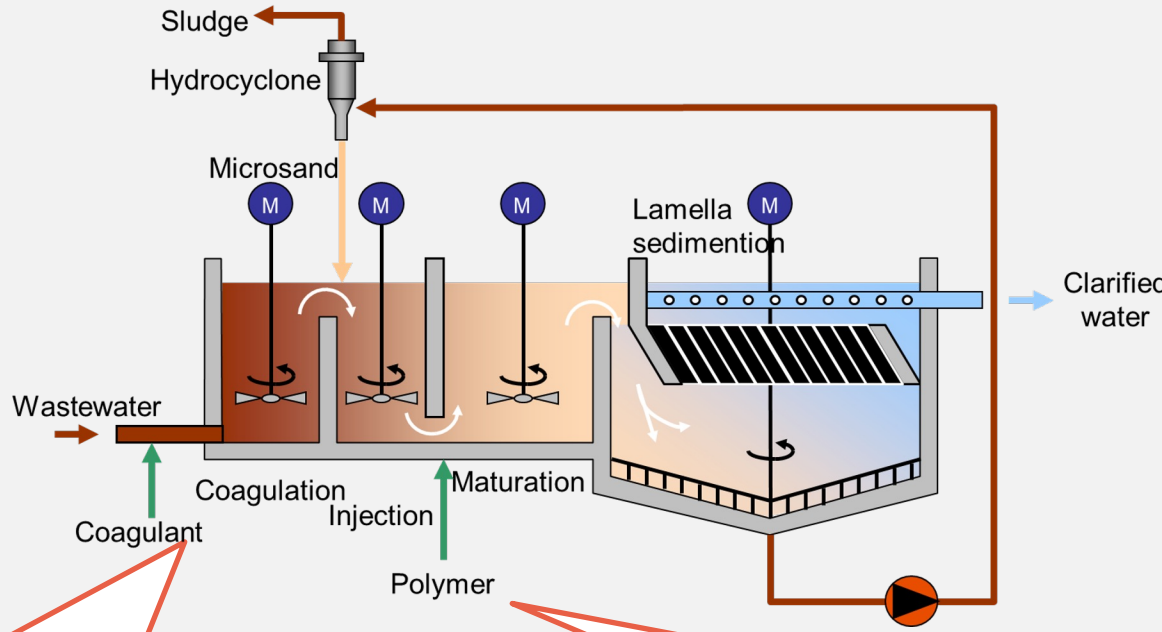


Reduction of overflow ?

Local treatment of the CSO

Removes phosphours, COD and particles
Needs space



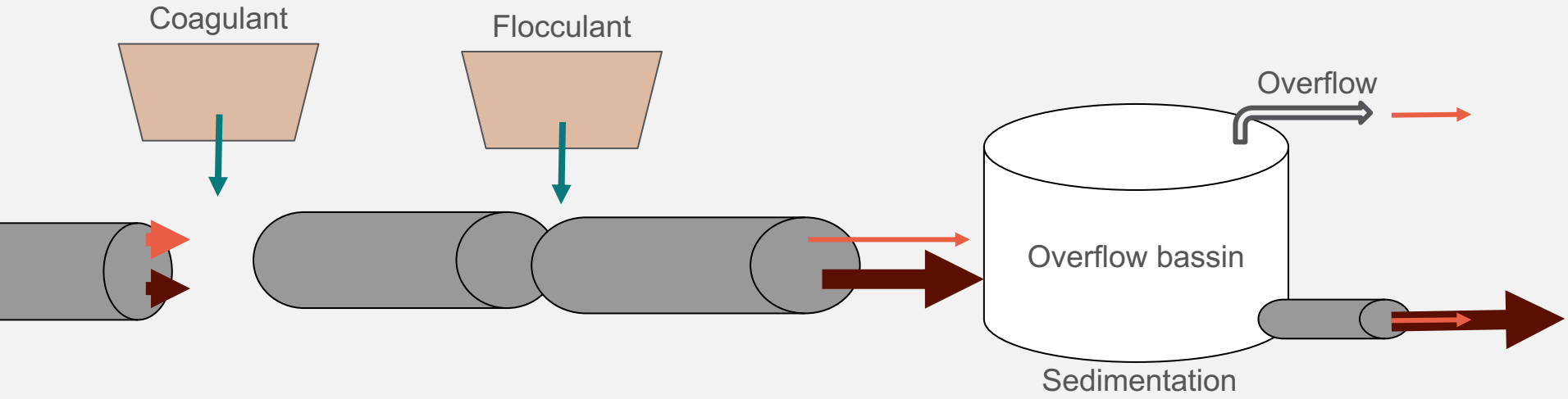


- Typically iron or aluminium
- **Reacts with phosphour -> smal particles**
- Used on a daily basis for small and local wwtp and restauration of lakes

- Typically a polymer
- Larger particles coagulates
- Used on a daily basis on wwtps

Our new concept
Chemical mechanical P removal – in existing infrastructure

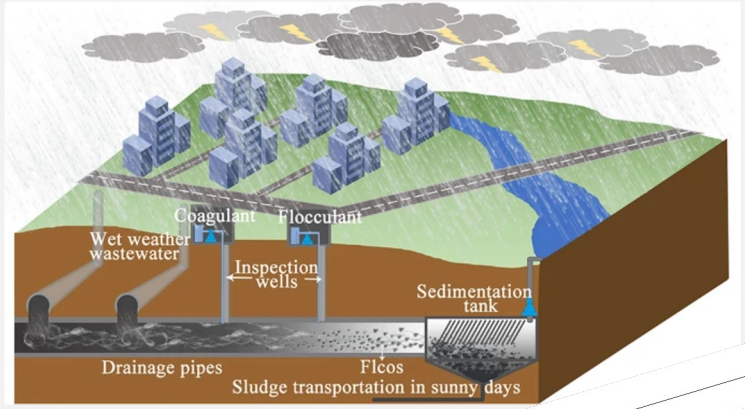
- Mixing and reaction inside the pipe system



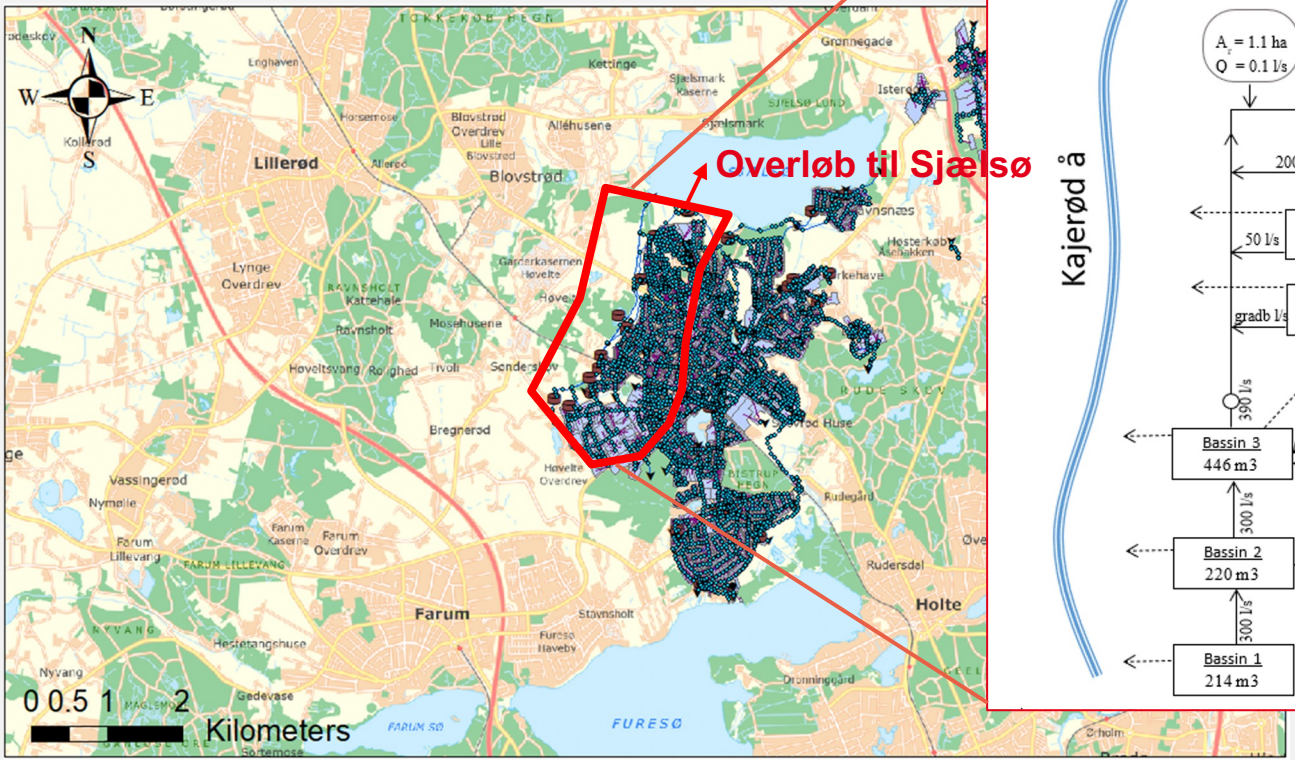
Our concept
- In other places

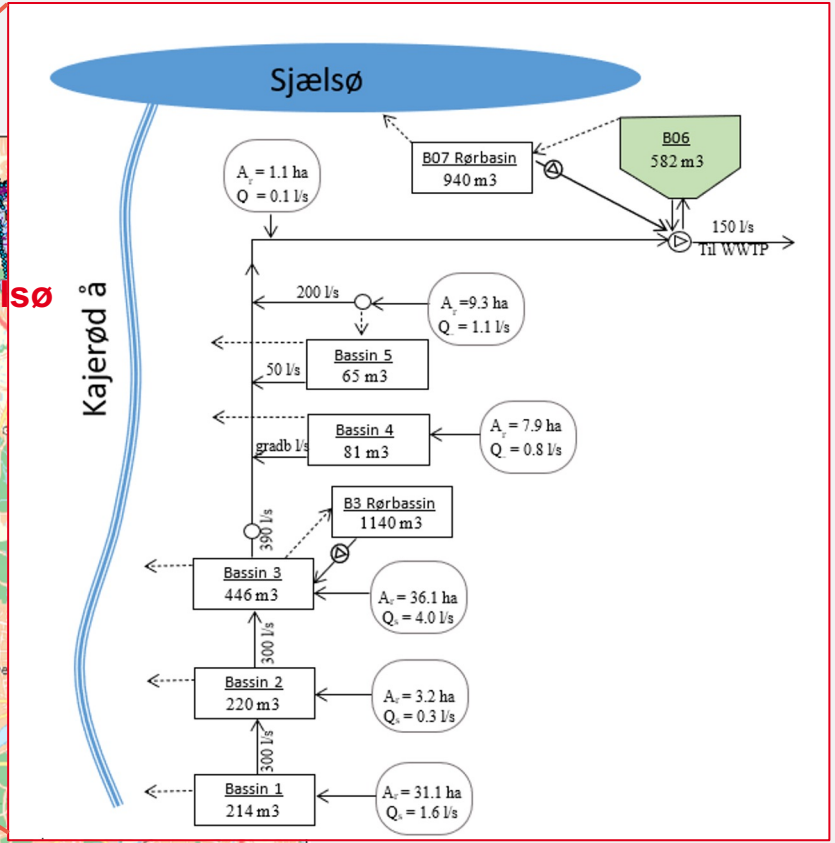
Study from 2020 indicates removal rates of more than 94% for a similar setup in Shanghai
(https://link.springer.com/article/10.1007/s11783-021-1400-z)

Coagulant is commonly used for rain water systems in North America since the 1990'ties

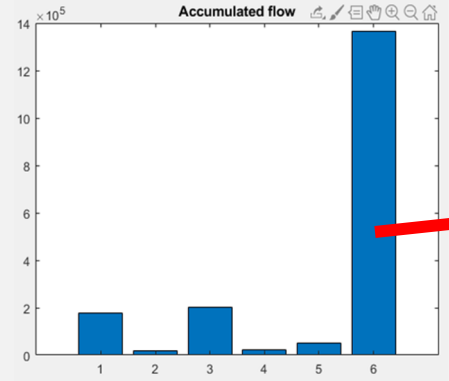


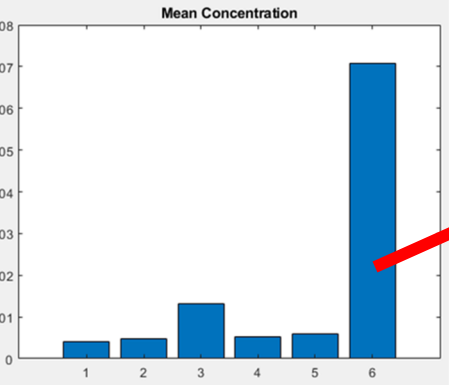
Case: Kajerød Å catchment





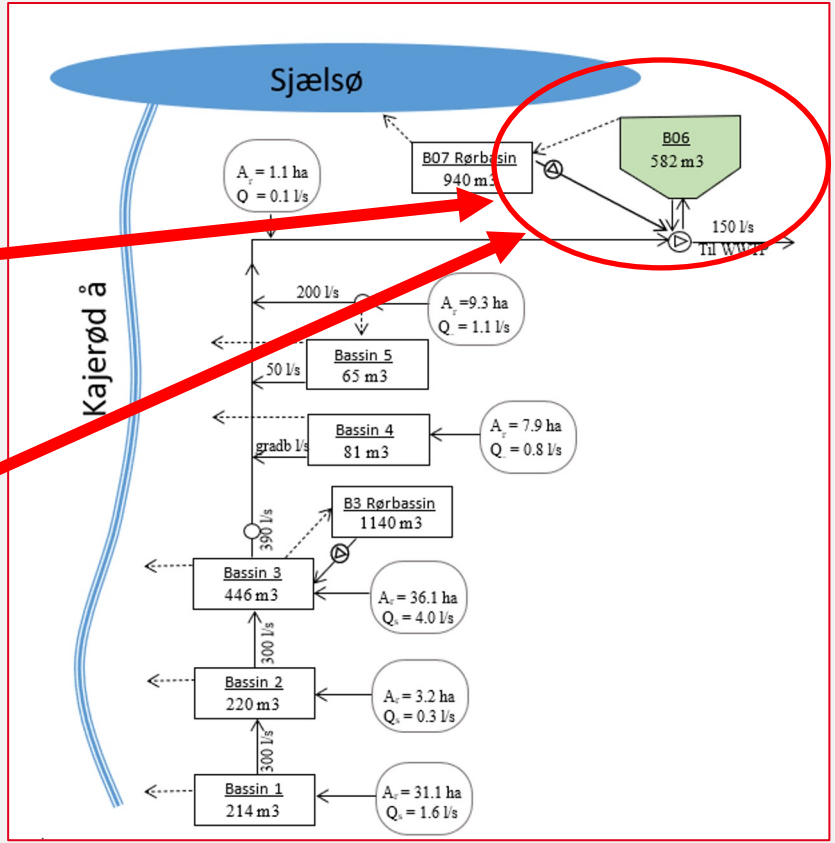
Status today



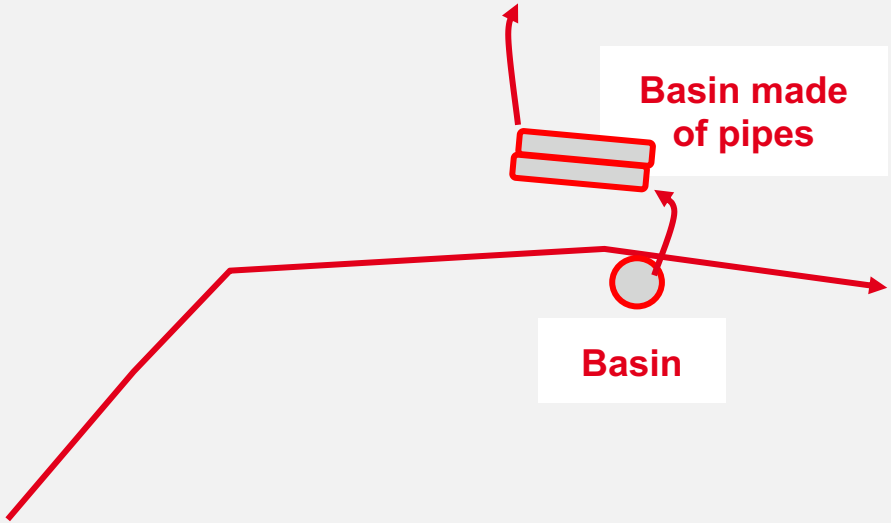


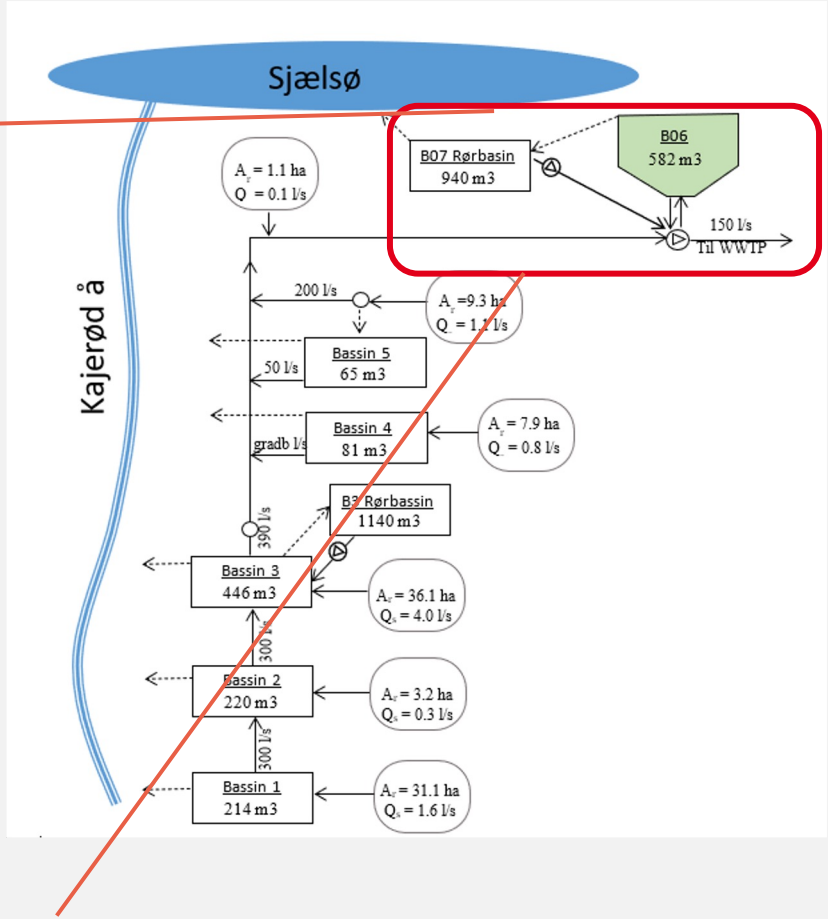
Overflow volumen for 10 years [m3]

Wastewater fraction in the overflow

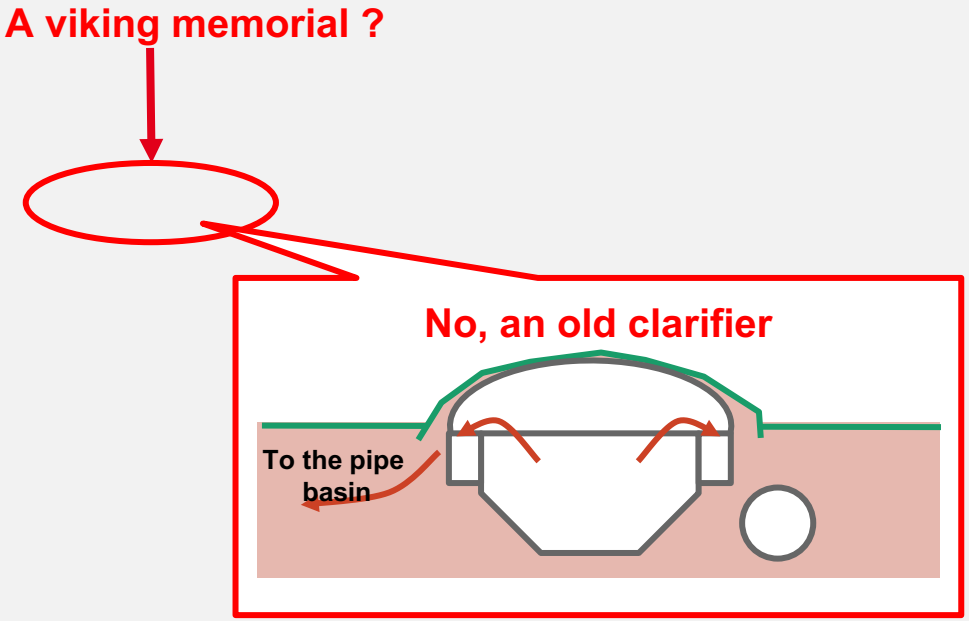


Kajerød Å catchment





Case area
Kajerød Å catcahment

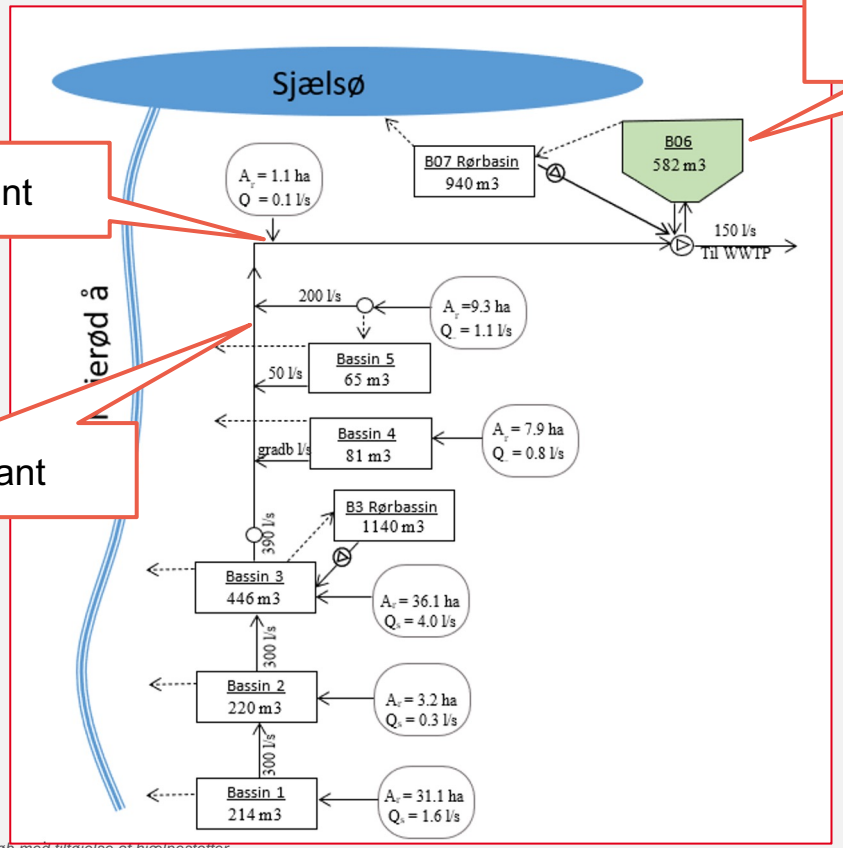


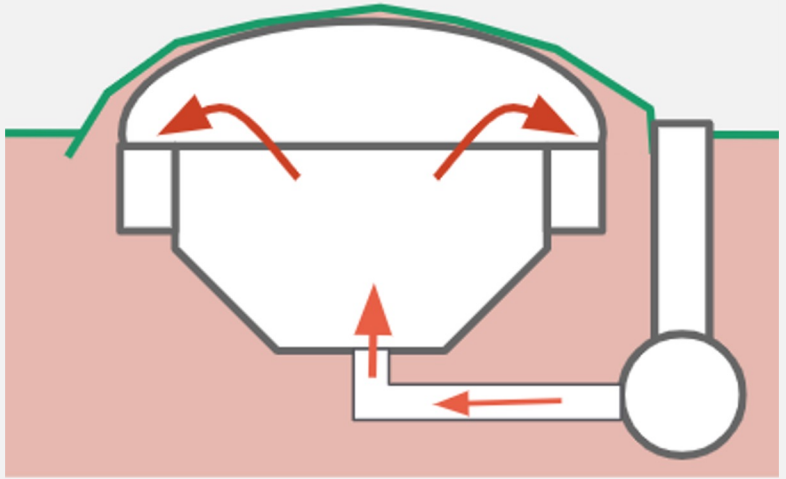
Setup: 2 places for dosing

Sedimentation

Flocculant

Coagulant





The Plan

Phase 1

- Determine the removal of pollution without doing anything
  -The basin may already today reduce the pollution going in the CSO

Phase 2

- Determine the removal of pollution after doing of flocculant and coaggulent in the sewers

How to find the right times dosing in this setup ?

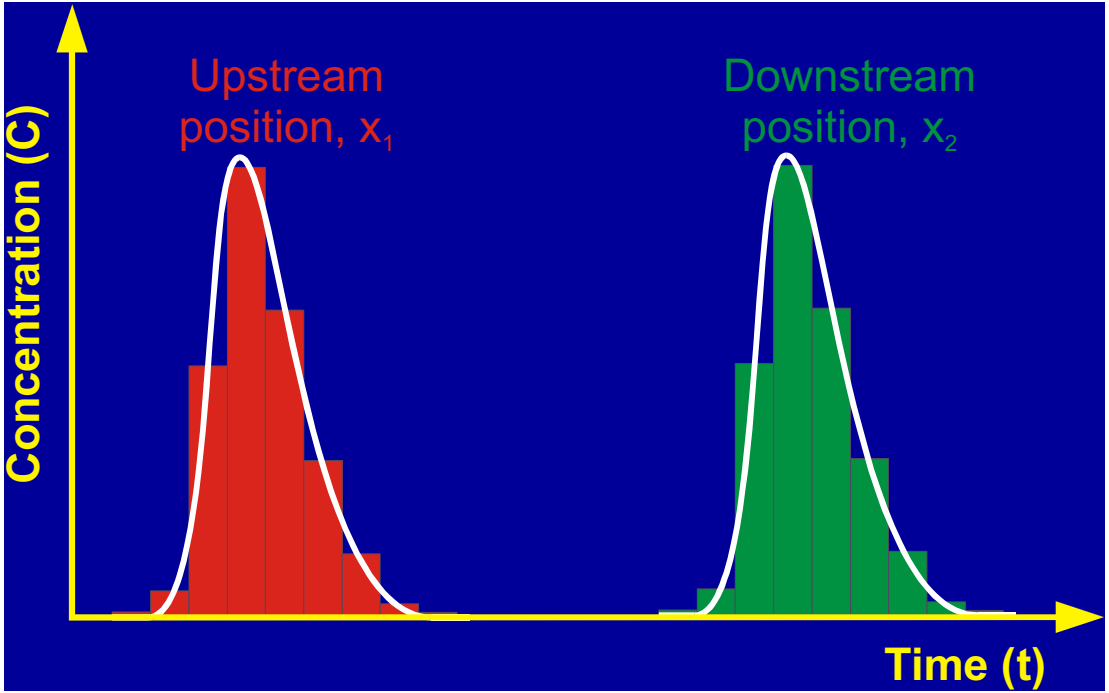
Questions

1. Time for coagulant to work ?
2. Time for the flocculant to hit and mix with the coagulant ?

Answer: Modelling 🤔

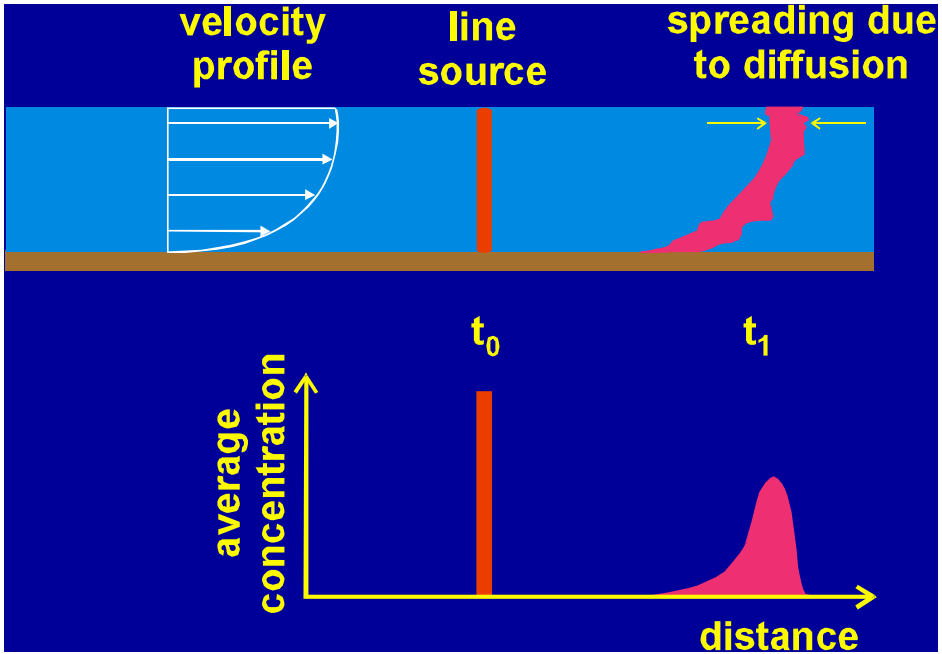
Answer: Tracer study 😃

Advection - “plug flow”



(From Ian Guimer - Sheffield University)

Dispersion



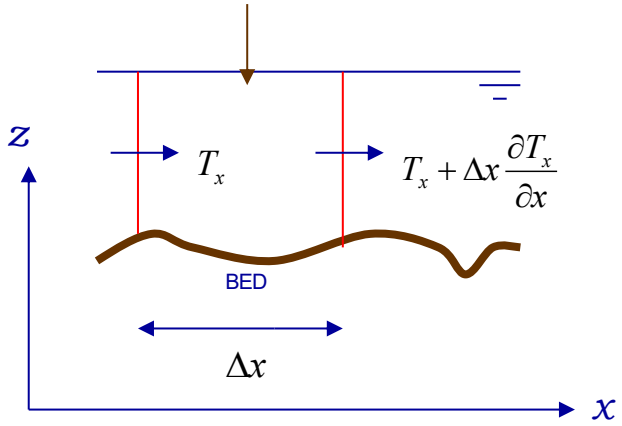
(From Ian Guimer - Sheffield University)

The Advection - dispersion equation

- solved each time step after the hydrodynamics

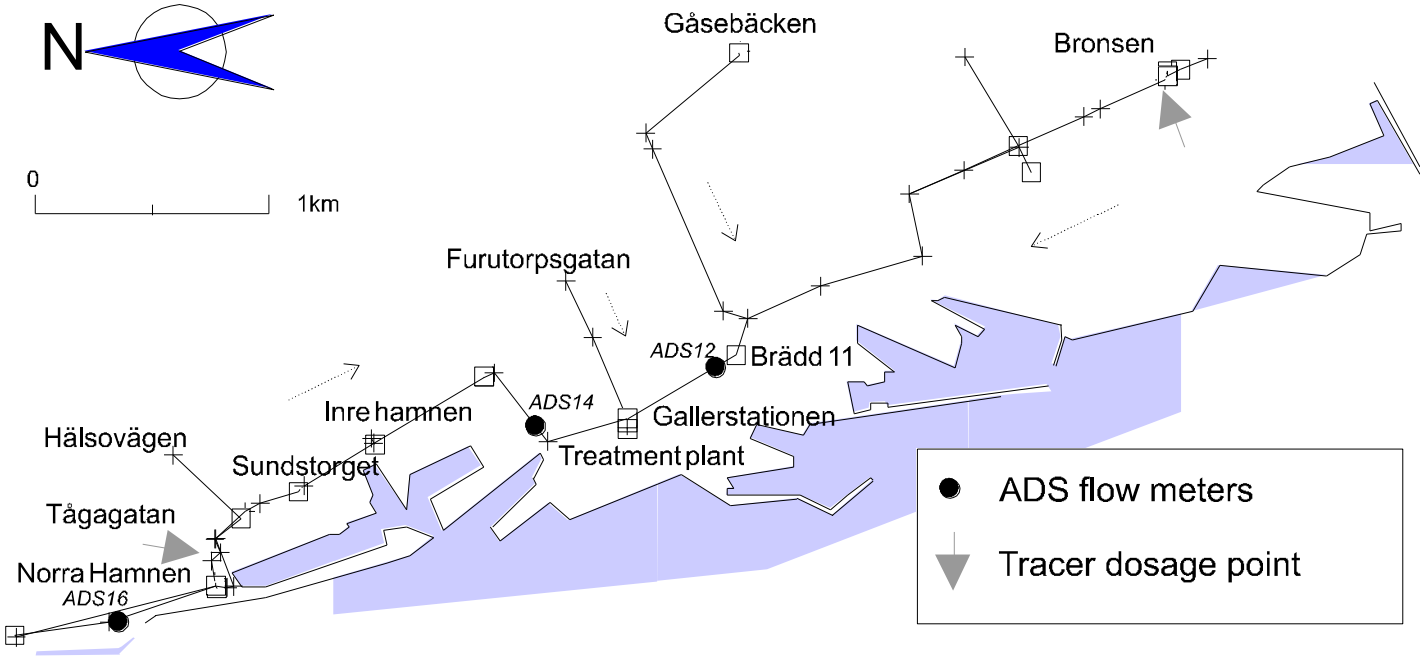
Conservation of mass:

$$\frac{\partial(AC)}{\partial t} + \frac{\partial T}{\partial x} = - A \cdot K \cdot C + C_s \cdot q$$



C	is the concentration (arbitrary unit),
A	is the area of the cross-section (m^2),
T	is the transport,
K	is the linear decay coefficient (s^{-1}),
C_s	is the source/sink concentration,
q	is the lateral inflow (m^2/s),
x	is the space co-ordinate (m),
t	is the time co-ordinate (s).

HELSINGBORG - MAIN SEWER SYSTEM
Central parts

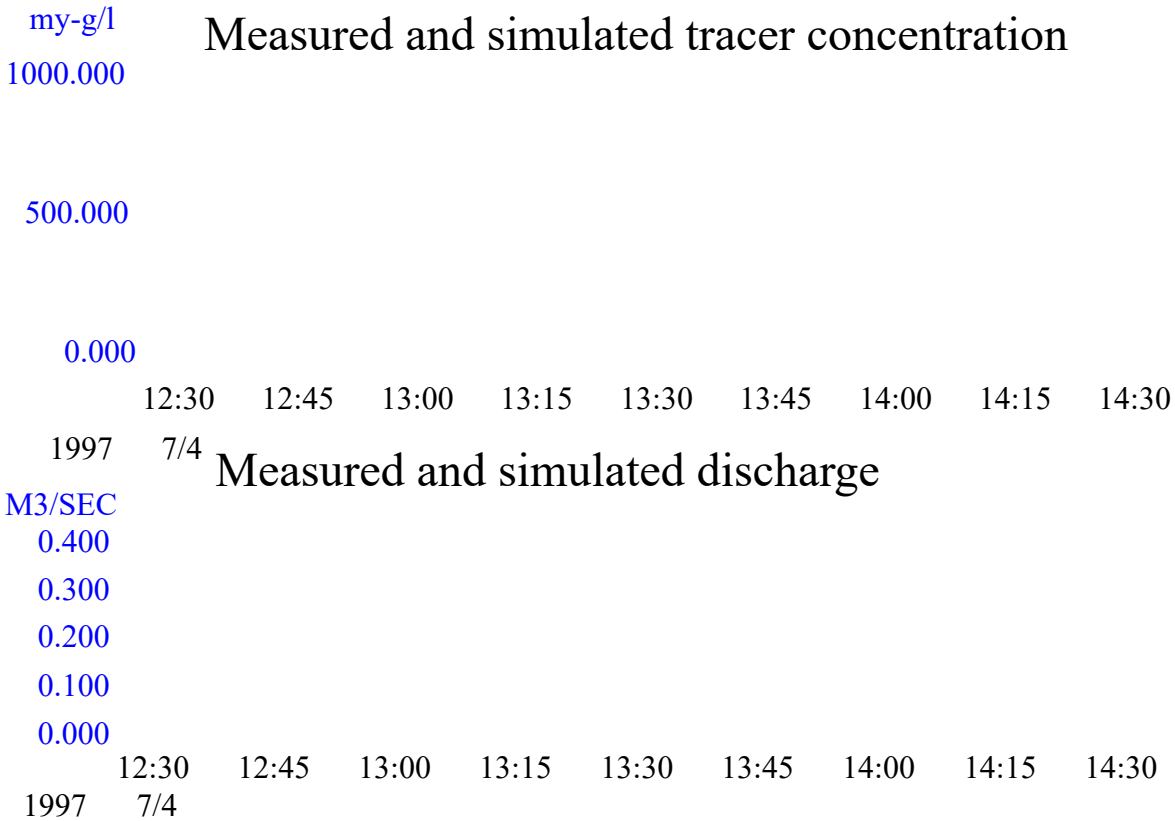


ADS Flow measurement sites

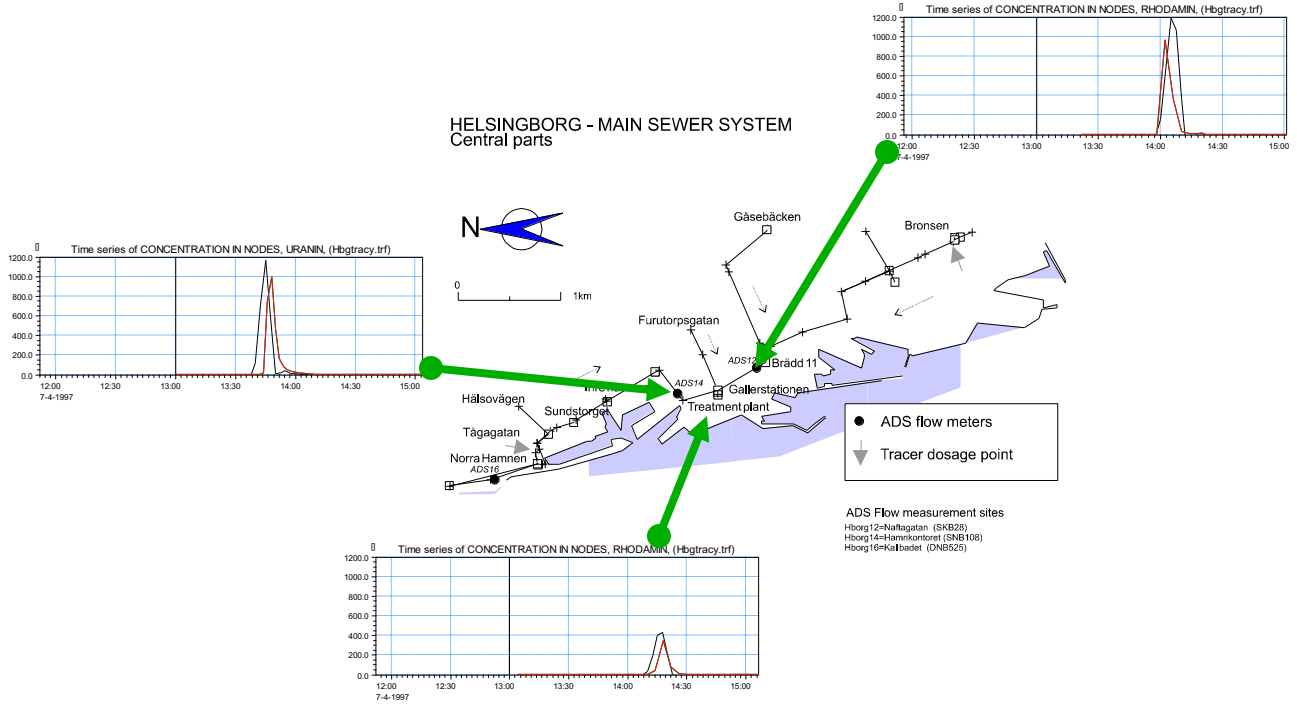
Hborg12=Naftagatan (SKB28)
Hborg14=Hamnkontoret (SNB108)
Hborg16=Kallbadet (DNB525)

Location ADS14, Helsingborg, Sweden

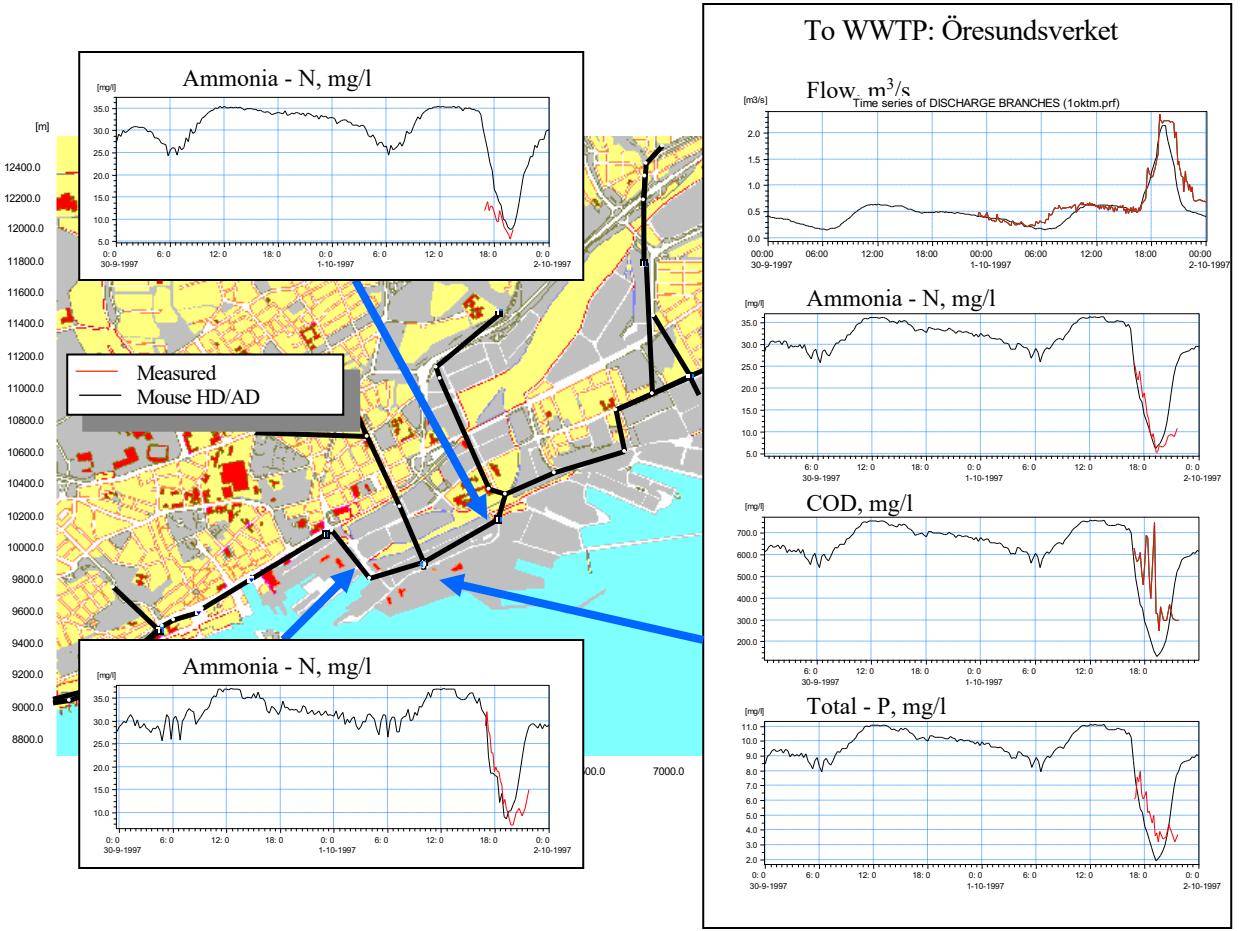
- A perfect flow calibration, but …



Calibrated tracers againgst MOUSE / Mike Urban, 1997



Simulated concentrations, Helsingborg 1997

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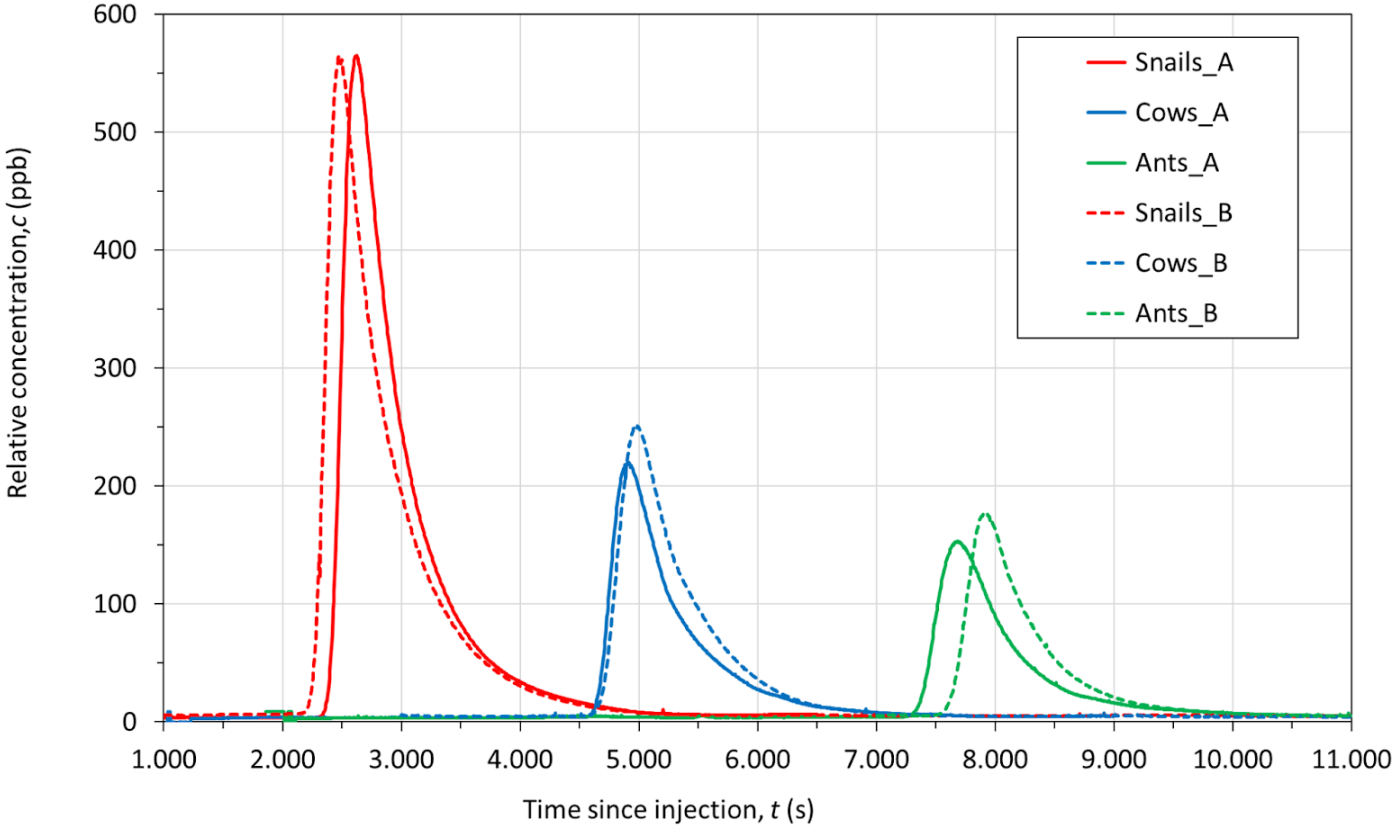
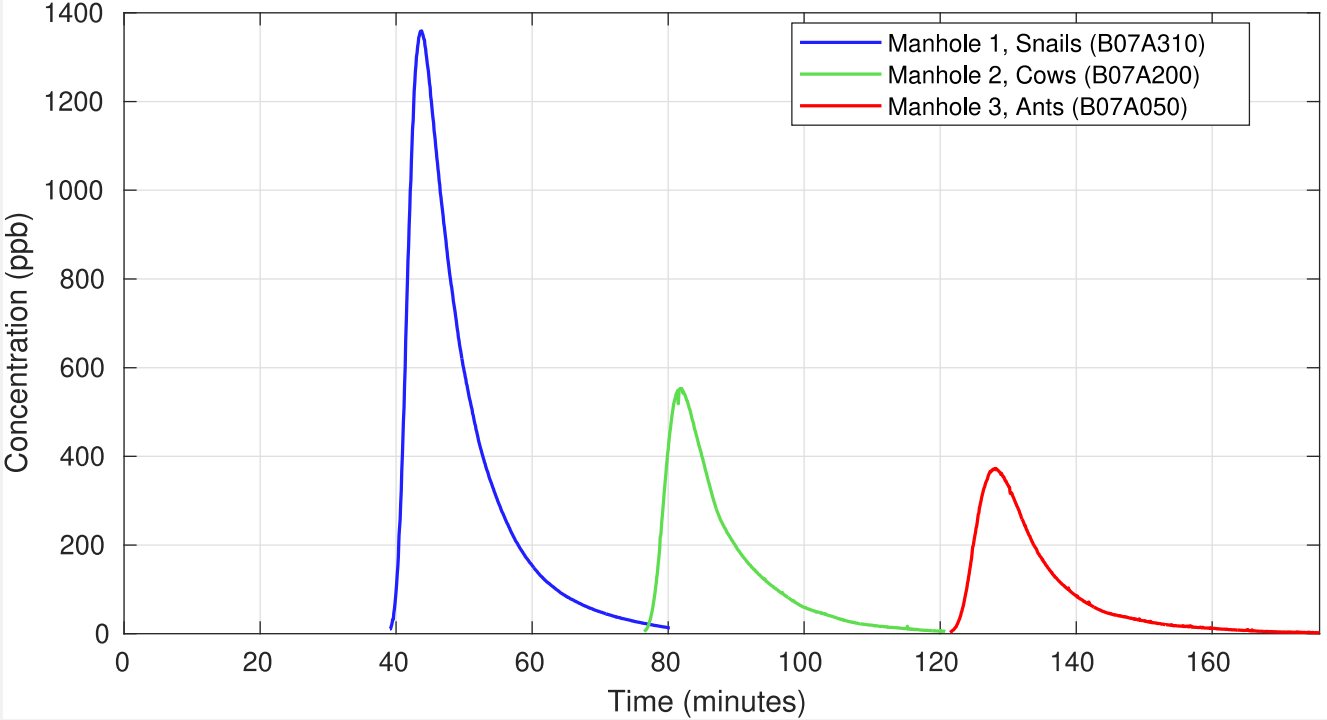
Results from 2 tracer experiments - during dry weather



Results from the tracer



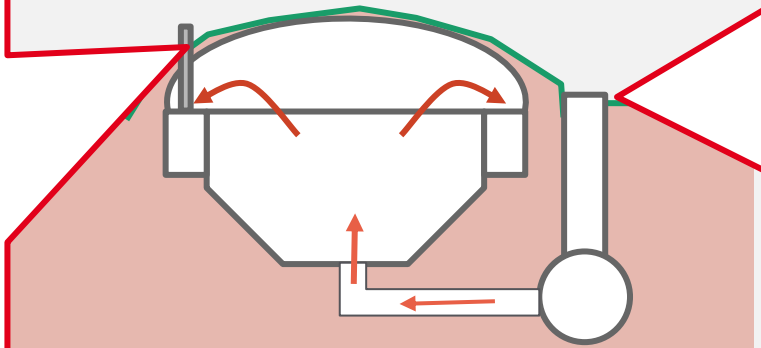
Equipment

2 auto samplers

At the weir

-after sedimentation

Main pipe
before sedimentation

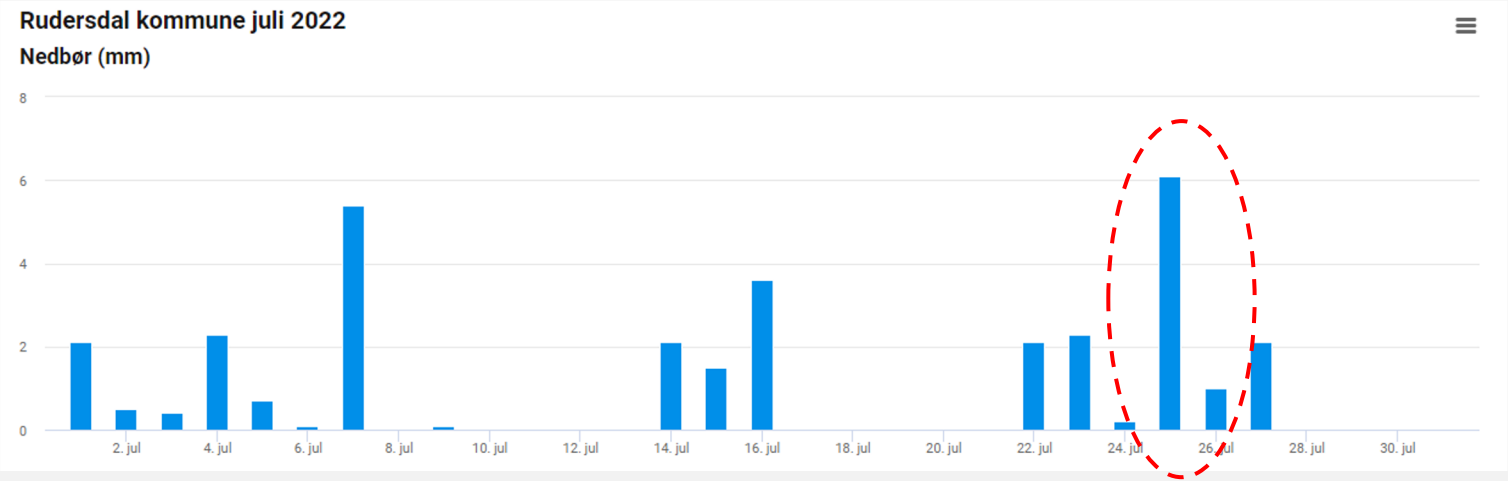


Test measurements for 1 event

Overløb

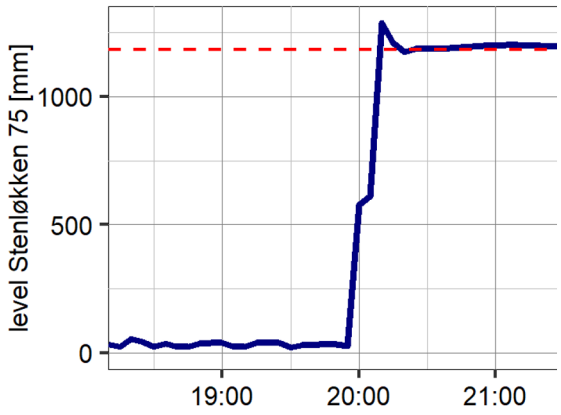
Measurements

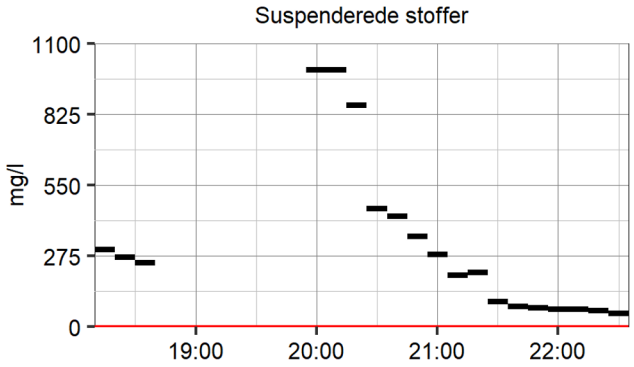
25 juli: large event in July – no overflow

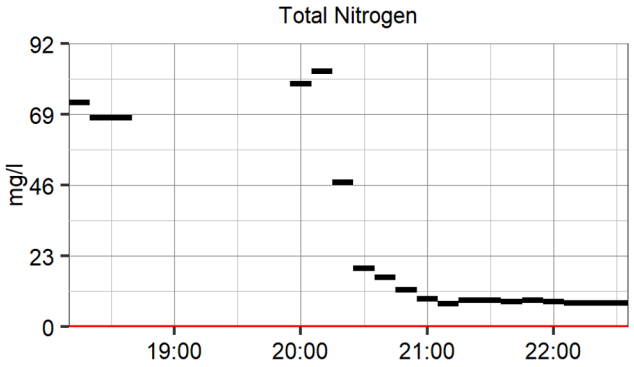


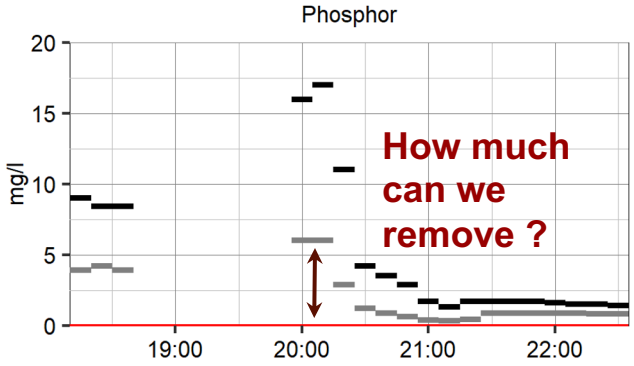
25th July – Results in the main pipe

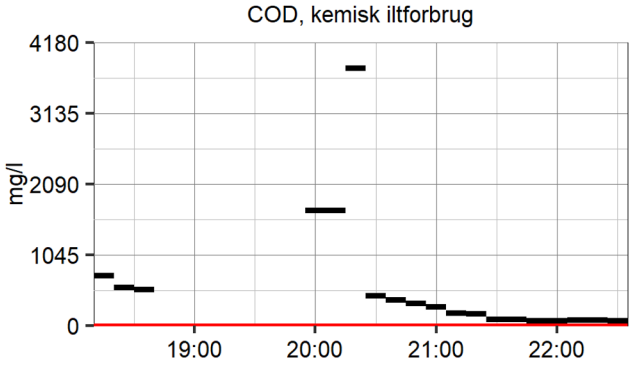
Level upstream









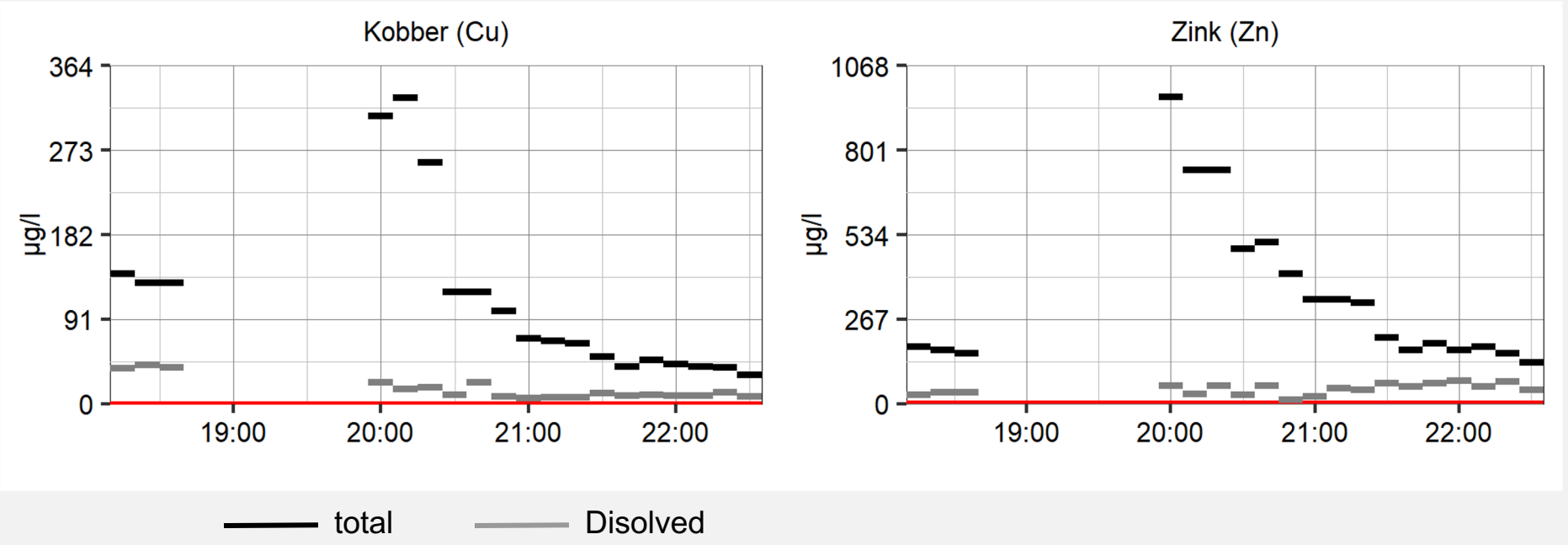


Total

Disolved

25th July – Resultats in the main pipe

Removal of heavy metal ?



Conclusion
From proof of concept to…

- The method has potential to reduce the emission from sewers of:
  - **Phosphourous**
  - **Heavy metal**
  - **COD**
  - **Anything else attached to particles**

- The tracer study is the key to success
- Use of existing infrastructure
- Looking for more locations to test

Now just waiting for rain….