Integrated RTC of Sewer systems and WWTP in Aarhus

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The municipality of Aarhus has decided to support the opportunities for recreational use of Lake Brabrand, River Århus and the area at Aarhus Harbour.

**Drivers:**
- Rapid city Development
- The citizen’s expects the Environment will be less polluted
- Water Framework Directive
- Bathing Water Directive

**The project support:**
- The re-opening of River Aarhus
- The establishment of a new district on Aarhus Harbour
- The recreational use of Lake Brabrand, River Aarhus og Harbour Aarhus

**Focus points in the project:**
- People having close contact with water
- Hygienic water quality

**The nessecary improvements:**
- Described on basis of the term in the
- EU Bathing Water Directive
The present water quality – described as e-coli (results from 2005 and 2006)

Bathing water is divided in four classes:
- Excellent
- Good
- Sufficient
- Poor (not bathing water)
Lake Brabrand, River Aarhus and Aarhus Harbour is affected by:

- 75 combined sewer overflow (CSO) – the red marks
- 58 rainwater drains – the blue marks
- treated wastewater from Viby and Åby WWTP
- app. halfpart the water in River Aarhus – is treated wastewater
Expected Outcome

- Bathing Water in Lake Brabrand (hygienic)
- Improved water quality/partly Bathing Water in River Aarhus
- Bathing Water in the Harbour (hygienic)
The system design for planning the project and for integrated real time control to ensure the water quality consist of a hydraulic model which describe the transport and dilution of E.coli and a model describing the delay of E.coli.

- Rural catchment model (mike she) driven by rainfall. Calculating the run-off from the rural area as an input for Lake and River model.
- Sewer catchments model (mike urban) driven by rainfall and dry weather flows. Calculating flows, run-off, CSO’s and E.coli transport as input to the Lake and River model.
- Lake and River model calculating flowpattern and E.coli transport as input to the Harbour model.
- Harbour model calculating flow pattern and E.coli transport using results from a marine model as the “downstream” boundary.
Solutions:

**Infrastructure**
- New retention basins (approx. 55,000 m³)
- Disinfection of the treated wastewater from 2 WWTPs
- Increased hydraulic capacity at WWTPs (Extensions of clarifications tanks)

**Monitoring/Control**
- Integrated real time modelling/control (sewer system/WWTP)
- Early Warning system for water quality
Traditionel structure of the sewersystem and the WWTP.

- It’s more normally using a rain gauge and not a radar as shown.

Function: The sewersystem ensure that the mixed wastewater and stormwater reach the WWTP very fast. This results in overflows and some time flooding.
The result is that the inflow to WWTP is balanced out according to the currently treatment capacity. It’s possible to predict the inflow to the WWTP, so the operation of the WWTP can switch to stormwater condition. The total outflow of the system is minimized.
Integrated RTC of Sewer systems and WWTP
Built up of 3 main system with 3 function

Communication, control and models

Radar

The sewer system

Real time modelling and control

Real time (modelling and) control

SCADA

Distribueret rain/

Communication, control and models

WWTP

Measurement point

Real time modelling and control

Sensor

Communication

PLC

Control Handles

Real time (modelling and) control

Distribueret rain/

Communication, control and models

WWTP

Measurement point

Real time modelling and control

Sensor

Communication

PLC

Control Handles

Real time (modelling and) control
All bassins, and pipes in the sewer system are built and in use. The clarification tanks at the WWTP are built and in use.
The sewer system

New pipes will ensure transport of stormwater

Flooding under construction of a new bassin – it was time for a cup of coffee
We have set up a new radar, which have been in function for more than 2 years

Task for the Radar:

- Produce area related rain intensity to every bassin in the hydraulic models
- Predict rain event
- Predict start and end of rain-event
The main task for the 3 main systems during rain-event:

Porpuse: Minimize the environmental consequences caused by heavy rainfall. (in this project the focus is hygienic water quality)

Task:

- The weather-rader (WR) transmit information to the sewersystem (SS) and the WWTP about the next rainfall. It transmit data about expected time of arrival, intensity and volume.
- SS og WWTP choose a control strategy
- WWTP calculate the possible inflow according to hydraulic capacity of the biological tanks
- SS calculate expected inflow to the WWTP according to the information about rainfall and the conditions in the sewer system.
- The global control strategy calculates the optimal strategy according to the information from SS and WWTP.
- WR transmit information to SS and WWTP
- Loop

The global control strategy is calculated by using a complex model-setup. Every 5 minutes during rainfall the WR, SS and WWTP transmit real-time information to calculate and calibrate the global strategy.
Early Warning System for WQ

Real time modelling/control:
Sewer system/WWTP

Real time modelling:
Catchment Lake/river Harbour

Real time modelling:
Marine environment

Early Warning:
Bathing Water Quality
Switch from off-line modelling to online modelling and control

**Step 1**
Off-line modelling and planning
- Global controlling
- Local PLC controlling
- Excel/VB Software Sensor

**Step 2**
Off-line modelling af planning
- Global controlling
- Local PLC controlling
- DIMS Software Sensor

**Step 3**
On-line modelling and control
- Global controlling
- Local PLC controlling
- DIMS Software Sensor

**OBJECTIVES**

- DESIGN (Mike Urban)
- DESIGN og VALIDATING (Mike Urban + Mike 11 + Mike 21)
- Operation (real life)

**Model and real world**

- Local control strategy in PLC
- Global control strategy in DIMS

**Place of Operation**

- Local control strategy in PLC
- Global control strategy in DIMS

**Copy of real operation system**

- Local PC
- Real operation system

**Switch from off-line modelling to online modelling and control**
Local condition => Local control (=> local restraint)
The princip of the global control strategy

Global control try to fulfill the demands
Heartbeat loop – Global control Strategy

**Calculation loop: 5 min**

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**1.** Level maks

**2.** Level (pipes) → Calculation of flows

**3.** Qmaks → Other calculations

**4.** Dynamic risk assessment

**5.** PID → Qwanted → Qactuel

**6.** iFix

- Q pumps
- Opening of gate

**DIMS**

- Area related rainfall
- WWTP

**Qmax.wwtp**

**Volumen Qmin, Qmaks**

**Local condition => Local control (to local restraint)**

**The principle of the global control strategy.**
Thanks for your attention