

# Integrated wastewater catchment modelling and planning in Odense, Denmark

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# Agenda

- The City of Odense, VCS and wet weather challenges
- Our approach using DHI WEST<sup>©</sup> integrated model & Urban Pollution Management (UPM) environmental quality standards (EQS)
- Some scenarios and results
- Closing remarks

# Odense

- 3rd largest city in Denmark
- Ca. 192 000 inhabitants
- Birth place of H.C. Andersen



# Vandcenter Syd – VCS Denmark

- Owned by the City Council of Odense & the Local Council of Northern Funen
- Since 1853
- 200 employees
- Drinking water & Waste water



# Odense wet weather challenges

## 150 CSOs & 80 storm water outfalls

WEST - Rivers - 042015 X Naturstyrelsen | Vandhåndlejplanpdfashx +

google.com/maps/d/viewer?mid=z2oCXVBRBcSE.kVfBRcb1aiL0

Naturstyrelsen DCU tilmelding DSB Plus - Formyelse Danmarks Cykle Dropbox - Log på Gospelkoret Faith Indbakke (1482) - e-Boks Importeret fra IE DMI - Vejet i LyngbyCC webmail Feltet.dk Google

Log ind

WEST - Rivers - 042015

Oprettet med Google My Maps

WEST Outlets - Combined (CSO)

- J10F01V
- J10F02V
- J11F03V
- J11F04V
- J12F02U
- J12F05V
- J13F06V
- J20F01D
- J20F08V
- J22F005
- J23F09V
- J30F10V
- J31F11V
- J40F12V
- J50F13V
- J50F14V
- J50F15V

Satellit

WEST - Rivers - 042015

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- J30F10V
- J31F11V
- J40F12V
- J50F13V
- J50F14V
- J50F15V

Satellit

# Odense wet weather challenges 3 WRRF (Water resource recovery facility)

The image is divided into two main sections. The left section is an aerial photograph of a modern wastewater treatment plant (WWTP) featuring numerous circular sedimentation tanks and associated infrastructure, set against a backdrop of green fields and urban areas. A blue banner at the top of this section contains the text "Creating the WWTP of the future". In the bottom right corner of this section, there is a logo for "VCS Denmark" accompanied by a stylized circular icon. The right section is a map of the city of Odense, Denmark, showing its intricate river network. Three specific locations along the rivers are marked with black dots, and a large yellow arrow points from the WWTP image towards these marked locations, indicating the proposed sites for the new Water Resource Recovery Facilities (WRRF).

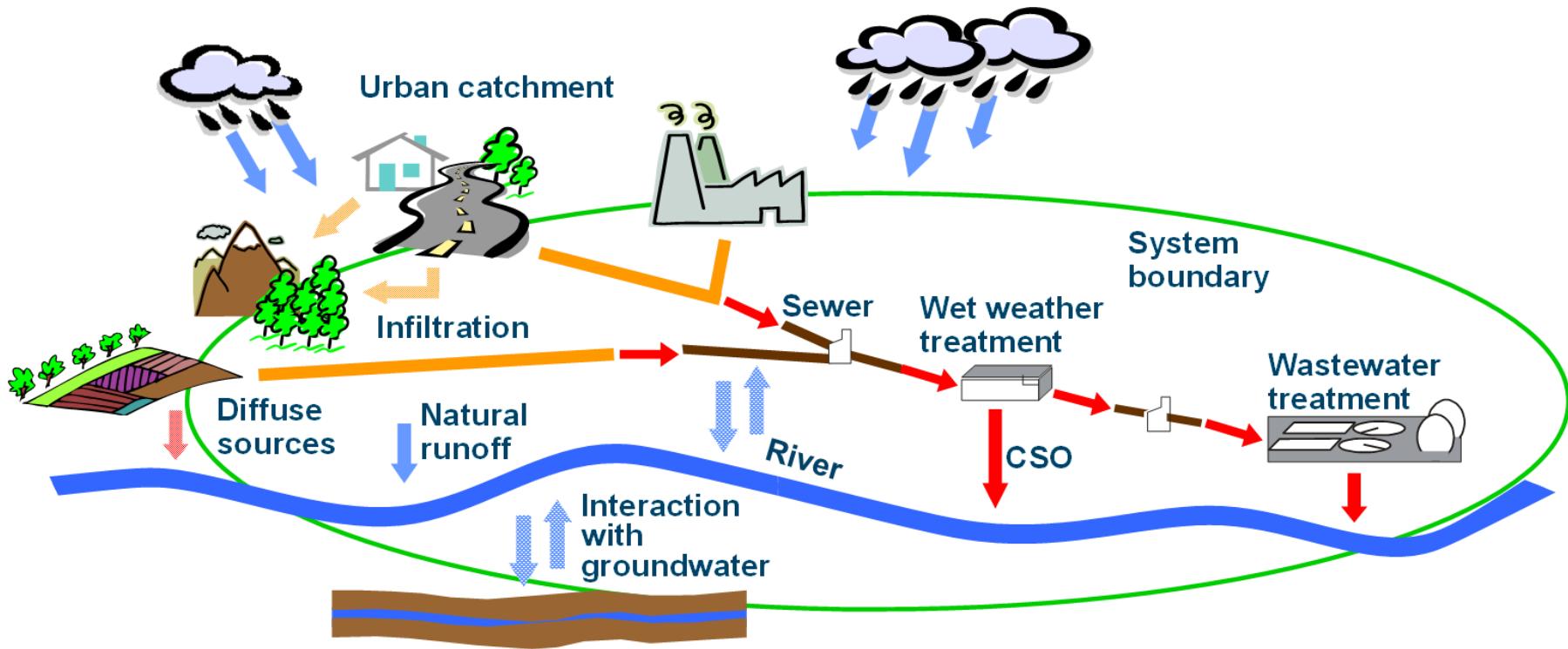
# Challenges

- Climate change – heavier rainfall, more frequent large storms
- City redevelopment & growth
- Rivers must achieve Water Framework Directive (WFD) Good Ecological Status (GES) ~ biological assessment of fish & invertebrates
- Regulator's standard approach to wet weather permitting
  - Separate consideration of CSO and WRFF
  - Annual spill volume ( $250\text{m}^3/\text{ha}$ ) & frequency limits (< 5) on each CSO
  - Conventional buried storage solutions
- Affordability? Protecting GES? Prioritisation? Operating costs?

# Our mission

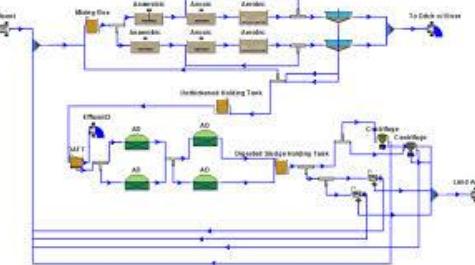
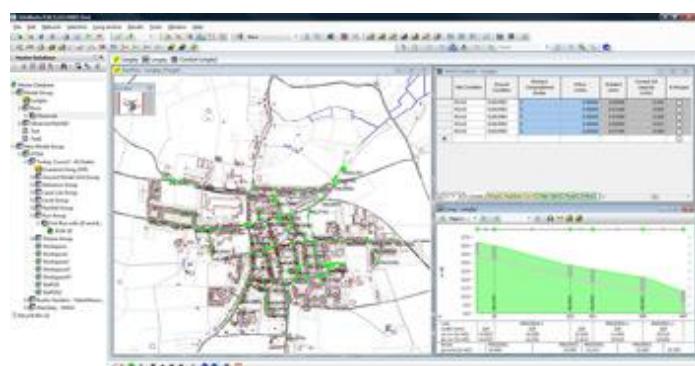
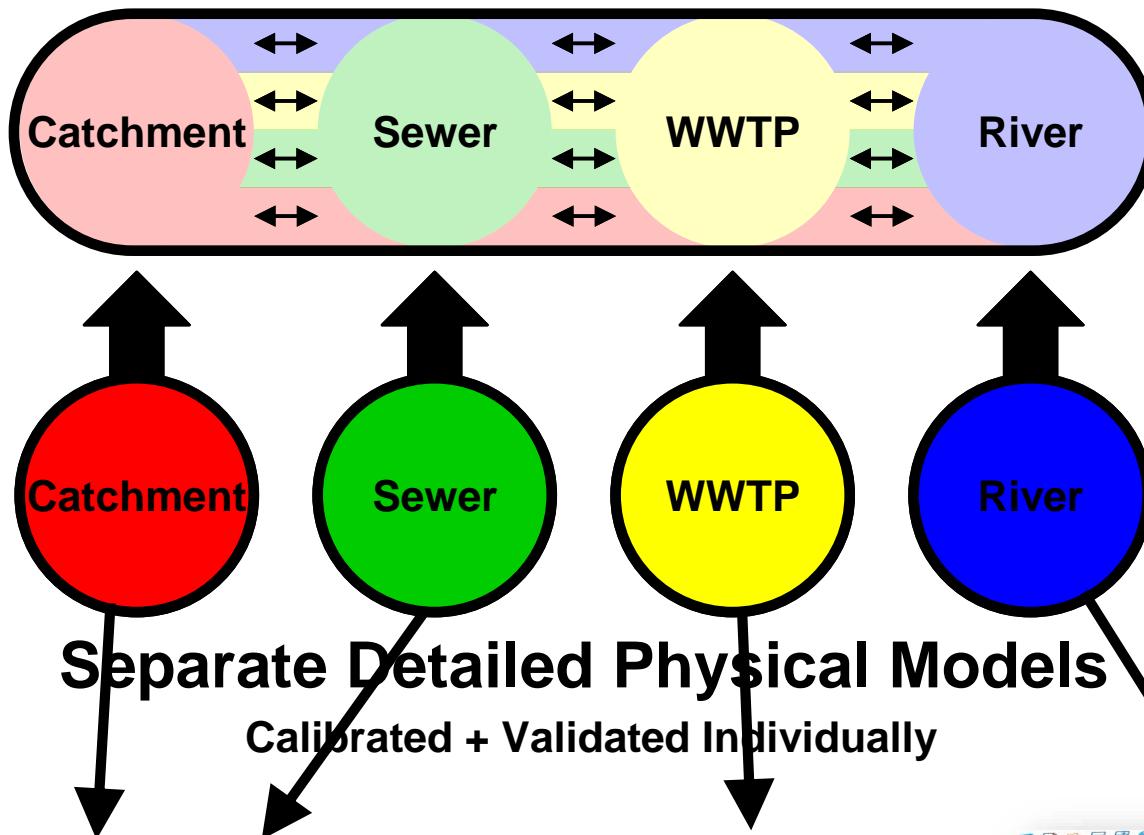
- Develop an alternative wet weather plan which:
  - satisfies Regulator,
  - delivers long term environmental benefit; and
  - supports the most efficient use of VCS investment
- Demonstrate leadership & innovation in wet weather planning
- New integrated modelling technology
- Wet weather water quality design criteria (UPM)

# Our integrated modelling approach

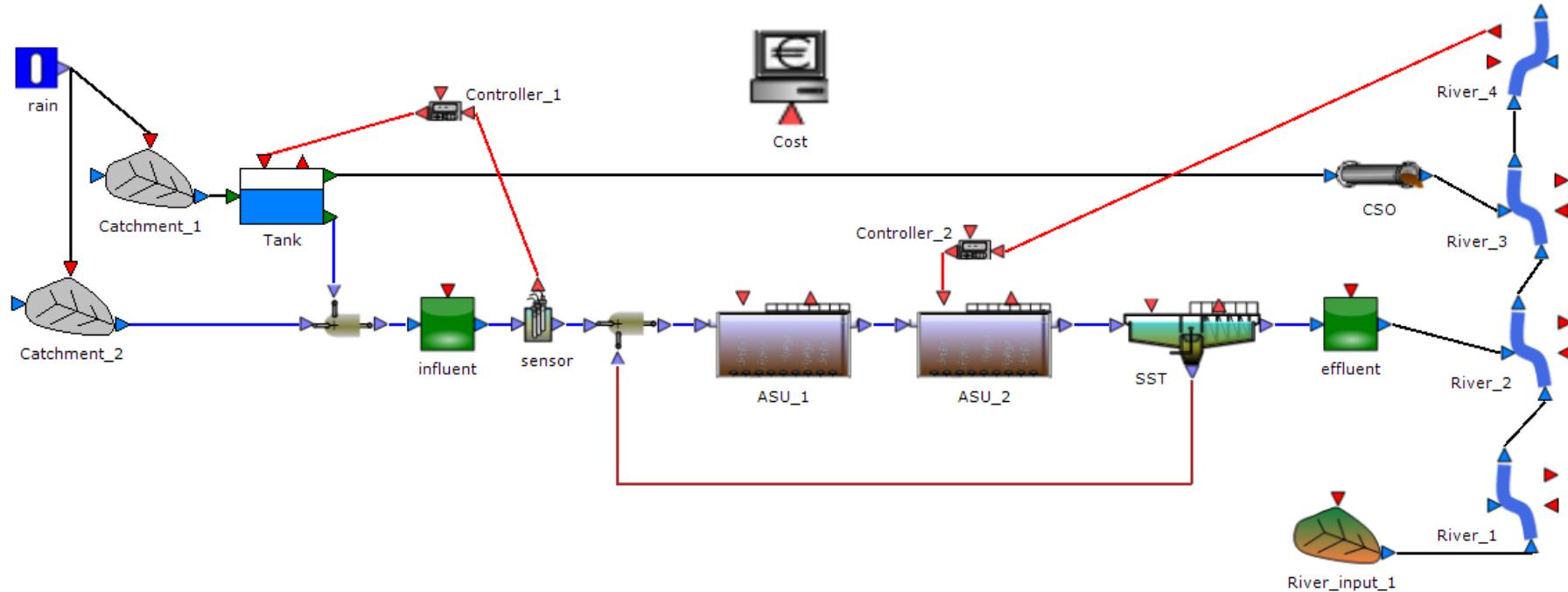


# Integrated Model

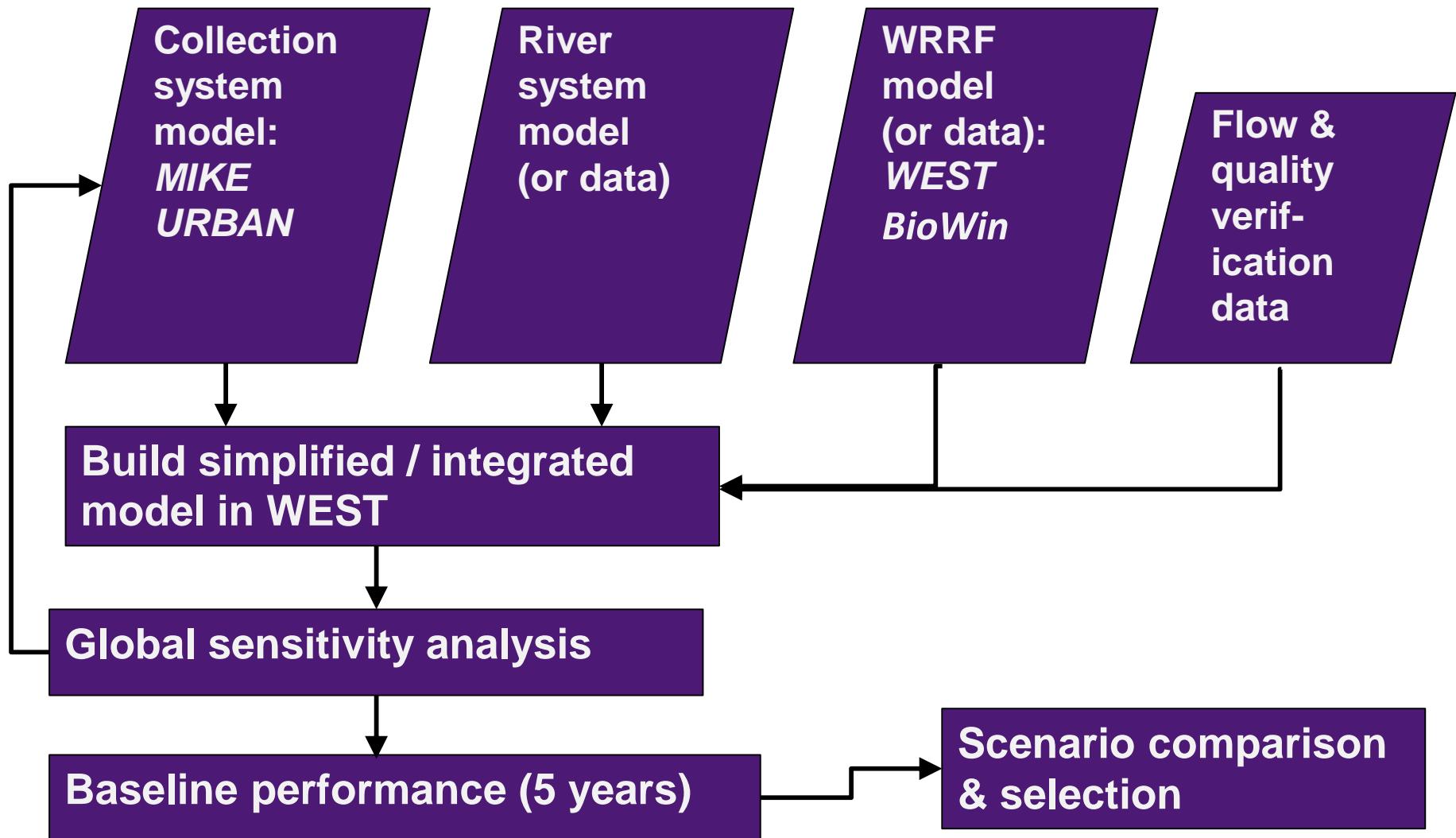
Calibrated + Validated Surrogate Sub-Models



# Simplified integrated model in DHI WEST

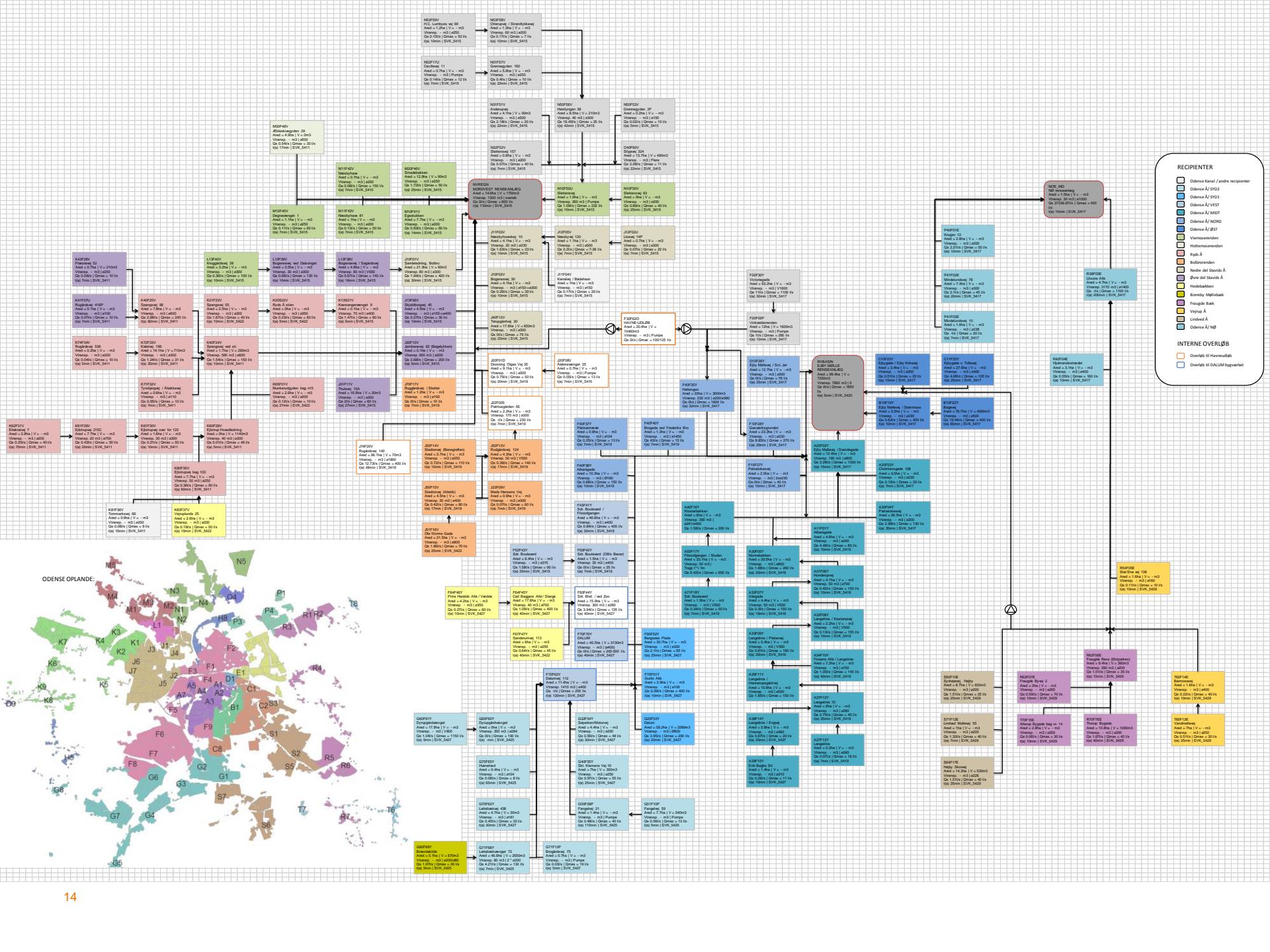


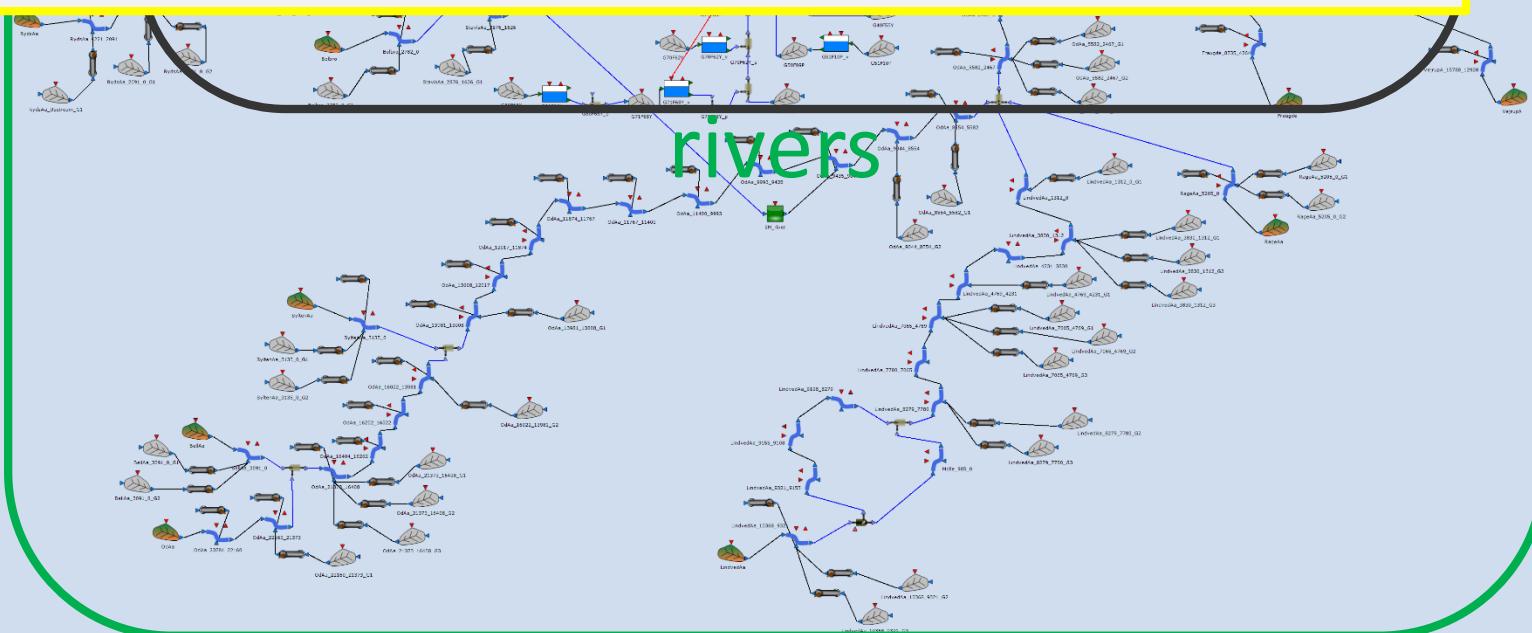
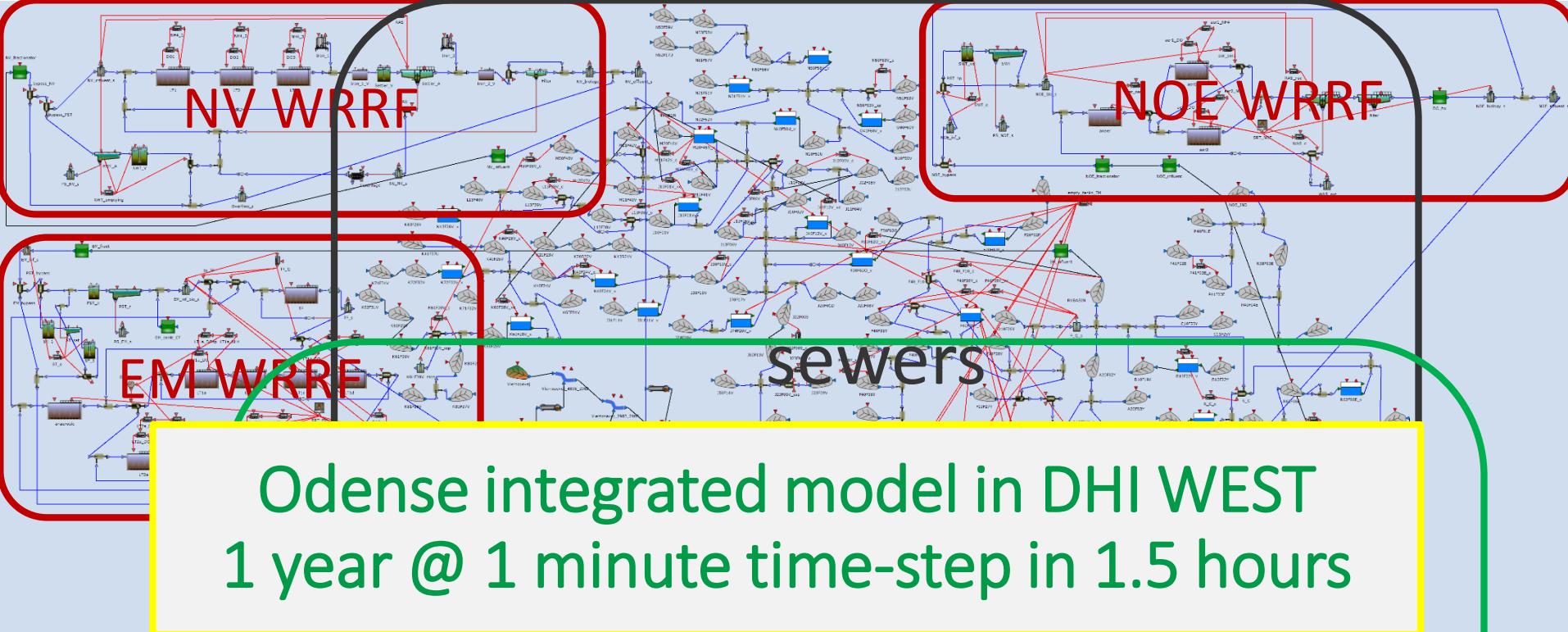
# Modelling workflow

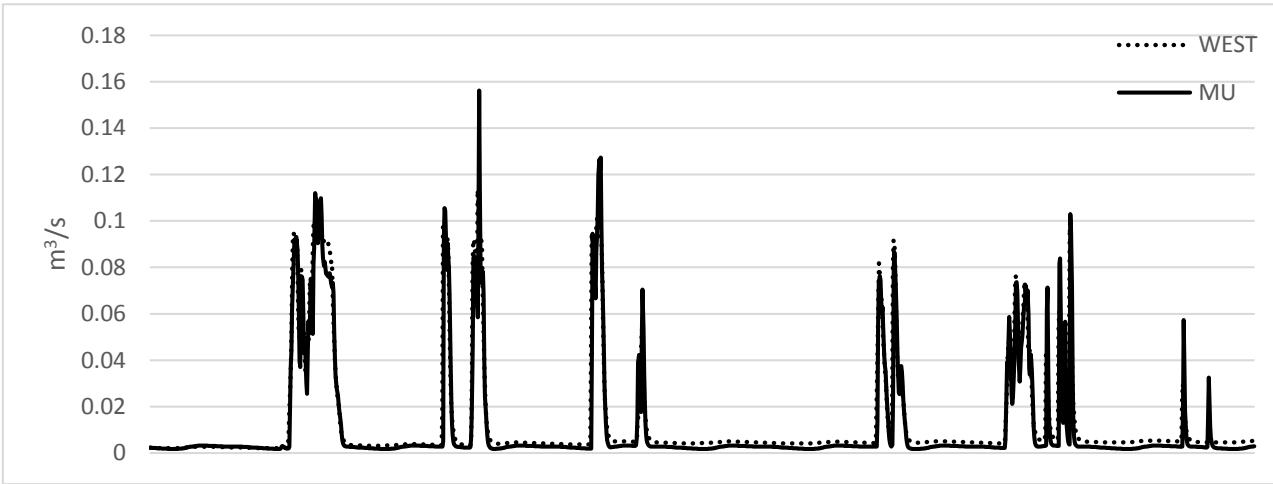


# Odense city

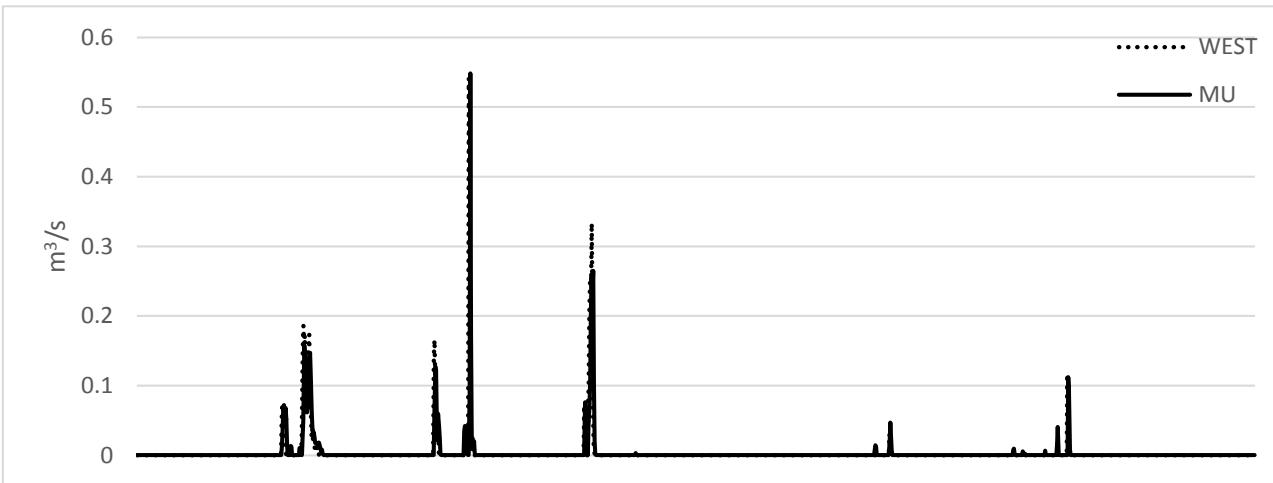




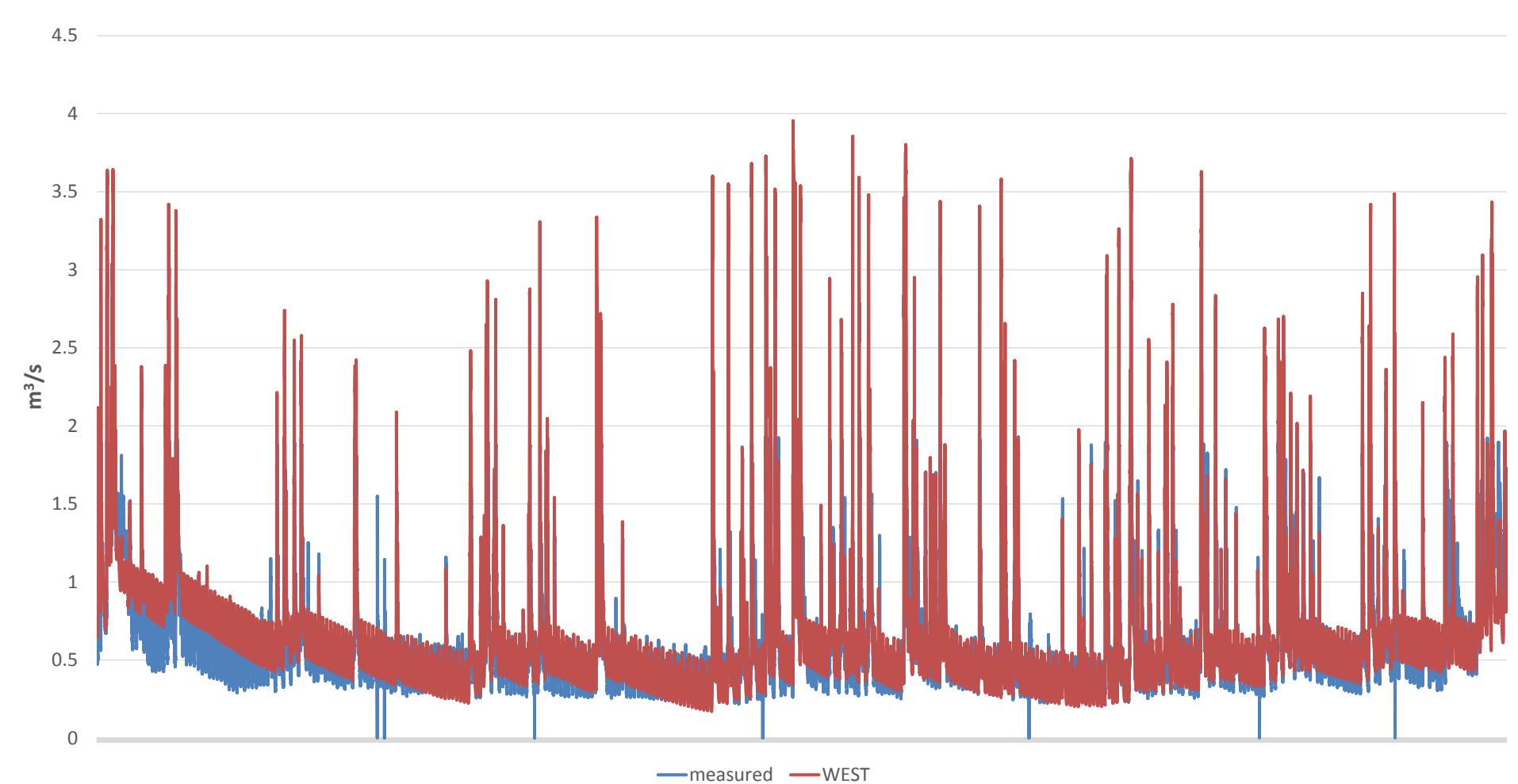




Pass-forward flow – 12 days



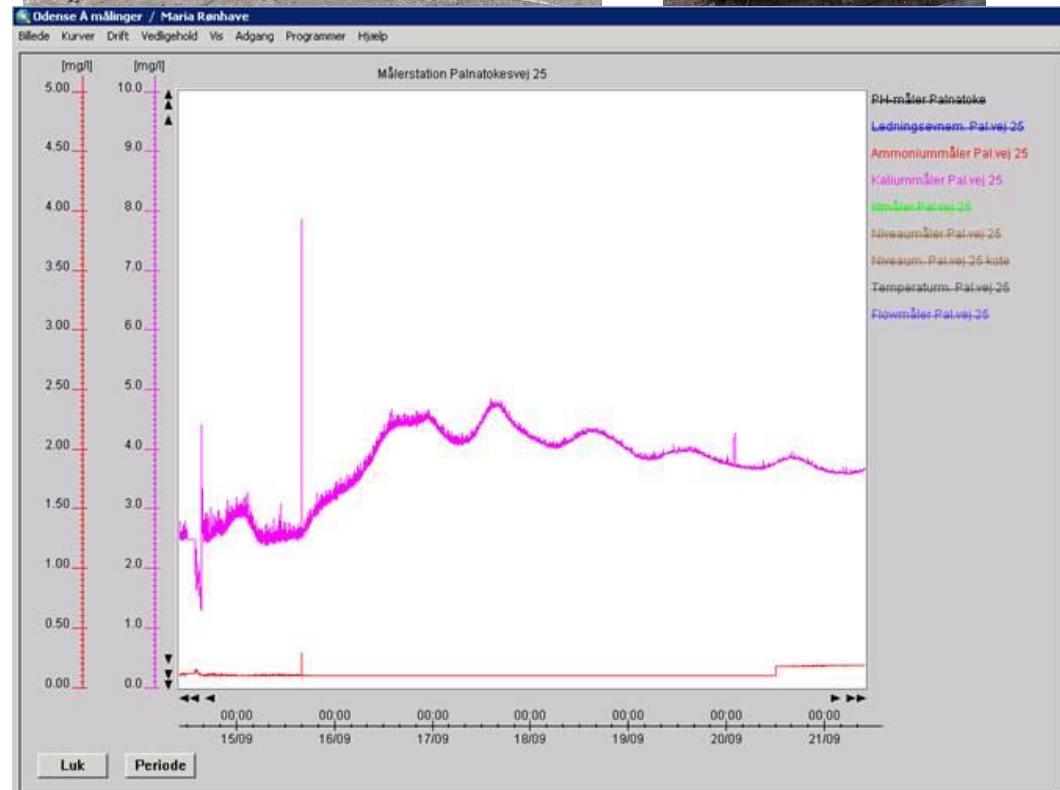
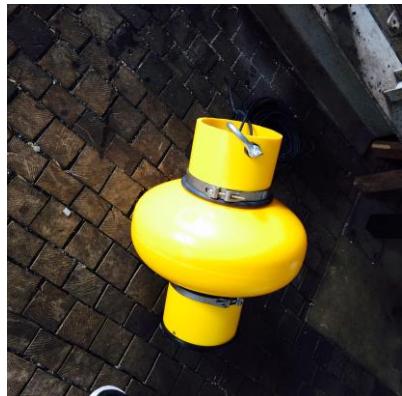
Overflow – 12 days



EM WRRF inflow – 1 year

# Monitoring program for river model calibration / validation

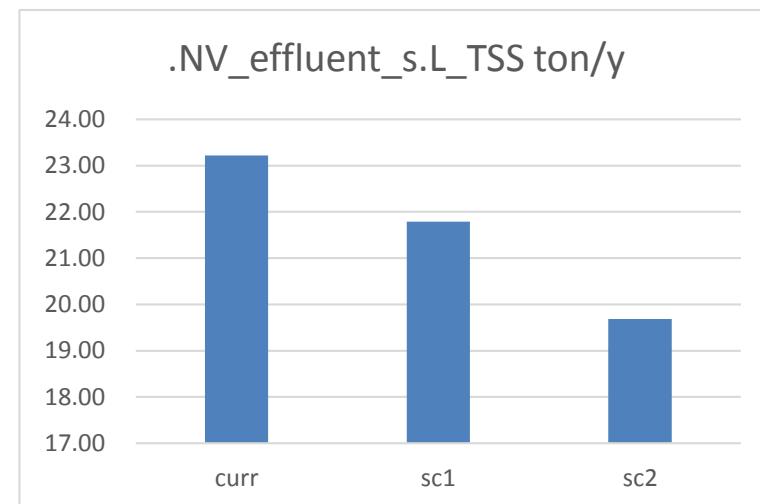
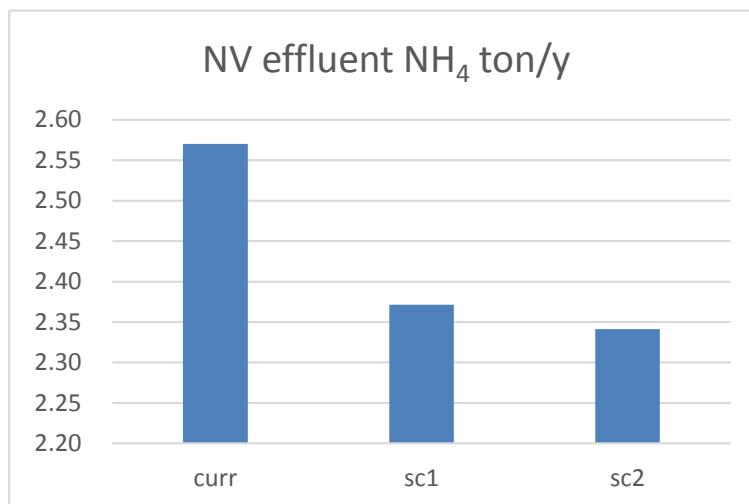
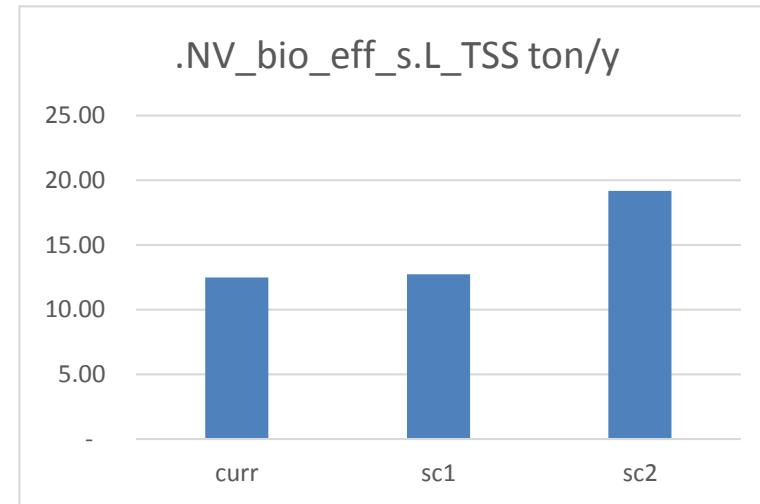
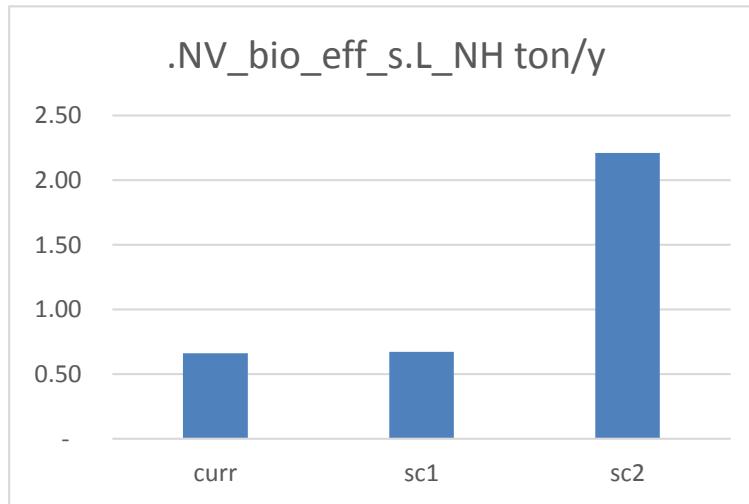
DO, NH<sub>4</sub>,  
temperature, pH,  
conductivity



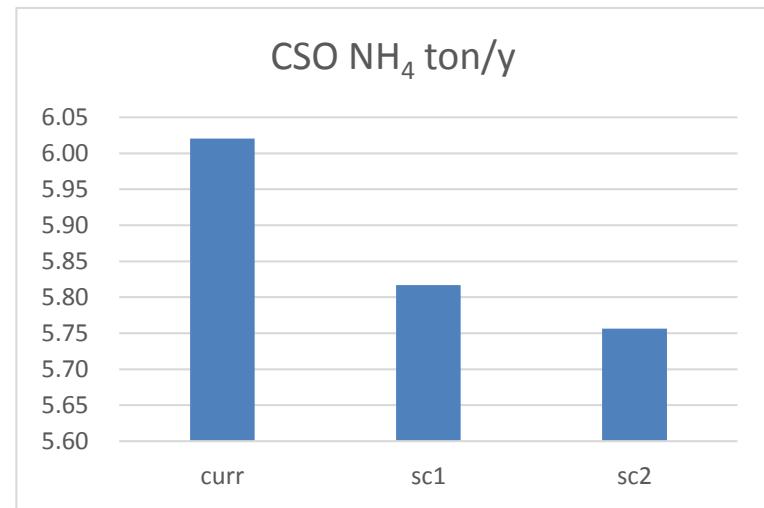
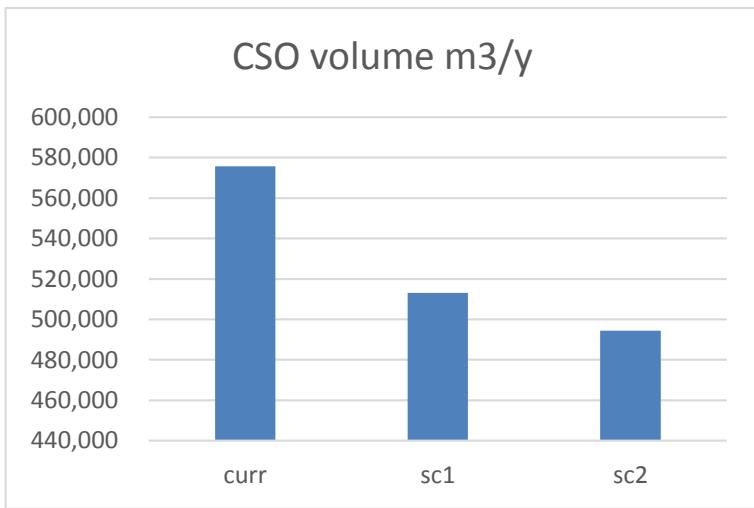
# Example of using the model to support decision making

- Current situation
- Scenario 1 (default regulator plan)
  - 9300m<sup>3</sup> of new storage at 9 locations
  - 3 upgraded pumping stations
- Scenario 2 (lower cost alternative across collection & treatment)
  - 700m<sup>3</sup> of new storage at 1 location
  - 11 upgraded pumping stations
  - Enhanced wet weather treatment at 1 WWRF
    - (full biological treatment up to 2,500m<sup>3</sup>/hr then settling/sand/filters up to 10,000m<sup>3</sup>/hr)

# Scenarios – WRRF (biology and total) effluent loads



# Scenarios – CSOs



# Some results

UIAc salm.	<i>Duration of the event</i>				curr			sc1			sc2			
		1 - 5 h	6 - 24 h	> 24 h										
Tolerated	<b>12</b>	0.065	0.025	0.018	1 3 1	4.0	16.0	2.0	1 2 1	0.0	11.0	2.0	1 1 1	1.0 7.0 1.0
frequency	<b>4</b>	0.095	0.035	0.025	1 4 1	0.0	8.0	2.0	1 1 1	0.0	2.0	1.0	1 1 1	0.0 1.0 1.0
per year	<b>1</b>	0.105	0.04	0.03	1 5 2	0.0	5.0	1.0	1 4 2	0.0	2.0	1.0	1 2 2	0.0 1.0 1.0
DO salm.	<i>Duration of the event</i>													
		1 - 5 h	6 - 24 h	> 24 h										
Tolerated	<b>12</b>	5	5.5	6	1 1 1	5.0	7.0	3.0	1 1 1	2.0	6.0	2.0	1 1 1	2.0 3.0 1.0
frequency	<b>4</b>	4.5	5	5.5	1 4 1	2.0	8.0	2.0	1 3 1	2.0	5.0	1.0	1 1 1	2.0 1.0 1.0
per year	<b>1</b>	4	4.5	5	4 5 2	3.0	7.0	1.0	2 4 2	1.0	4.0	1.0	4 2 2	2.0 1.0 1.0

# Closing remarks

- Integrated model approach gives fresh insight into wet weather dynamics (ww collection | stormwater | treatment | river) & whole system operating costs
- Simplicity & simulation speeds allows proper sensitivity testing & uncertainty analysis & robust scenario testing
- Integrated model adds value to detailed modelling already completed
- Model is being used before validation is complete
- Regulatory approach is focussed on demonstrating the achievement of an EQS in a model - replacing concerns about CSO frequencies & volumes
- Danish Regulator is on-board following workshops in September 2015
- VCS, Regulator and CH2M working in partnership to develop a long term wet weather plan

# The End

