Urban wastewater system modelling: Use of particle classes for a better characterisation of the settling process

CWWA - CAWQ

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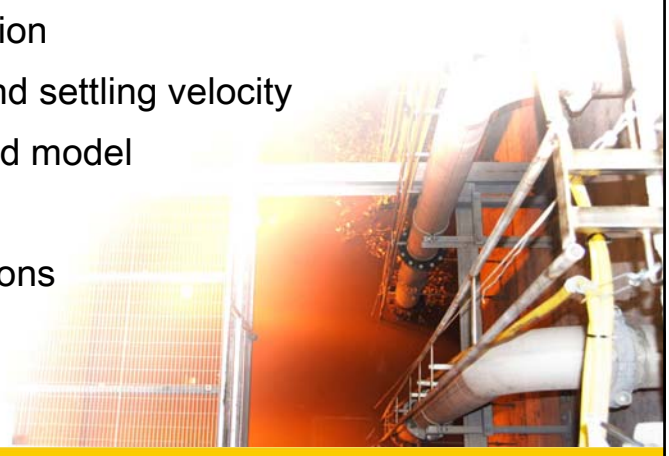
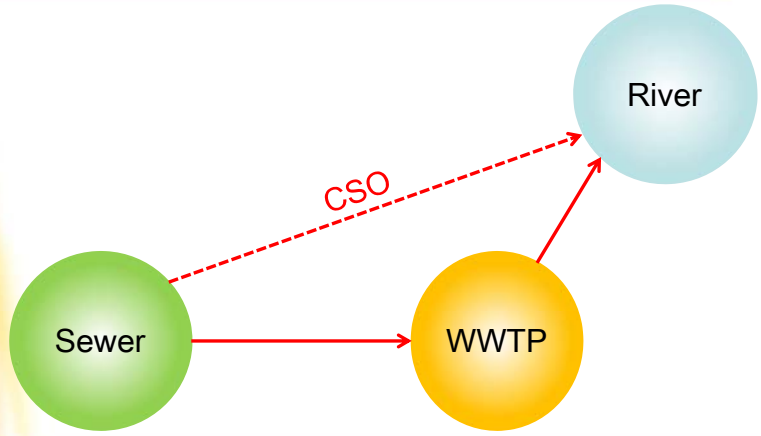
Outline

- Introduction
- ViCAs and settling velocity
- Integrated model
- Results
- Conclusions



Introduction
Integrated physical systems



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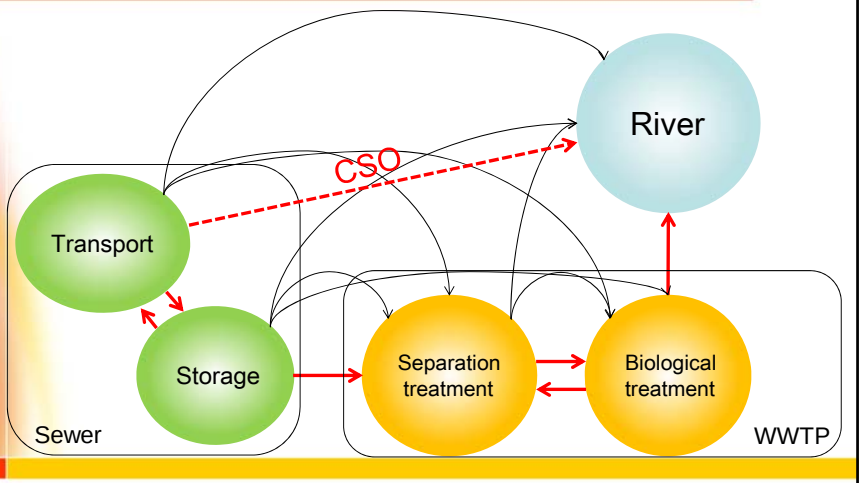
Integrated physical systems



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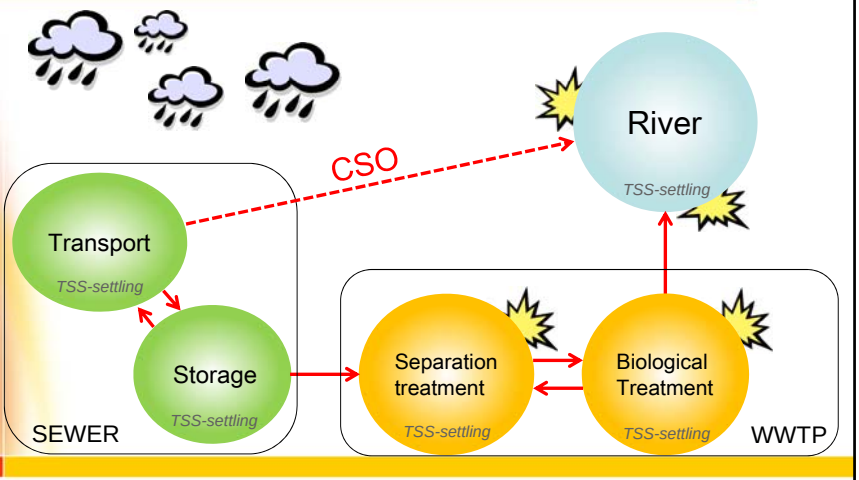
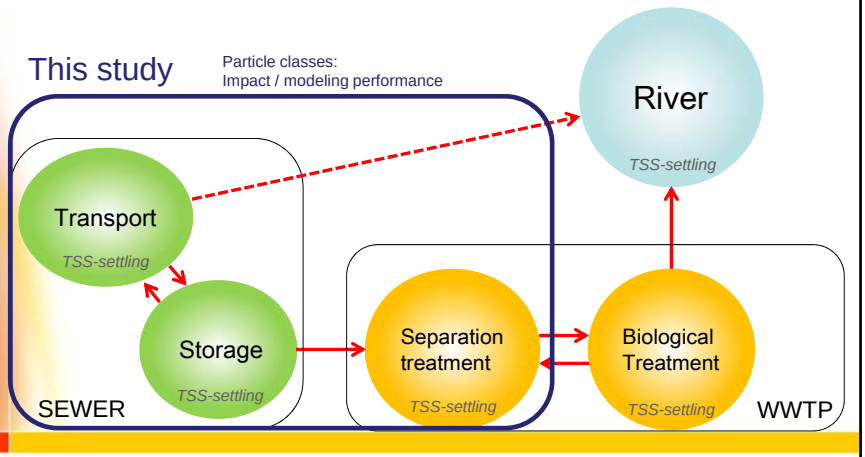
Integrated physical systems



Introduction
Integrated physical systems

This study

Particle classes:
Impact / modeling performance



Objectives

- Develop an integrated model reproducing sedimentation taking advantage of the particle settling velocity distribution (PSVD)
- Assess the impact of retention tanks (RT) emptying to the WWTP in terms of TSS

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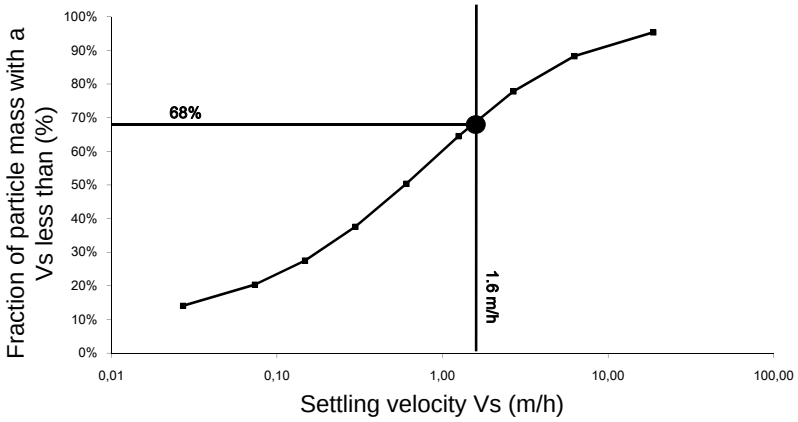
ViCAs

m/h)

ViCAs



Chebbo and Gromaire (2009) – *Journal of Environmental Engineering*

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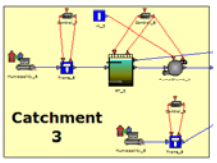
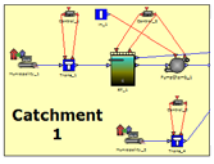
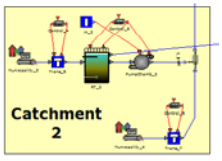
Integrated model

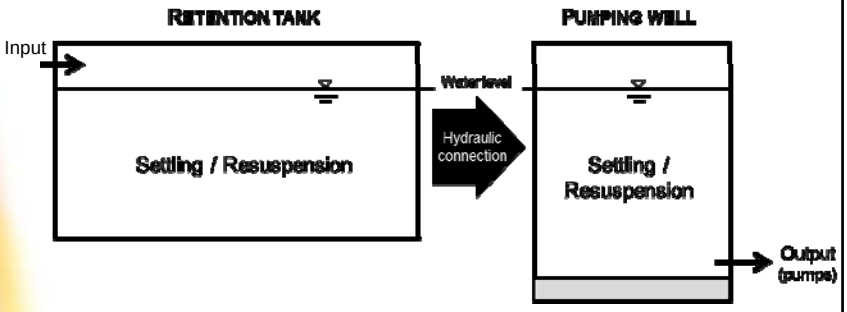
- ✓ 3 identical catchments
- ✓ 9 reservoirs
- ✓ 1 primary clarifier







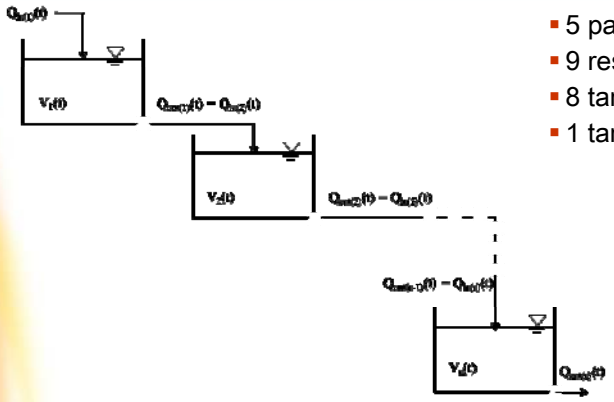
Integrated system
RT model concept



- 5 particle classes
- Pumping well with resuspension
- ASM1 compatible

Maruejouls *et al.* (2012) – *Water Research*

Integrated system
Sewer model concept

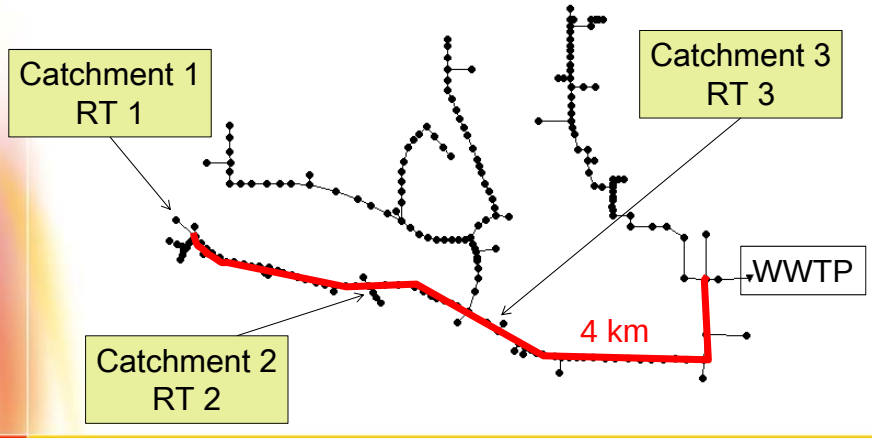


- 5 particle classes
- 9 reservoirs
- 8 tanks = 360 m^3
- 1 tank = 600 m^3

Schuetze, M. (1998) – *Thesis*

Integrated system

SWMM sewer model of Quebec City



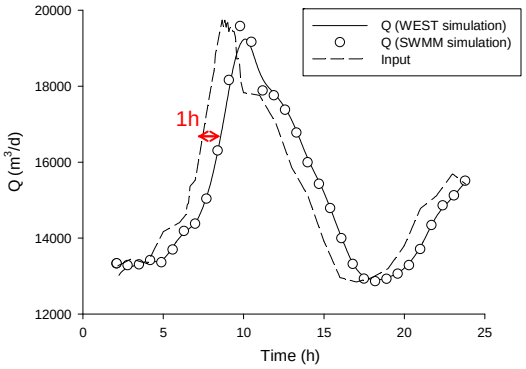
Integrated system

Sewer model calibration

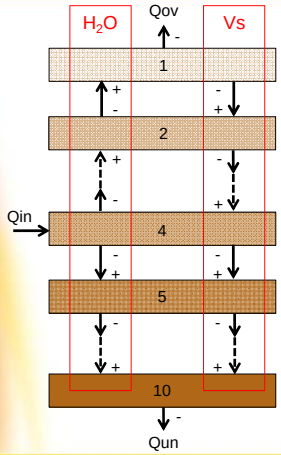
Simulated data from SWMM model of Quebec City

Travel time: 1h

Real length: 4,000 m



Integrated system
Primary clarifier model

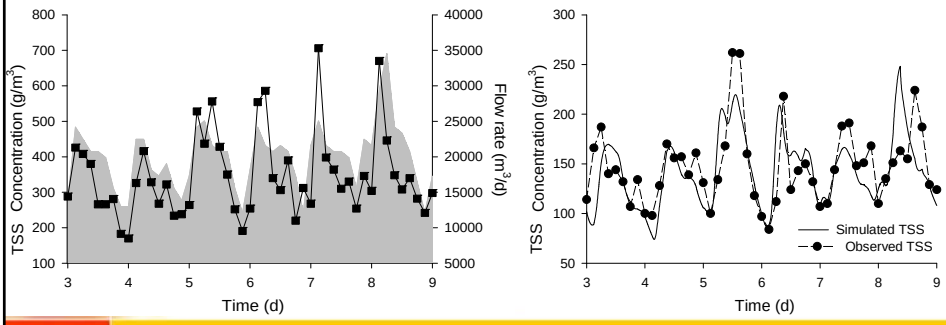


- Adaptation of model of Bachis *et al.* (2012) model to incorporate 5 particle classes
- 10 layers
- Calibrated with field data

Bachis *et al.* (2012) – *Proceedings IWA Particle Separation Conference*

Integrated system
Primary clarifier model calibration

Norwich WWTP, England	
Flow rate (1,000 m³/d)	10 - 35
Overflow rate range (m/h)	0.6 – 2
Shape	Circular



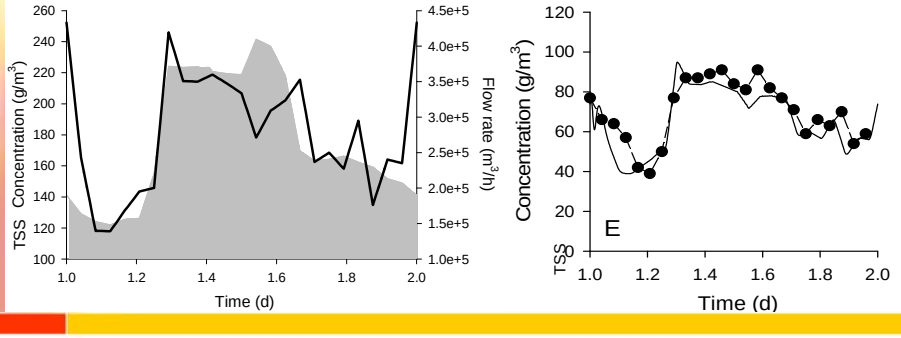
Lessard & Beck (1988) – *Journal of Environmental Engineering*

Integrated system

Primary clarifier model calibration

Eastern Quebec WWTP, Canada	
Flow rate range (1,000 m³/d)	120 - 470
Overflow rate range (m/h)	1 – 3.7
Shape	Rectangular

April 9th 2010

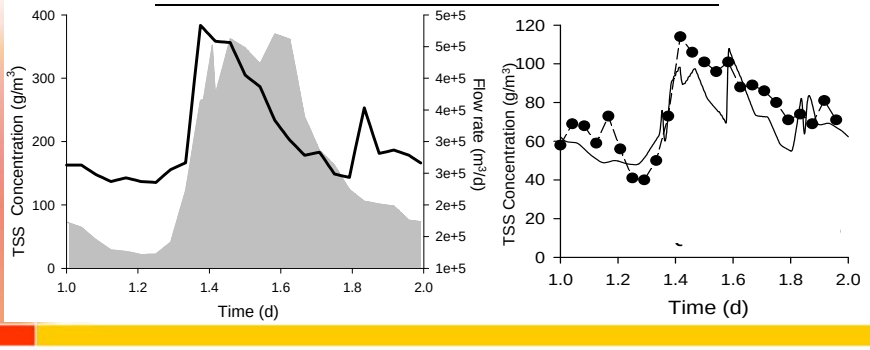


Integrated system

Primary clarifier model validation

Eastern Quebec WWTP, Canada	
Flow rate range (1,000 m³/d)	120 - 470
Overflow rate range (m/h)	1 – 3.7
Shape	Rectangular

April 17th 2010



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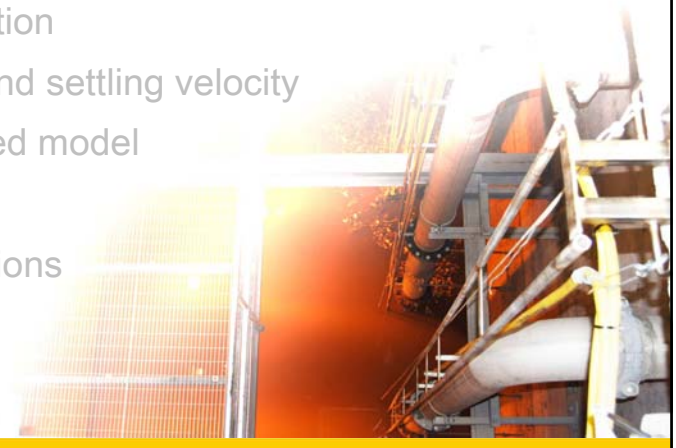

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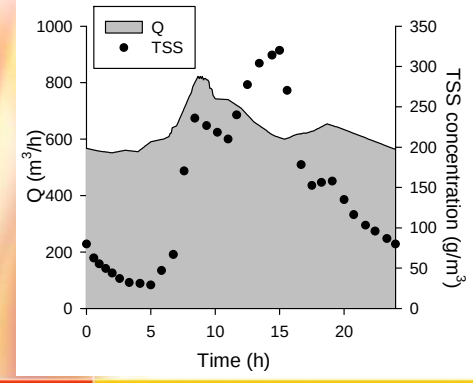
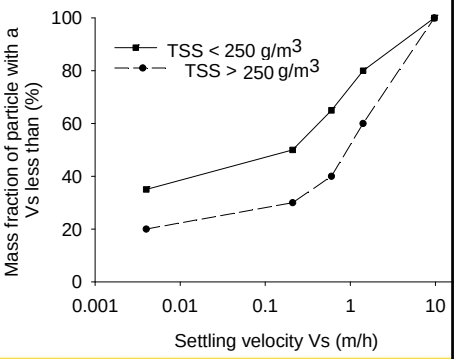
modelEAU

Integrated system
Inputs (DW)

DW: 1 hydrograph and 2 PSVD depending on TSS





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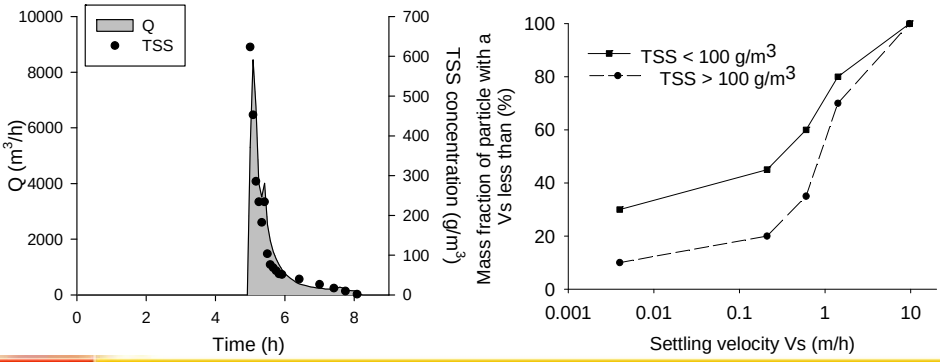
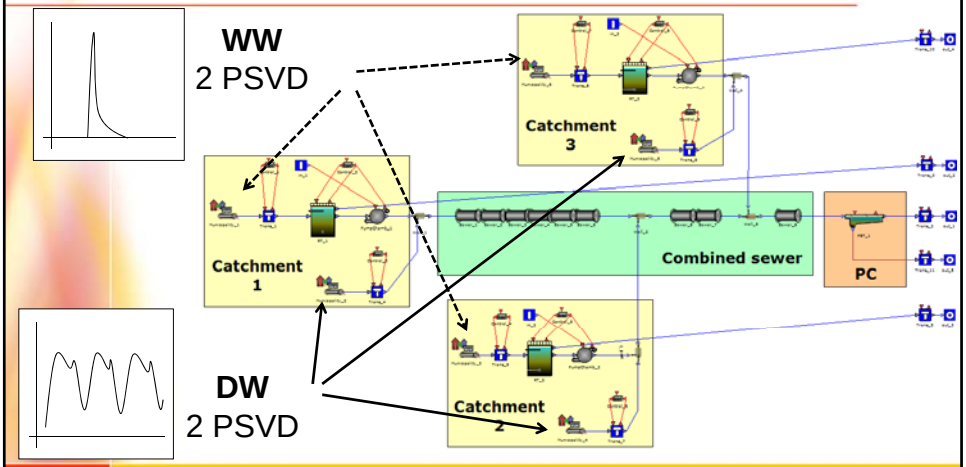
modelEAU

Integrated system
Inputs (WW)

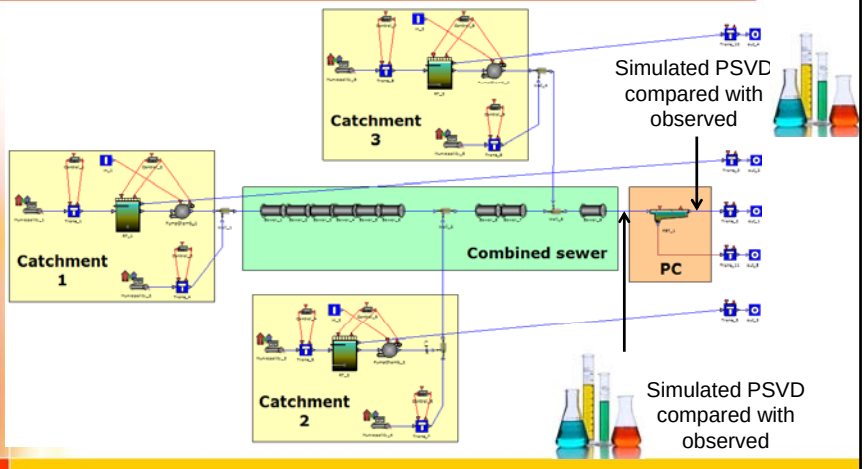
WW: 1 hydrograph and 2 PSVD depending on TSS



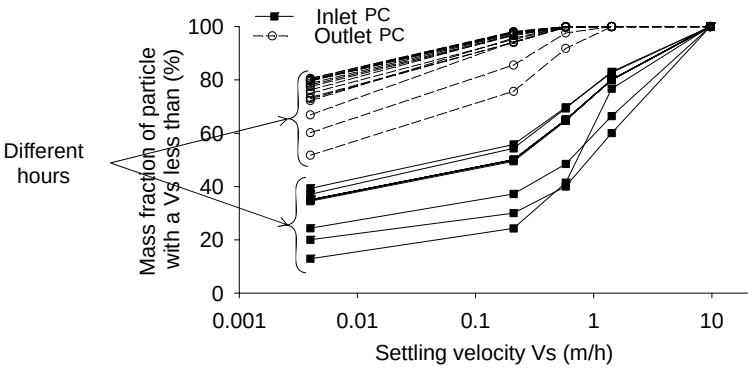
Integrated system
Inputs



Integrated system
Outputs



Integrated system
PSVD simulated



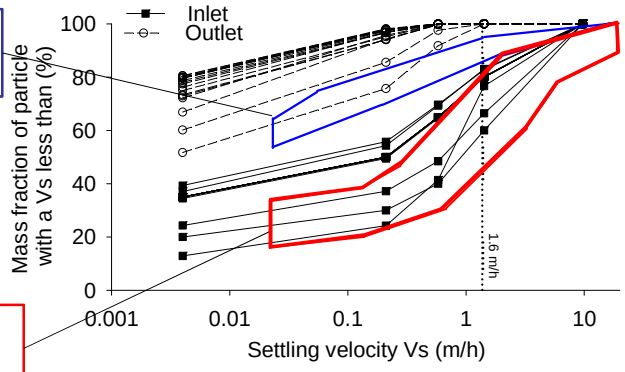
Maruejouls *et al.* (2011) – *Water Science & Technology*

Integrated system

PSVD simulated vs. observed

Observed outlet zone

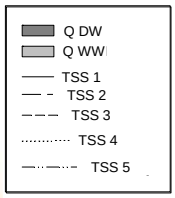
Observed inlet zone



Maruejouls *et al.* (2011) – *Water Science & Technology*

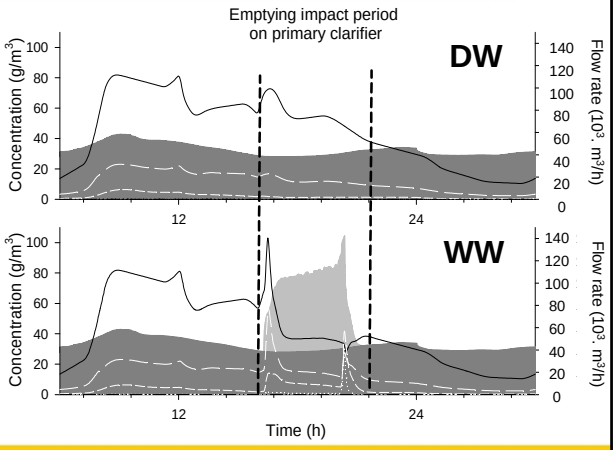
Integrated system

Primary clarifier effluent



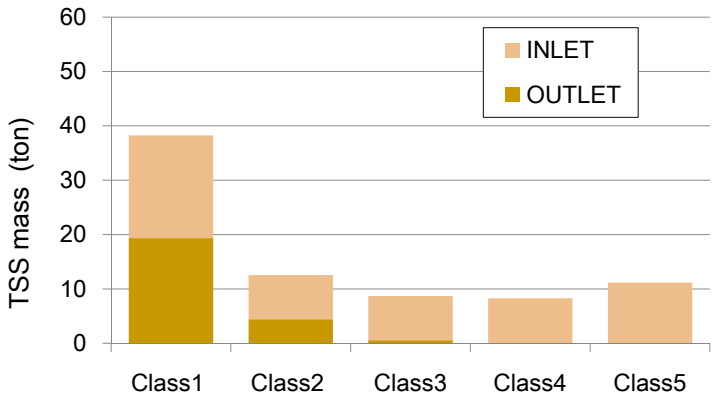
DW
24 ton

WW
46 ton



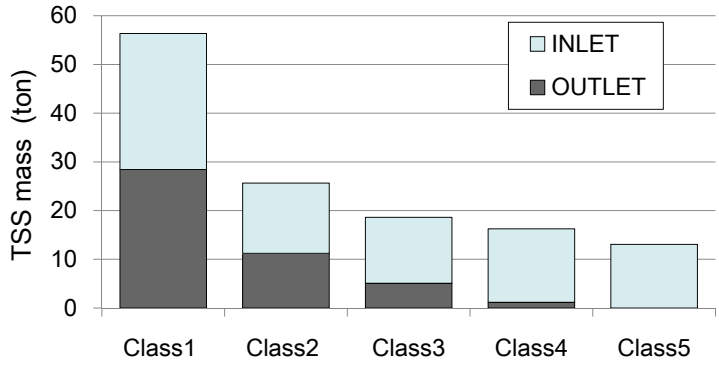
Integrated system

Primary clarifier effluent (DW)



Integrated system

Primary clarifier effluent (WW)



Conclusions

- Integrated model with particle classes
- Reproduces the PSVD evolution
- Particle transport through urban system is improved
- Many processes are simulated under DW and WW conditions: sedimentation, RT cleaning systems, pumps resuspension
- Need of only few ViCAs

Perspectives

- Analysis of various management scenarios: tuning RT emptying flow rate, setting delay between emptyings…
- Investigate addition of chemicals for settling enhancement
- Integrated RTC taking into account Vs for treatment optimization
- Use of the model at Eindhoven WWTP