Urban stormwater management: Calibration and validation of an off-line retention tank (RT) dynamic model for water quality

9th International Conference on Urban Drainage Modelling

3-6 Sept. 2012

Thibaud Maruejouls, **Peter A. Vanrolleghem** and Paul Lessard

Fonds de recherche sur la nature et les technologies Québec

Canada Research Chair on Water Quality Modelling

Université Laval

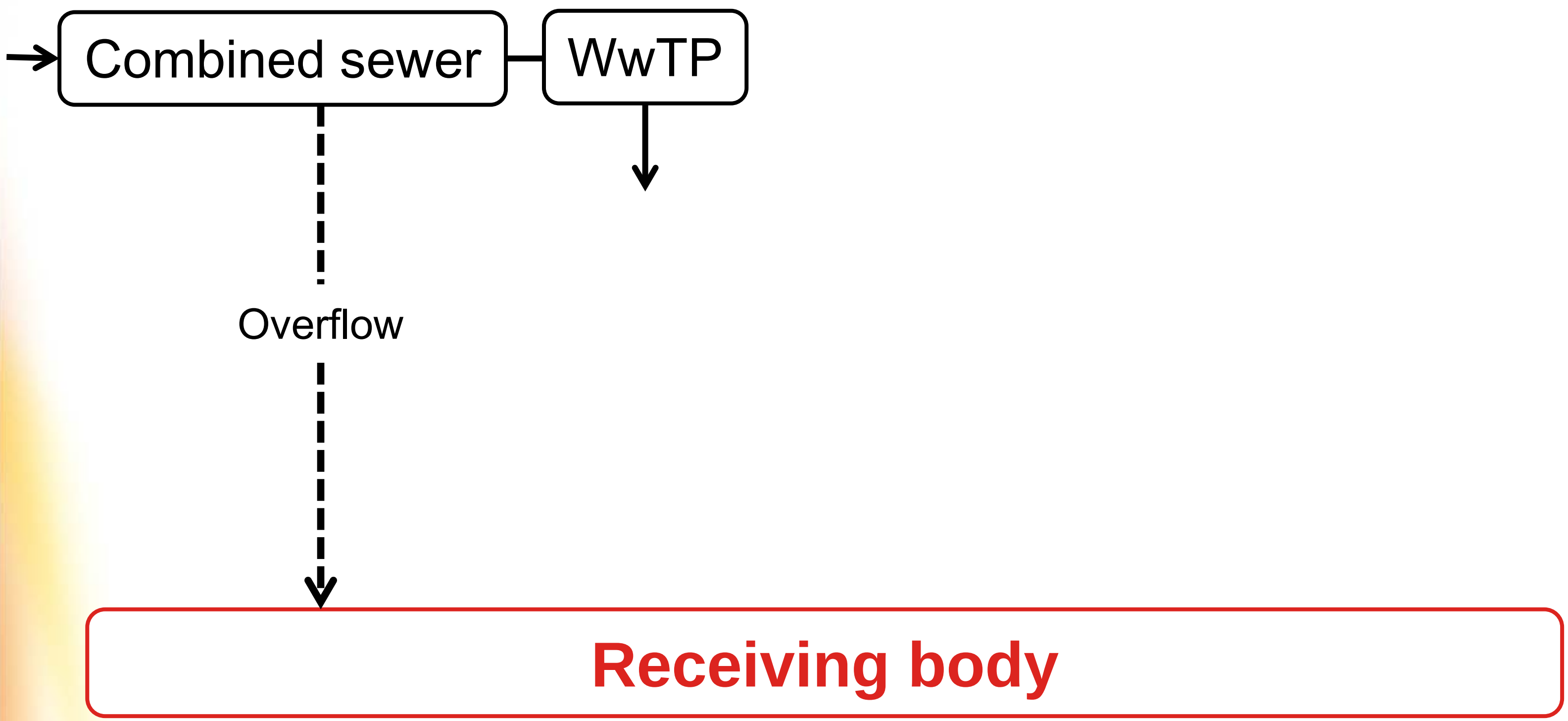
Ville de Québec

Outline

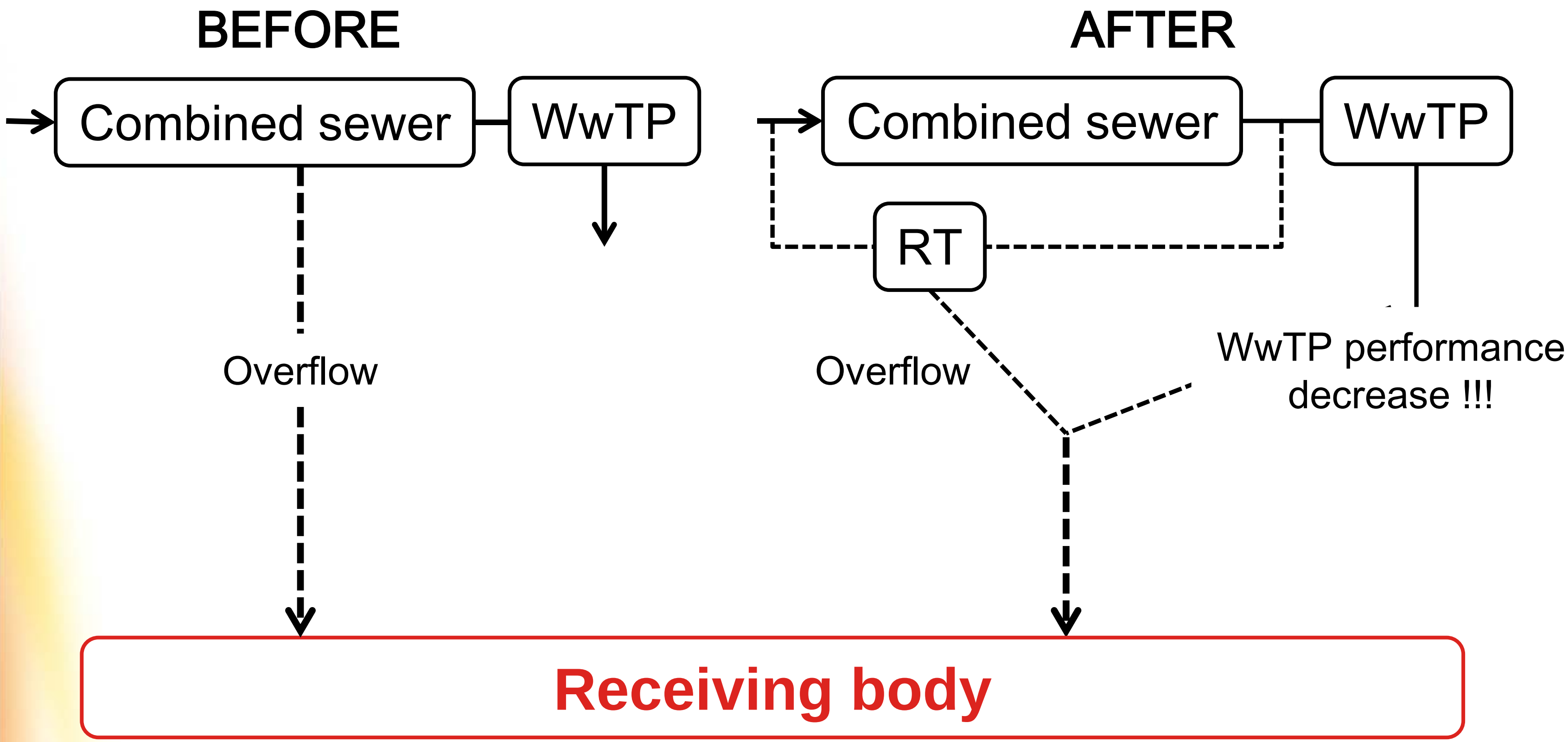
- Problem statement
- Proposed model
- Calibration method
- Validation results
- Conclusions/Perspectives

Problem statement

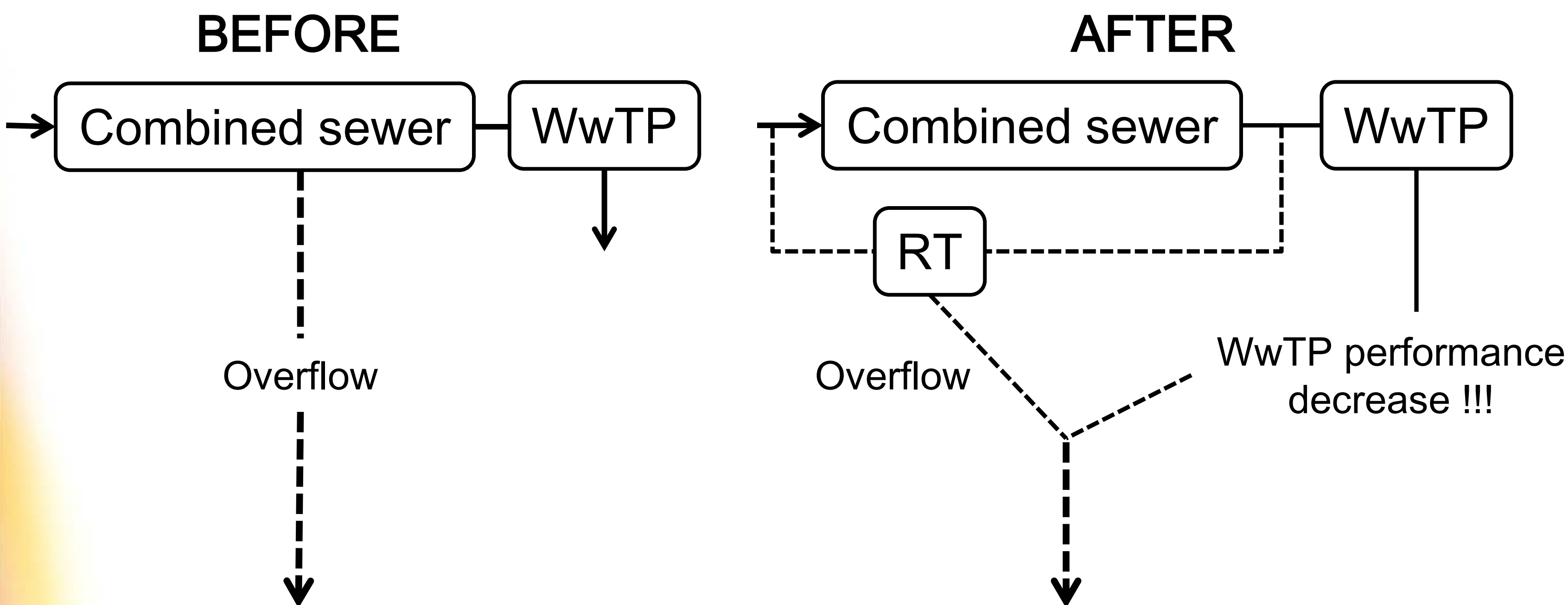
BEFORE



Problem statement



Problem statement



Which impact is worse for receiving body ?

=> Need for integrated modelling

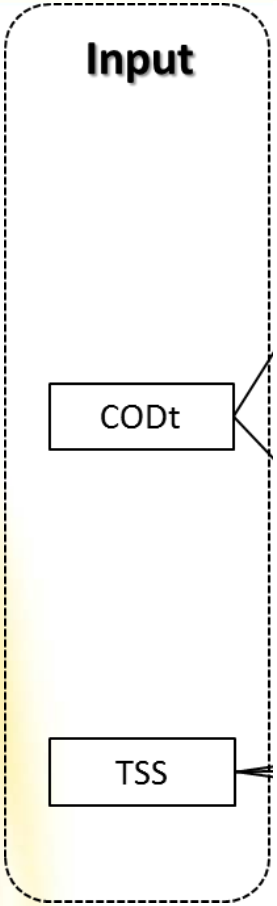
Problem statement

- Pollutant characterisation in RT
  - Little data during rain events mainly for:
    effluent quality returned to WWTP, Vs distribution
- RT water quality modelling
  - No existing **calibrated** nor **validated** RT model
- RT in IUWS modelling
  - RT models used in IUWS are **quite simple:**
    removal rate or **linear settling**
  - Important for description of **wet weather quality**

Outline

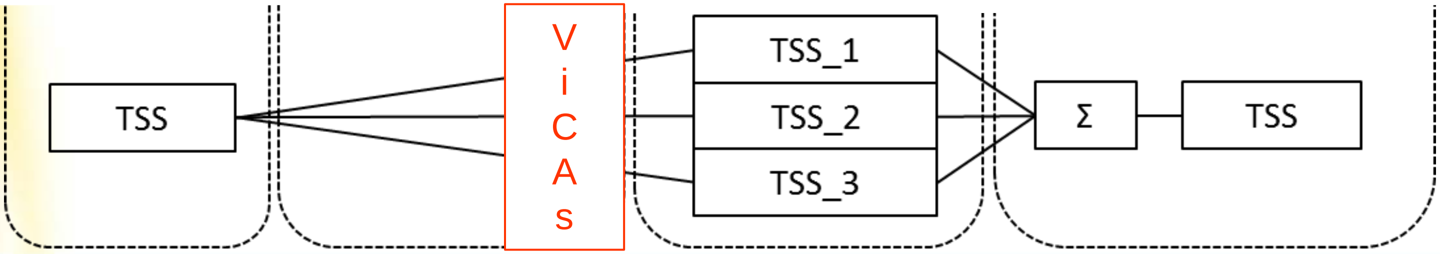
- Problem statement
- Proposed model
- Calibration method
- Validation results
- Conclusions/Perspectives

Model state variables



Model state variables

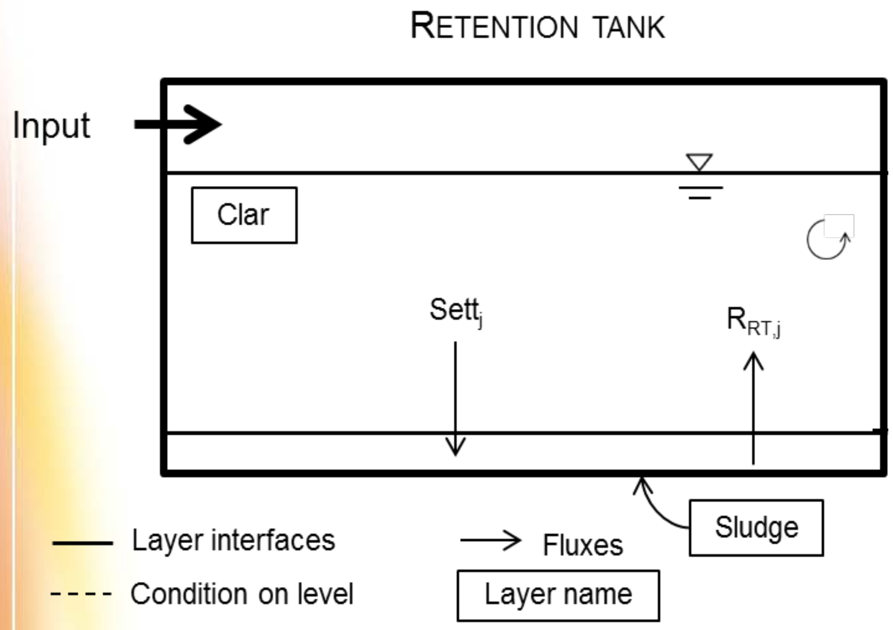
Literature + respirometry



UNIVERSITÉ LAVAL

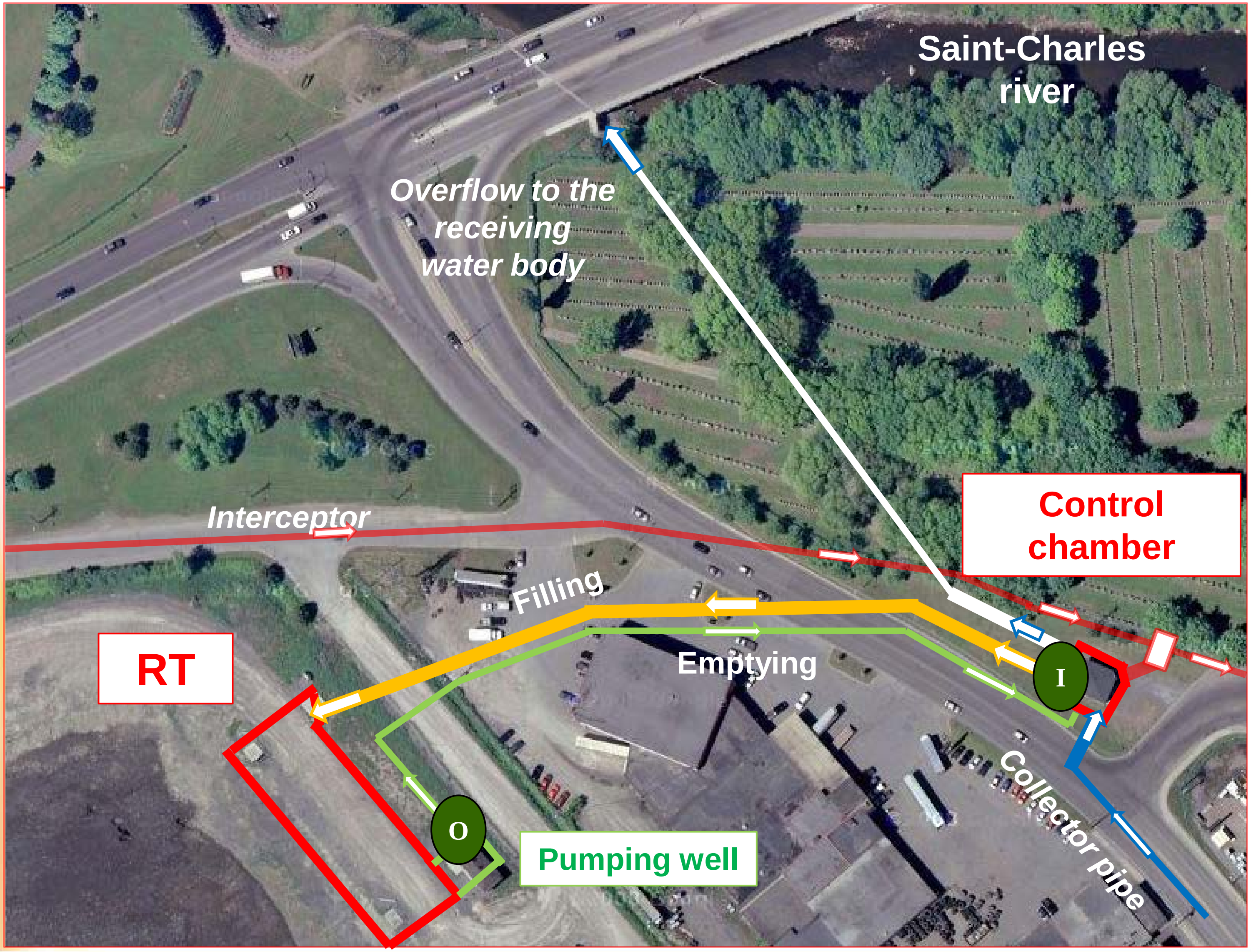
modelEAU

Proposed model



Outline

- Problem statement
- Proposed model
- Calibration method
- Validation results
- Conclusions/Perspectives



Saint-Charles river
Overflow to the receiving water body
Interceptor
Control chamber
Filling
Emptying
RT
I
O
Pumping well
Collector pipe

Calibration

Initial parameter set

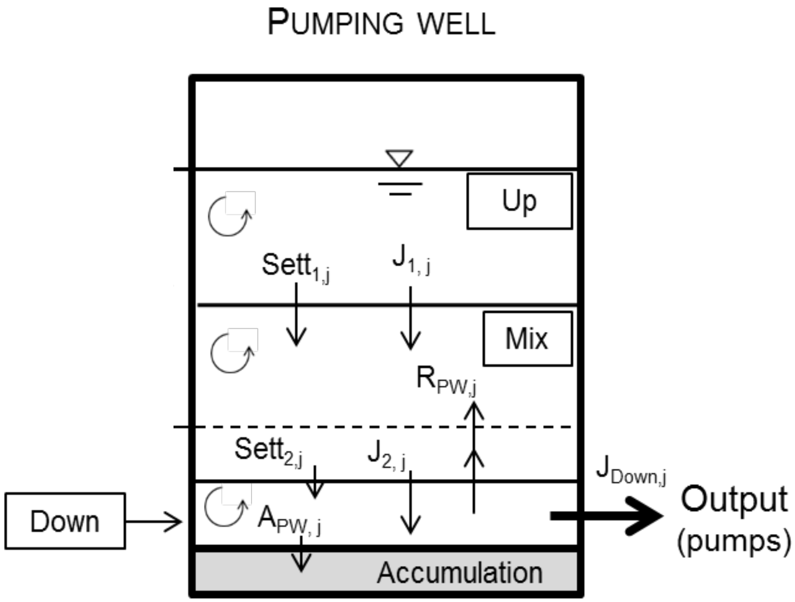
↓

PW layer volumes
V_{Min}, V_{Mix}, V_{Down}

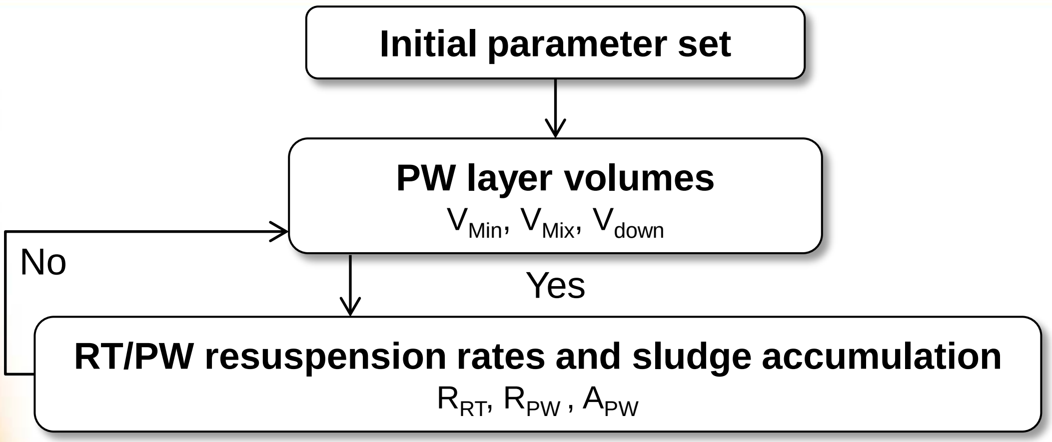
$V_{Up} = 80\ m^3,k$
(~ 2.2 m)

$V_{Mix} = 11\ m^3$
(~ 0.4 m)

$V_{Down} = 13\ m^3$
(~ 0.3 m)



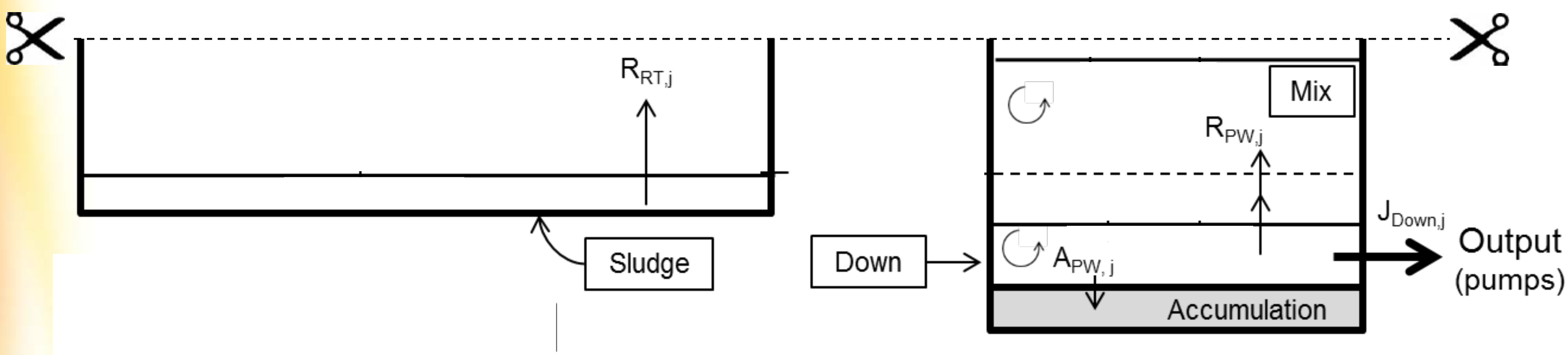
Calibration



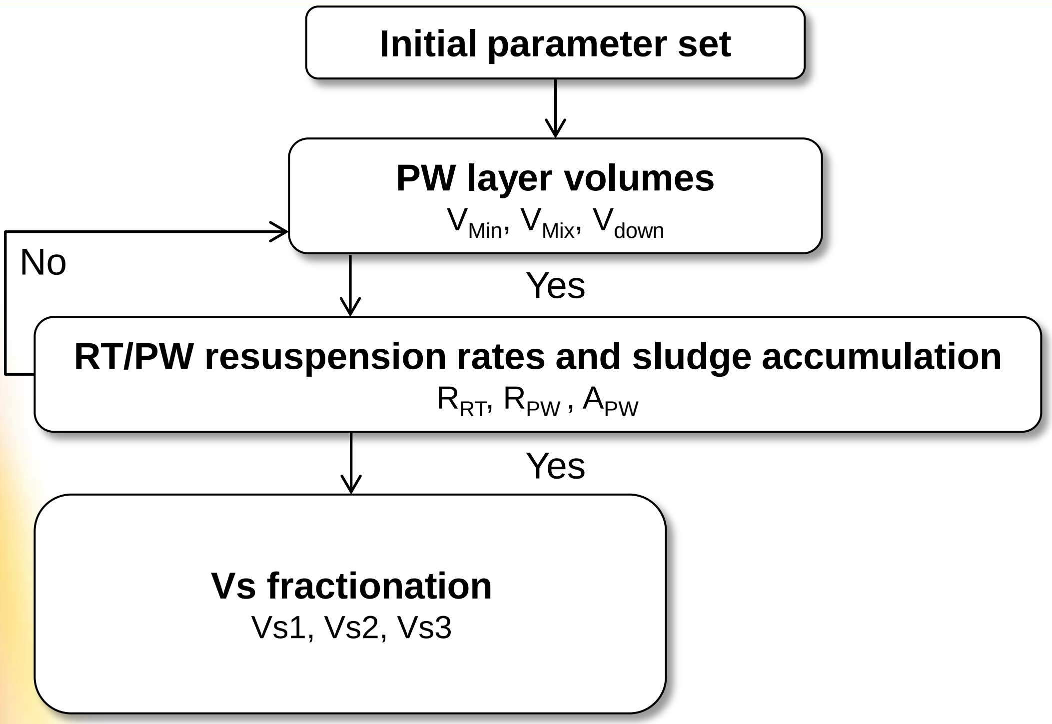
$R_{RT,j} = 1000\ h^{-1}$

$R_{PW,j} = 200\ h^{-1}$

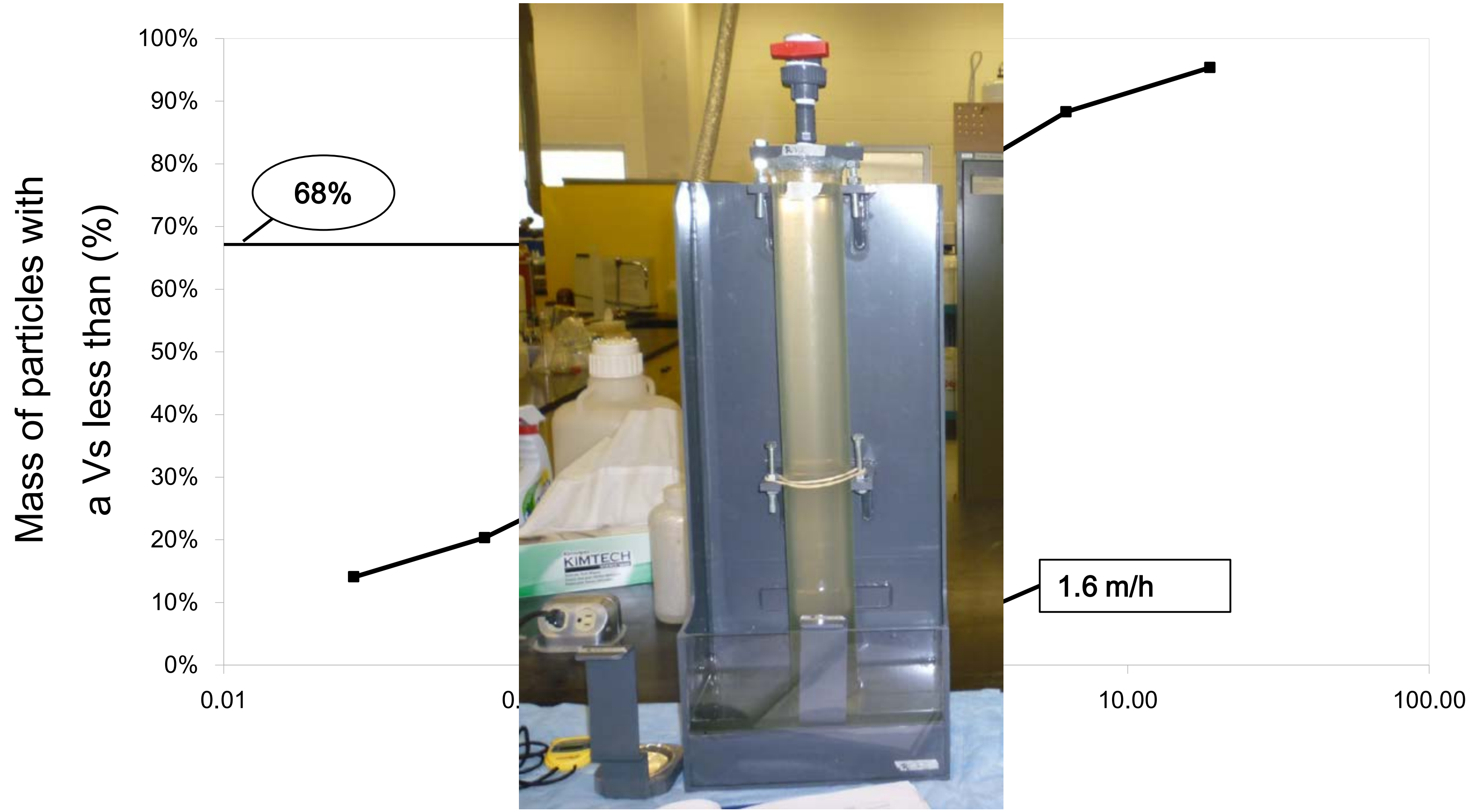
$A_{PW,j} = 83\%$



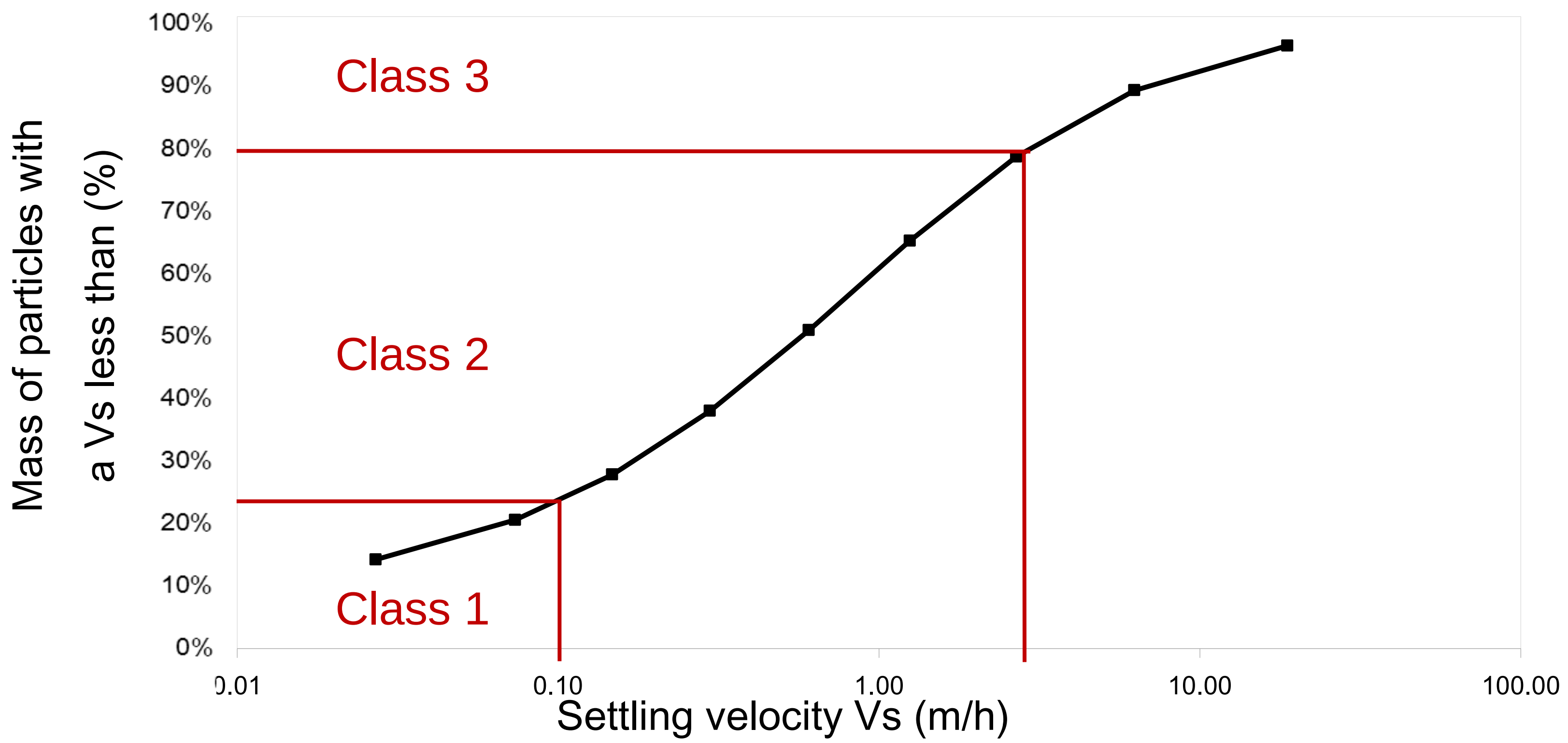
Calibration



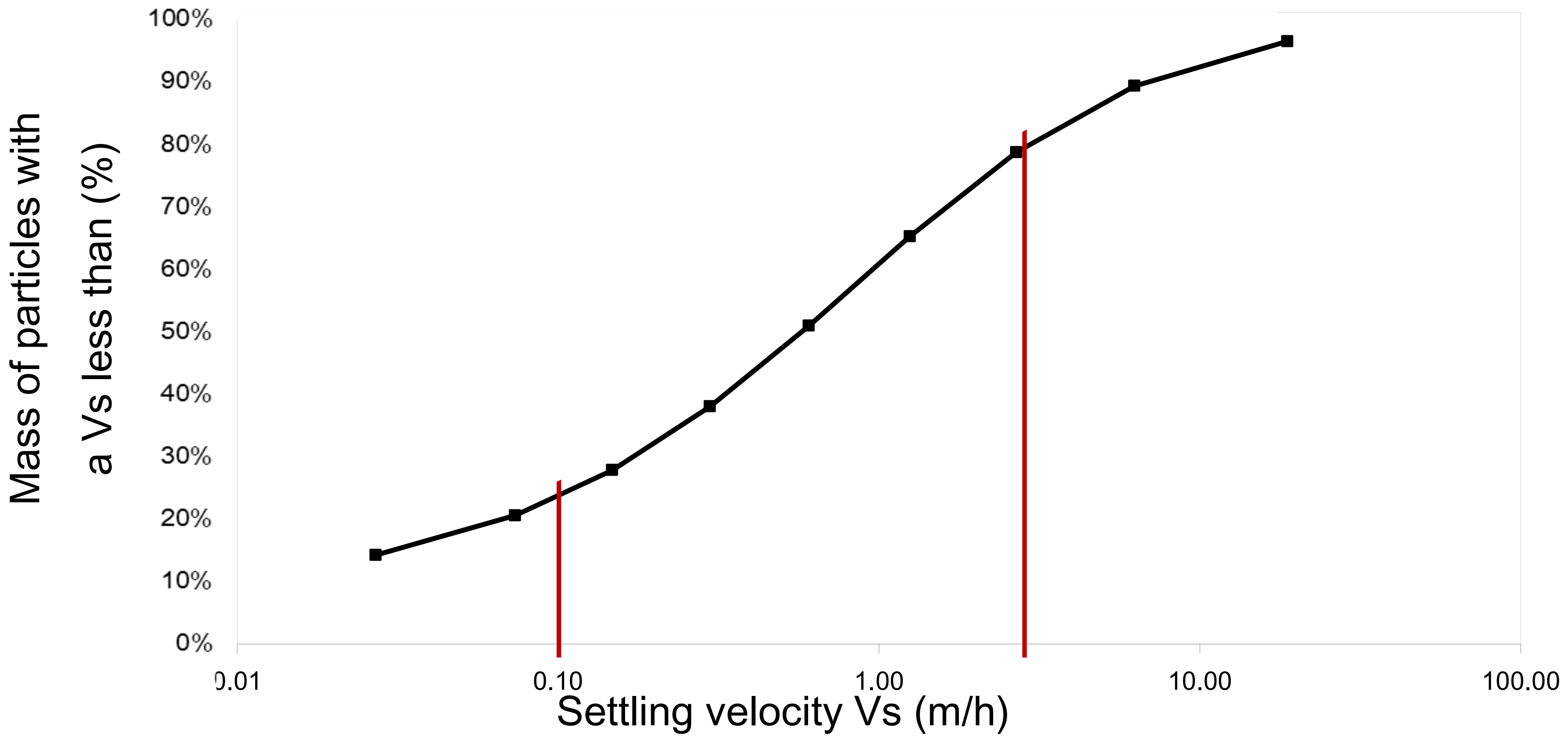
Classes fractionation (ViCAs)



Classes fractionation (ViCAs)



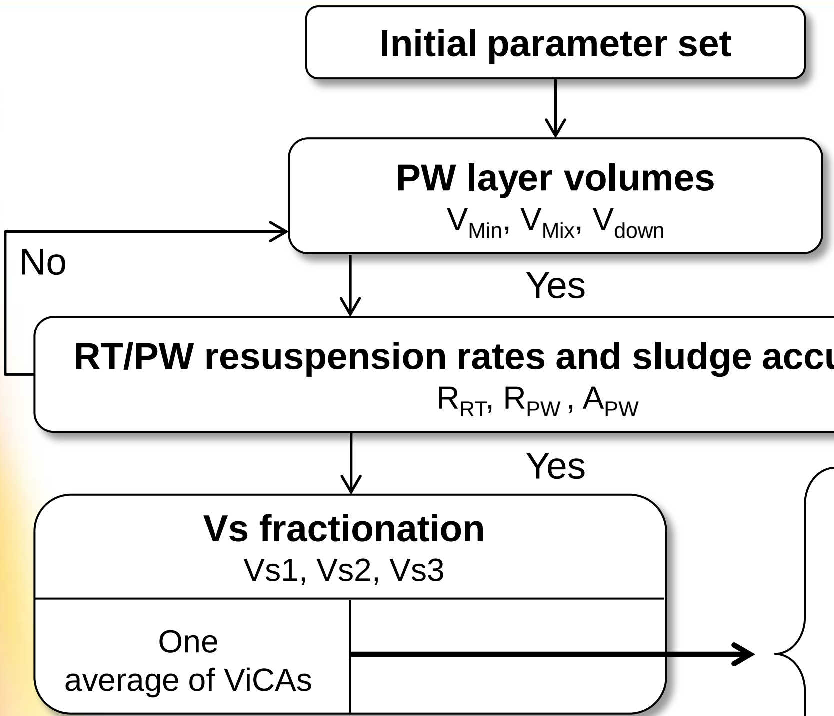
Classes fractionation (ViCAs)



UNIVERSITÉ LAVAL

modelEAU

Calibration

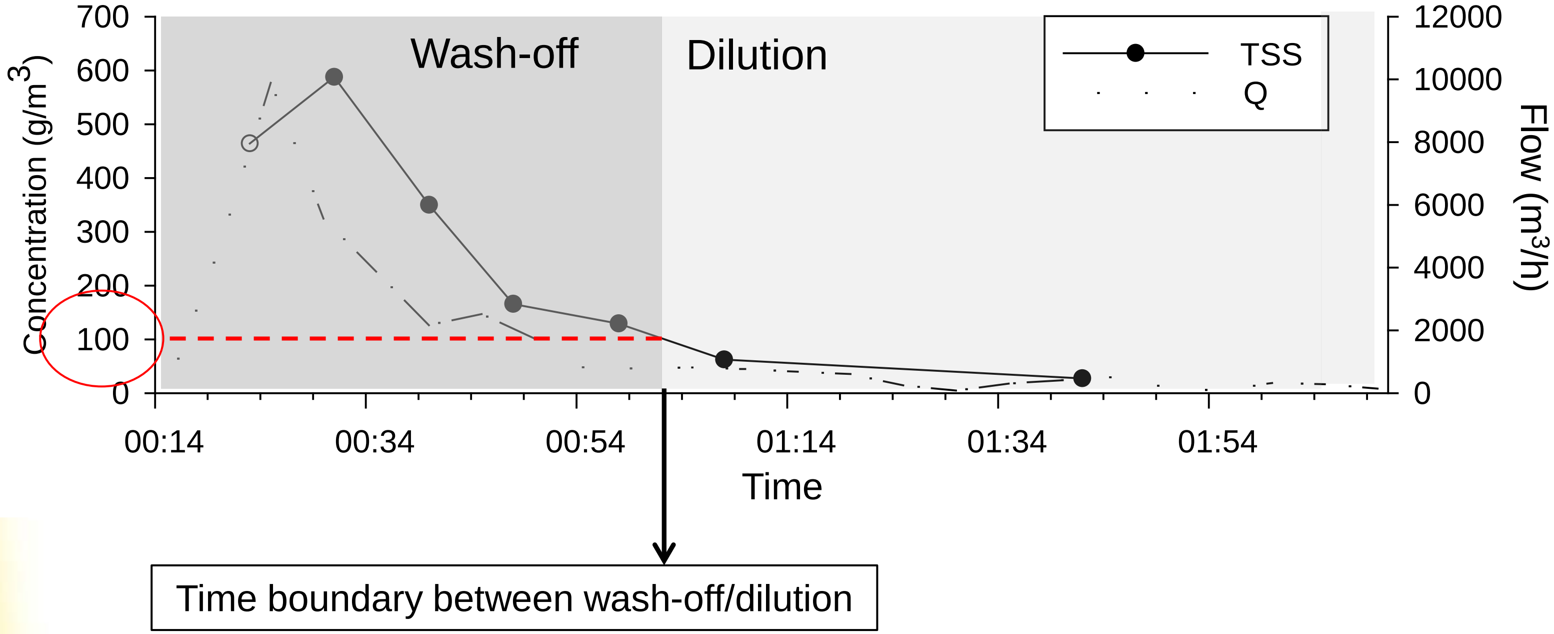


One Vs average distribution

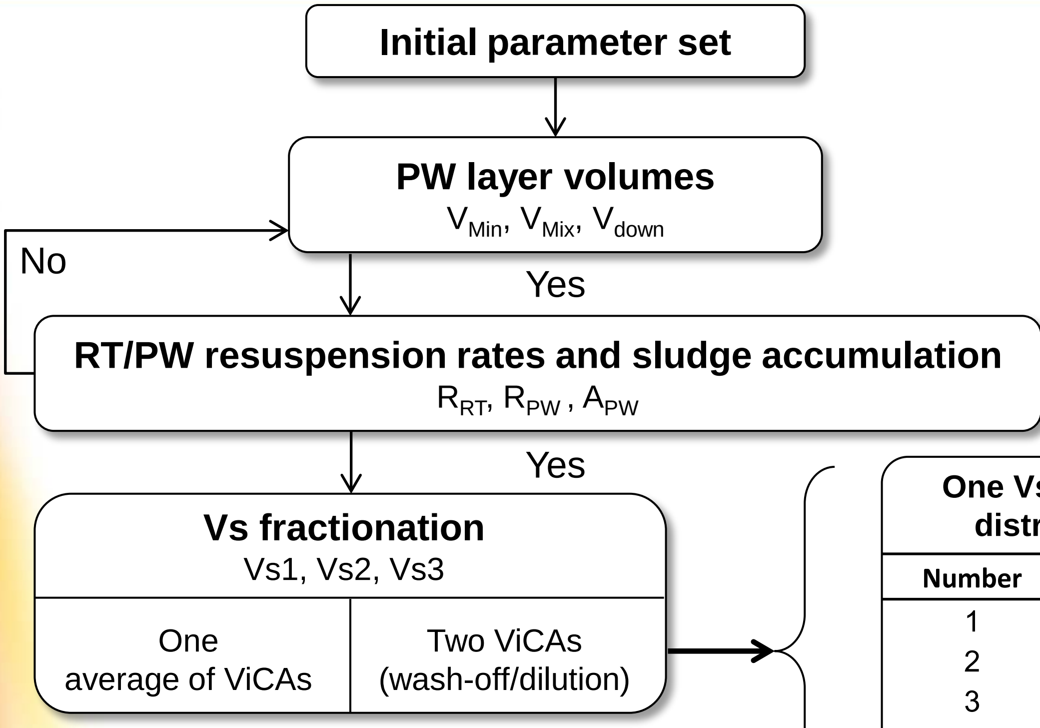
Number	%
1	10-10-80
2	20-20-60
3	10-80-10
4	20-60-20
5	80-10-10
6	60-20-20
7	33-34-33
8	15-40-45

Calibration

Inflow: June 6th 2010 : 2 periods → 2 Vs distributions



Calibration



One Vs average distribution

Number	%
1	10-10-80
2	20-20-60
3	10-80-10
4	20-60-20
5	80-10-10
6	60-20-20
7	33-34-33
8	15-40-45

Two Vs distributions

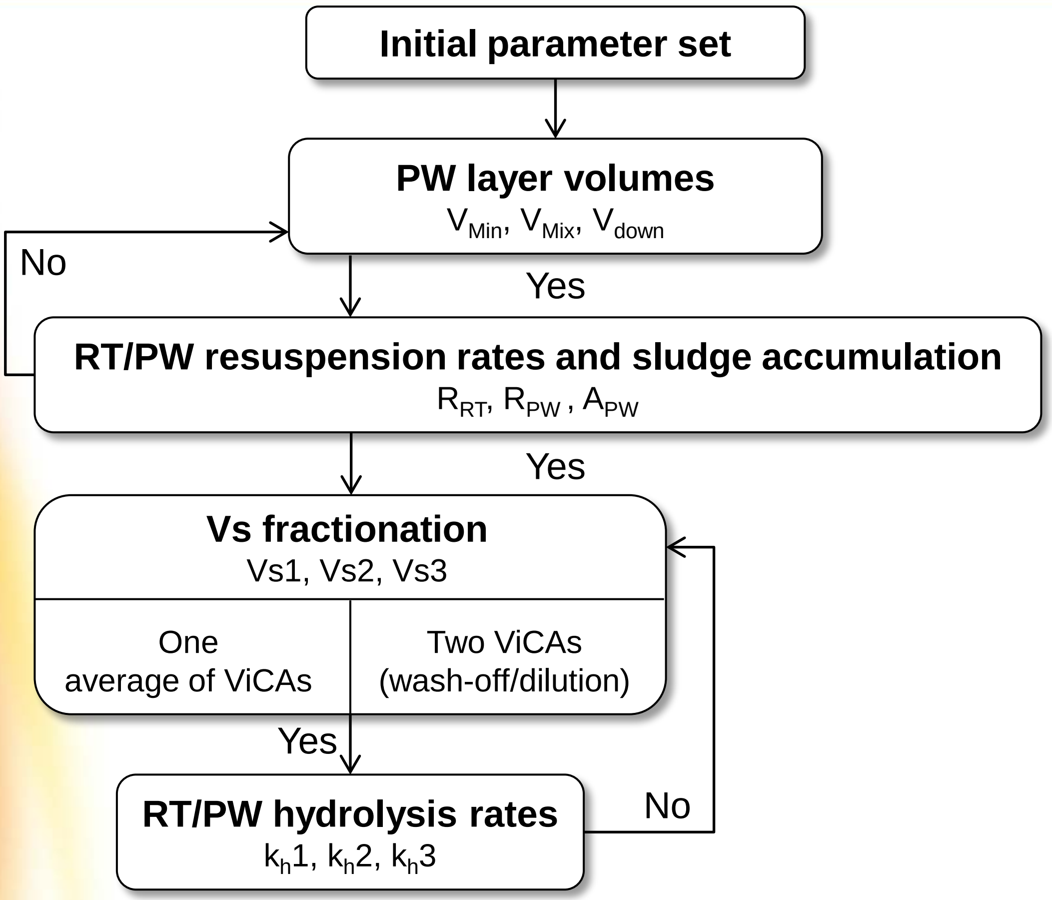
Wash-off (%)
15-40-45

Dilution (%)
45-25-30

UNIVERSITÉ LAVAL

modelEAU

Calibration



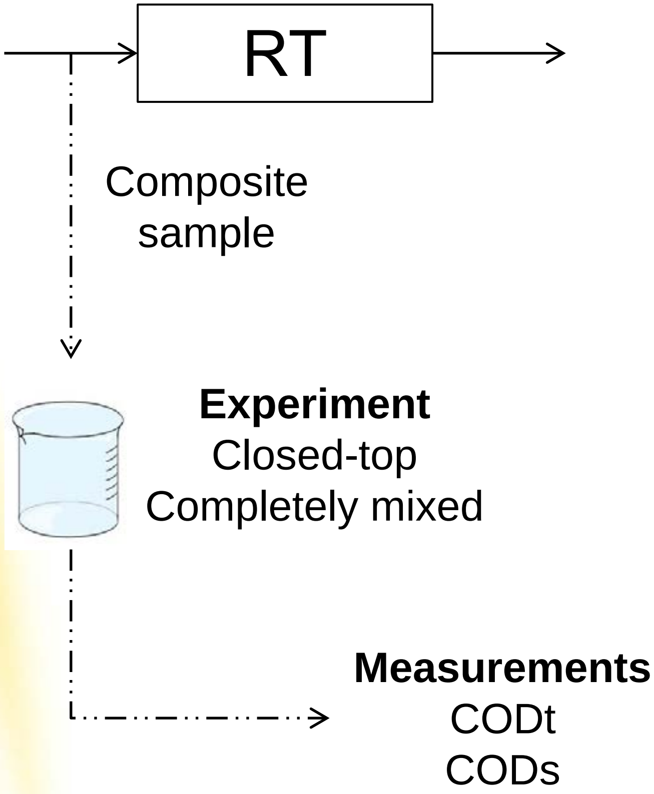
$k_h1 = 2\ h^{-1}$

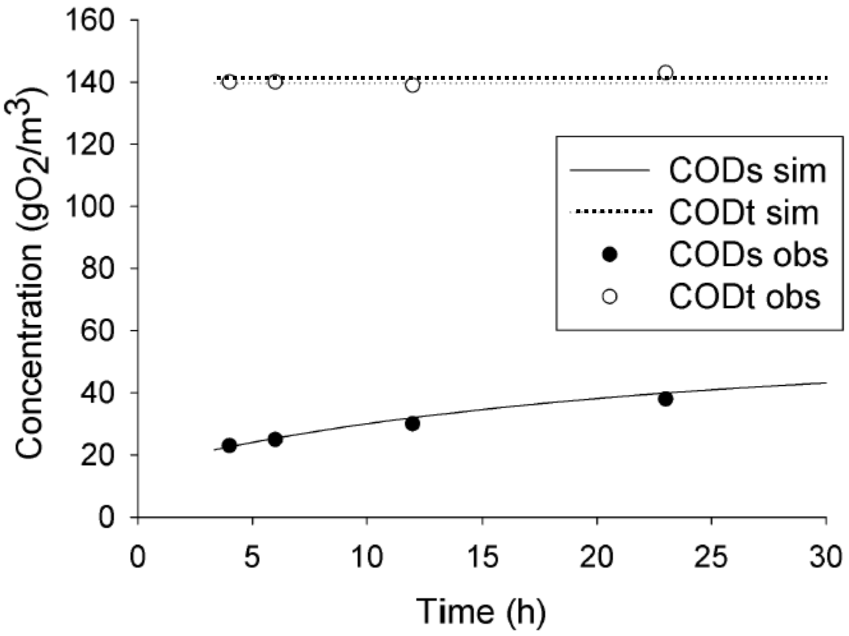
$k_h2 = 1.5\ h^{-1}$

$k_h3 = 0.5\ h^{-1}$

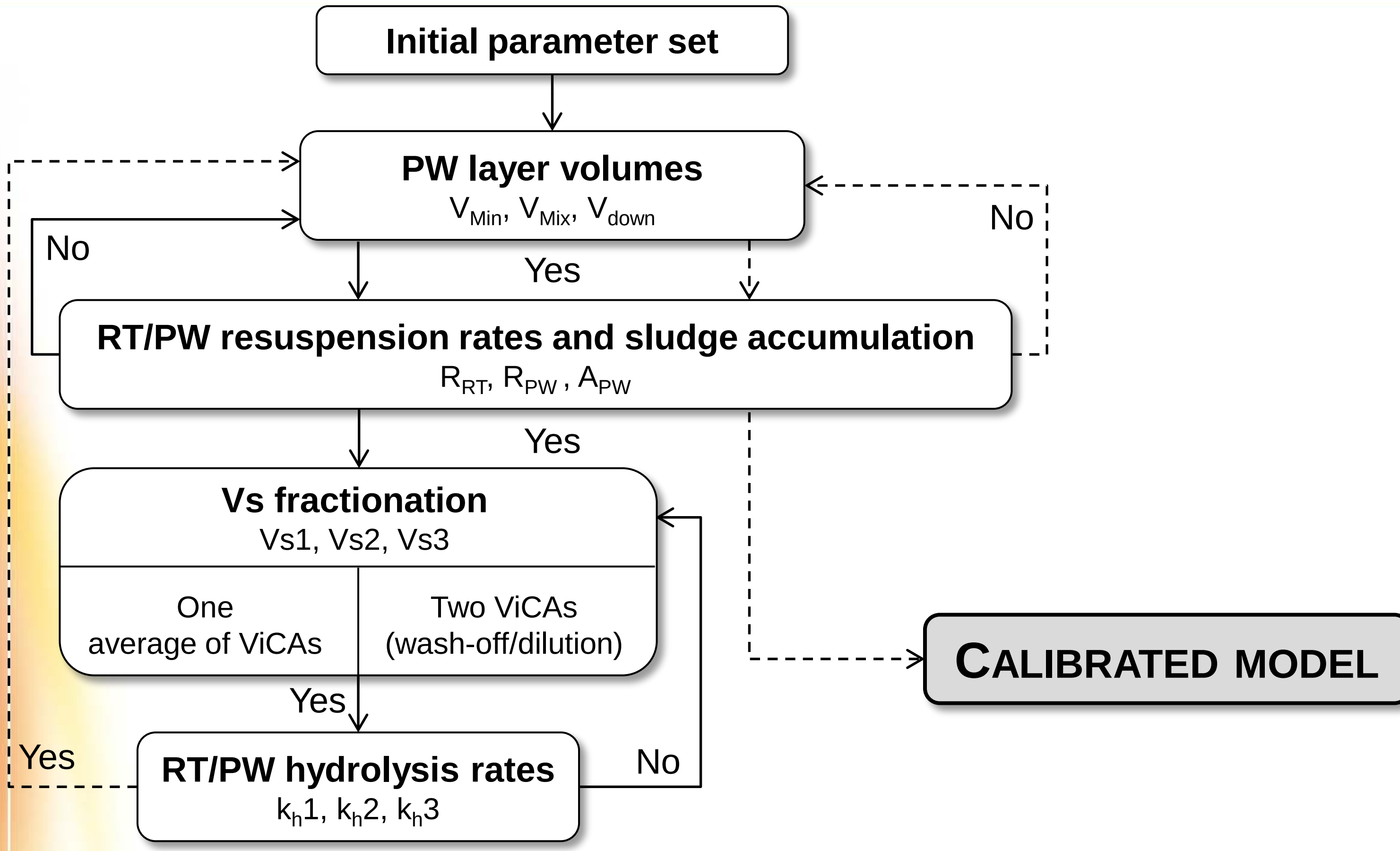
Calibration

Laboratory experiment data vs. simulation data



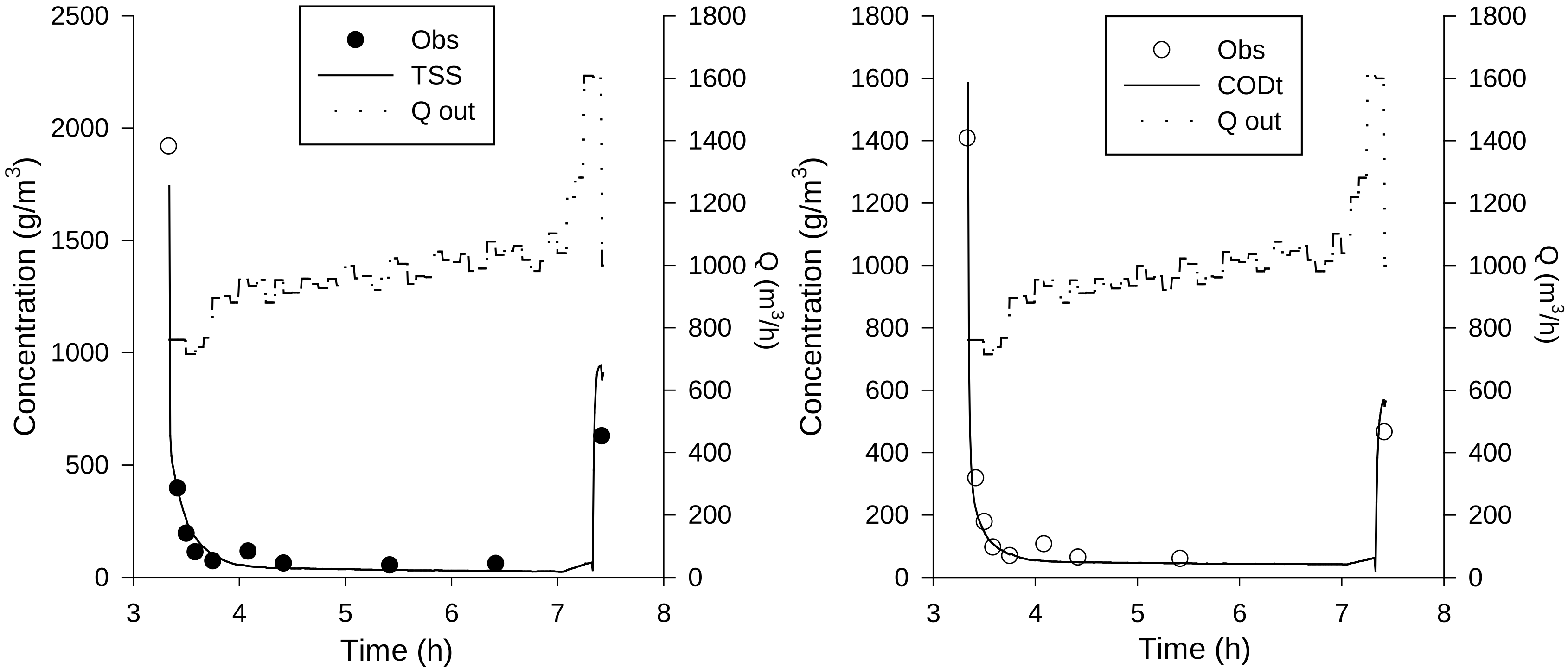


Calibration



Calibration

July 27th 2009

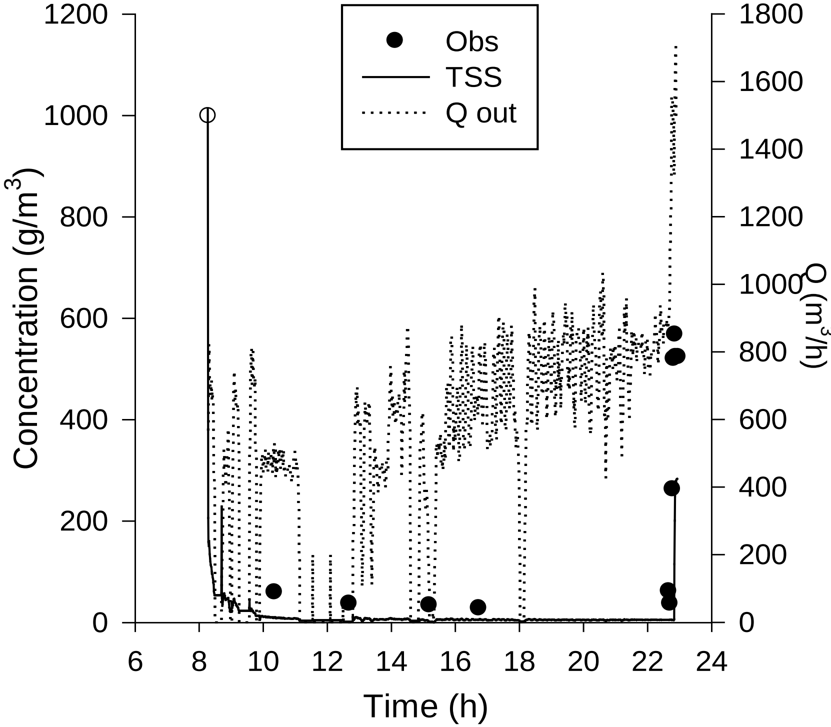


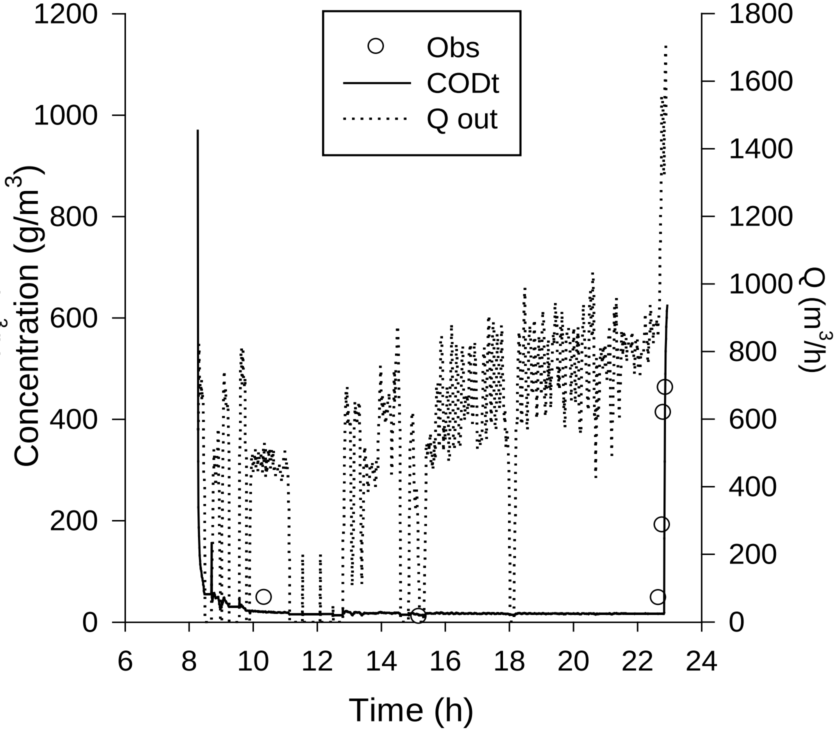
UNIVERSITÉ LAVAL

modelEAU

Calibration

September 27th 2009





UNIVERSITÉ LAVAL

modelEAU

Outline

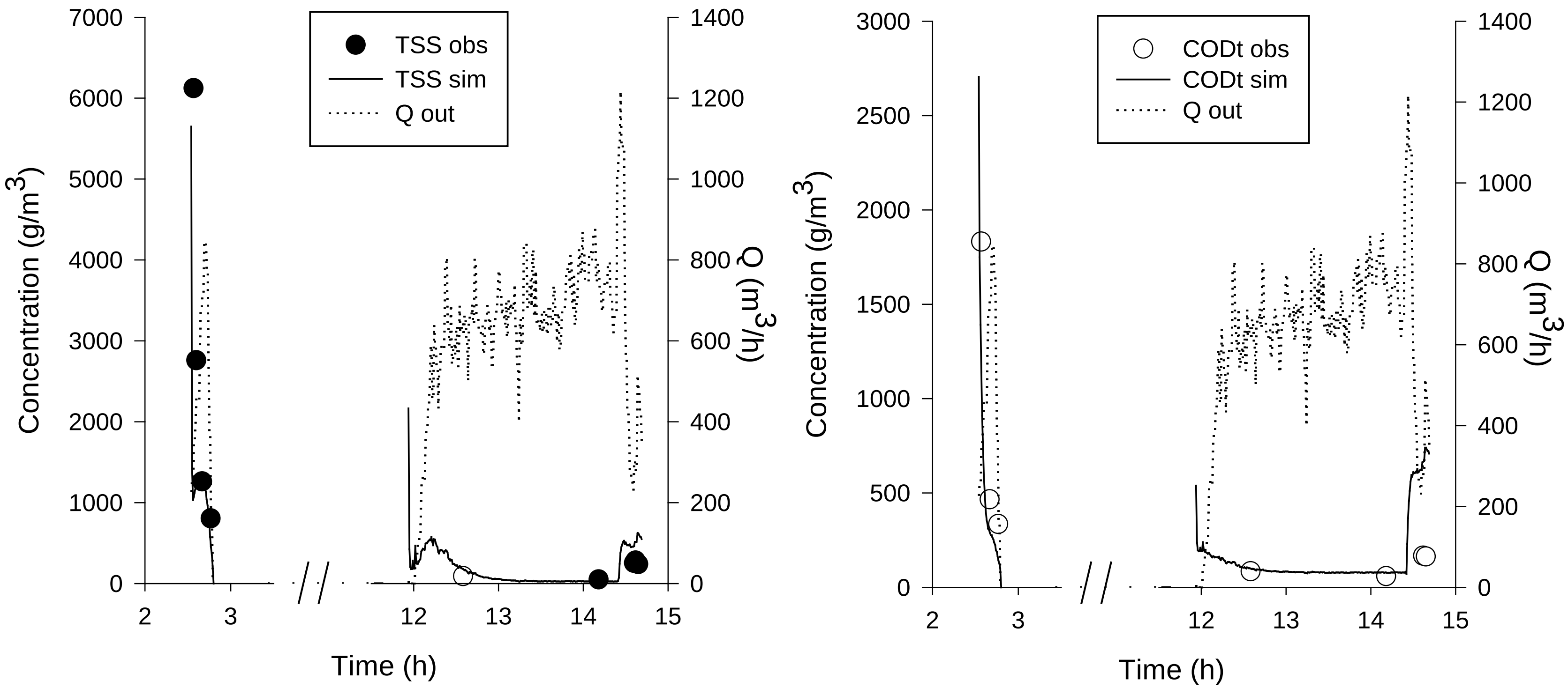
- Problem statement
- Proposed model
- Calibration method
- Validation results
- Conclusions/Perspectives

UNIVERSITÉ LAVAL

modelEAU

Validation

July 13th 2010: 2 periods of emptying



Outline

- Problem statement
- Proposed model
- Calibration method
- Validation results
- Conclusions/Perspectives

UNIVERSITÉ LAVAL

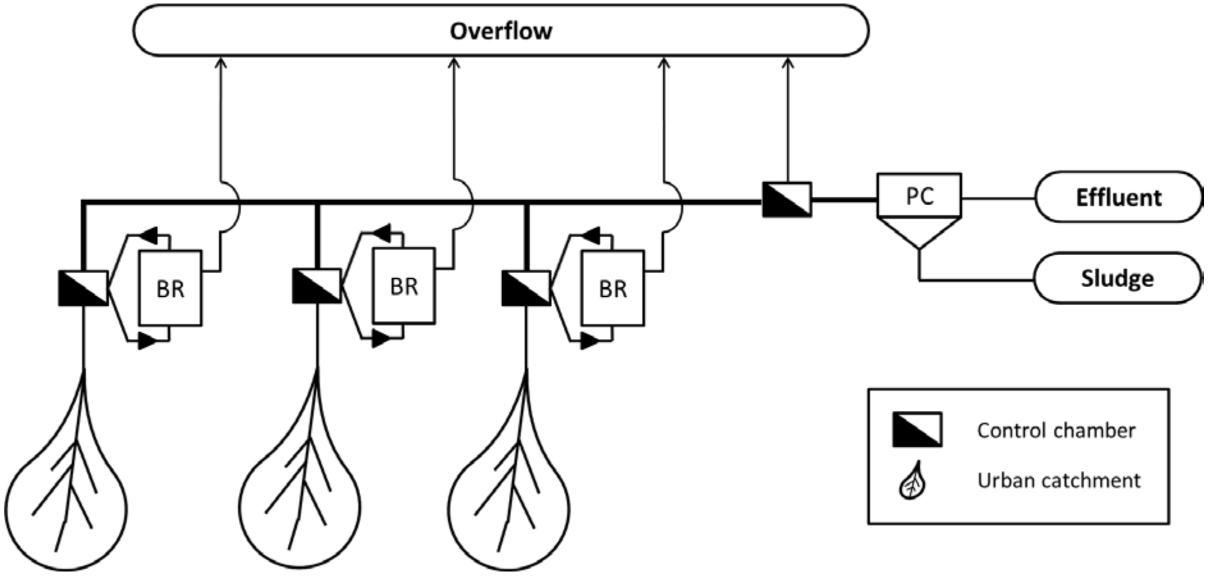
modelEAU

Conclusions

- A new fast RT model describing the TSS and total COD fluxes, both in the tank and in the pumping well
  - Settling
  - Hydrolysis
- It takes into account the settling velocity distribution variation depending on the inflow TSS concentration
- As far as known, model calibration and validation performed for the first time

Perspectives

- Propose an integrated model “sewer – RT – primary clarifier”
- Validate the Vs distribution dynamics (3 classes)
- Carry on a parameter sensitivity analysis



UNIVERSITÉ LAVAL

modelEAU

Questions

Acknowledgements

Fonds de recherche sur la nature et les technologies Québec

Ville de Québec

Canada Research Chair on Water Quality Modelling