

# Characterisation of particle settling velocity distributions in wastewater systems by the use of a single experimental protocol

CWWA - CAWQ

Hamilton, ON

March 6 - 8, 2013

Giulia Bachis

T. Maruéjols, B. Vallet, P. Lessard and P.A. Vanrolleghem

JOHN MEUNIER



## Overview

- Background
- Objectives
- Review of protocols
- ViCAs protocol
- Applications and results
- Conclusion and perspectives



JOHN MEUNIER  
VEOLIA  
ENVIRONNEMENT

2



## Background

Sedimentation is a critical process in many wastewater systems

- ✓ Sewer systems
- ✓ Retention tanks in combined sewers
- ✓ Stormwater management in storm sewers
- ✓ Primary clarifiers at WWTP

## Background

Description of wastewater particle systems  
→ Settling velocity

Few data about settling velocity distribution in wastewater systems

- ✓  $V_m$  → mean settling velocity

- ✓ Stokes:  $V_s = \frac{g(\rho_p - \rho_w) \cdot d_p^2}{18\mu}$

## Background

**Reality  $\equiv$  Heterogeneity**

Variety of particles with different settling velocities

→ Distribution of settling velocities

### How to measure the Vs distribution?

- Dynamic settling devices
- Settling column tests

## Overview

- Background
- Objectives
- Review of protocols
- ViCAs protocol
- Applications and results
- Conclusion and perspectives

## Objectives

- Identification of a simple protocol for measuring Vs distribution
- Demonstration of the usefulness of the protocol for different WW systems
  - primary settler
  - chemically enhanced primary treatment (CEPT)
  - combined sewer retention tank (RT)
  - stormwater tank

## Review of protocols

Comparison of 8 protocols for Vs distribution measurement (Berrouard, 2010)

- ASTON (Tyack *et al.*, 1993)
- UFT (Wong et Piedrahita, 2000)
- ViCAs (Chebbo et Gromaire, 2009)
- CERGRENE (Skilling, 2008)
- CERGRENE 95 (Gromaire, 1998)
- VICTOR (EPA, 1999)
- VICPOL (Torres, 2008)
- CAMP (Lin, 2003)

Different criteria (e.g. sample volume, length of analysis, sample pretreatment, filling method, etc.)

## Review of protocols

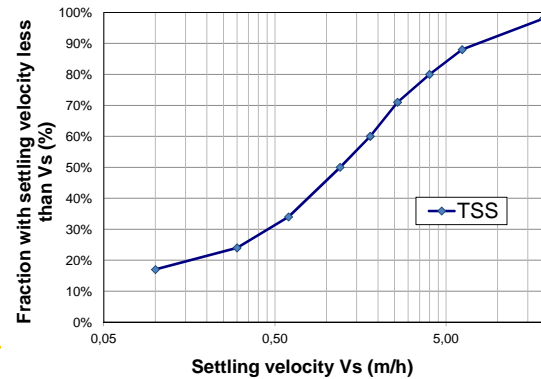
PROTOCOL	ASTON	UFT	CERGRENE	ViCAs	Camp (EPA, long column)
Settling height (mm)	1620	700	200	650	
Sample volume (L)	5	1	20	4,5	45-50
Pre-treatment	3h settling	2h Imhoff cone	Sieve (50µm)	Sieve (2mm)	-
Sampling	Column rotation	Bottom of cone	Device	Water sub-sample	Valves(Ø=1cm) on the H

## Overview

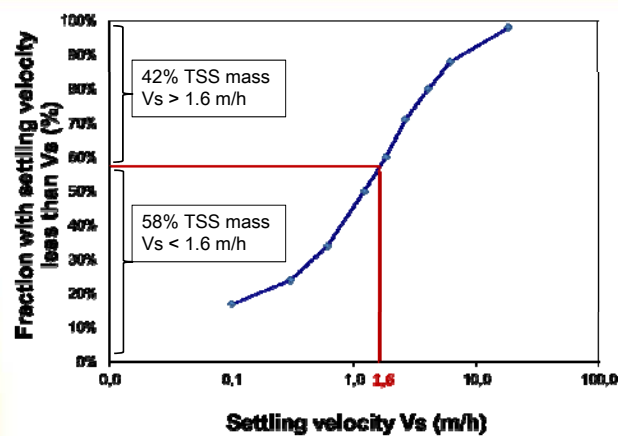
- Background
- Objectives
- Review of protocols
- ViCAs protocol
- Applications and results
- Conclusion and perspectives

## ViCAs - Methodology

ViCAs (*Vitesse de Chute en Assainissement*), Chebbo&Gromaire, 2009



## ViCAs – A $V_s$ distribution curve



## ViCAs – Advantages & Drawbacks

- Small sample volume (4.5 L)
- No sample pre-treatment
- Easy to run
- Results obtained in a few hours
- Inexpensive equipment



- Some experience required in manipulation
- Start of the test tricky



## Overview

- Background
- Objective
- Review of protocols
- ViCAs protocol
- Applications and results
- Conclusion and perspectives

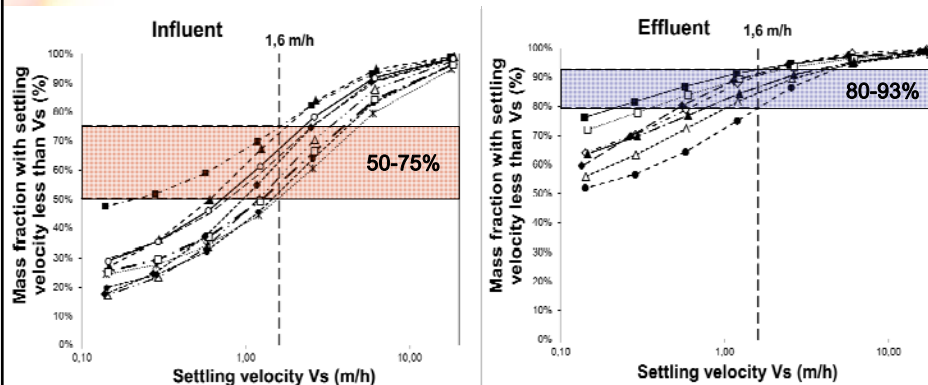
## Primary clarifier

Eastern WWTP of Québec (full scale and pilot PC)



## Results

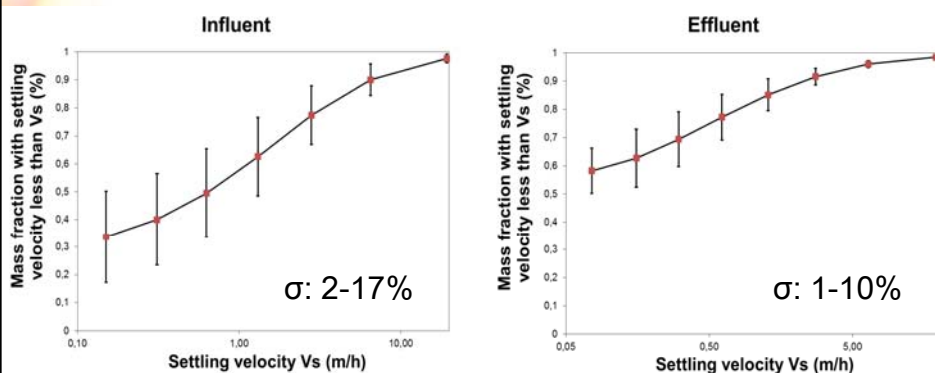
Primary clarifier – Range of results





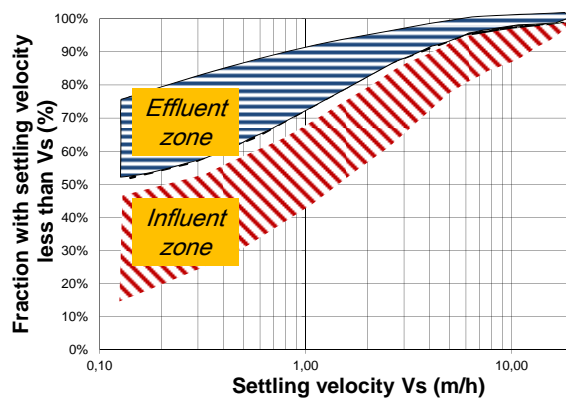
## Results

### Primary clarifier - Summary



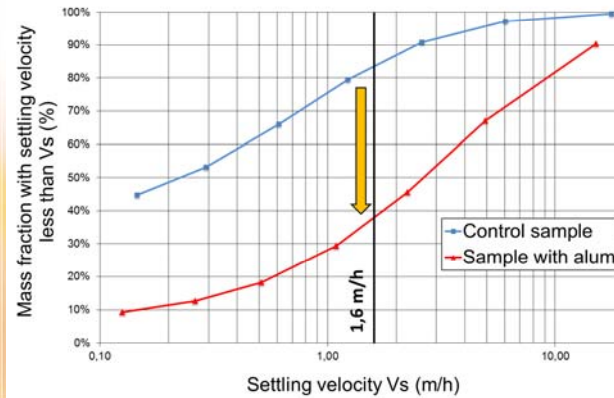
## Results

### Primary clarifier - Summary

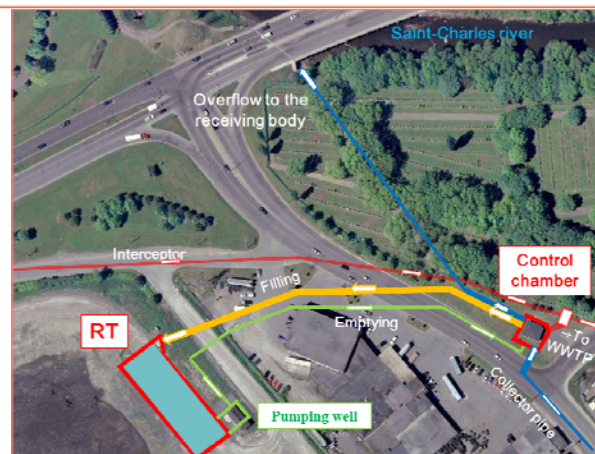


## Results

### ViCAs of raw sewage with/without alum (CEPT)



## Combined sewer retention tank (RT)

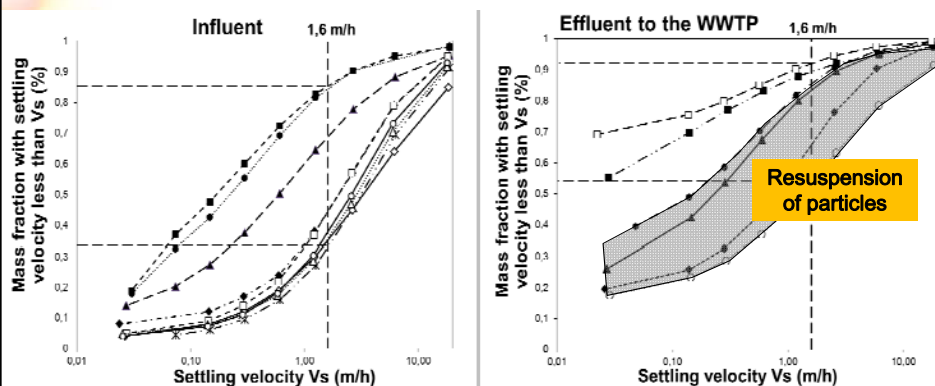


## Combined sewer retention tank (RT)



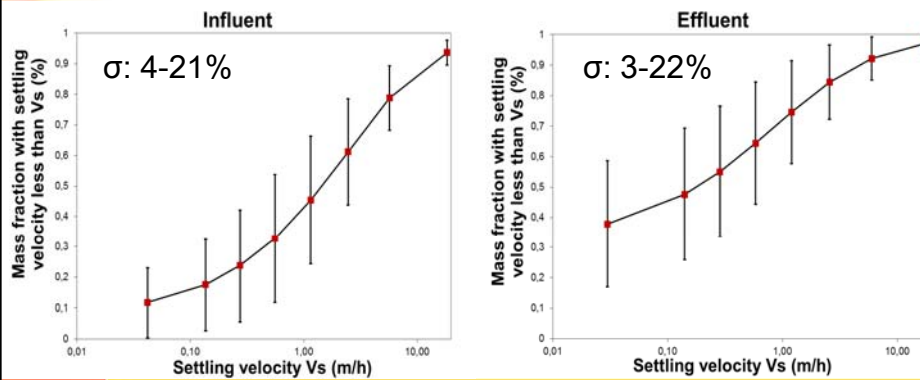
## Results

RT (Maruejouis *et al.*, 2011) – Range of results

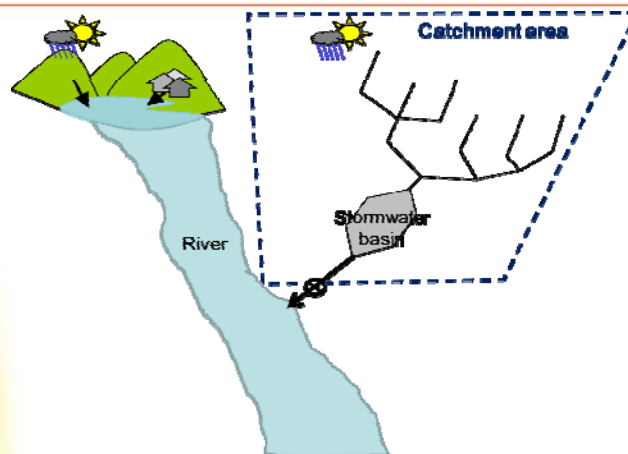


## Results

RT (Maruejols *et al.*, 2011) - Summary



## Stormwater tank

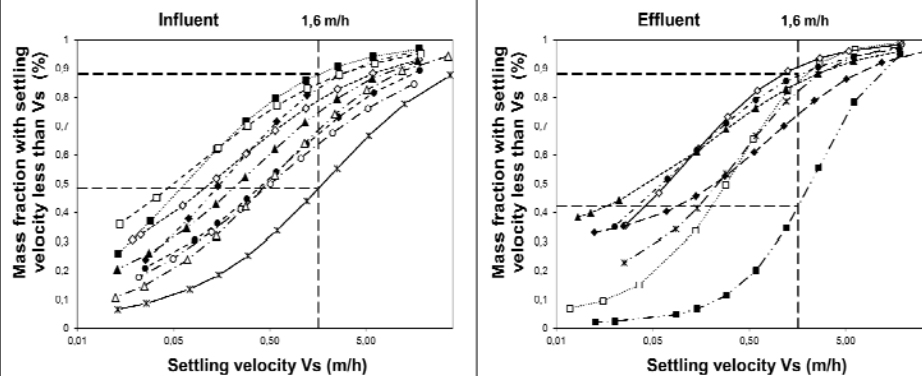


## Stormwater tank



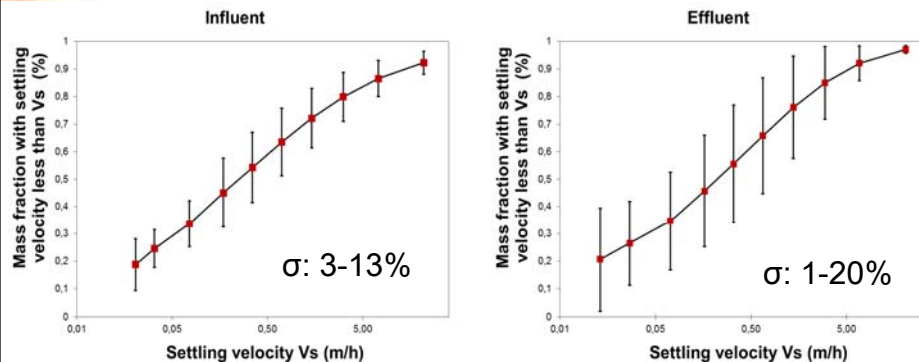
## Results

Stormwater tank (Vallet, 2011) – Range of results



## Results

### Stormwater tank (Vallet, 2011) - Summary



## Overview

- Background
- Objective
- Review of protocols
- ViCAs protocol
- Applications and results
- Conclusion and perspectives

## Conclusion and perspectives

- A unique and simple protocol can describe the settling velocity distribution of different WW systems
- Results show two typical particle Vs distributions for samples of influent and effluent primary settler
- In all WW systems we observe a variety of Vs distributions and ViCAs allows the different phenomena to be understood (settling in PC, resuspension, washing phase in RT, etc)
- ViCAs represents a useful tool for describing Vs distribution and modelling of WW systems

## Acknowledgements

- ✓ primEAU, retEAU and rivEAU research teams
- ✓ Québec City and CRIQ
- ✓ Financial partners