The EU funded SWIM-SM: developing capacity for Sustainable and Integrated Wastewater Treatment and Reuse

Online Course on Natural Treatment Systems: Wastewater Stabilization Ponds

Waste Stabilization Ponds

Course contents

1. Introduction
2. Anaerobic ponds
3. Facultative ponds
4. Maturation ponds
5. Pond system lay-out
6. Operation and maintenance
7. Costs

This course is based on lecture notes of dr.ir. Peter van der Steen

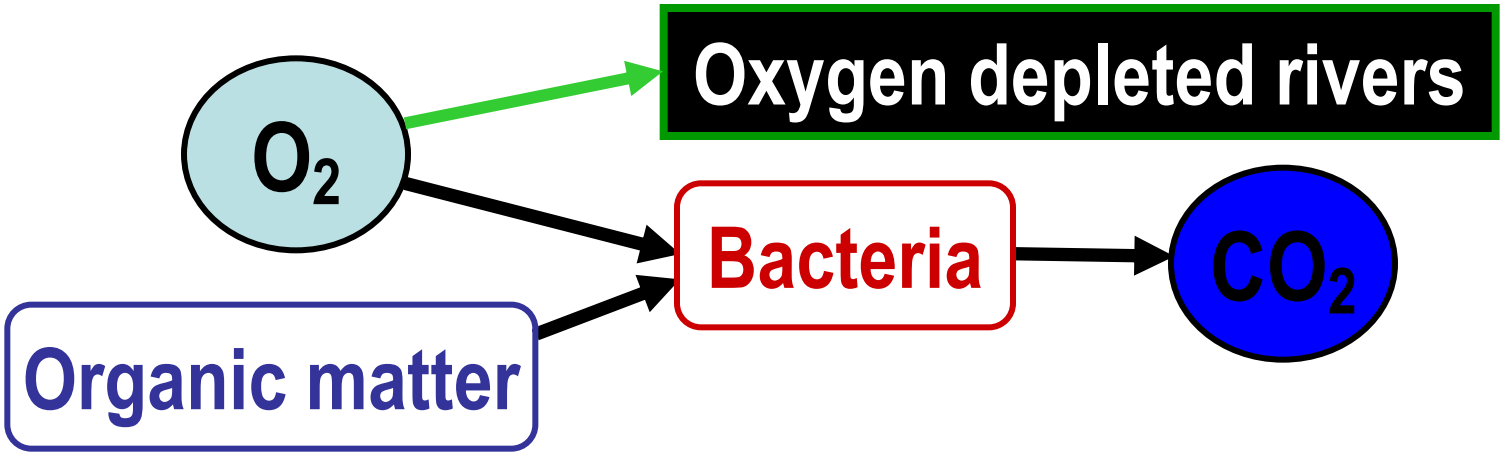
Part 1
Introduction

Introduction (1)

Waste Stabilisation Ponds

*What is **Stabilisation ??***

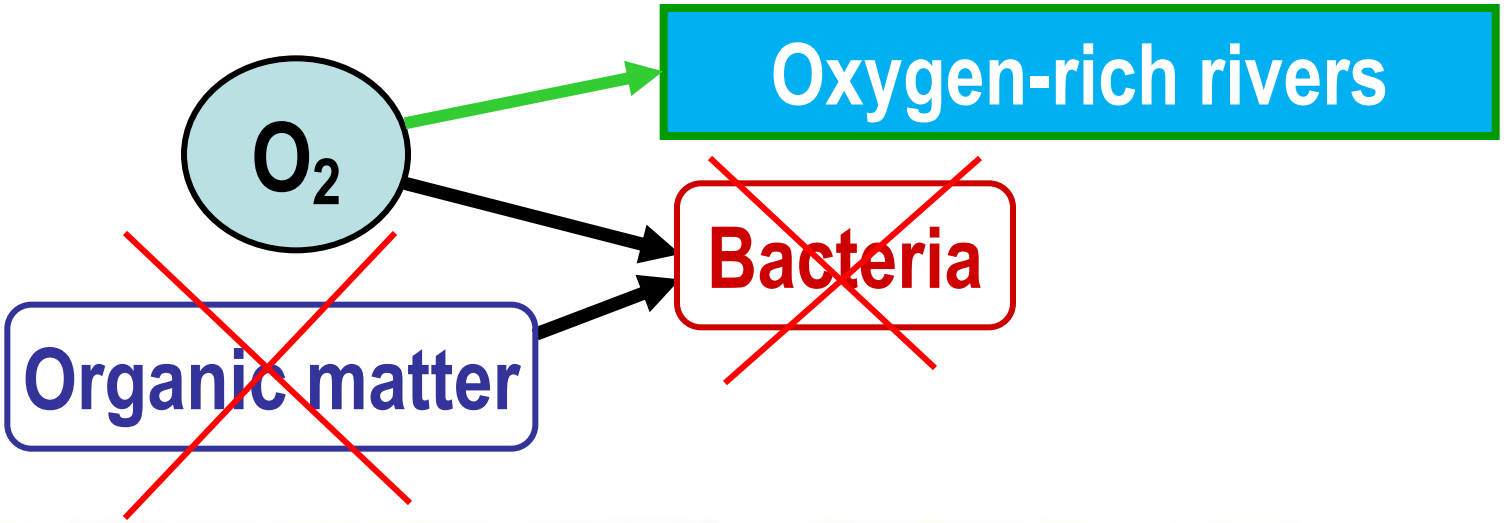
- ✓ Most wastewaters contain **organic matter**
- ✓ If discharged into the environment without treatment:



Introduction (2)

*What is **Stabilisation** ??*

Treatment through stabilisation refers to the degradation of organic matter (either aerobic or anaerobic) in a ***confined and engineered system*** rather than in the environment.



Introduction (3)

- In waste stabilisation ponds both **aerobic** and **anaerobic bacteria** contribute to **waste stabilisation**.

- The oxygen required for aerobic stabilisation is produced by **photosynthesis**, waste stabilisation ponds are therefore typical **natural** systems: not requiring any electricity for oxygen input.

Introduction (4)

How do pond systems look like?

- Ponds are simple man-made basins/lagoons, often surrounded by an earthen embankment.
- The waste is confined and bacteria stabilise the waste.

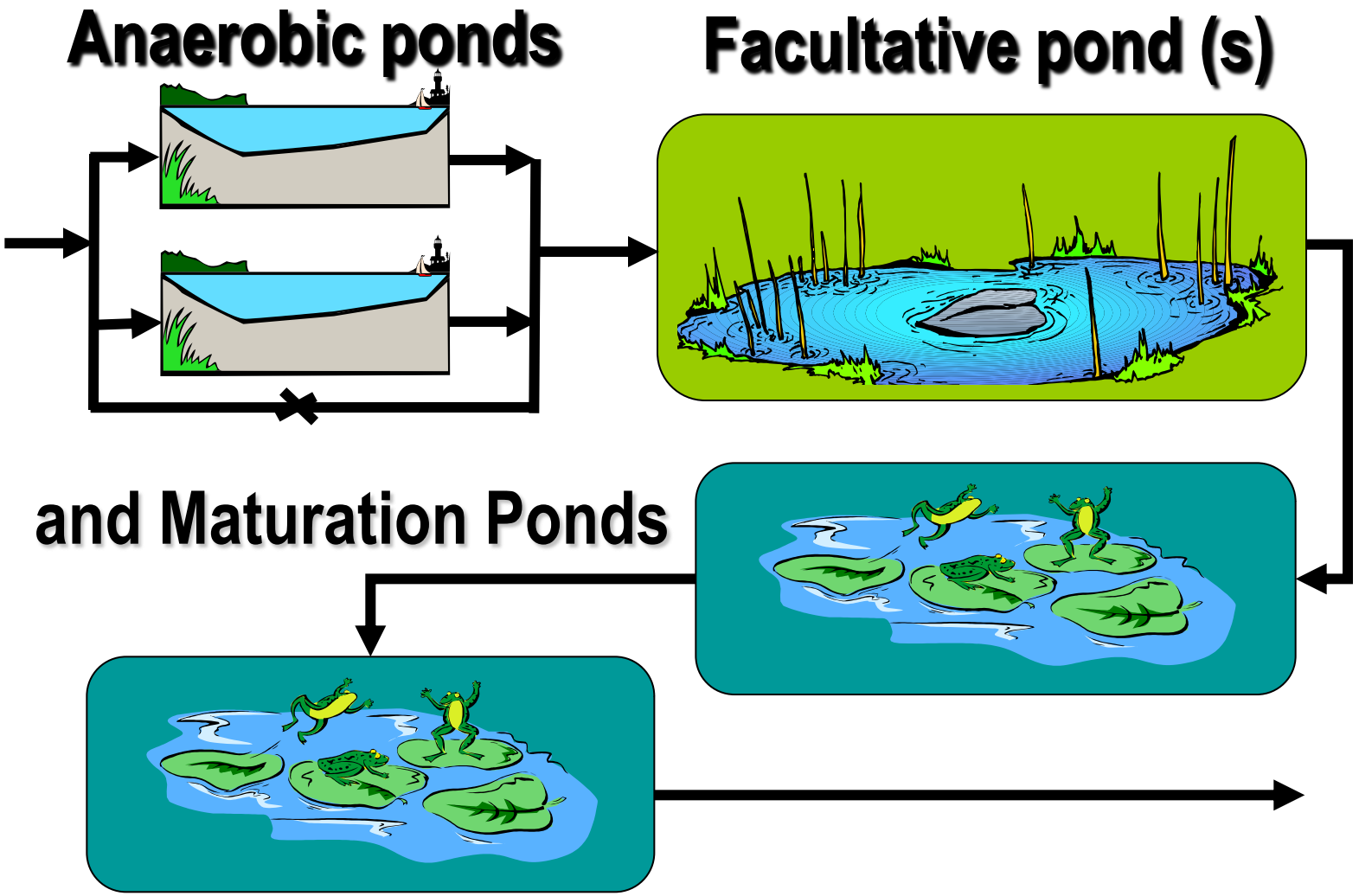
Advantages of WSP

- Very effective removal of pathogens, and therefore effluent suitable for reuse
- Effective BOD removal
- Simple and cheap construction, operation and maintenance
- Low energy requirements
- Simple sludge management

Disadvantages of WSP

- Large land area required
- Performance strongly affected by temperature
- Potential odour release
- Low degree of operational control

A typical WSP system



Part 2
Anaerobic Ponds

Mechanisms (1)

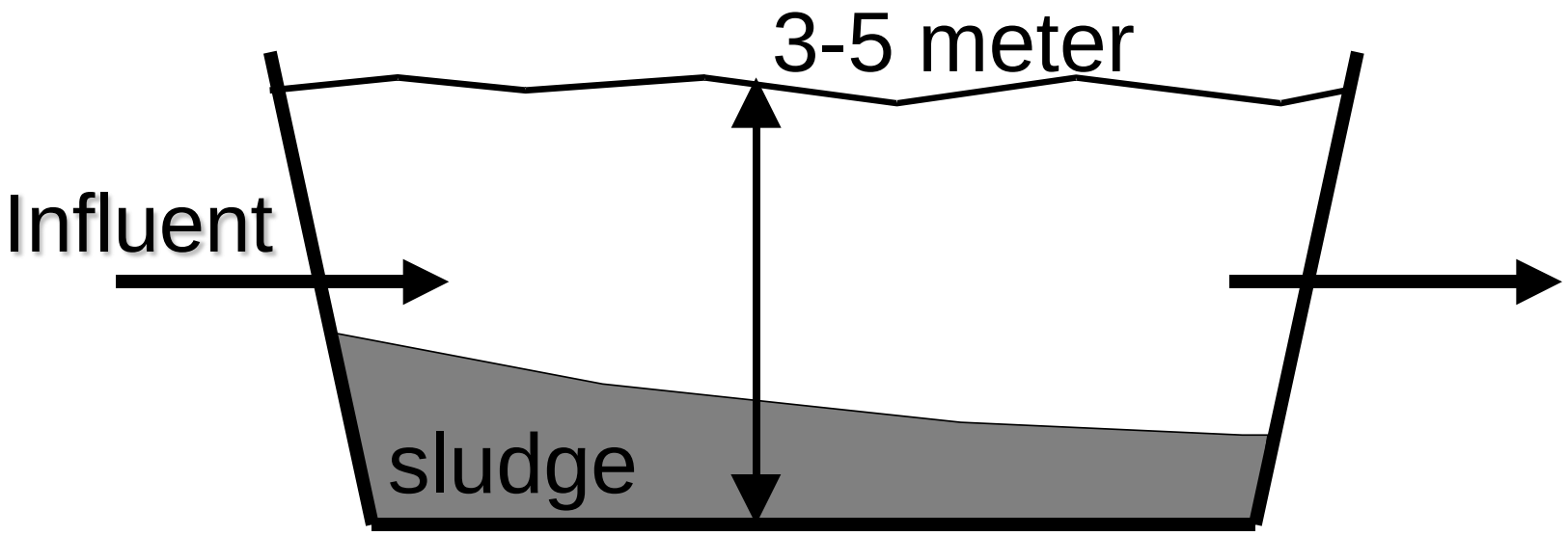
The two main mechanisms in Anaerobic ponds:

- Sedimentation of particles
- Degradation of organic material via a multi-step anaerobic degradation process

Mechanisms (2)

These mechanisms are realised in a simple pond:

depth 3-5 meters, HRT for municipal sewage 1-3 days



Sludge accumulation

- Sludge accumulation causes the effective pond volume to decrease.
- This shortens the HRT and may result in incomplete settling and incomplete anaerobic degradation.
- Therefore pond desludging is required after one third of the pond volume is filled with sludge.
  - Can be done by means of sludge pump
  - In case of parallel ponds, one can be temporary taken out of service, dried and then excavated

Summary

Removal efficiencies in APs

- BOD 40-60%
- TSS 50-70%
- Faecal coliforms 90%
- Helminth eggs 75-90%

Additional treatment is required!

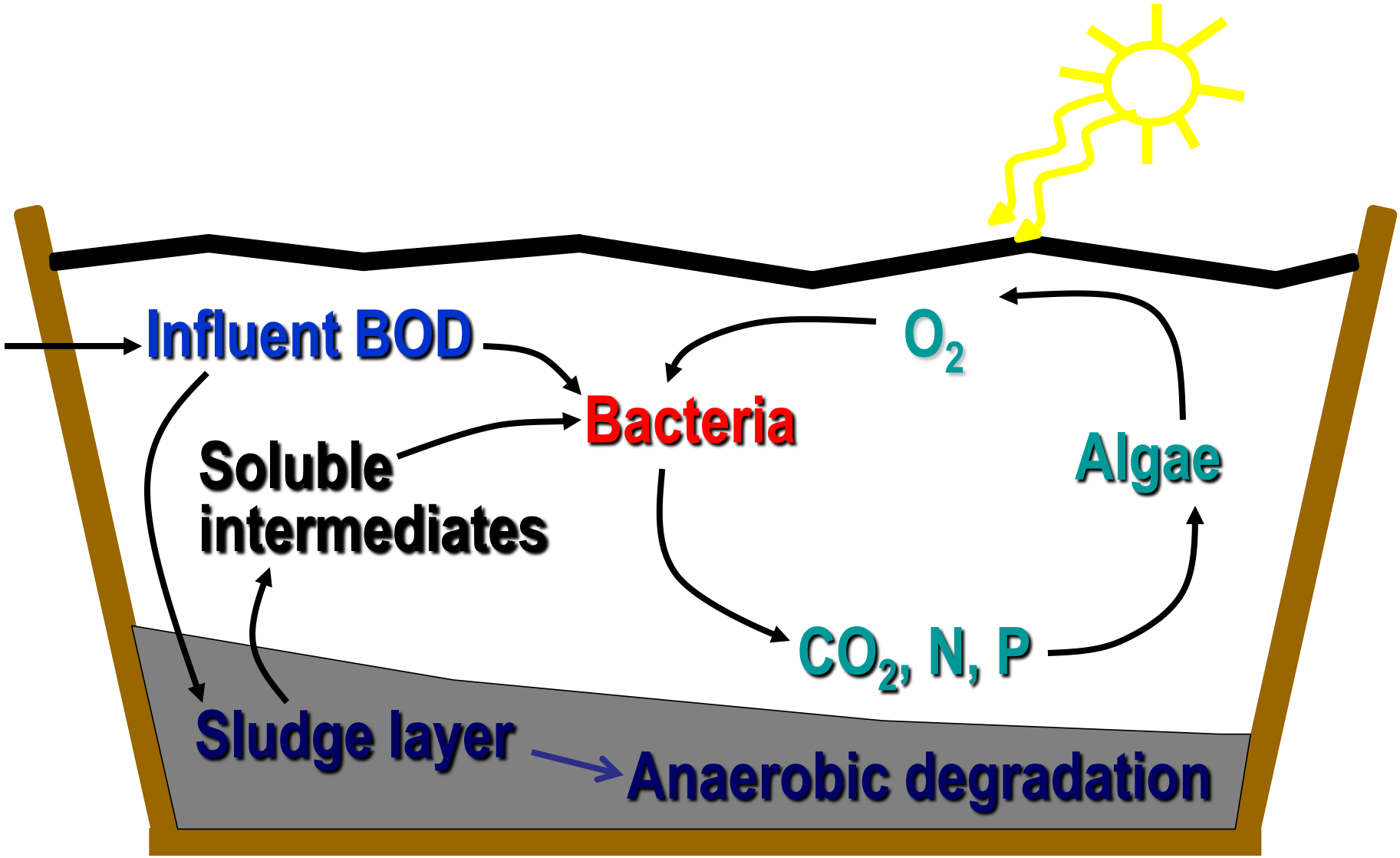
Part 3
Facultative Ponds

Facultative ponds: what means facultative?

- In a facultative pond both an aerobic and an anaerobic section is present.

- Oxygen production is by algae photosynthesis
- A well functioning pond has therefore a **green** colour
- Removal of BOD is a co-operative action of algae and bacteria.

Algae – bacteria symbiosis & anaerobic digestion



Summary facultative ponds

Typical facultative pond effluent quality:

BOD	**20 - 60**	**mg/l**
TSS	**30 - 150**	**mg/l**
Faecal coliforms	**10^4-10^6**	**1/100ml**
Helminth eggs	**0-50**	**1/liter**

In most cases additional treatment is required!

→ pathogen removal & algae removal

Part 4
Maturation Ponds

Maturation ponds

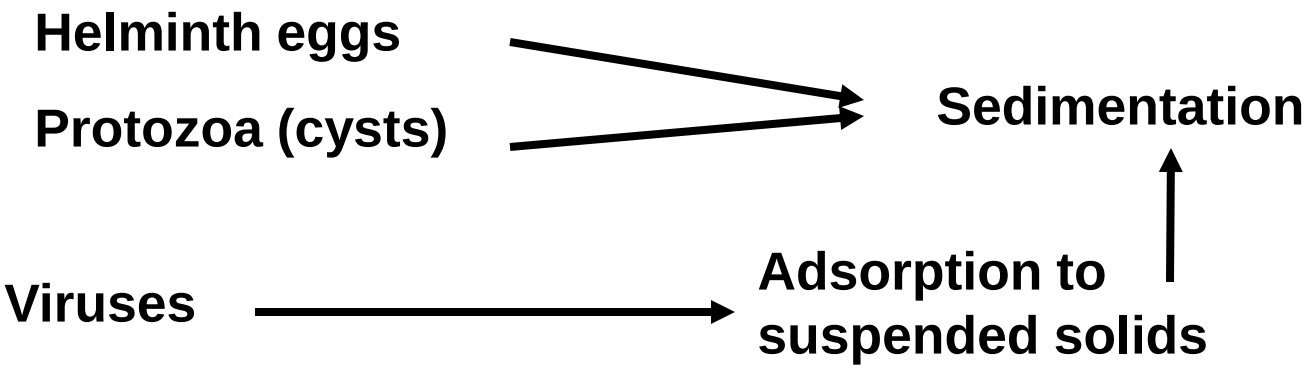
- Main objective: pathogen removal
- Entirely aerobic and 1-1.5 m deep
- Typical HRT 3-10 days
- BOD removal less than 25%
- Usually more ponds in series

Comparison of removal efficiencies

	Removal (log units)	
	Bacteria	H. eggs
Primary sedimentation	0-1	0-2
Activated sludge*	0-2	0-2
Trickling filter*	0-2	0-2
Chlorination/ozonation	2-6	0-1
WSPs	1-6	1-3

* Including settling pond/tank

Pathogen removal mechanisms



FC removal mechanisms

Removal mechanisms:

- Adsorption to suspended solids and sedimentation
- Grazing by protozoa
- **Natural decay**

Natural decay is the most important mechanism. There are four sub-mechanisms:

→ Lack of food

→ DNA damage by UV radiation

→ pH stress

→ photo-oxidation

Summary maturation ponds

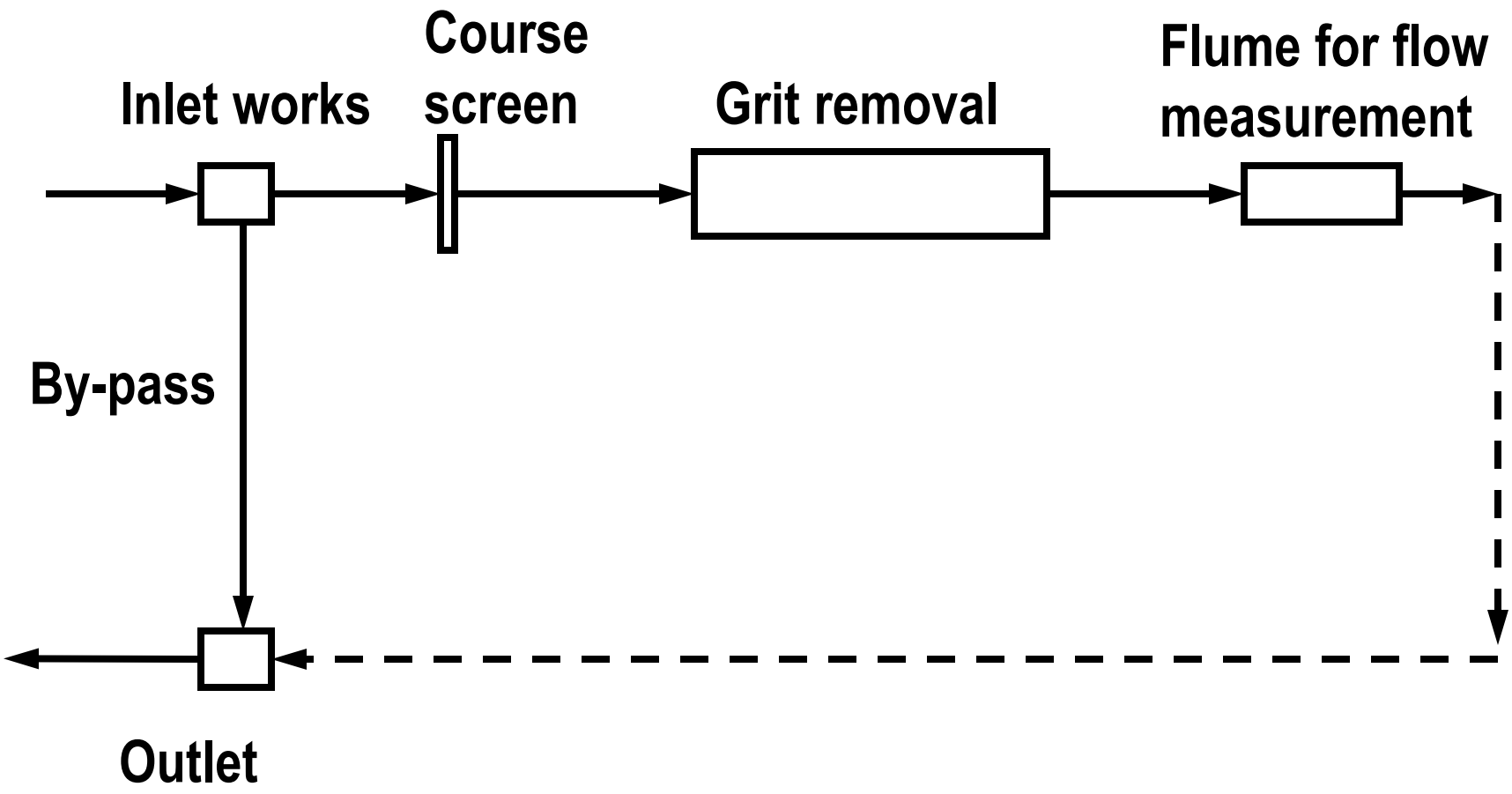
Typical maturation pond effluent quality:

BOD	10 - 50	mg/l
TSS	20 - 100	mg/l
Faecal coliforms	10^2-10^3	1/100ml
Helminth eggs	0	1/liter

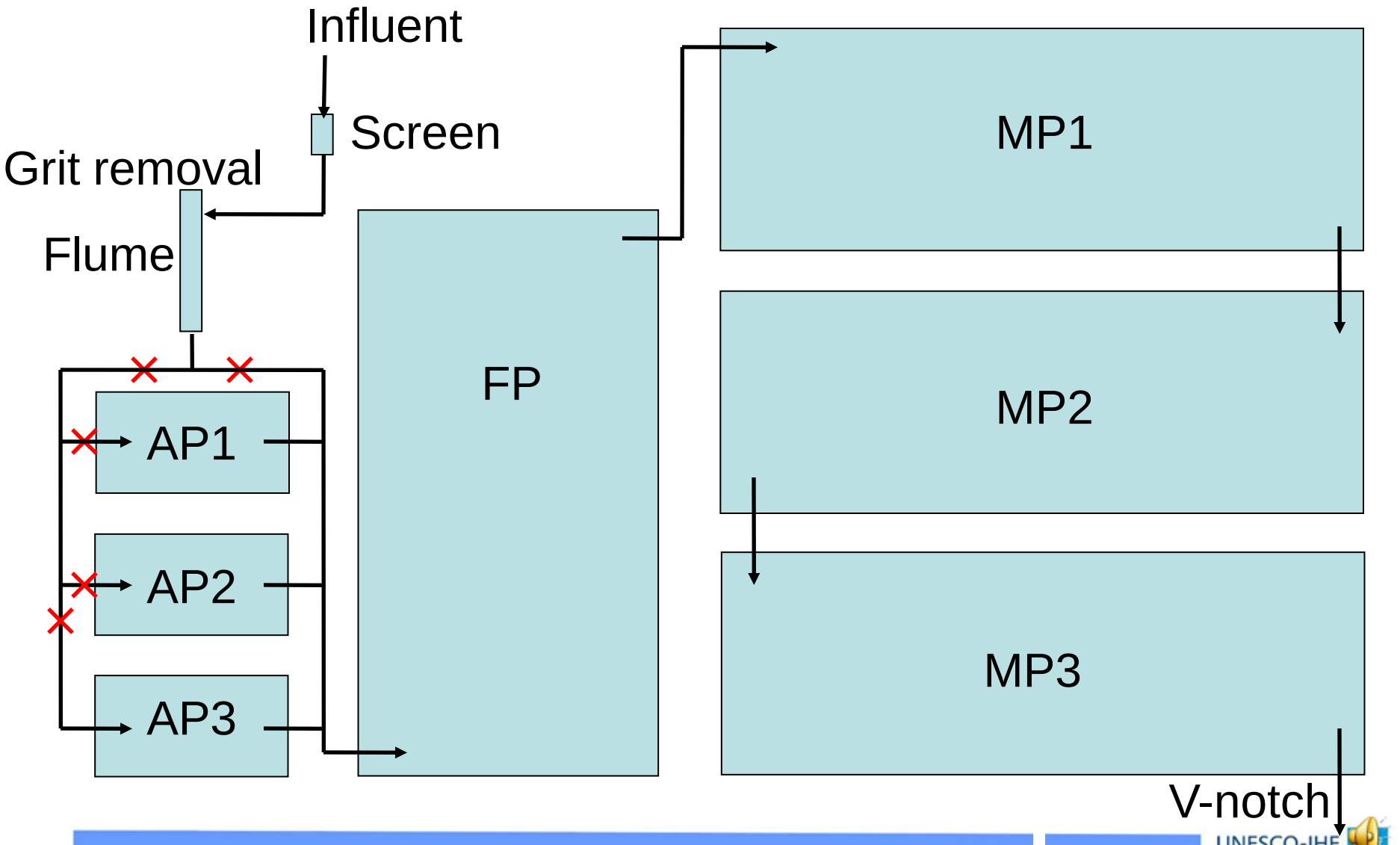
Maturation pond effluent satisfies the strictest WHO criteria for effluent reuse in irrigation (< 1000 FC/100 mL).

Part 5
Pond system lay-out

WSP lay-out (1)


Inlet works
Course screen
Grit removal
Flume for flow measurement
By-pass
Outlet

WSP lay-out (2)


× = stop cock or gate
Influent
Screen
Grit removal
Flume
AP1
AP2
AP3
FP
MP1
MP2
MP3
V-notch

Part 6
Operation and maintenance

Operation and maintenance

- WSP have low O&M requirements
- Low does not mean no!

- Main O&M activities:
  - Cleaning inlet/outlet
  - Cleaning/maintaining embankments
  - Prevent scum layers in FP and MP
  - Desludging anaerobic ponds
  - Influent/effluent monitoring

Part 7
Costs

WSP costs (1)

- Investment cost
  - Civil works
  - Electrical and mechanical equipment
  - Land ← !
- Operating costs
  - Maintenance
  - Electricity
  - Labour
  - Sludge disposal


The End