



# Green Village Delft

## Integration of an Autarkic Water Supply in a Local Sustainability Energy System

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# Content



- Welcome to the Green Village
- Water reuse in the Dutch context and legislation
- Design boundary conditions
- Design philosophy
- Conclusions



WELCOME



TO THE

GREEN



VILLAGE

# THE GREEN VILLAGE MISSIONS

## CLEAN ENERGY PRODUCER

Energy efficient  
Green Buildings  
Electric transport  
Clean Lighting systems  
Smart heat grids  
Smart DC electricity grids

## WASTE AS RESOURCE

Re-use and recycling  
Material production from waste  
Circular products  
Circular buildings  
Smart waste grids

## CLEAN WATER PRODUCER

Water efficient  
Re-use of waste water  
Produce from rain  
Produce with fuel cell  
Smart water grids

## CLEAN AIR PRODUCER

No CO<sub>2</sub> emissions into the air  
Reduction of fine dust in the air  
Removing NOx from the air  
Production of oxygen

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# *Water reuse in the Dutch context and legislation*

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# Water reuse regulations



-  national legislation
-  guidelines and/or technical standard/norm
-  no specific legislation

The Netherlands

Source: Hochstrat et al. IWA Water Reuse Conference, Barcelona, 26-29 September 2011

# Dutch drinking water regulations

- All water supplied to customers must comply with the Dutch drinking water standards
- Domestic dual water supply systems:
  - only for toilet flushing
  - sources: rainwater and groundwater
  - exemption from the Ministry

# Dutch drinking water production philosophy

- No use of a persistent disinfectant during production and distribution (“The Dutch approach”)
- Multiple barrier concept for:
  - micro-organisms
  - organic micropollutants





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 **VILLAGE**   
**SUSTAINABLE,**   
 **LIVELY AND**  
**ENTREPRENEURIAL**

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# *Design boundary conditions*

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- Supply of only one water quality: drinking water
- Application of multiple barrier concept

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# *Design philosophy*

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1. Reducing the overall consumption of water by making efficient use of water and applying water conservation measures
2. Using greywater and rainwater as raw water sources, and reclaiming them in a multiple barrier treatment concept for drinking water production
3. Treating blackwater anaerobically for energy recovery from wastewater

# 1. Efficient use of water & water savings

	<b>Consumption NL<sup>1</sup></b> (L/person/day)	<b>Reduction<sup>2</sup></b>	<b>Consumption Green Village</b> (L/person/day)
shower	48.6	35%	31.6
sink faucet	5.0	35%	3.2
laundry	15.4	35%	9.7
dishwashing	6.1	60%	2.0
toilet	33.7	Vacuum toilets	3.0

<sup>1</sup> VEWIN – NIPO “Water use at home 2010”

<sup>2</sup> Hofman-Caris “Trends in water conservation”

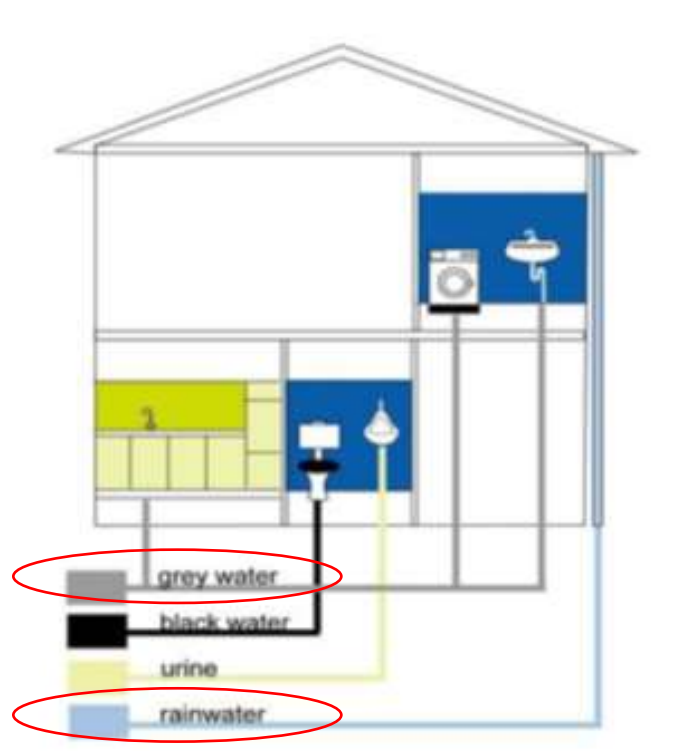
# 1. Efficient use of water & water conservation

<b>Overall water use Green Village</b> (L/day)	
Conventional systems	Efficient use & water conservation
4,584	1,337



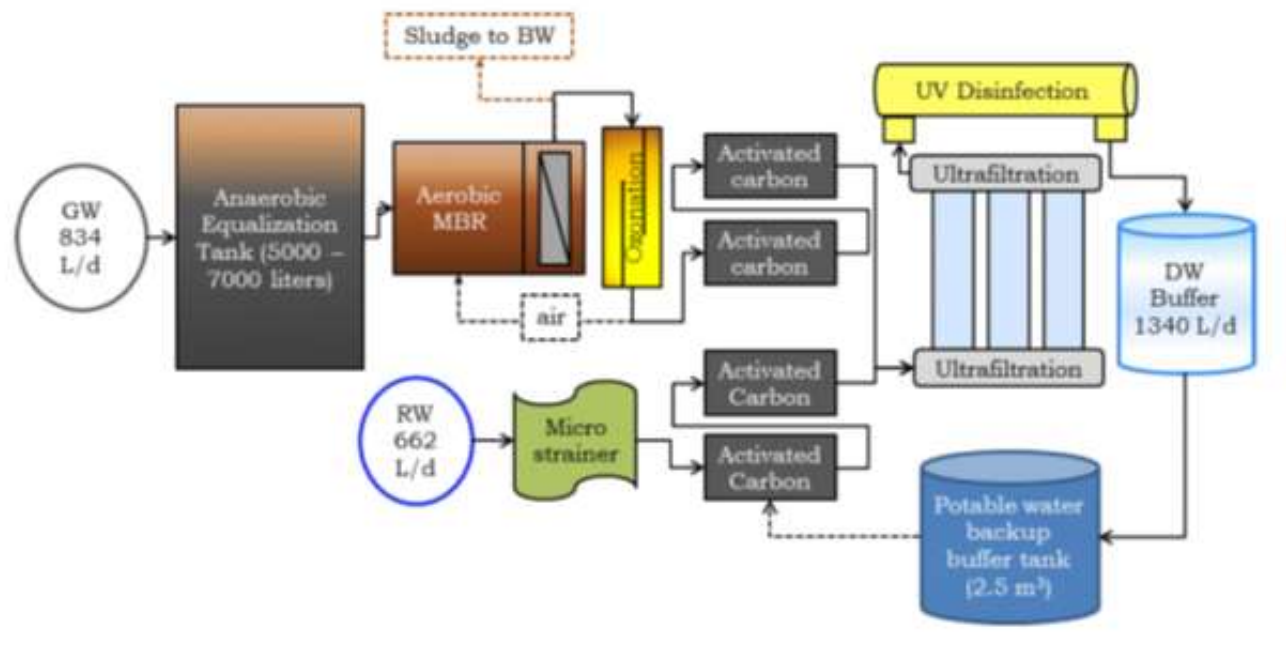
## 2. Greywater and rainwater as sources for drinking water and use of multiple barrier treatment

Separation at source concept



## 2. Greywater and rainwater as sources for drinking water and use of multiple barrier treatment

### Multiple barrier treatment concept

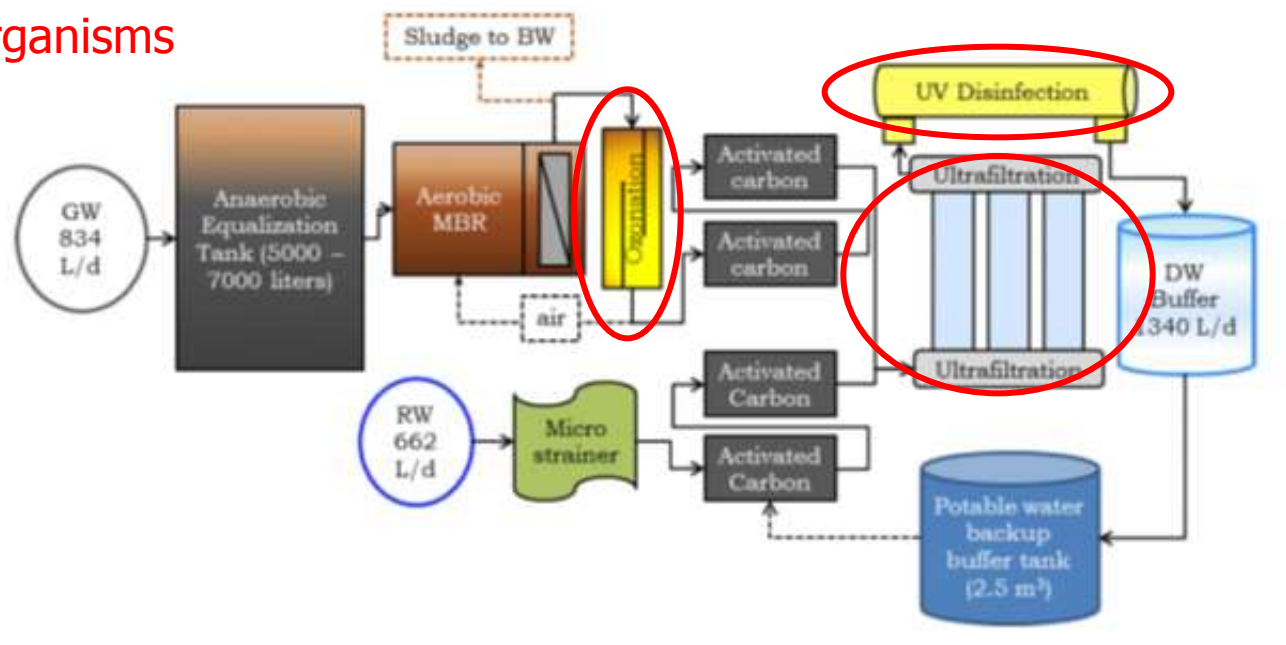




## 2. Greywater and rainwater as sources for drinking water and use of multiple barrier treatment

### Multiple barrier treatment concept

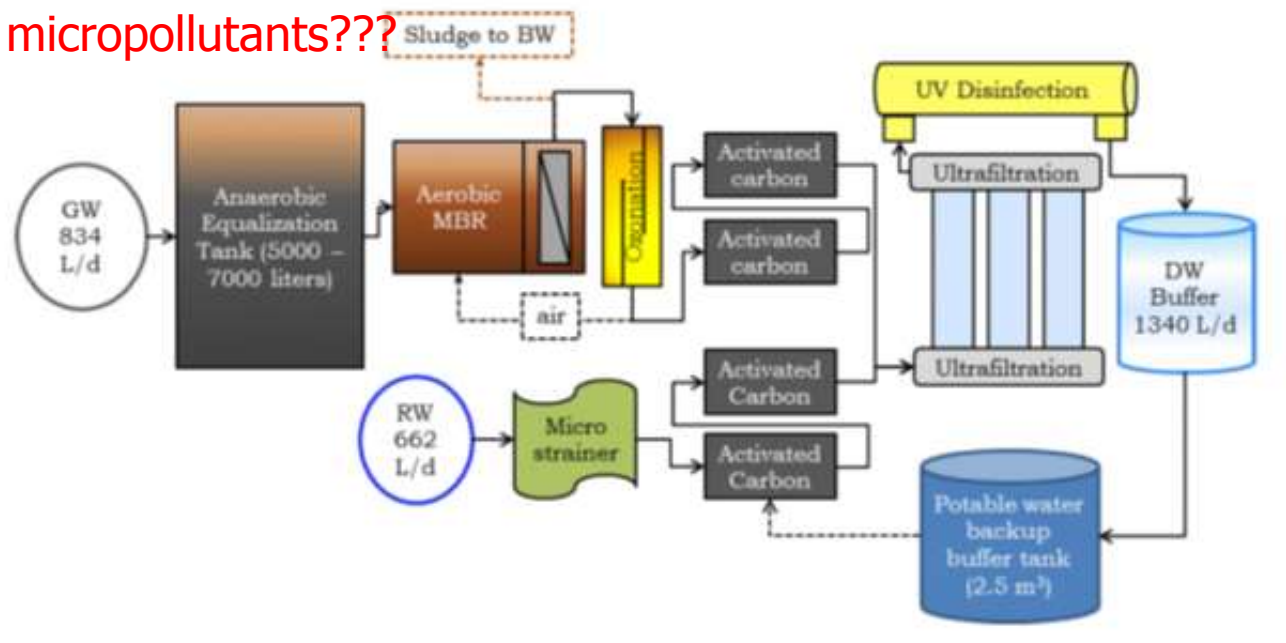
#### Micro-organisms



## 2. Greywater and rainwater as sources for drinking water and use of multiple barrier treatment

### Multiple barrier treatment concept

Organic micropollutants???



# What do we know about the application of greywater as a source for drinking water?

- Only a few studies investigated the use of greywater as a direct source for drinking water – much more research on the use of wastewater
- **Lack of knowledge about the presence and risks of organic micropollutants in greywater – much more knowledge about pathogen concentrations**

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

ScienceDirect

journal homepage: [www.elsevier.com/locate/watres](http://www.elsevier.com/locate/watres)

## Health risk assessment of organic micropollutants in greywater for potable reuse



Ramiro Etchepare <sup>a,b,\*</sup>, Jan Peter van der Hoek <sup>c,d</sup>

- Literature review into organic micro pollutants in greywater
- Conceptual framework to assess human health risks from organic micro pollutants
- Treatment goals and treatment schemes

# Organic micropollutants in grey water

Class	Number of OMPs
Plasticisers and softeners	13
Preservatives	20
UV filters	7
Fragrances and flavors	46
Surfactants	55
PAHs	11
PCBs	5
Solvents	33
Organotin compounds	5
Brominated flame retardants	6
Miscellaneous	76

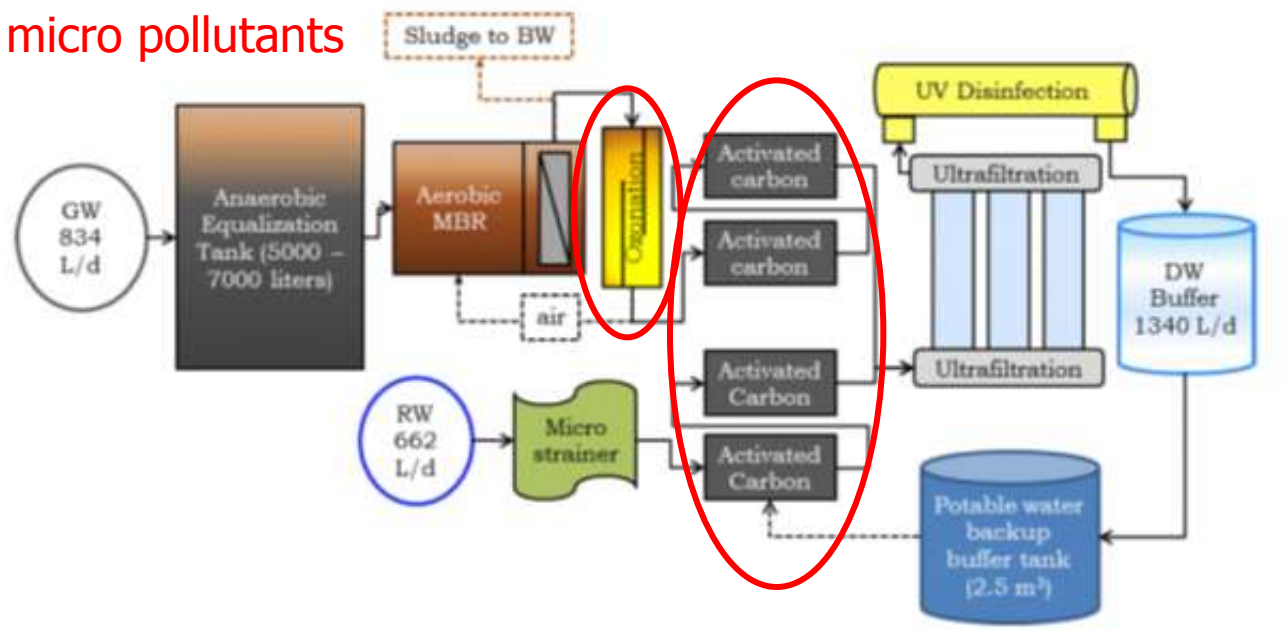
# 14 organic micropollutants in greywater that warrant further investigation

RQ > 1	0.2 < RQ < 1
benzene	dibutyl tin
2-ethyl-1-hexanol	dichloromethane
benzenesulfonic acid methyl ester	trichloromethane
dodecanoic acid	nicotine
tetracanoic acid	acetamide
	indole
	decanamide, N-(2-hydroxyethyl)-
	sulphuric acid, dimethyl ester
	methyl dihydrojasmonate

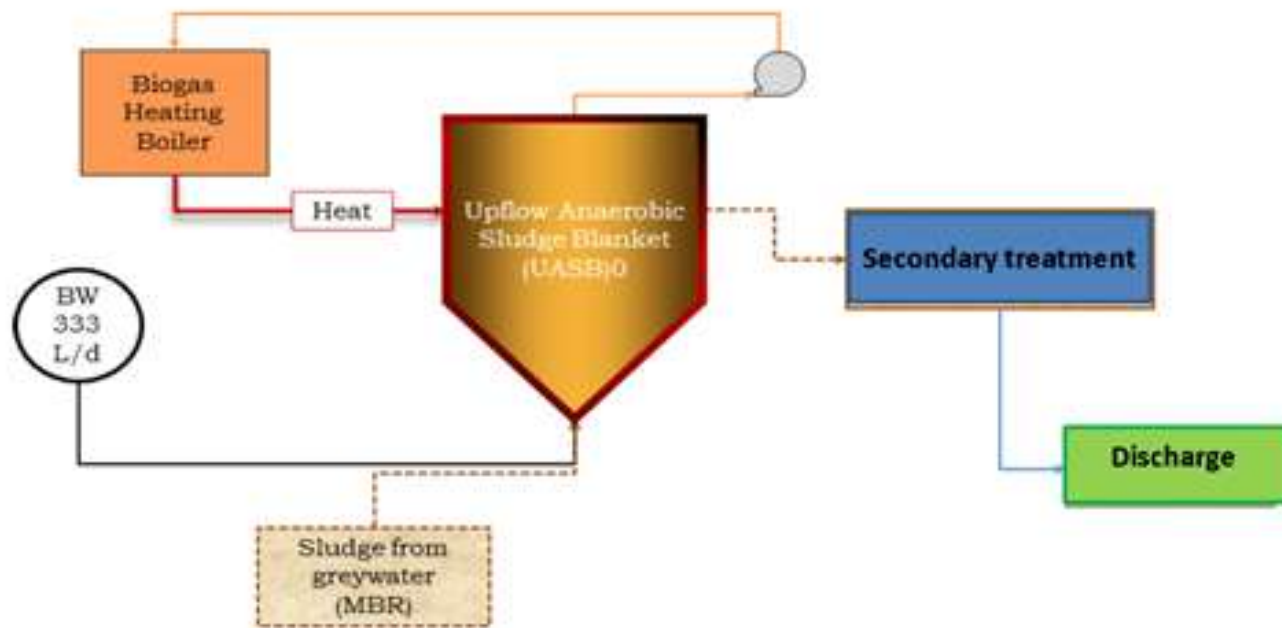
## 2. Greywater and rainwater as sources for drinking water and use of multiple barrier treatment

### Multiple barrier treatment concept

Organic micro pollutants



### 3. Anaerobic treatment of blackwater with energy recovery





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# *Conclusions*

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- An autarkic water management system seems possible
  - in compliance with the Dutch drinking water regulations
  - in line with the Dutch drinking water production philosophy
- The water management system is not autarkic with respect to energy use
- Options for a total autarkic system:
  - use of solar energy
  - use of wind energy
  - co-digestion of organic (kitchen) waste



# THE VIRTUAL GREEN VILLAGE

[www.thegreenvillage.org](http://www.thegreenvillage.org)

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