

Direct surface water treatment

CTB3365x Introduction to water treatment

Prof.dr.ir. Luuk Rietveld

Surface Water



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Impression

Developments

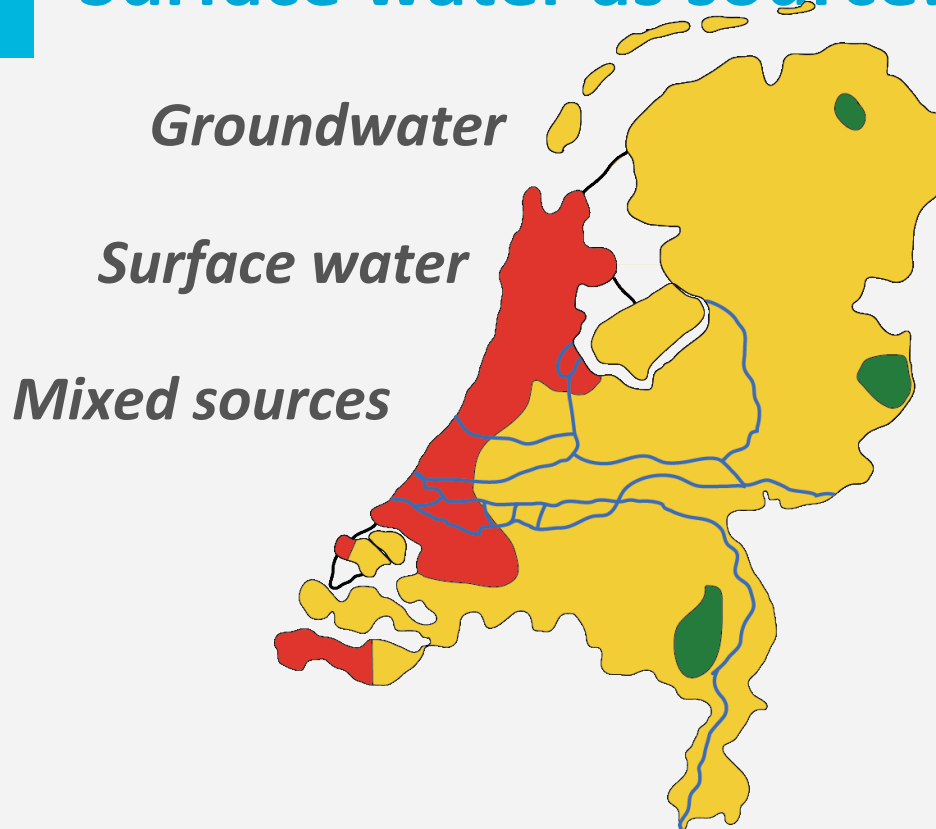
Influence

Treatment steps

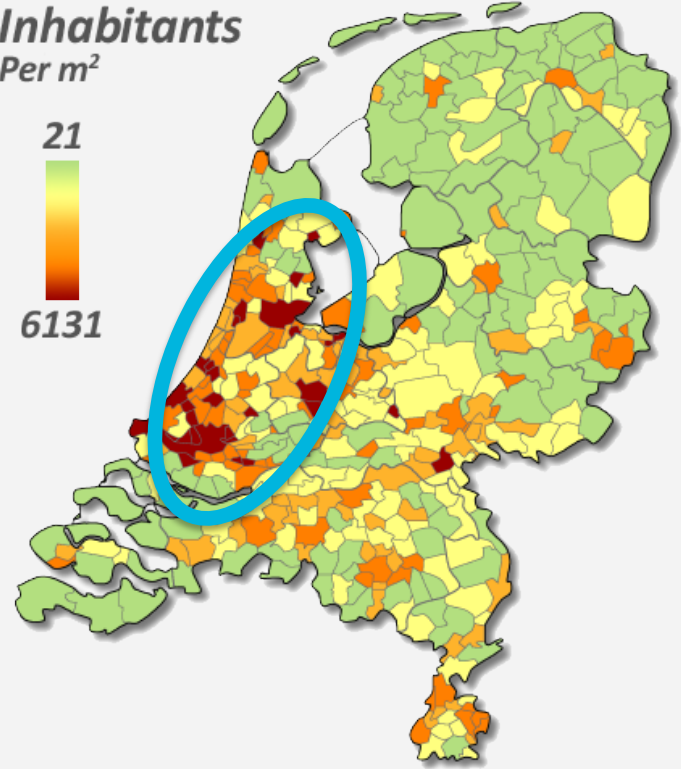
Final

Quality

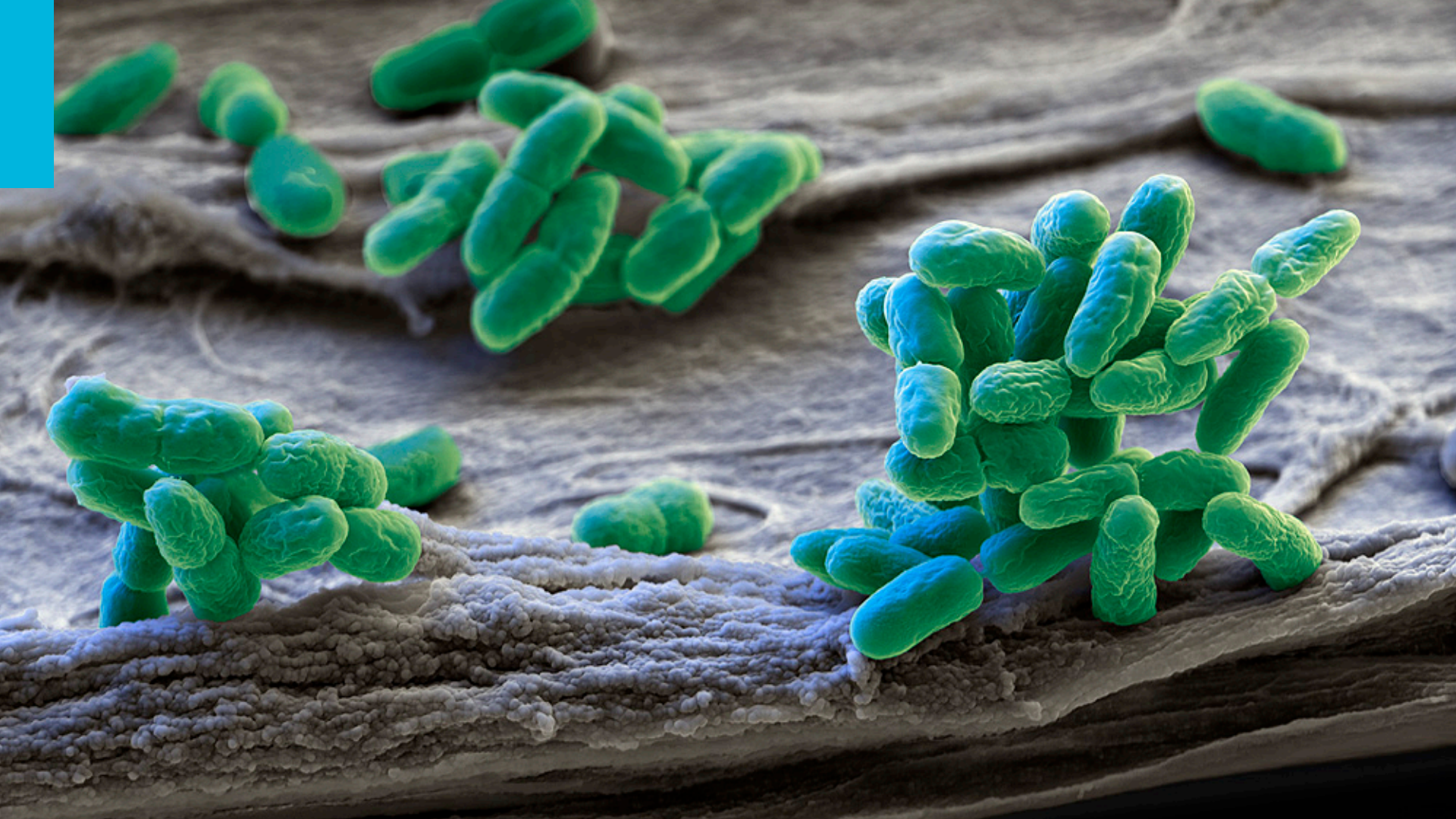
Surface water as source: Dutch coastal areas

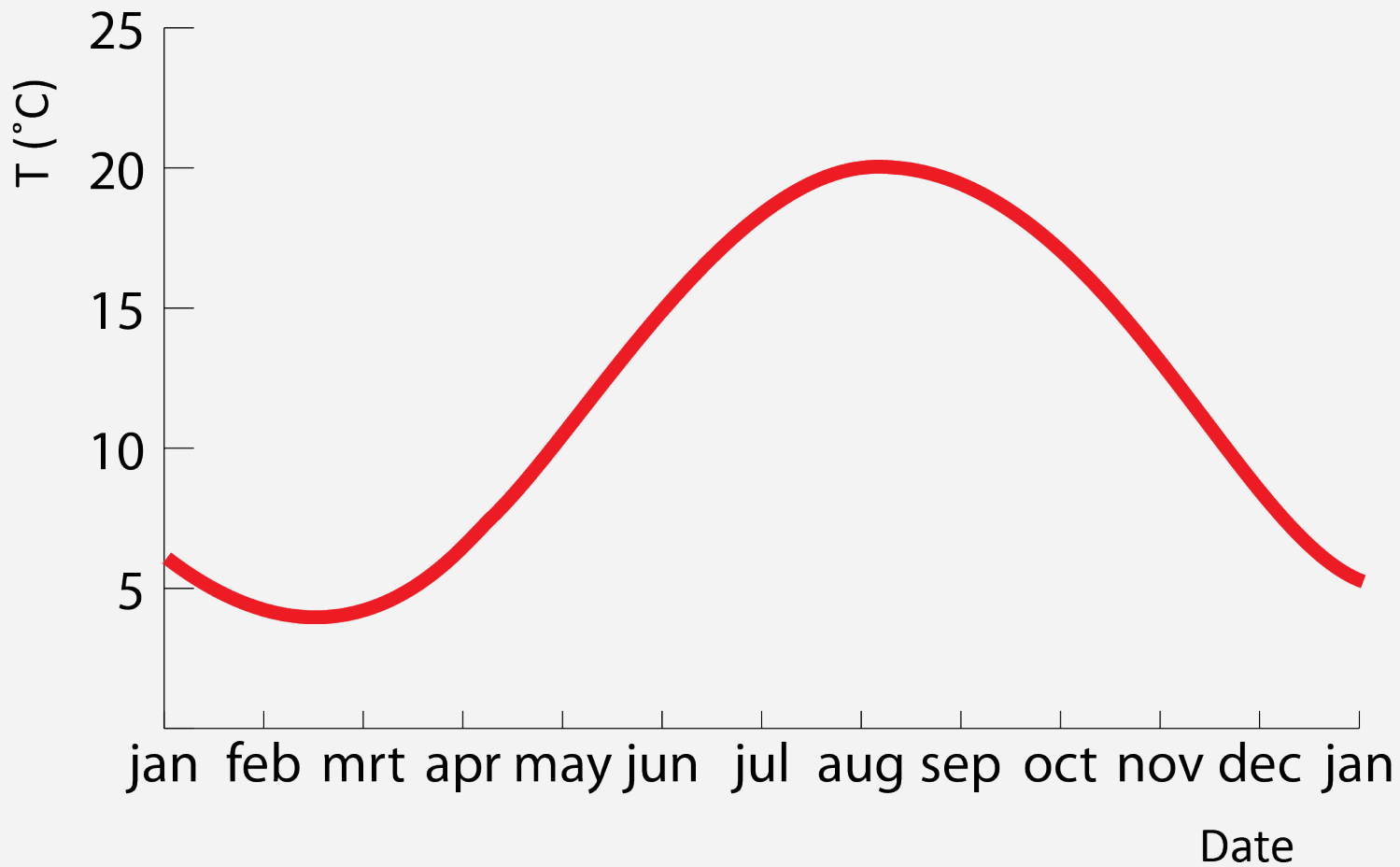


*Inhabitants
Per m²*

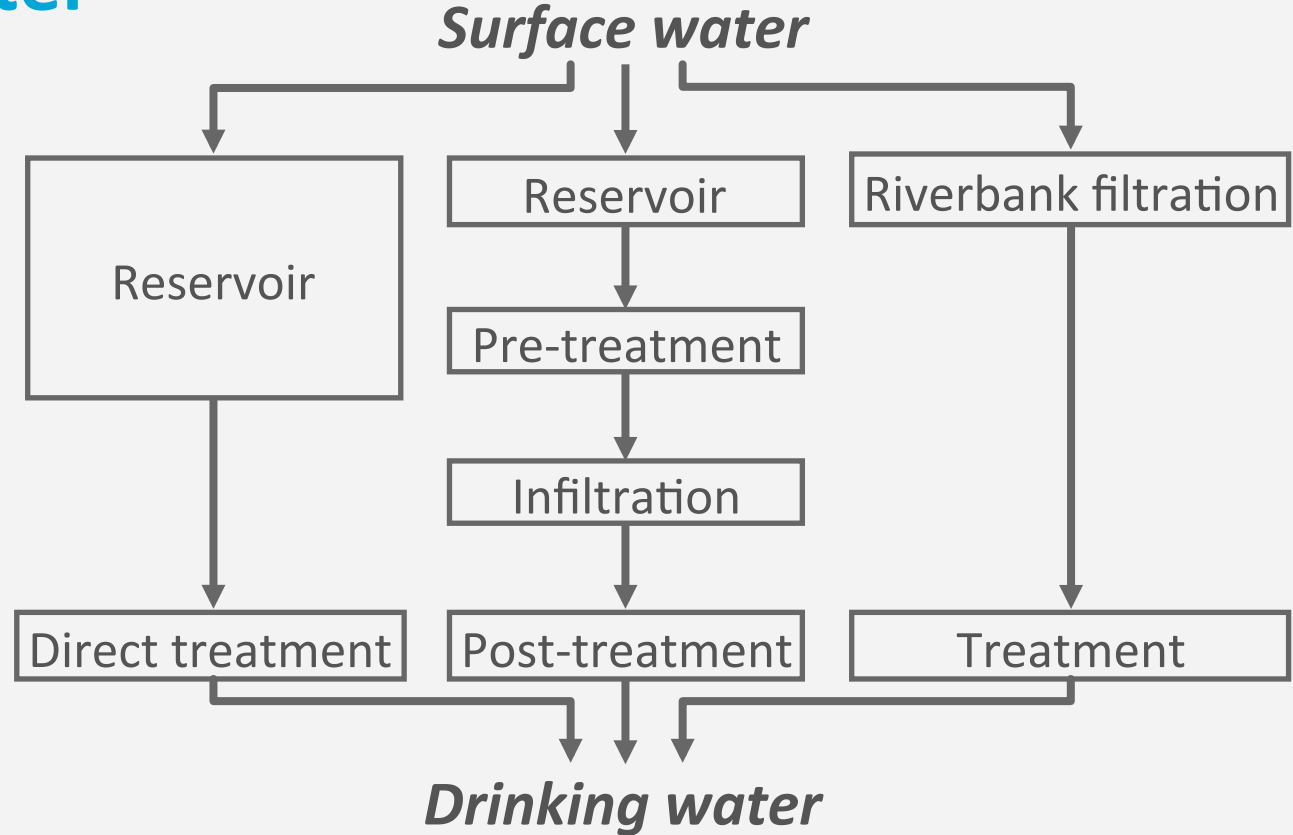




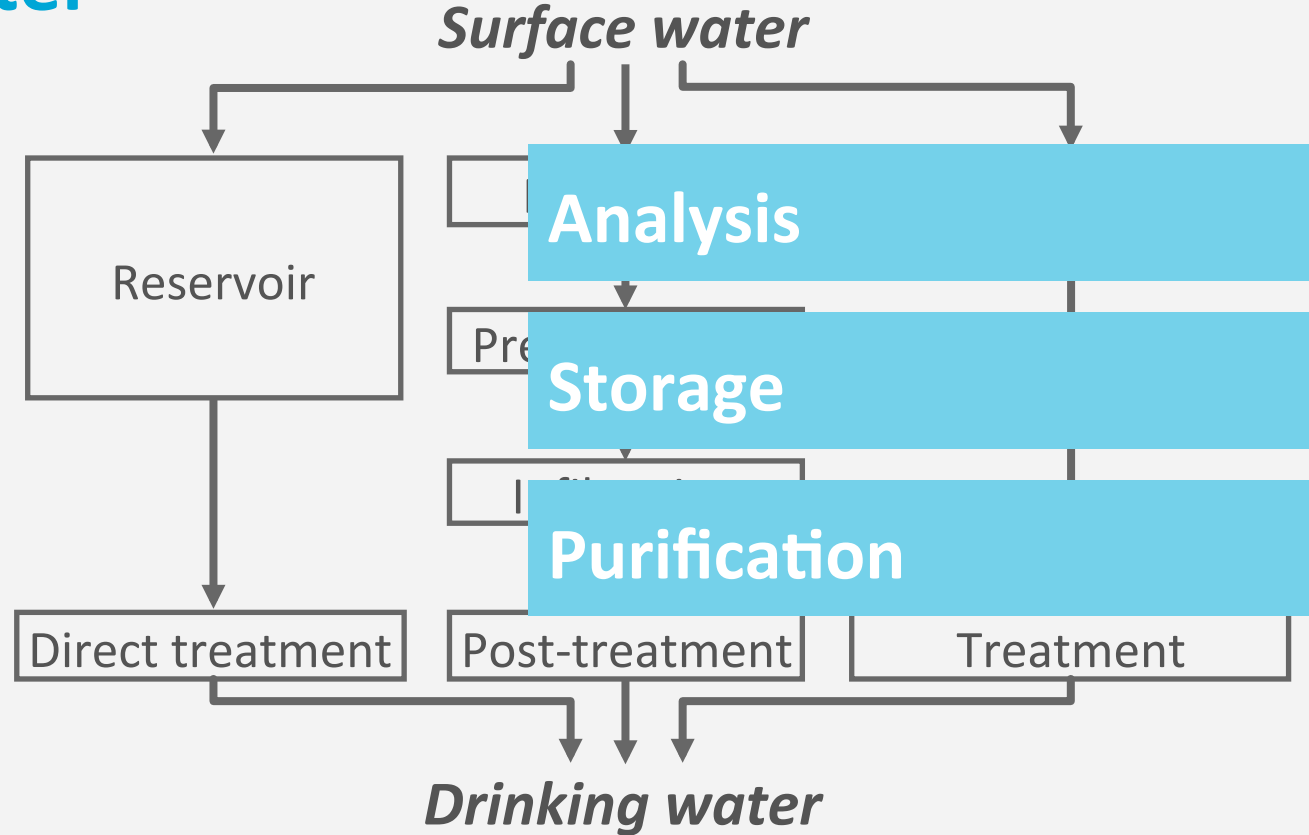




Surface water treatment



Surface water treatment



Autopurification

Salt

Levelled off

Suspende solids

Settle

Gas and heat

Exchanged

Organic material

Broken down

Micro-organisms

Decay

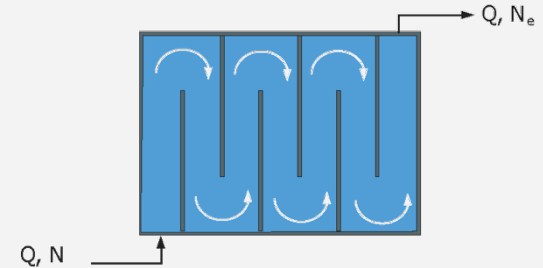
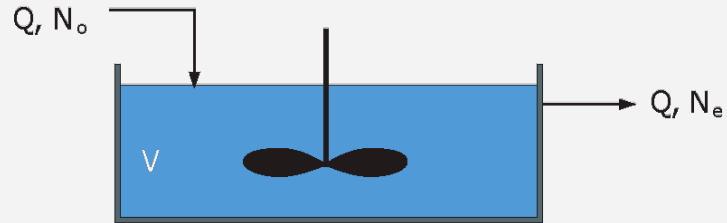
Water Quality

Parameter	Unit	Raw water	Clear water
Temp.	°C	13.5	11.9
pH	-	7.9	9
EC	mS/m	51	51
Turbidity	FTU	10	2
K ⁺	Mg/l	6	6
Ca ²⁺	Mg/l	63	51
Mg ²⁺	Mg/l	8	8
Cl ⁻	Mg/l	61	72
HCO ₃ ⁻	Mg/l	154	87
SO ₄ ²⁻	Mg/l	52	64

Parameter	Unit	Raw water	Clear water
NO ₃ ⁻	Mg/l	4	3
O ₂	Mg/l	9.2	11.1
CH ₄	Mg/l	-	-
CO ₂	Mg/l	3.5	-
Fe ²⁺	Mg/l	-	-
Mn ²⁺	Mg/l	-	-
NH ₄ ⁺	Mg/l	-	-
<i>E. Coli</i>	n/1000ml	4800	100
Bentazon	µg/l	0.2	0.2
Bromate	µg/l	<2.0	<2.0

Decay in reservoirs

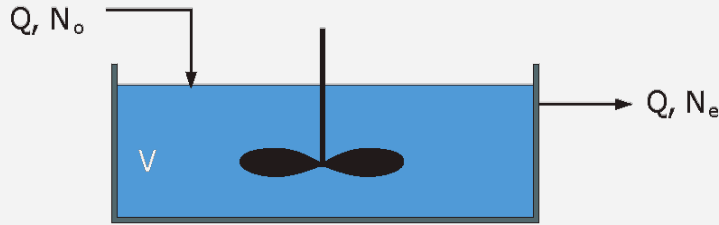
Completely mixed or plug flow



Decay in reservoirs

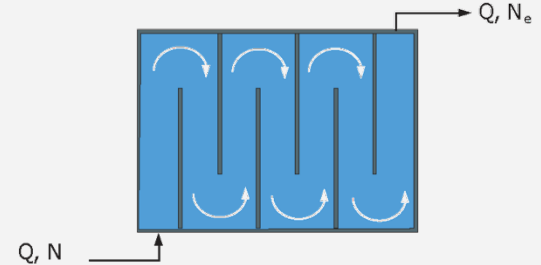
Completely mixed or plug flow

inlet = outlet + decay/mortality



$$Q \cdot N_o \cdot dt = Q \cdot N_e \cdot dt + k_0 \cdot V \cdot N_e \cdot dt$$

$$N_e = \frac{N_o}{1 + k_0 \cdot T}$$



$$Q \cdot N = Q \cdot (N + dN) + k_0 \cdot N \cdot A dx$$

$$N_e = N_o \cdot \exp(-k_0 \cdot T)$$

Decay in multiple consecutive reservoirs

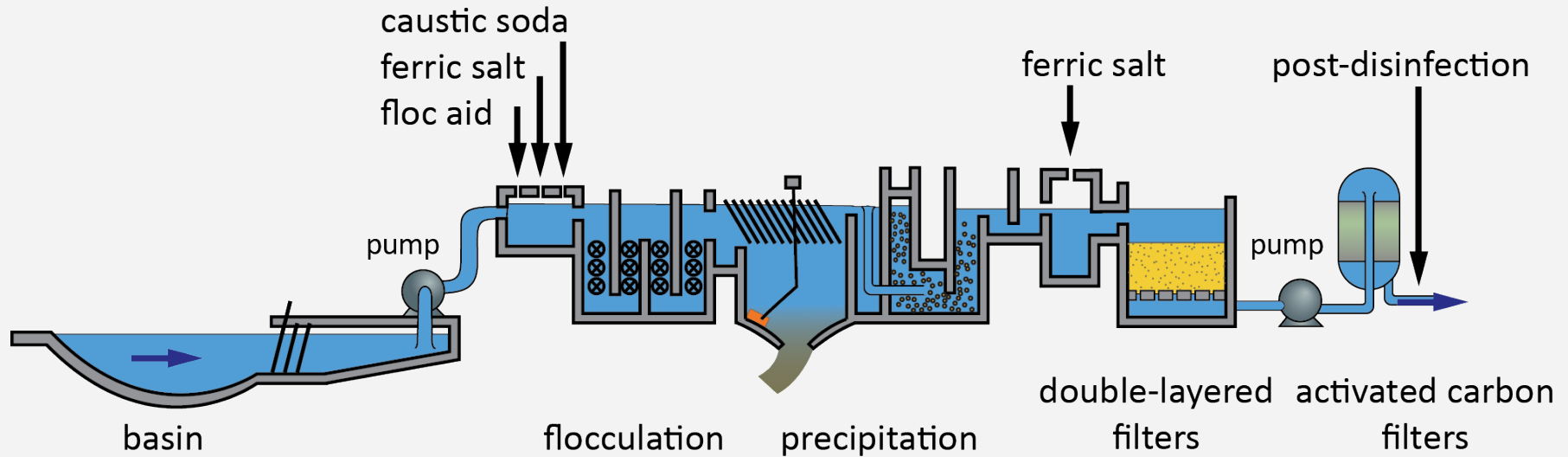
1 reservoir:
$$\frac{N_e}{N_o} = \frac{1}{1 + k_0 \cdot T}$$

T = total retention time [d]

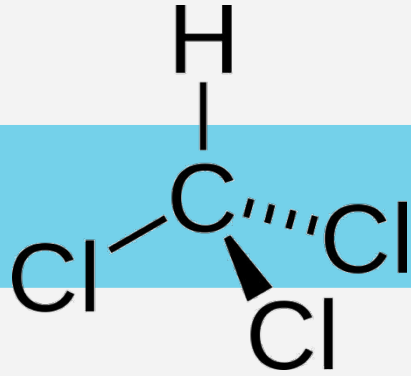
2 reservoirs:
$$\frac{N_e}{N_o} = \left(\frac{1}{1 + \frac{k_0 \cdot T}{2}} \right)^2$$

n reservoirs :
$$\frac{N_e}{N_o} = \left(\frac{1}{1 + \frac{k_0 \cdot T}{n}} \right)^n$$

Treatment train



Chlorination of natural water



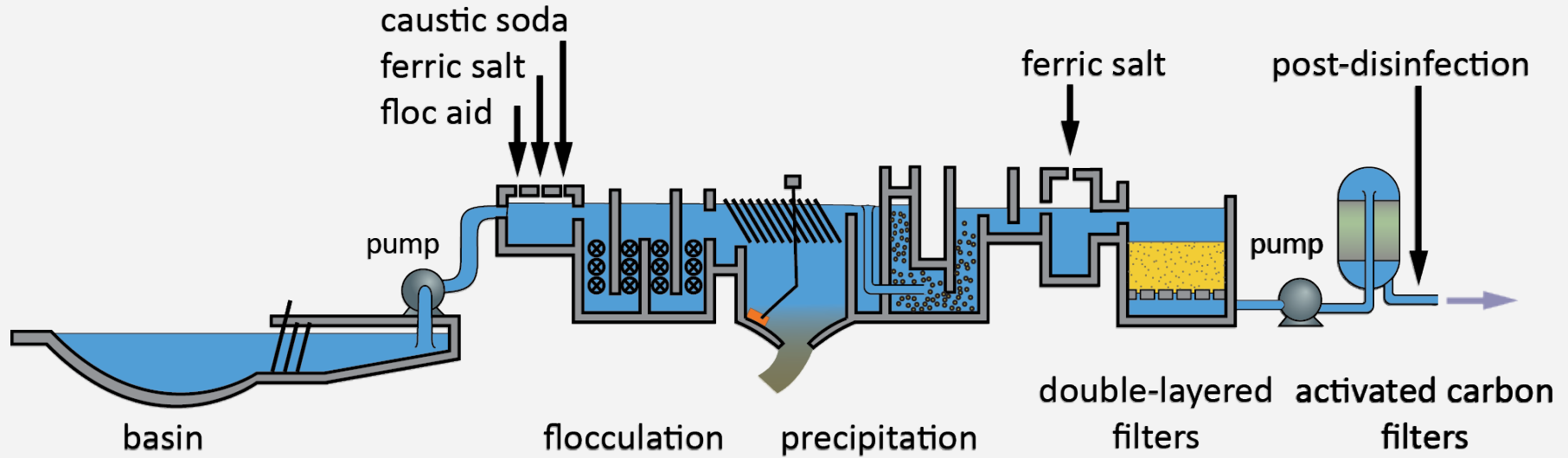
Chloroform: CHCl₃

NO CHLORINE

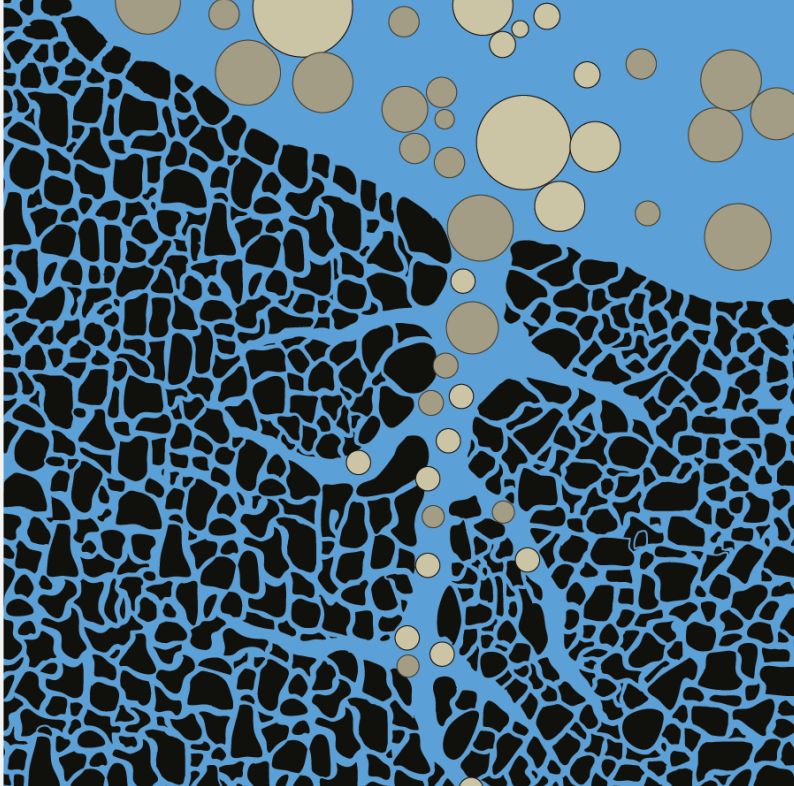


Ozone Generator

Activated Carbon Filtration



Activated Carbon Filtration



Activated Carbon Filtration

Parameter	Unit	Raw water	Clear water
Temp.	°C	11.9	12.1
pH	-	9	8.2
EC	mS/m	51	55
SI	-	0.9	0.1
Turbidity	FTU	2	0.05
Na ⁺	Mg/l	46	52
K ⁺	Mg/l	6	6
Ca ²⁺	Mg/l	51	51
Mg ²⁺	Mg/l	8	8
Cl ⁻	Mg/l	72	73
HCO ₃ ⁻	Mg/l	87	94
SO ₄ ²⁻	Mg/l	64	65

Parameter	Unit	Raw water	Clear water
NO ₃ ⁻	Mg/l	3	3
O ₂	Mg/l	11.1	10.2
CH ₄	Mg/l	-	-
CO ₂	Mg/l	-	0.9
Fe ²⁺	Mg/l	-	-
Mn ²⁺	Mg/l	-	-
NH ₄ ⁺	Mg/l	-	-
DOC	mg/l	3.6	1.9
E. Coli	1000 ml	100	0
Bentazon	µg/l	0.2	<0.1
Bromate	µg/l	<2.0	<3.9

Contamination of surface water



AOP: UV + H₂O₂



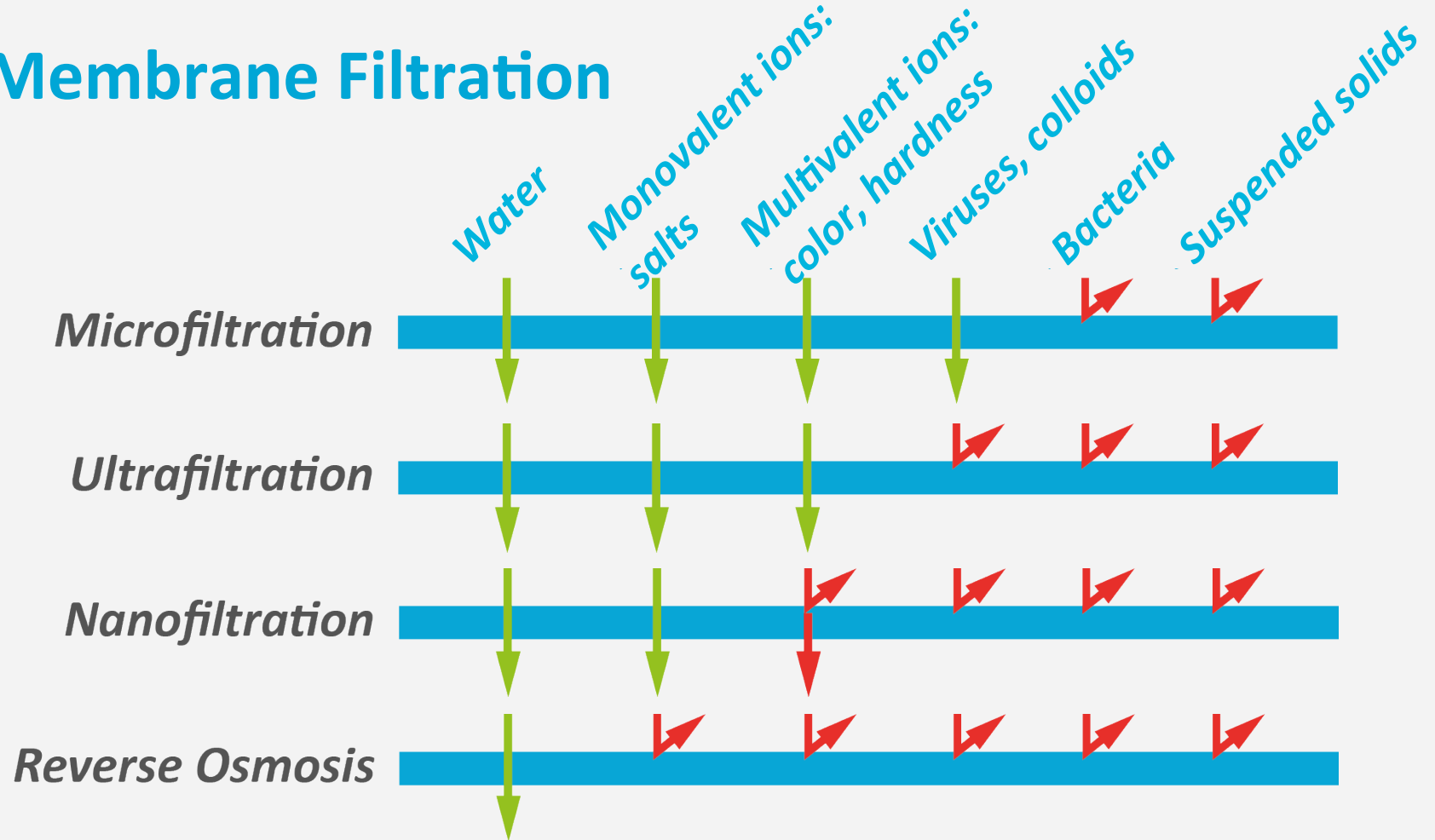
TROJAN UVSWIFT™ ECT





courtesy PWN Technologies / 11/21

Membrane Filtration



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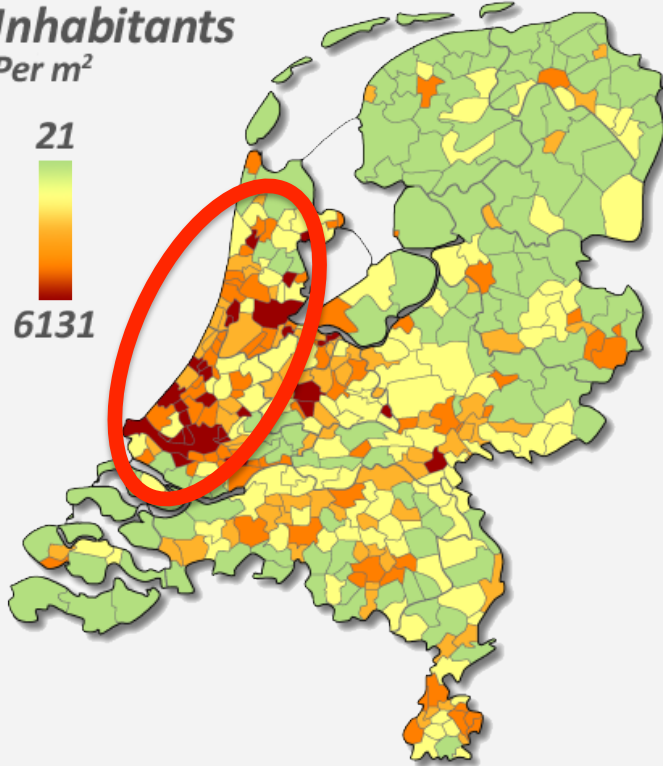
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Surface water as source: Dutch coastal areas

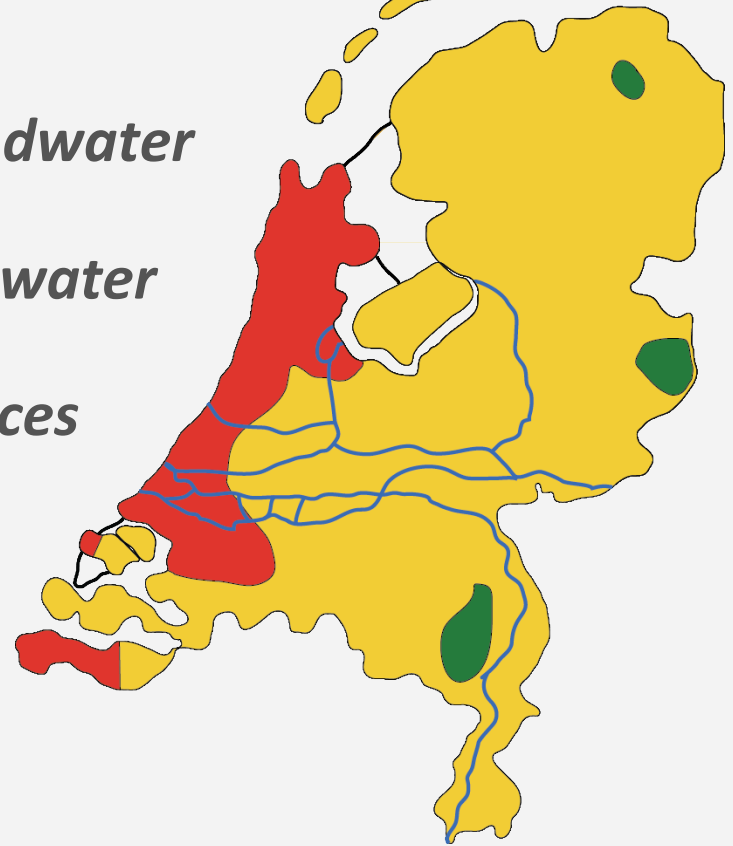
*Inhabitants
Per m²*



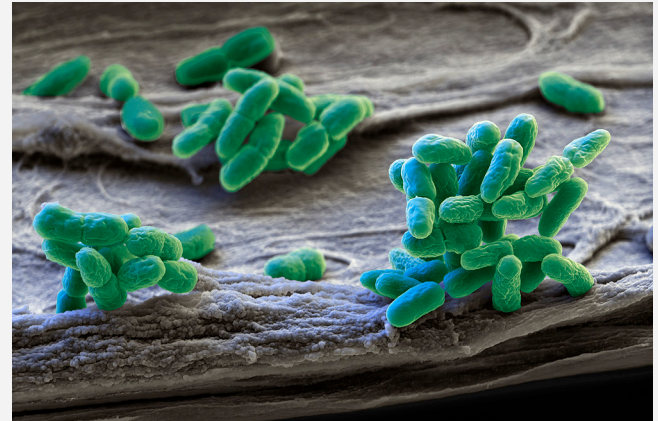
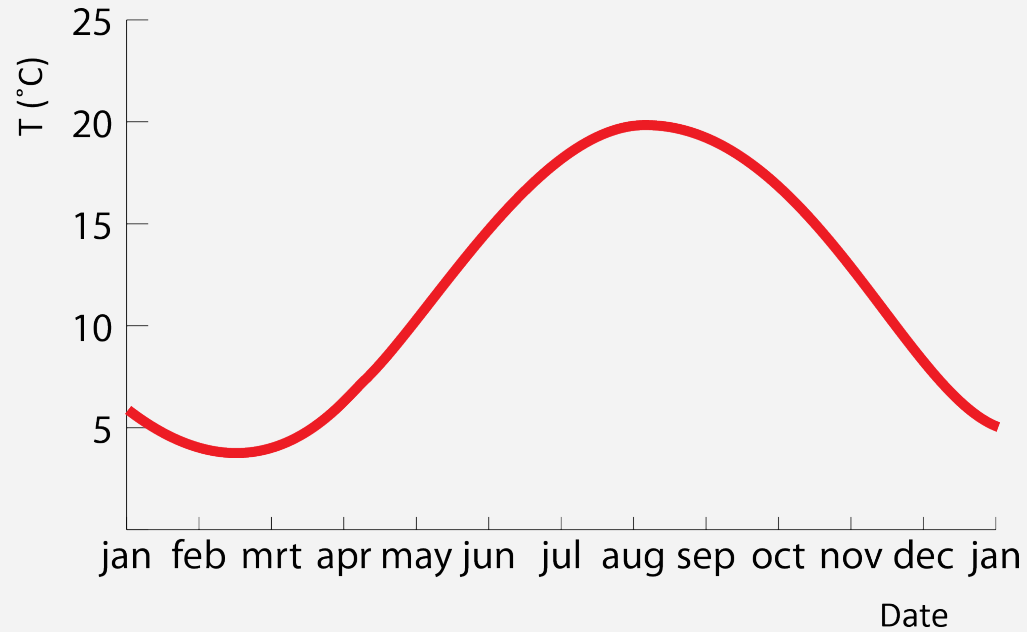
Groundwater

Surface water

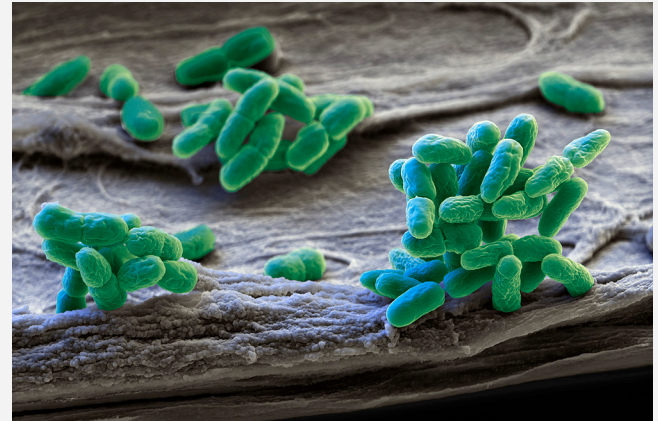
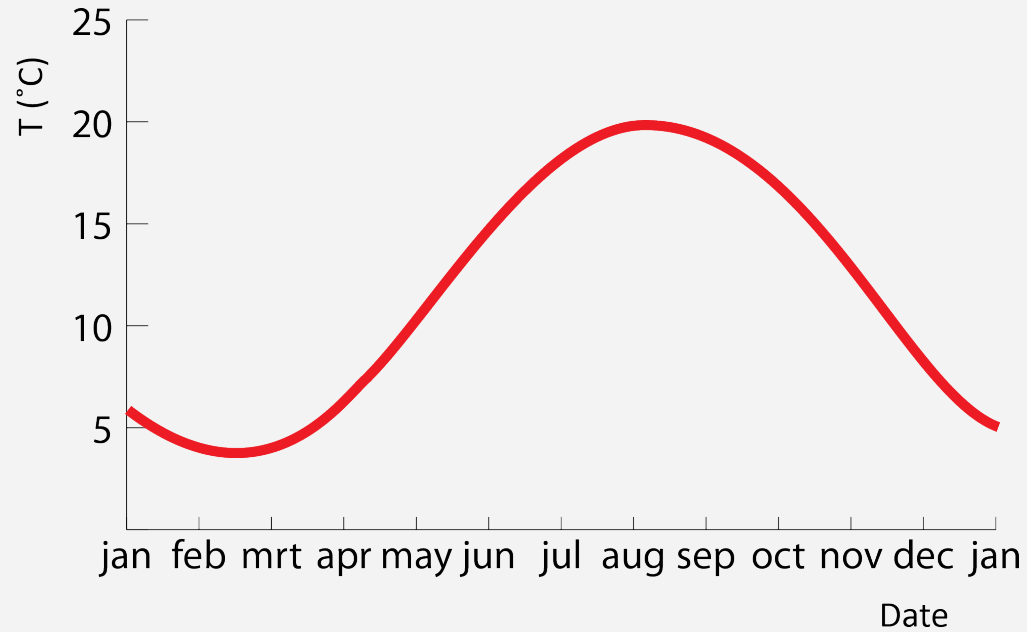
Mixed sources



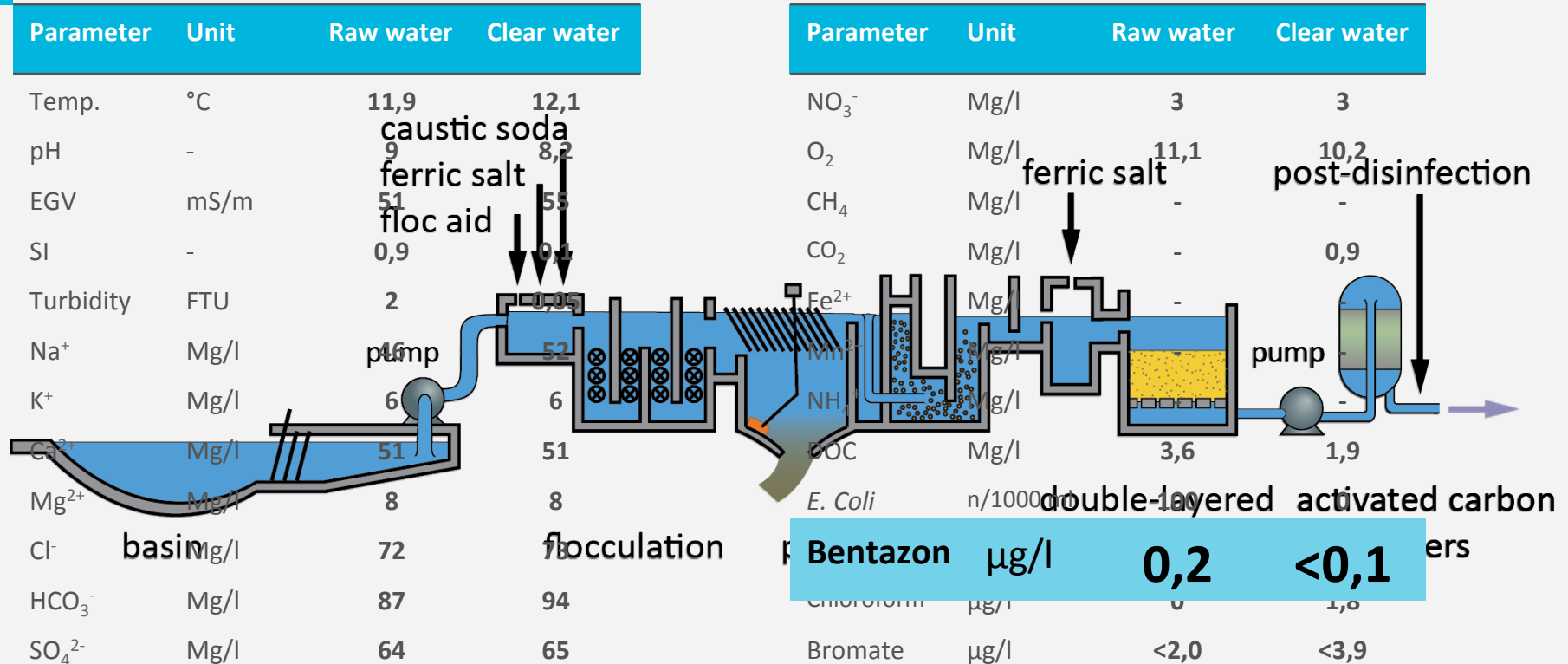
Contamination



Contamination



Activated Carbon Filtration



Bentazon

