



مهندسی آب و فاضلاب

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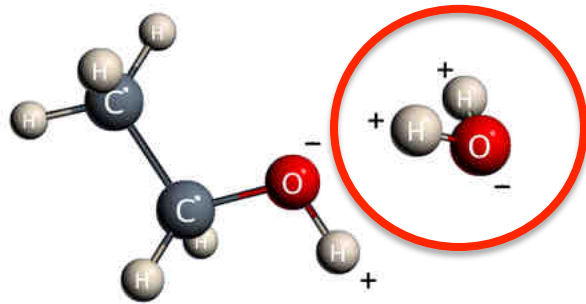
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What should be removed?

CTB3365x Introduction to water treatment

Prof.dr.ir. Jules B. van Lier

Organic matter in sewage



Suspended matter in sewage

Food left overs



Feacal matter



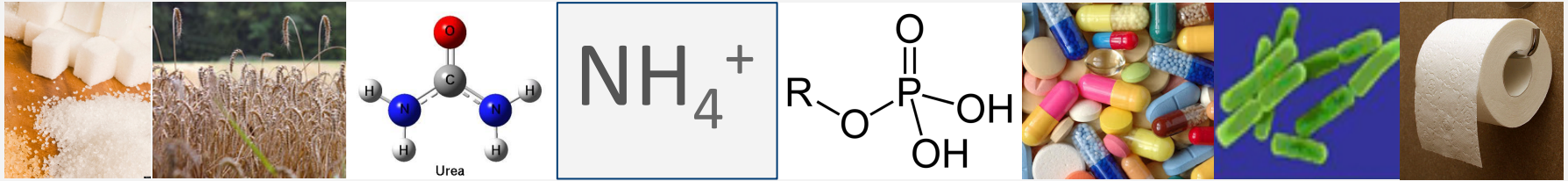
Sand particles



Water is used for transport



Wastewater composition - Contaminants



Impact of untreated sewage discharge

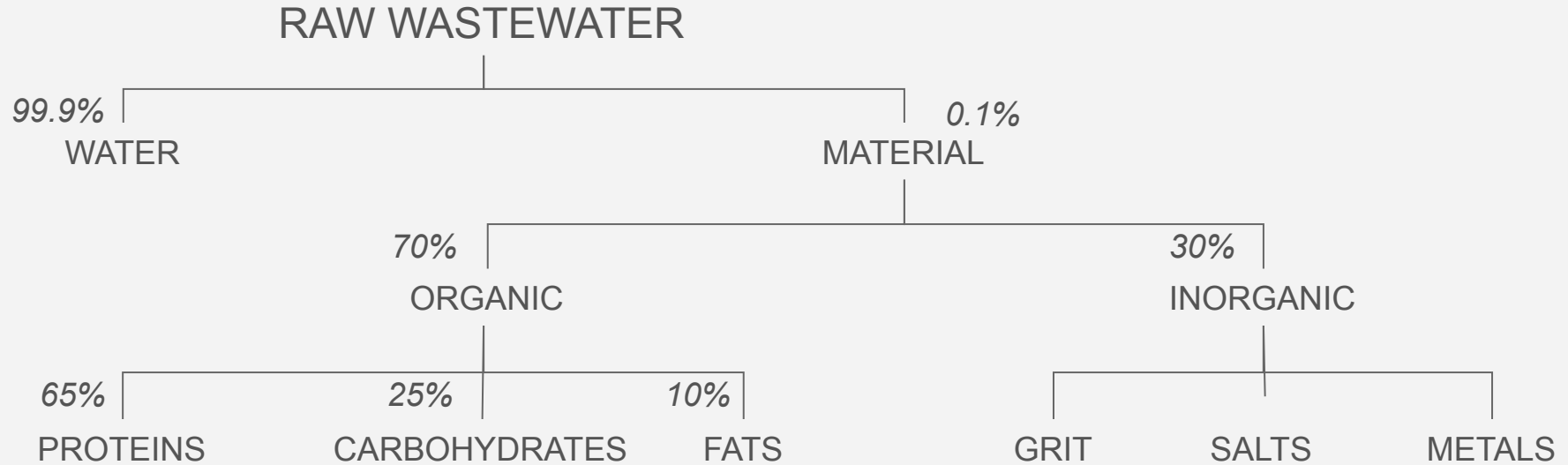


- Carbon emission \rightarrow O_2 Depletion \rightarrow dead fish

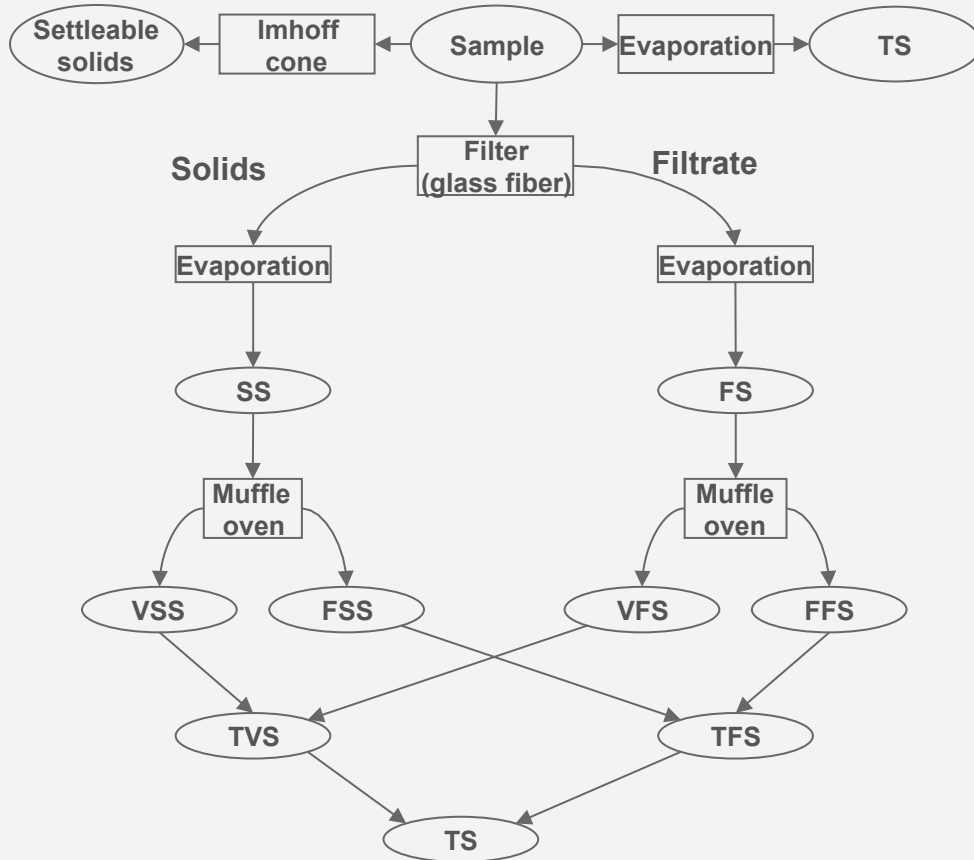


- N & P emission \rightarrow Eutrophication \rightarrow algae

Wastewater composition



Wastewater composition - Solids



Wastewater solids:

TS = total solids

SS = suspended solids

VSS = volatile suspended solids

FSS = fixed suspended solids

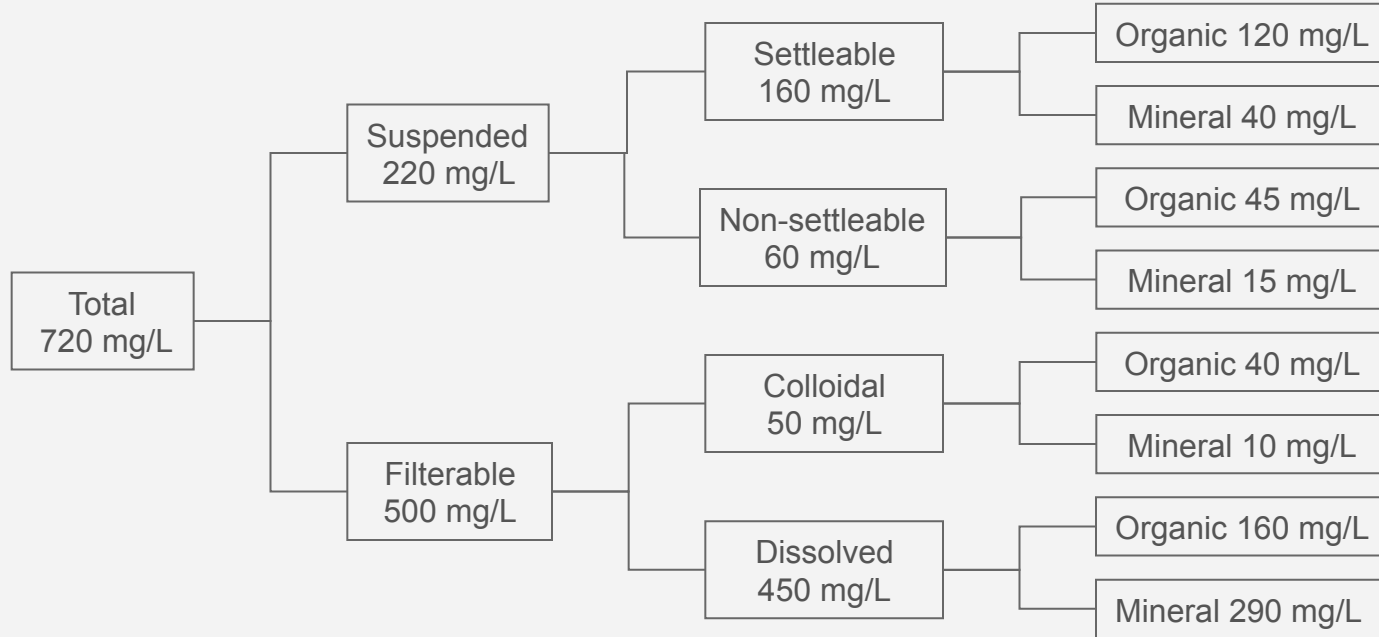
TVS = total volatile solids

FS = filterable solids

VFS = volatile filterable solids

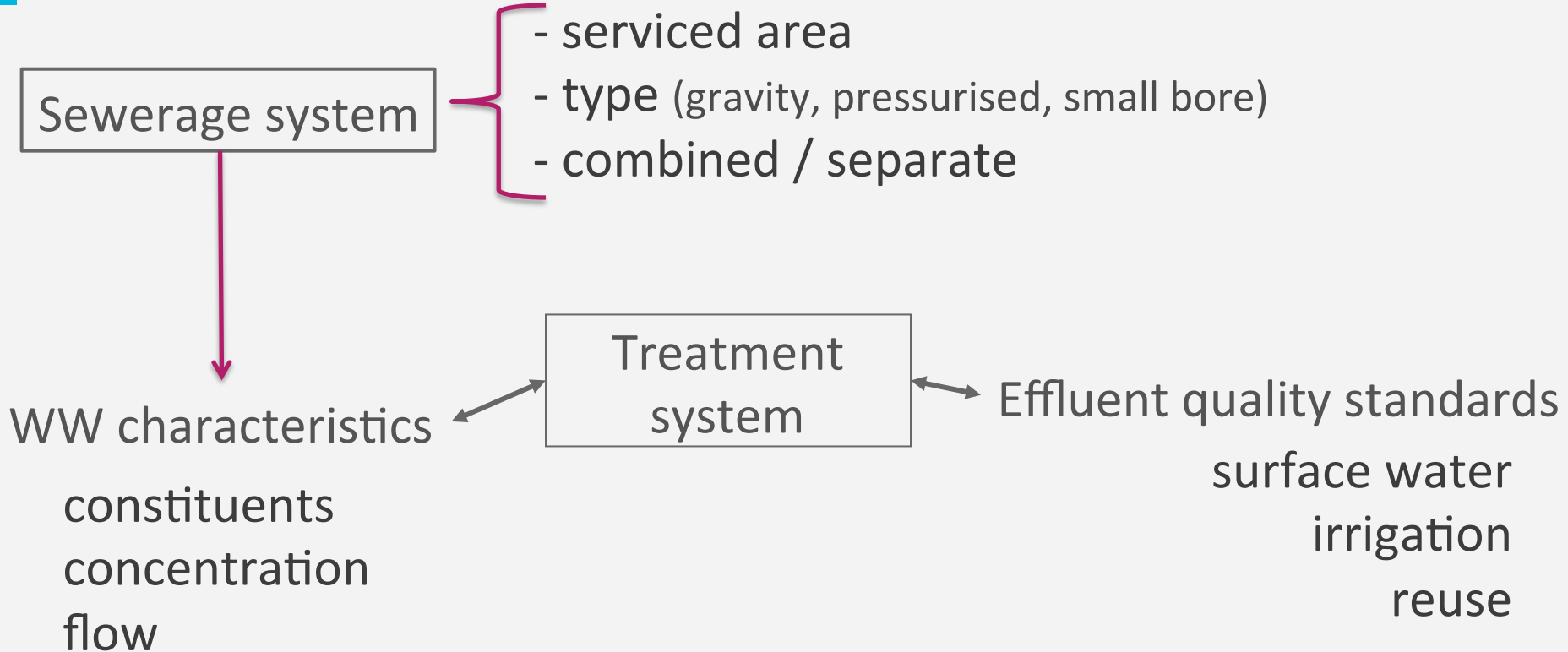
FFS = fixed filterable solids

Wastewater composition - Solids





*(Wastewater Engineering, Treatment, Disposal, and Reuse
Metcalf & Eddy, 1991)*

Characteristics of domestic sewage



Wastewater characteristics

Average values for NL

<i>BOD</i>	180 mg/l		
<i>COD</i>	470 mg/l		
<i>Suspended solids</i>	150 – 200 mg/l		
<i>Total N</i>	40 mg N/l		
<i>Kjeldahl-nitrogen</i>	40 mg N/l		Organic N + NH ₄ ⁺
<i>Total P</i>	6 – 7 mg/l		Organic P + PO ₄ ³⁻
<i>Pathogens (E-Coli)</i>	10 ⁷ – 10 ⁸ /100 ml		

Hygienic aspects

Man-own bacteria (gut)

- Pathogenic organisms
 - *Bacteria*
 - *Viruses*
 - *Protozoa: Giardia/Cryptosporidium*

▪ *E. Coli*

- *Influent:* $3 \cdot 10^7$ /100 ml
- *Effluent:* $6 \cdot 10^5$ /100 ml
- *Swimming water:* 1/ml



2 log units removal

No hygienic restriction of sewage effluents, except for swimming

Example of sewage variations

Constituent	Sao Paulo Brazil	Cali, Colombia	Small city Netherlands	Accra, Ghana
Suspended Solids				
Total	429	215	-	980
Fixed	177	106	-	211
Volatile	252	107	-	769
BOD	368	95	231	879
COD	727	267	520	1546
Nitrogen (as N)	44	24	45	93
Phosphorus (total P)	11	1.3	18	15.6
<i>Escherichia coli</i>	$4 \cdot 10^7$	$2.2 \cdot 10^7$	-	-
Sulphates	18	-	15	55
Chlorides	110	-	-	-
Alkalinity	388	120	350	491
Calcium	110	-	4	-
Magnesium	105	-	2	-
Temperature (°C)				
Maximum	26	27	20	36
Minimum	24	24	8	29

Effluent restrictions (NL)

Basic criteria 'water protection law' (1970's):

- BOD 20 mg/l
- Suspended matter 30 mg/l
- N-Kjeldahl 20 mg/l

Since 1990's: more stringent criteria:

- P-total 1 – 2 mg/l
 - N-total 10 – 15 mg/l
- } *And thus lower BOD values*

Effluent restrictions (NL)

European Frame Work Directive (EFD):

- P-total 0.15 mg/l
- N-total 2.2 mg/l



Achievable?

Current discussion in NL:

- P-total < 0.3 mg/l
- N-total < 5 mg/l

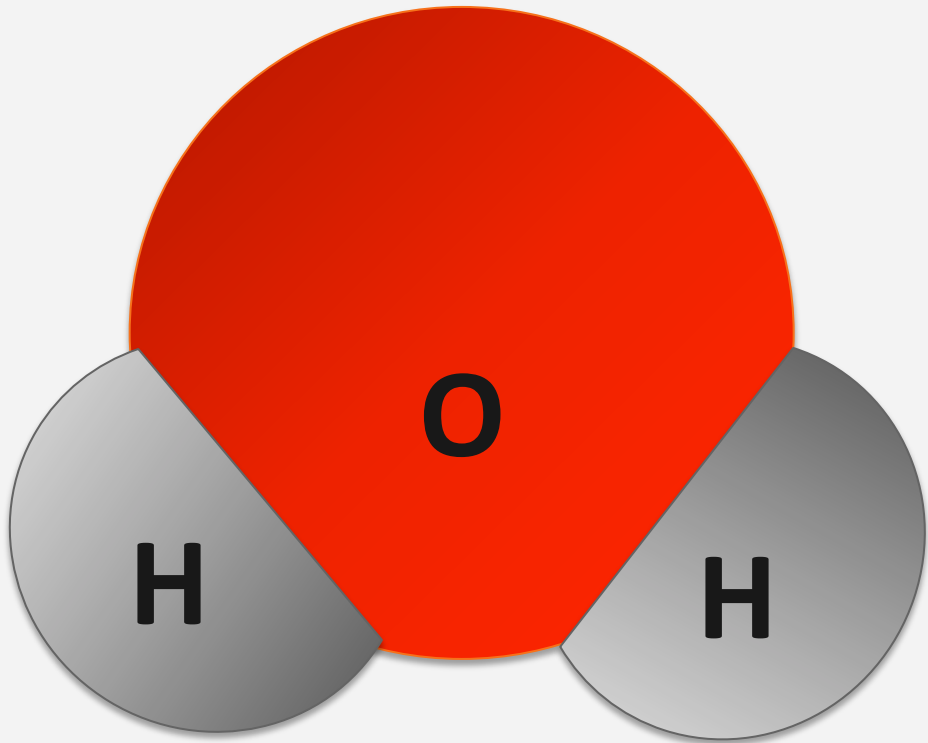
Health and environmental concerns

- Discharge of effluents:
 - *Micro pollutants: endocrine disruptors, medicine rests*
 - *Chlorine*
 - *Volatile components*
- Combined sewer overflows (CSO's):
 - Untreated sewage discharge during heavy rain
- Analytical techniques to monitor these discharges
- Effect on our water supply

What should be removed?

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H₂O

Polar compound

Wastewater composition - Contaminants

Organic matter (measured as BOD or COD)

Nutrients

Sand

Suspended Solids

Salts

Stones

Heavy metals

Pathogens

Others?