Aalto University
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Water and wastewater treatment

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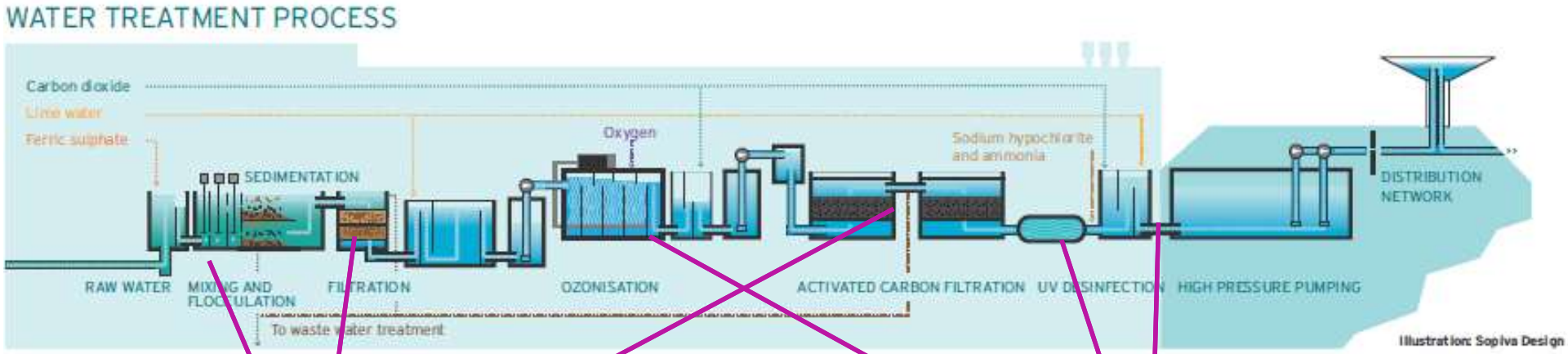
Why do we need good quality water?

- **Human health impacts**
  - Long-term health effects
  - Waterborne diseases from microbiological contamination
- **Food production needs**
  - Animal farming
  - Food processing industry
  - Irrigation
- **Industrial needs**
  - Varying requirements for quality

What and why do we typically treat?

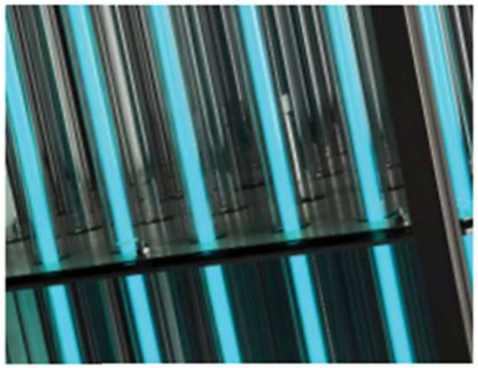
Raw water sources	
- Groundwater or Artificial groundwater/bank filtration	Iron and manganese pH, corrosivity Pesticides Other persistant organic micropollutants (Microbiological quality)
- Surface water (lake or river)	Natural organic matter Taste and odor Turbidity and color Microbiological quality
- Sea water	Desalination

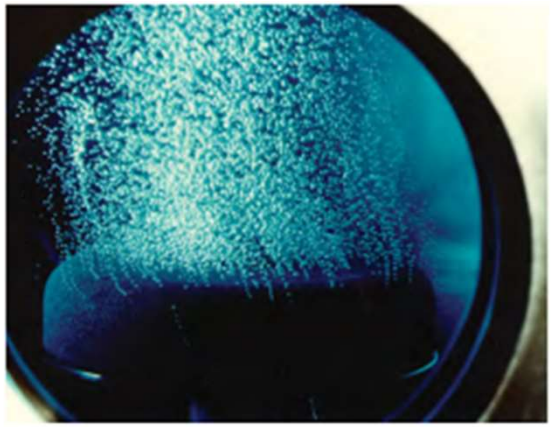
Multi-barrier approach in drinking water production



Organic matter removal treatment steps **Disinfection treatment steps**

Examples of water treatment processes





Discussion in groups (10 min.)

You have all been drinking a lot water. Water is treated very differently in Espoo, in your summer cottage and e.g. in Berlin. What do you know about the purification processes of the water that you drink in different places?

Sometimes water receives a lot of treatment and sometimes very little?

What do you prefer? And why?

Why do we treat wastewater?

- **Improve public health and safety**
  - Decrease of pathogenic microbes
- **To avoid the negative effects in the receiving water body**
  - Oxygen depletion
  - Eutrophication
    - *Nitrogen and phosphorus*
    - *Limiting nutrient*
  - Toxic substances e.g. heavy metals, micropollutants
  - Microplastics
- **To recover valuable resources**
  - Energy
  - Nutrients
  - Water
- **Requirements from the legislation**
  - Waste framework directive ”polluter pays”
  - Water framework directive
  - Priority substances

Current requirements for wastewater treatment (PE > 10 000)

EU minimum requirements

Nitrogen >70%
Phosphorus >80%, <1,0 mg/l
Suspended solids <35 mg/l
BOD >70%, <30 mg/l
COD >75%, <125 mg/l

Environmental permit typically in Finland

Nitrogen >70%
Phosphorus >95%, <0,3 mg/l
Suspended solids <15 mg/l
BOD >95%, <10 mg/l
COD >80%, <75 mg/l

BOD = Biological oxygen demand
COD = Chemical oxygen demand

Development of the wastewater treatment

1900 1920 1940 1960 1980 2000 2020

Solid removal, hygienic quality

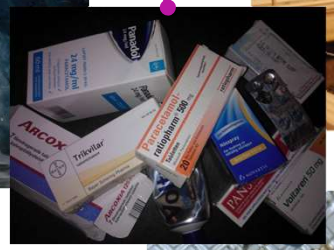
Nutrient removal

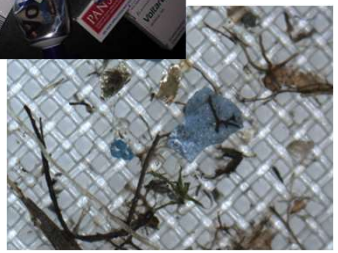
Micropollutants
Microplastics

GHG emission control

Resource recovery

Water reuse





Quality of wastewater

- **Households and services**
- **Industries**
- **Rural areas (loading to the WWTP from septic tanks)**
- **Rain and storm water**

- **Everything you put to the sewer system ends up in the wastewater treatment**
  - Feaces, urine
  - Paper, fiber, plastic
  - Food waste (grease, carbohydrates, proteins, sugars)
  - Drogs, solvents, cleaning agents, beauty products
  - Heavy metals, toxic compounds,...

The basic principle of wastewater treatment

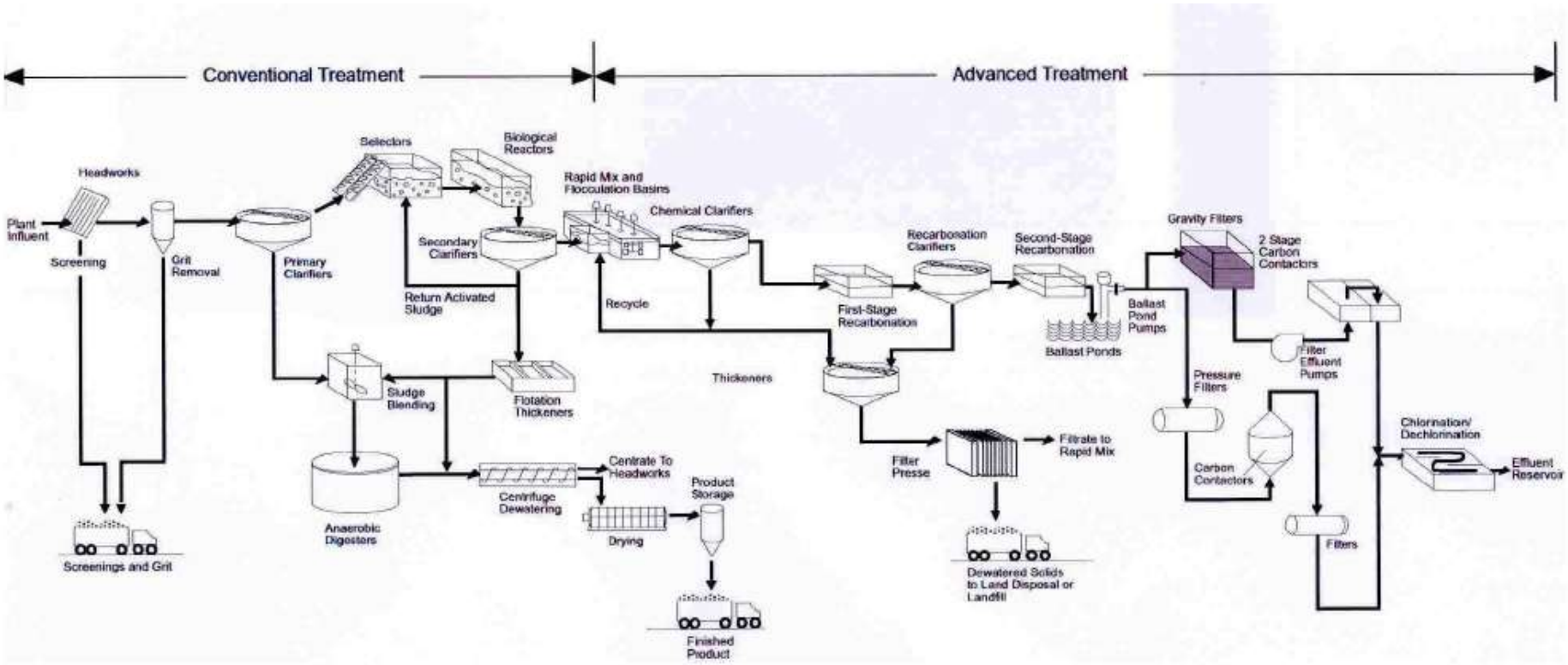
- Suspended solids →
- Colloidal matter →
- Soluble matter

- Mechanical treatment
- Chemical treatment
- Biological treatment

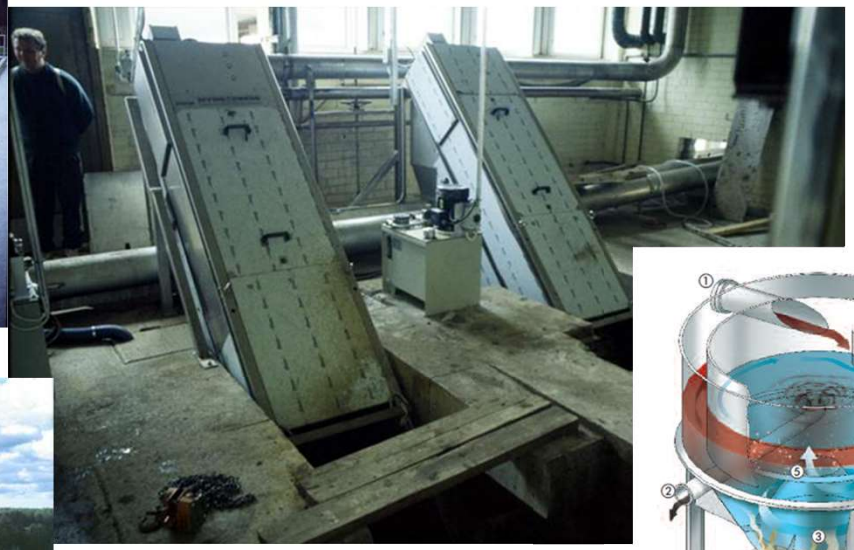
- Nutrients mainly soluble
- Phosphorus removal biologically or chemically by precipitation
- Nitrogen biologically
- Emerging micropollutants: different biological and chemical treatment processes

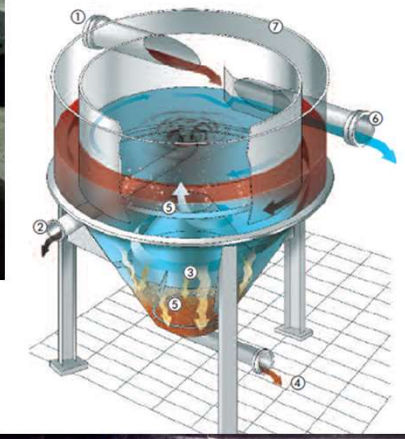
Example: Kalteva Hyvinkää

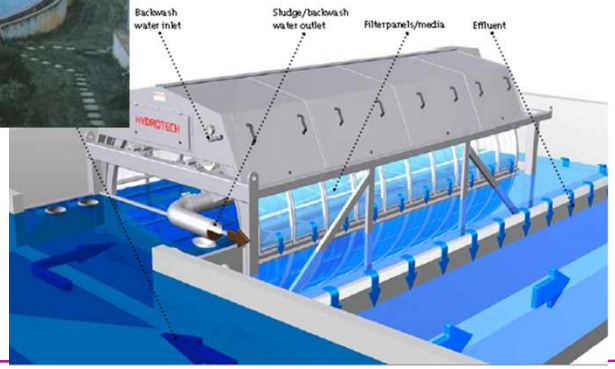
Example: UOSA WWTP



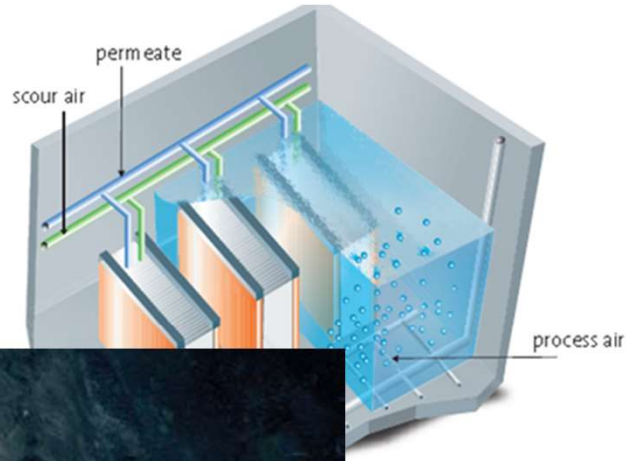
Examples of primary treatment processes

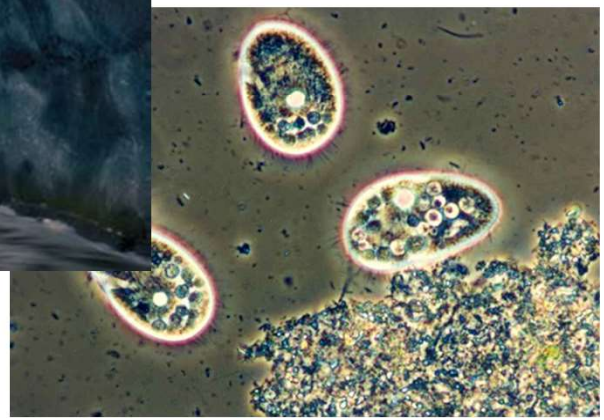




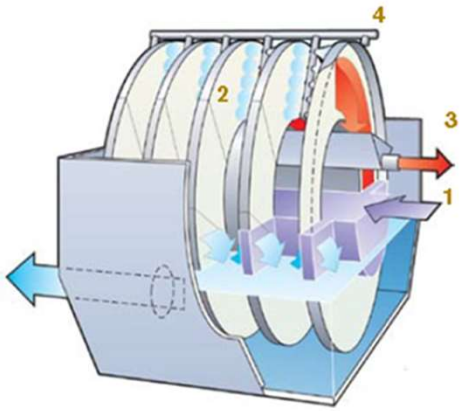


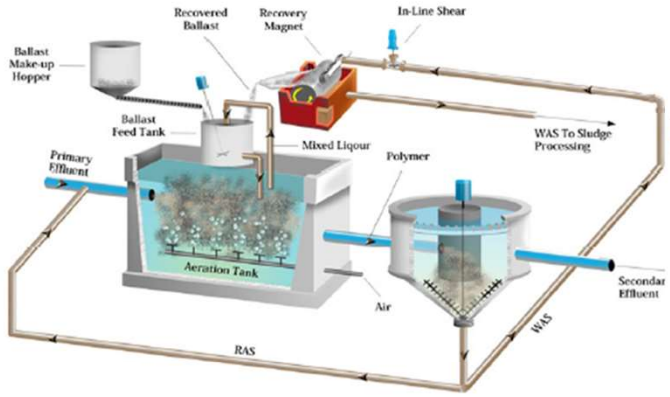
Examples of secondary treatment (biological treatment)

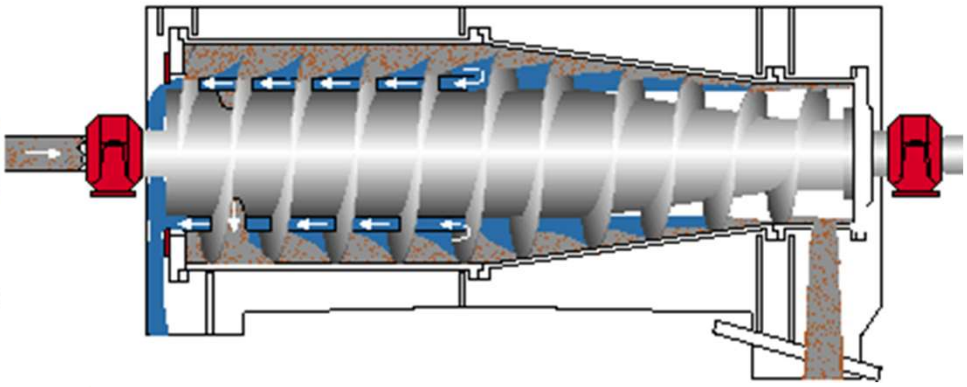




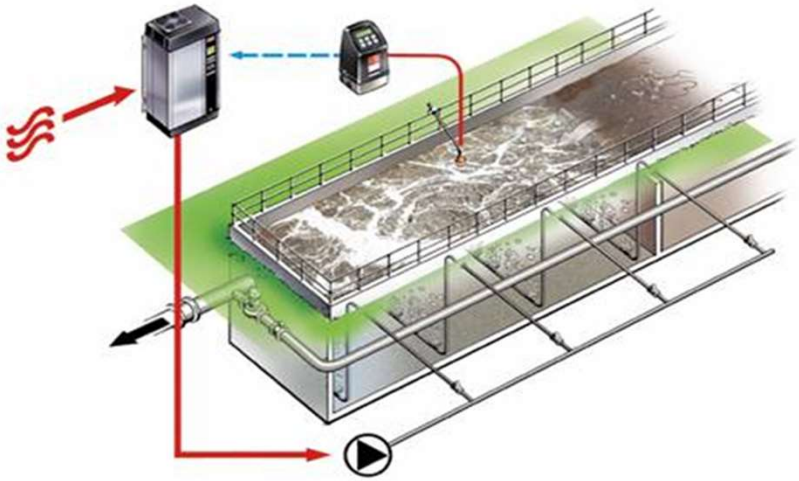
Examples of solid separation processes



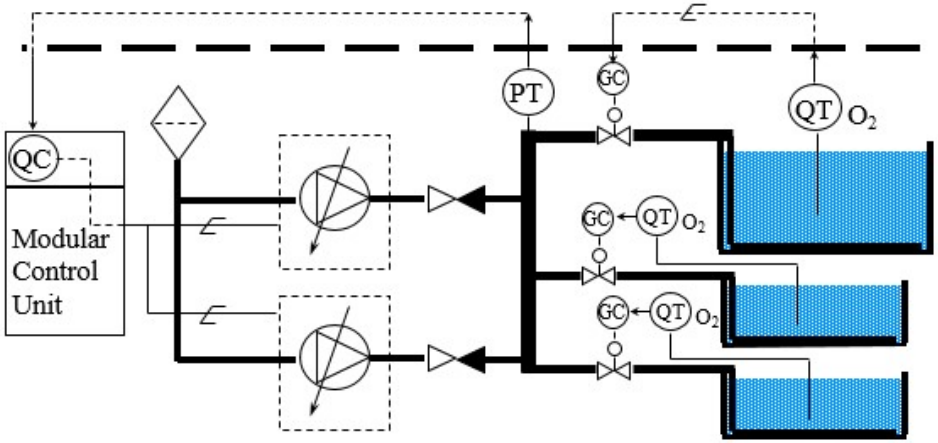




Process monitoring and control



Plant control automation



Water and wastewater treatment is a multi-disciplinary engineering task that saves human lives and protects the environment