Mykolaiv Water Hub

Water Leaders Course

National University of Water and Environmental Engineering

Newcastle University

University of Maryland

FUNDED BY

European Bank
for Reconstruction and Development

Module 2 – Wastewater

Wastewater Treatment Systems

Wastewater treatment is a vital part of wastewater infrastructure systems

It protects public health and the environment by removing contaminants from used water before it is reused or returned to the environment

This presentation provides an overview of key concepts and processes involved in wastewater treatment

Overview:

- Characteristics of wastewater
- Stages of wastewater treatment
- Water quality testing
- Waste management

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Wastewater Treatment Systems

Characteristics of Wastewater

Domestic Wastewater



Normal household sewage often mixed with surface run off

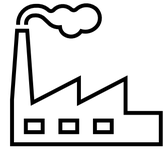
Typically appears **brown to grey** in colour with suspended material giving it a murky appearance

Domestic wastewater has a characteristic **sewage smell**

Aged wastewater has a grey to black appearance and a stronger smell due to increased decomposition

Common pollutants include organic matter, suspended solids, nutrients and microorganisms

Industrial Wastewater



Wastewater produced by factories, heavy industry and manufacturing processes

Depending on the industry type it may contain a wider range of potentially hazardous contaminants at much higher concentration than domestic wastewater

Often requires specialised treatment and may require **pretreatment** before entering a wider wastewater treatment system to protect public health, the environment and treatment infrastructure

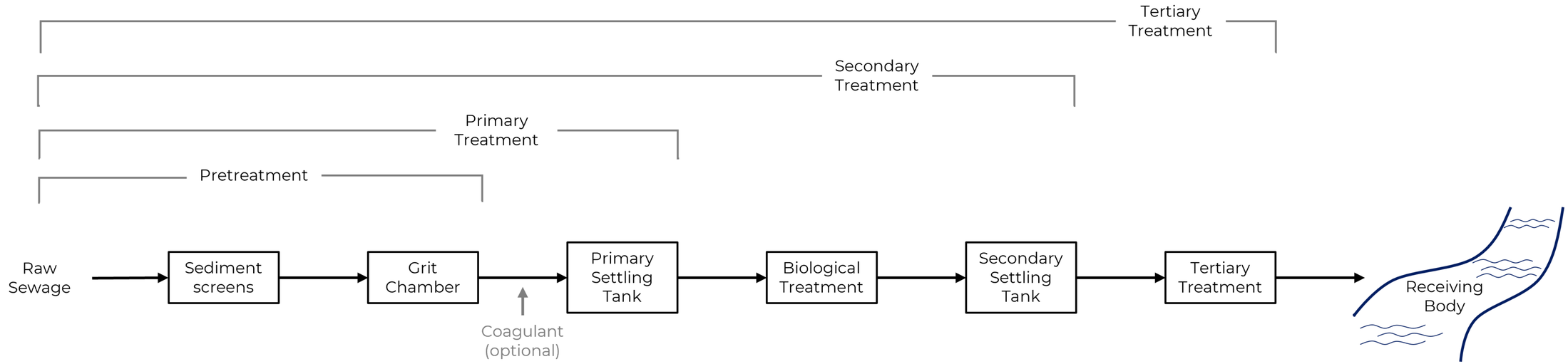
Wastewater Treatment Systems

Stages of Wastewater Treatment

Wastewater Treatment systems are designed according to the requirements of the influent water

Most commonly, wastewater treatment plants have pretreatment, primary and secondary treatment stages

Tertiary treatment is normally included when influent water is highly contaminated, maybe including industrial wastewater, or if required by local regulations



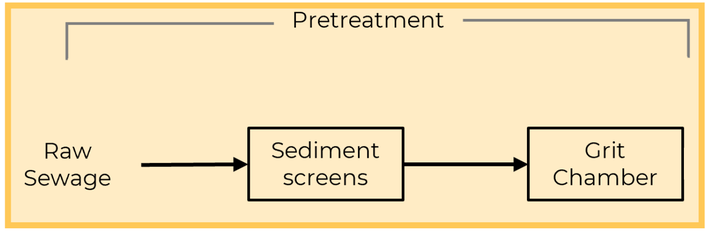
Wastewater Treatment Systems

Pretreatment

Purpose: Removal of large debris and grit, to prepare water for treatment and to protect treatment equipment

Typical Units:

- Sediment Screens
- Grit Chambers
- Grease and Oil removal
- Flow equaliser (occasionally required, when in influent conditions are not constant)



SEDIMENT SCREEN



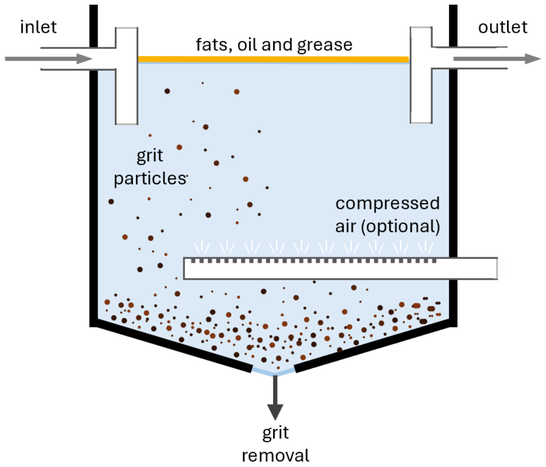
LadderEnd.jpg, Wikimedia Commons, by David Grundler, Wes Hardaker and Evan Edwards, [CC BY-SA-3.0]

GREASE AND OIL REMOVAL

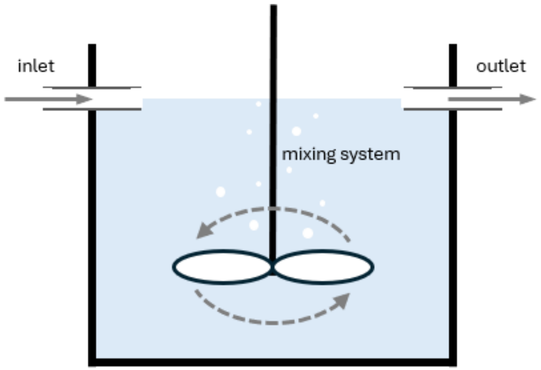


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GRIT CHAMBER



FLOW EQUALISER



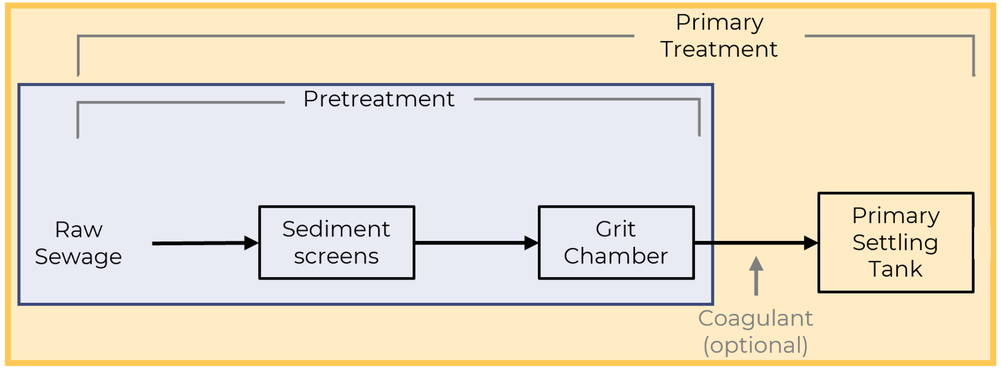
Wastewater Treatment Systems

Primary Treatment

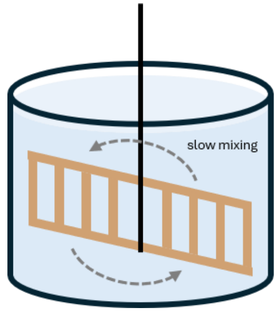
Purpose: Removal of suspended solids and floating material, through physical processes

Typical Units:

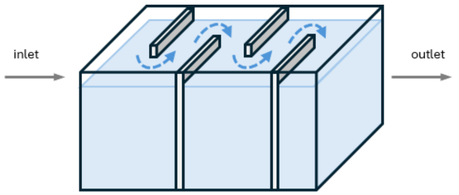
- Flocculation Tank
- Primary Settling Tank
- Diffused Air Floatation (DAF)
- Coagulant Addition (as required)



FLOCCULATION TANK



FLOCCULATION TANK

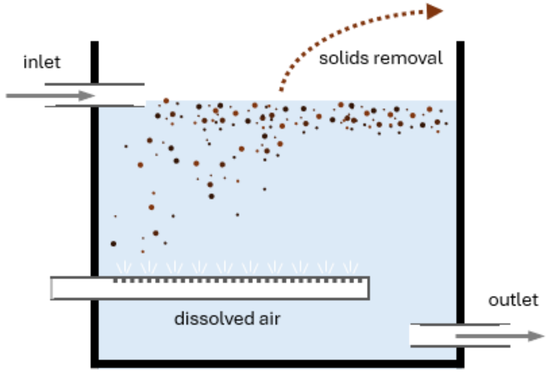


PRIMARY SETTLING TANK

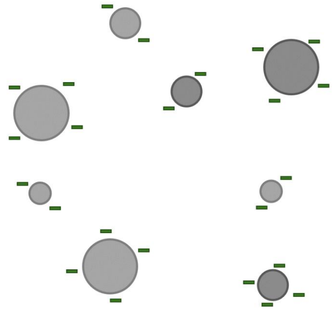


Vorklarung-primarysettlingtank.jpg, Wikimedia Commons, bySuSanA, [CC BY-2.0]

DIFFUSED AIR FLOTATION (DAF)



COAGULATION



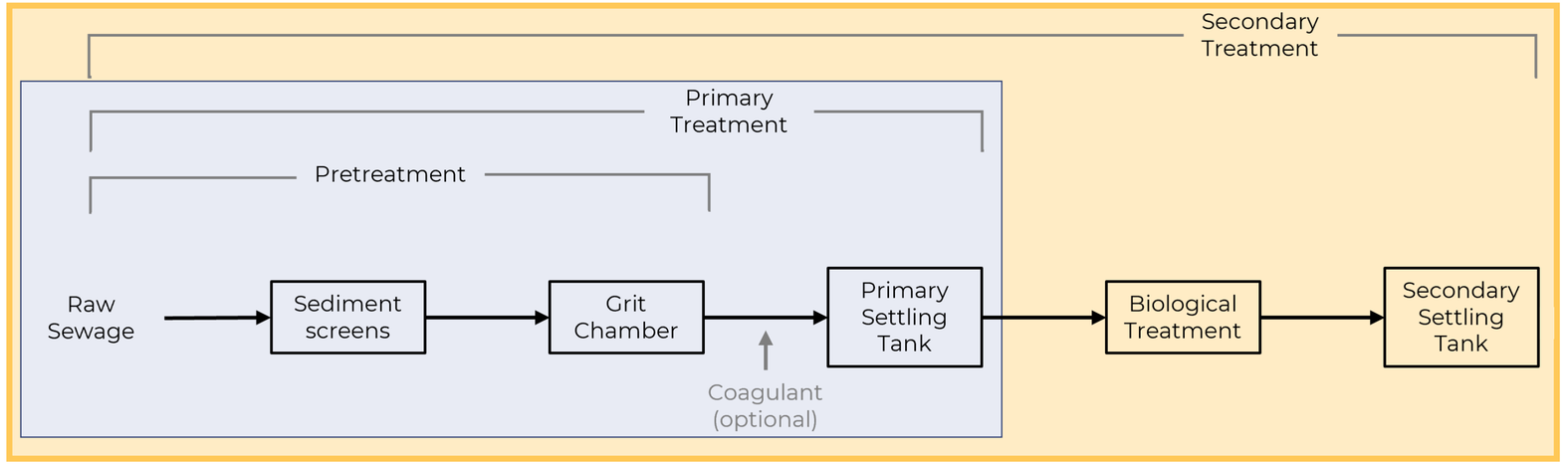
Wastewater Treatment Systems

Secondary Treatment

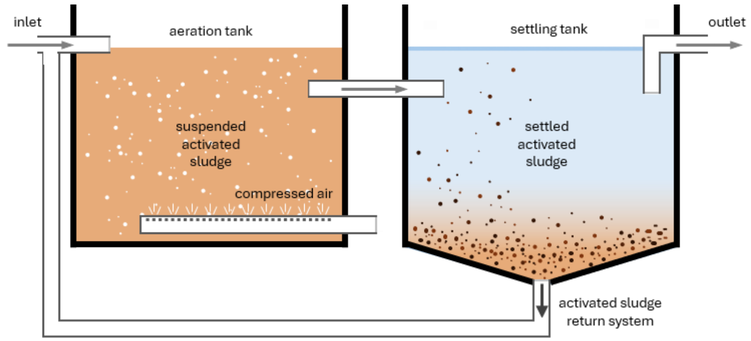
Purpose: Removal of dissolved and biodegradable organic matter, through biological treatment (microorganisms break down pollutants)

Typical Units:

- Suspended-growth systems
  - Activated Sludge
  - Sequencing Batch Reactors (SBR)
  - Oxidation Ditches
- Attached-growth systems
  - Trickling filters
  - Rotating Biological Contactors
  - Moving bed Reactors



SUSPENDED-GROWTH SYSTEM



ATTACHED-GROWTH SYSTEM



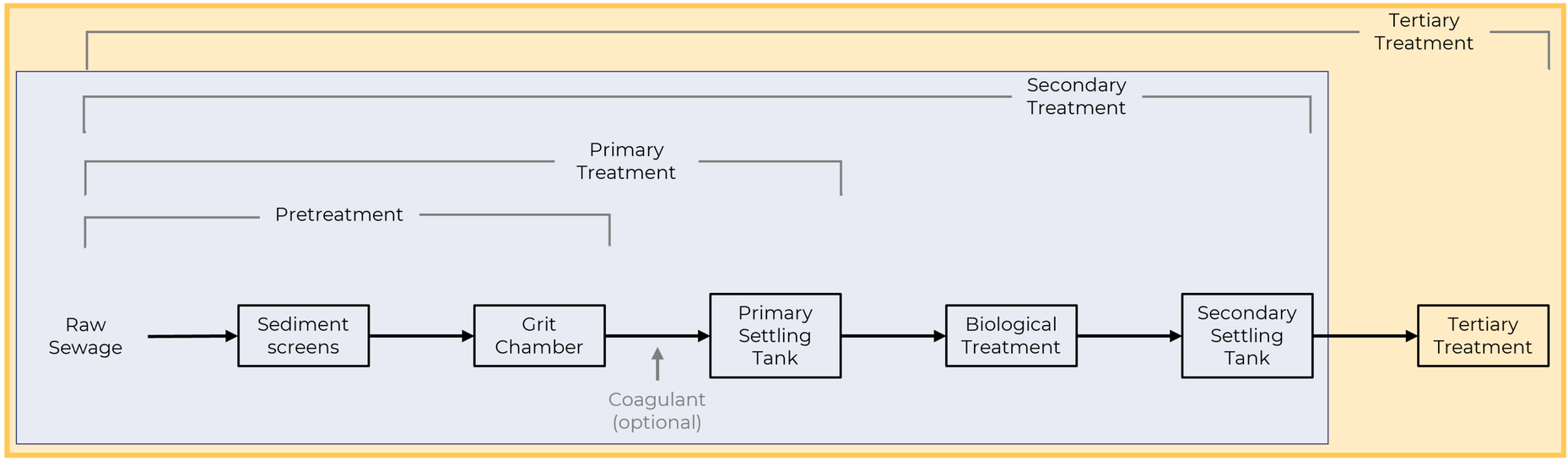
Wastewater Treatment Systems

Tertiary Treatment

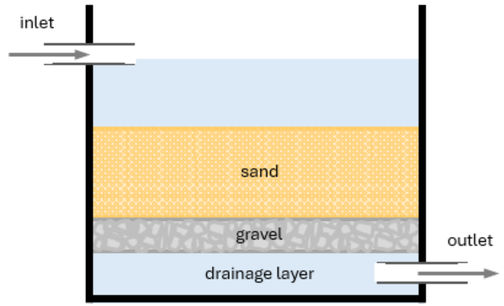
Purpose: Advanced treatment to polish effluent; targeted removal of residual and specific contaminants

Typical Units:

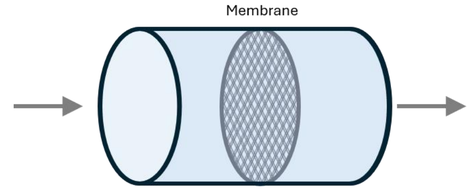
- Solids removal
  - Sand filters
  - Membrane filters
- Nutrient removal
- Adsorption
  - Activated carbon
- Membrane processes
  - Ultrafiltration
  - Reverse osmosis



SAND FILTER



MEMBRANE FILTER



Wastewater Treatment Systems

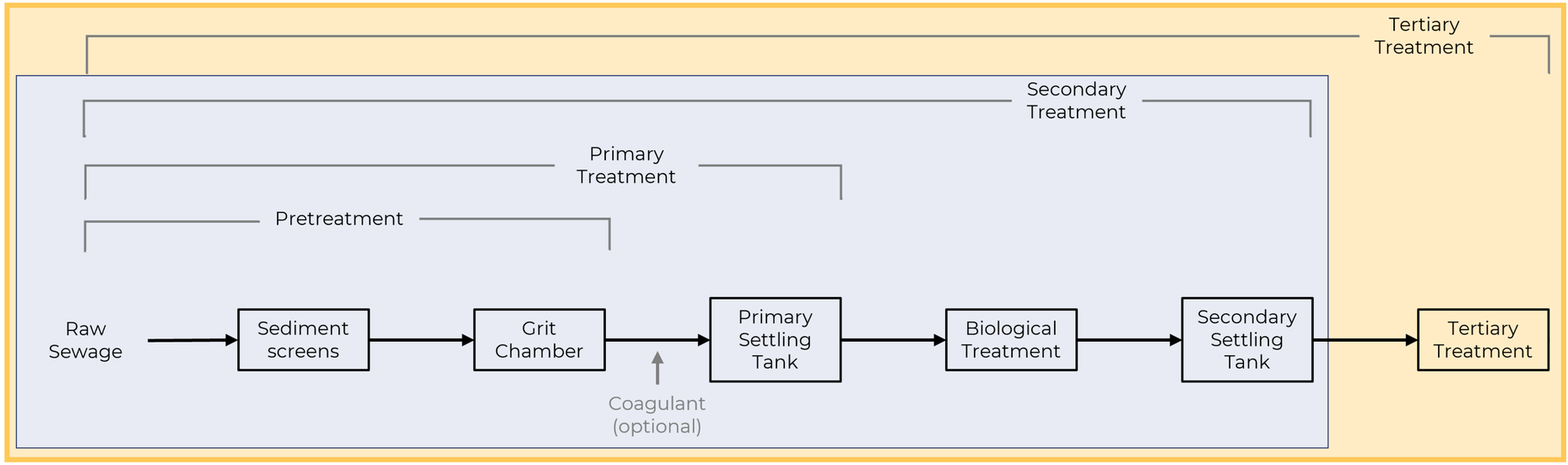
Tertiary Treatment - Disinfection

Depending on local regulation disinfection may be a required stage in wastewater treatment

Purpose: Removal of Pathogens

Typical Units:

- Chlorination
- UV radiation



CHLORINE



UV RADIATION



VBlacklightUVLEDFlashlight.jpg, Wikimedia Commons, by DanceWithNyanko, [CC-BY-SA-4.0]

Wastewater Treatment systems

Treated Water Discharge

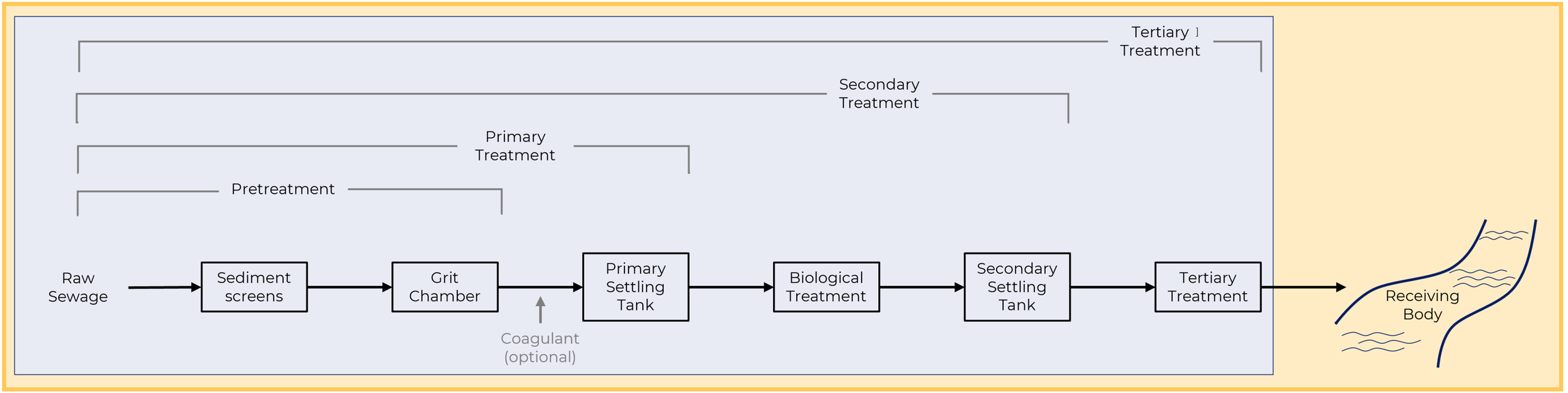
Once treated, wastewater leaves the treatment plant, most commonly being discharged to a receiving water body such as a river, lake or coastal water

Treated wastewater can be sometimes reused for non-potable (not-drinking) purposes, where appropriate and in accordance with local regulation

TREATED WATER DISCHARGE



Wateruitstroombij-8°Celsius.Locatie,NatuurterreinDeFamberhorst01.jpg, Wikimedia Commons, by Dominicus Johannes Bergsma, [CC-BY-SA-4.0]



Wastewater Treatment Systems

Water Quality Standards

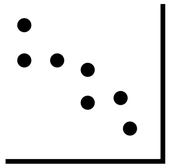


All wastewater treatment plants monitor water quality of incoming wastewater and treated water

Why is water quality monitored?

To assess treatment performance

- Determine how polluted incoming wastewater is
- Check whether each treatment stage is effectively removing contaminants



To ensure regulatory compliance

- Check that treated water meets required water quality standards before discharge
- Comply with environmental regulations and avoid potential penalties (or similar repercussions)



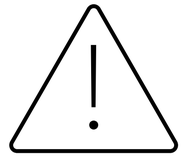
How is water quality measured?

- **Online monitoring**: continuous measurements using sensors and instruments
- **Offline monitoring**: samples are collected and analysed in a laboratory



Wastewater Treatment Systems

Waste Management



SLUDGE

As contaminants are being removed during wastewater treatment, waste by-products are formed which must be managed separately



SludgedischargefromAquacyclethickener(5206005923).jpg, Wikimedia Commons, by Peter Craven, [CC-BY-2.0]

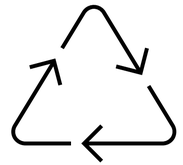
Key waste streams:

- **Pretreatment:** Large debris such as grit, plastics, wipes and rags
- **Primary treatment:** Settled solids, commonly referred to as **sludge**

Why is waste management important?

- Waste materials must be handled and disposed of in accordance with local environmental regulations
- Poor waste management can pose risks for public health, worker safety and the environment
- Sludge requires particular attention due to the large volumes produced and its potential biological hazard





Some sludge can be treated, recycled and reused, for example, in agriculture, land restoration, energy production, depending on local regulations and requirements

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