# Wastewater Treatment

By Samuel Lam

# What is wastewater treatment

- Usually refer to sewage treatment, or domestic wastewater treatment
- process of removing contaminants from wastewater, both runoff and domestic

# Goals

- To produce waste stream (effluent)
- To produce solid waste (sludge)
- To discharge or reuse them back into the environment

# Where does wastewater come from?

- Residences (kitchen, bathroom)
- Commercial institution
- Industrial institution (usually require specialized treatment process)

# How can it be treated?

- collected and transported via a network of pipes and pump stations to a municipal treatment plant

# 3 stages of water treatment

- Primary
  - solids are separated
- Secondary
  - dissolved biological matter is converted into a solid mass by using water-borne bacteria
  - 95% of the suspended molecules should be removed
- Tertiary
  - biological solids are neutralized then disposed, and treated water may be disinfected chemically or physically

# Types of treatment

- **Mechanical treatment**
  - Influx (Influent)
  - Removal of large objects
  - Removal of sand and grit
  - Primary Sedimentation
- **Biological treatment**
  - Trickling bed filter
  - Activated sludge
- **Chemical treatment**
  - Disinfection

# Preliminary treatment

- Remove large objects
- Ex: sticks, rags, toilet paper, tampons
- Raked screen
- Clog equipment in sewage treatment plant

# Treatment stages - Primary treatment

- typical materials that are removed during primary treatment include
  - fats, oils, and greases (aka FOG)
  - sand, gravels and rocks (aka grit)
  - larger settleable solids including human waste, and
  - floating materials

# Methods used in primary treatment

- Sand catcher
  - Remove sand and grit
  - Control wastewater velocity
    - Sand grit and stone settle
    - Keep suspended organic matter in water
  - Damage equipments in the remaining treatment stage
  - Landfill

- Primary Sedimentation Tank
  - Remove grease, oil
  - Fecal solid settle, floating material rise to the surface
  - Produce a homologous liquid for later biological treatment
  - Fecal sludge are pumped to sludge treatment plant

# Treatment stages - Secondary treatment

- Degrade biological content (dissolved organic matter) of the sewage
  - Ex: human waste, food waste, soaps, detergent
- Added bacteria and protozoa into sewage
- 3 different approaches
  - Fixed film system
  - Suspended film system
  - Lagoon system

# Three approaches

- Fixed Film Systems
  - grow microorganisms on substrates such as rocks, sand or plastic
  - wastewater is spread over the substrate
  - Ex: Trickling filters, rotating biological contactors

# Trickling filters bed

- Spread wastewater over microorganism
- made of coke (carbonised coal), limestone chips or specially fabricated plastic media
- Optimize their thickness by insect or worm grazing

- Suspended Film Systems
  - stir and suspend microorganisms in wastewater
  - settled out as a sludge
  - pumped back into the incoming wastewater
  - Ex: Activated sludge, extended aeration

# Activated sludge

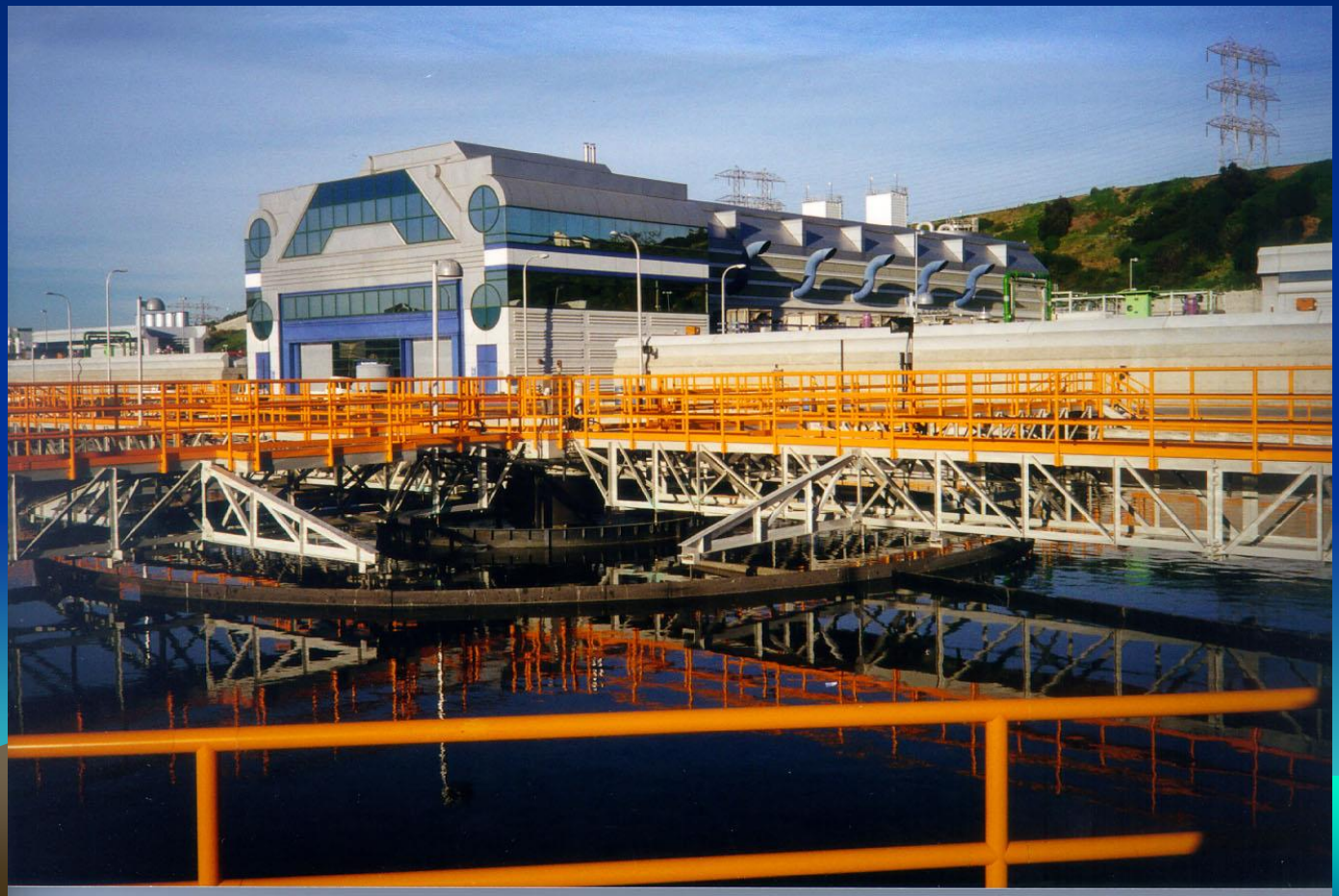
- mixed community of microorganisms
- Both aerobic and anaerobic bacteria may exist
- Biological floc is formed

# 5 physical components of activated sludge process

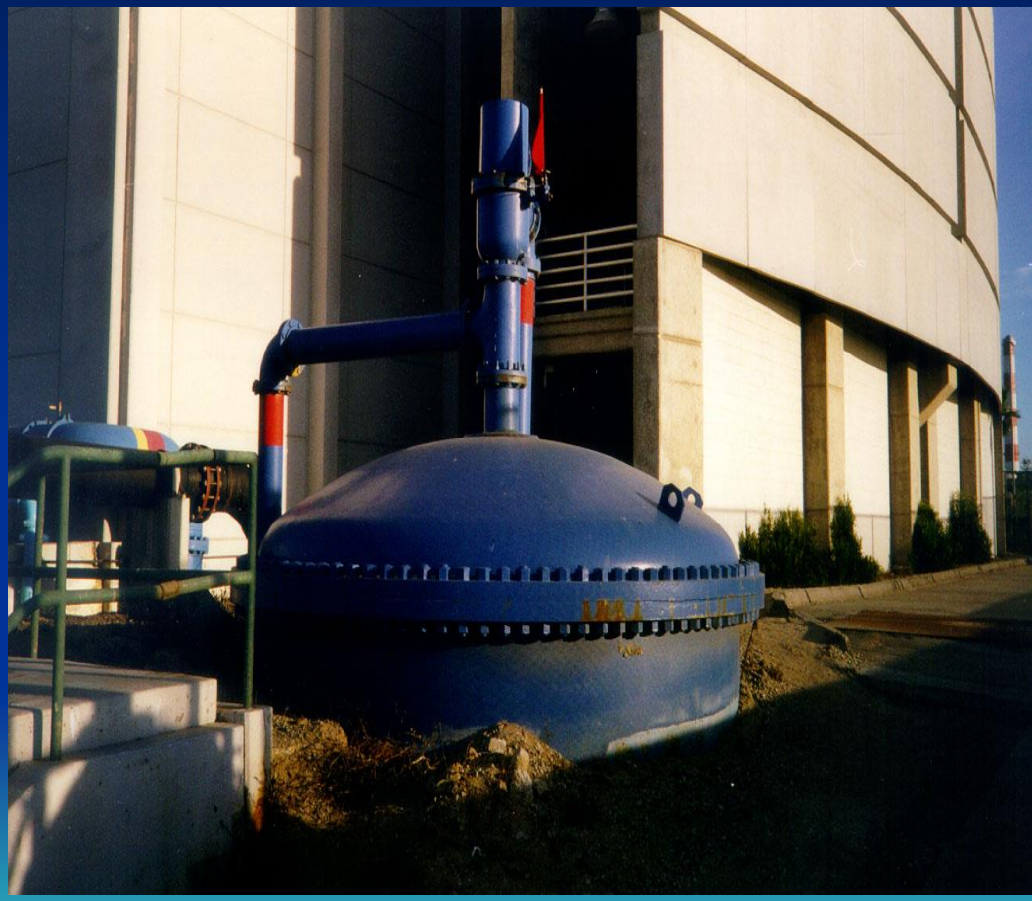
- aeration tank
  - oxygen is introduced into the system

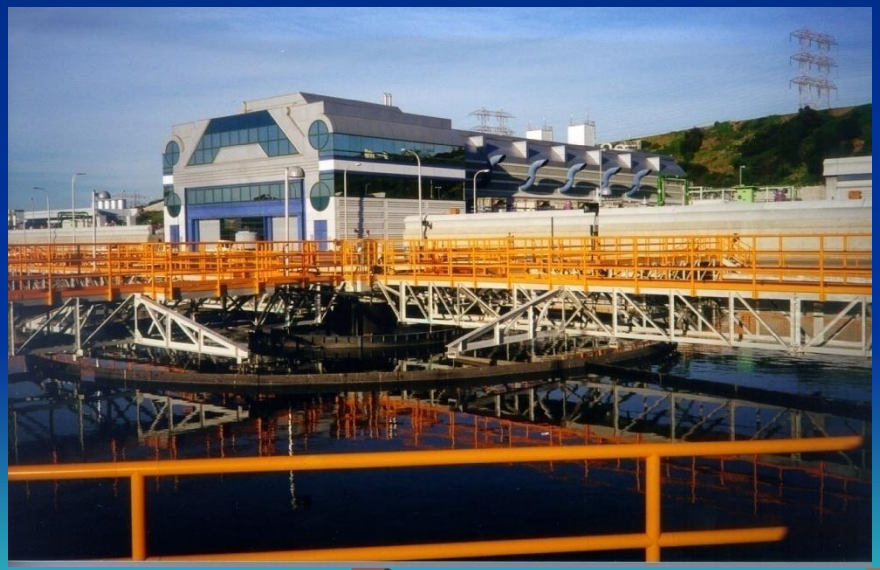
- aeration source
  - ensure that adequate oxygen is fed into the tank
  - provided pure oxygen or compressed air

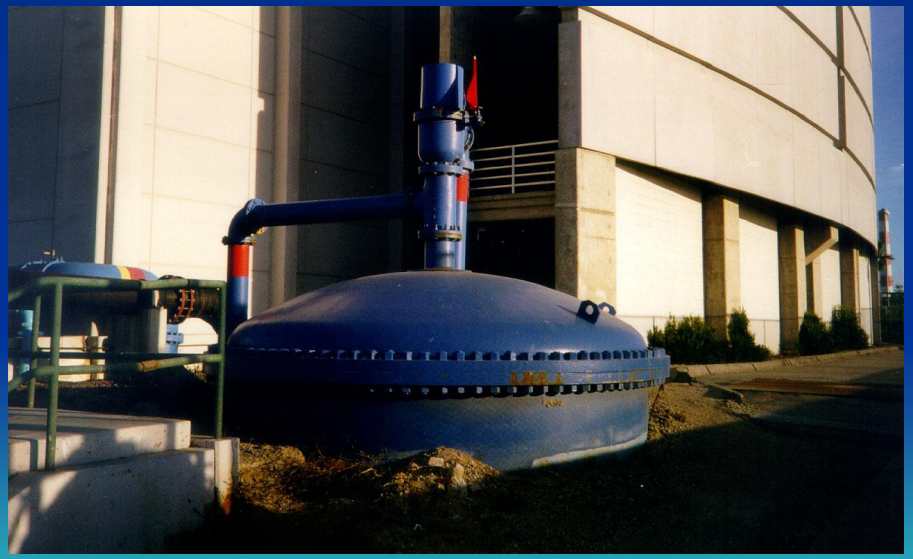
- secondary clarifiers
  - activated-sludge solids separate from the surrounding wastewater



- Activated sludge outflow line
  - Pump activated sludge back to the aeration tank
- Effluent outflow line
  - discharged effluent into bay or tertiary treatment plant







- Lagoon Systems
  - hold the waste-water for several months
  - natural degradation of sewage
  - Usually reeds are preferred

# Treatment stages – Tertiary treatment

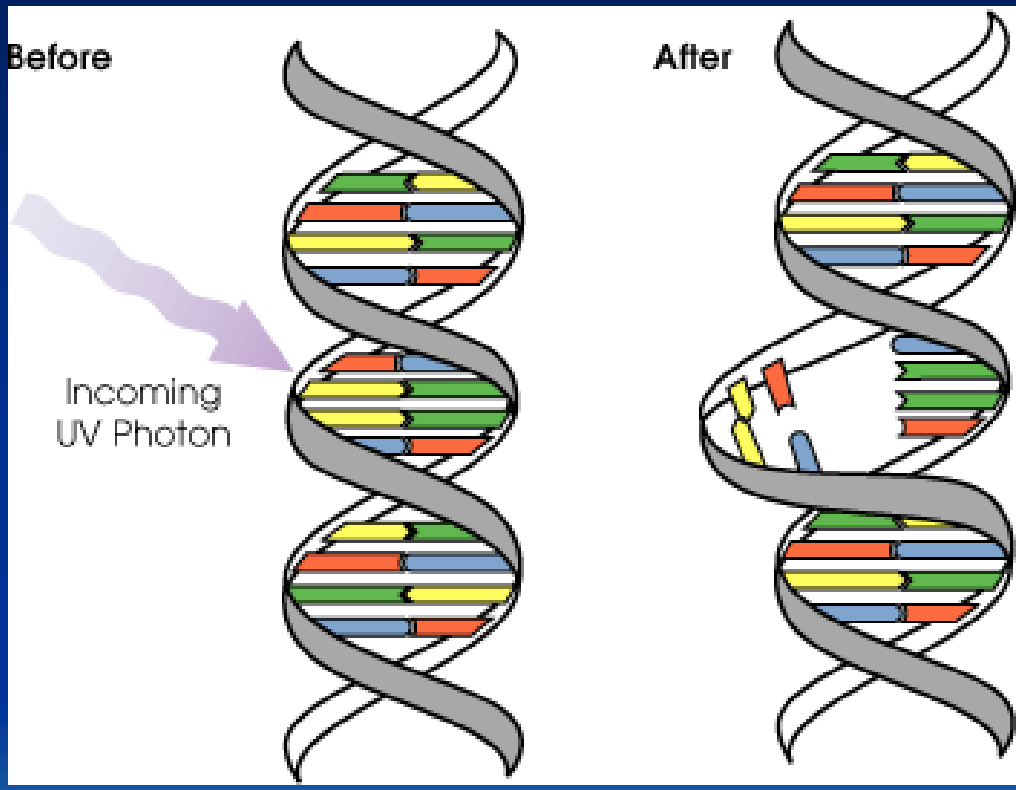
- remove disease-causing organisms from wastewater
- 3 different disinfection process
  - Chlorination
  - UV light radiation
  - Ozonation

# Chlorination

- Most common
- Advantages: low cost & effective
- Disadvantages: chlorine residue could be harmful to environment

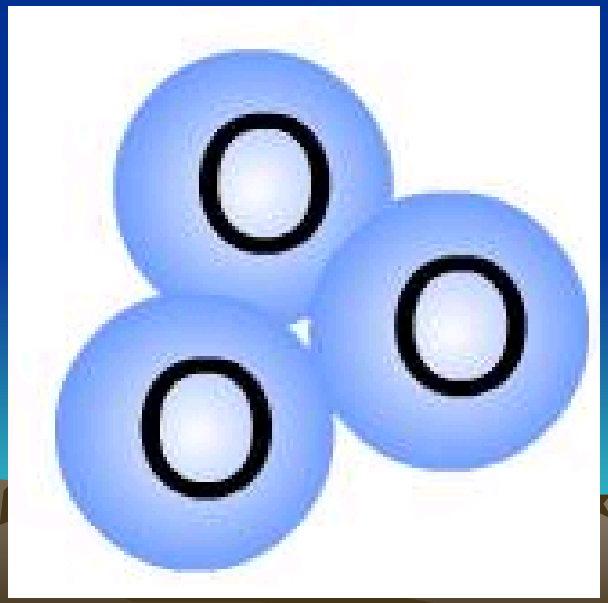
# UV light radiation

- Damage the genetic structure of bacteria, viruses and other pathogens.
- Advantages: no chemicals are used
- water taste more natural
- Disadvantages: high maintenance of the UV-lamp



# Ozonation

- Oxidized most pathogenic microorganisms
- Advantages: safer than chlorination
  fewer disinfection by-product
- Disadvantage: high cost



# What can effluent use for?

- discharged into a stream, river, bay, lagoon or wetland
- used for the irrigation of a golf course, green way or park
- If it’s sufficiently clean, it can be used for groundwater recharge

# Advanced Treatment

- Nitrogen removal
  - Ammonia ($NH_3$) → nitrite ($NO_2^-$)→ nitrate ($NO_3^-$)
- Phosphorous removal
  - Precipitation with iron or aluminums salt
- Lead to eutrophication
- May cause algae bloom

# Sludge treatment

- Primary sludge usually have strong odors
- Secondary sludge have high concentration of microorganism
- Goals of treatments are:
  - Reduce odors
  - Remove water reduce volume
  - Decompose organic matter

- Untreated sludge are about 97 percent water
- Settling can reduce about 92 to 96 percent of water
- dried sludge is called a sludge cake

# 3 different sludge treatments

- Aerobic digestion
- Anaerobic digestion
- composting

# Aerobic digestion

- Bacterial process
- Need oxygen
- Consume organic matter
- Convert into carbon dioxide ($CO_2$)

# Anaerobic digestion

- Bacterial process
- Do not require oxygen
- Consume organic matter
- Produce biogas, which can be used in generators for electricity

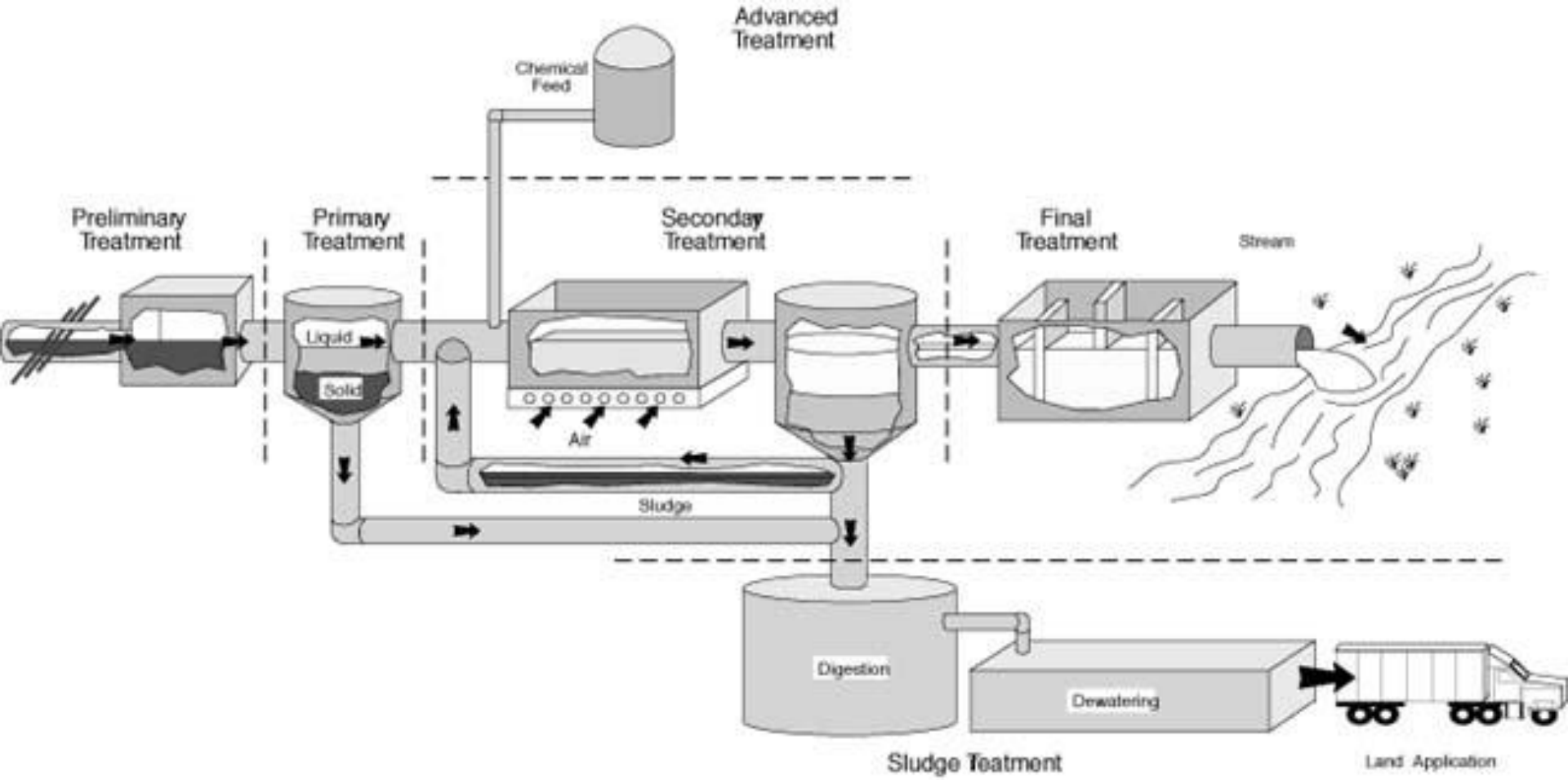
# Composting

- aerobic process
- requires the correct mix of carbon, nitrogen, oxygen and water with sludge
- Generate large amount of heat

# Sludge disposal

- Superheat sludge and convert into small granules that are rich in nitrogen
  - Sell it to local farmer as fertilizer
- Spread sludge cake on the field
- Save landfill space

# Summary


Advanced Treatment
Chemical Feed
Preliminary Treatment
Primary Treatment
Secondary Treatment
Final Treatment
Stream
Liquid
Solid
Air
Sludge
Digestion
Dewatering
Sludge Treatment
Land Application

# Questions