Sanitary Sewer Systems

General Overview

Sewage Collection System

• Pipes
• Pumping stations
• Maintenance entry points – manholes

Types of Sewage

• Sanitary
  – Domestic sewage: human wastes and washwater from public and private sources
• Industrial
  – By-product of industrial processes may contain a variety of chemical compounds
• Storm
  – Run off includes organic, suspended & dissolved solids, objects carried in from land surface
Types of Sewage

• Separated
  – Sanitary and storm separated

• Combined
  – Antiquated
  – Large diameter pipes but still subject to overflow (like all systems)

Combined Sewer Overflows at Edgewater Beach

Wastewater Treatment

Types of treatment systems include: Septic Tanks, On-site Wastewater Treatment Systems, Package Plants, and Wastewater Treatment Plants (WWTPs)

• Septic Tanks and OWTS typically treat small volumes of waste (e.g., from a single household, small commercial/industrial)
• WWTPs typically treat larger volumes of municipal or industrial waste
• Note other systems do exist
Wastewater Treatment Objectives

- Wastewater treatment systems take human and industrial liquid wastes and make them safe enough (from a public health perspective) to return to the aquatic or terrestrial environment.
- Wastewater treatment systems use some of the same processes of purification that would occur in a natural aquatic system only they do it faster, in a controlled situation, and with expected outcomes.

Septic Tanks

- Approx. 22 million systems in operation (30% of US population)
- Suitability determined by soil type (Percolation Test), depth to water table, depth to bedrock and topography
- Commonly fail due to poor soil drainage
- Potential contaminants: bacteria, heavy metals, nutrients, synthetic organic chemicals
OWTS Aerobic Treatment Process

- Biological treatment of wastewater using aerobic organisms in the presence of free oxygen
- Converts soluble organic material (food) into a non-soluble bacterial mass (floc)
- Bacterial mass removed by sedimentation (settling), filtration, or both
- Organisms release carbon dioxide, water and energy (heat)

Types of aerobic treatment
- Suspended growth: activated sludge or extended aeration
  - Bacteria suspended in wastewater; oxygen pumped into wastewater
- Attached growth: fixed film, sand filters, peat
  - Bacteria attach to inert media

Aerobic Treatment Process

- Wastewater + O₂ + Aerobes = New Aerobes + CO₂ + H₂O + Energy

- Air Contains: 78% Nitrogen + 21% Oxygen + 1% Other Gases
- Facultative Anaerobes reduce NO₃ in the absence of Oxygen
- Constant air supply maximizes digestion of wastewater
- Churning brings food to microbes and maximizes contact time
Disinfection prior to release to mound system available and required in some areas.
Commercial Wastewater Package Plants

- Schools
- Restaurants
- Subdivisions
- Drive-Ins
- Service Stations
- Laundromats
- Mobile Home Parks
- Rest Stops
- Churches
- Bowling Alleys
- Dance Halls
- Country Clubs
- Factories
- Hospitals
- Institutions
- Motels
- Rect Homes
- Office Buildings
- Shopping Centers
- Vacation Cottages

Components

- Blower Housing
- Control Panel
- Sludge Holding Chamber
- Aeration Chamber
- Settling Chamber or Clarifier

Commercial Installations
750 House Subdivision - Mexico

Treated Wastewater Reuse- Irrigation

Thanks:

Jet Wastewater Treatment Solutions
750 Alpha Drive
Cleveland, OH  44143

www.jetincorp.com

• Slides and photos of OWTS
Municipal Wastewater Treatment

Sanitary Sewer Design

General Characteristics for Sewer Materials

- Strong
- Resistant to stress of being buried
- Resistant to corrosion and abrasion
- Joints slightly flexible but prevent leakage in either direction
- Clay pipes, concrete pipes, plastic pipes
Additional Design Issues

- Inflow and infiltration
  - Domestic water use = inflow
  - Groundwater = infiltration
- Peak flow and minimum self-cleaning velocity
- Underdesign and overdesign
  - Surcharging

Defeating Gravity: Lift

Wet well lift station

Typical Lift Stations
Sewage Treatment

Wastewater or sewage treatment is a multistep process:

Preliminary and Primary Treatment (Physical Process)

– Removal of large objects using grates, bar screens, and/or comminutors
– Settling to remove suspended solids (primary sludge)
  • flocculating chemicals are added to enhance sedimentation
  • Grit removal
– Removes floating/settling pollutants and protects subsequent processes
Secondary Sewage Treatment

A Microbial Process

- Supernatant or primary effluent contains high loading of dissolved organic compounds (causing BOD)
- Aeration to stimulate aerobic degradation
  - activated sludge reactor or trickling filter reactor
  - rotating biological contactors
- Removal of much of the carbonaceous BOD
- Followed by a clarifying step

An Activated Sludge System

(a) Diagram of an activated sludge system

An Activated Sludge System

(b) An aeration tank, showing surface that is frothing from aeration
A Trickling Filter

### Tertiary Sewage Treatment

- Primary activated sludge effluent contains:
  - Residual BOD
  - 50% of the original nitrogen
  - 70% of the original phosphorus
- Tertiary treatment removes these by
  - Filtration through sand and activated charcoal
  - Chemical precipitation – $PO_4^{3-}$ - flocculation and coagulation
  - Biological denitrification available – N
    - Removal non-carbonaceous BOD
    - Another activated sludge process
- Adds considerable cost to treatment
Disinfection

Pathogen Removal by Activated Sludge

- Bacteria are removed by inactivation, grazing by ciliated protozoa, and adsorption to sludge solids
- Viruses are removed mainly by adsorption process
- Final Disinfection: Chlorination or UV light

Sewage Treatment: Disposal of Final Effluent

- Treated water is discharged to waterways
- Used for irrigation
- Reuse in non-potable water applications
Sludge Handling

- Sludges generated throughout sewage treatment process
  - Many are recycled back into system to maintain activated sludge processes
    - Microorganism loading
    - Organic loading
- Sludge thickening to reduce volume followed by disposal
  - Gravity tank thickening
  - Thermal treatment: sterilization and water release
  - Dewatering: Gravity belt and belt presses, others
- Sludge digestion
- Sludge incineration
- Land application
- Note: grits are inorganic and don’t break down
Anaerobic Digestion of Sludge

- Sludges from the primary and secondary treatment settling tanks are pumped into an anaerobic digester
- Sludges contain cellulose, proteins, lipids and other insoluble polymers
- Anaerobic bacteria digest the sludge to methane and carbon dioxide

![Anaerobic Sludge Digester](image)

(a) An anaerobic sludge digester at a California sewage treatment plant. Much or all of a typical digester is below ground level, especially in cold climates. Methane from such a digester is often used to run pumps or heaters in the treatment plant. Excess methane is being burned off in the flues shown at the top of the digester.

(b) Section of a sludge digester. The scum and supernatant layers are low in solids and are recirculated through secondary treatment.

Sludge Belt Press

Gravity Belt Thickener