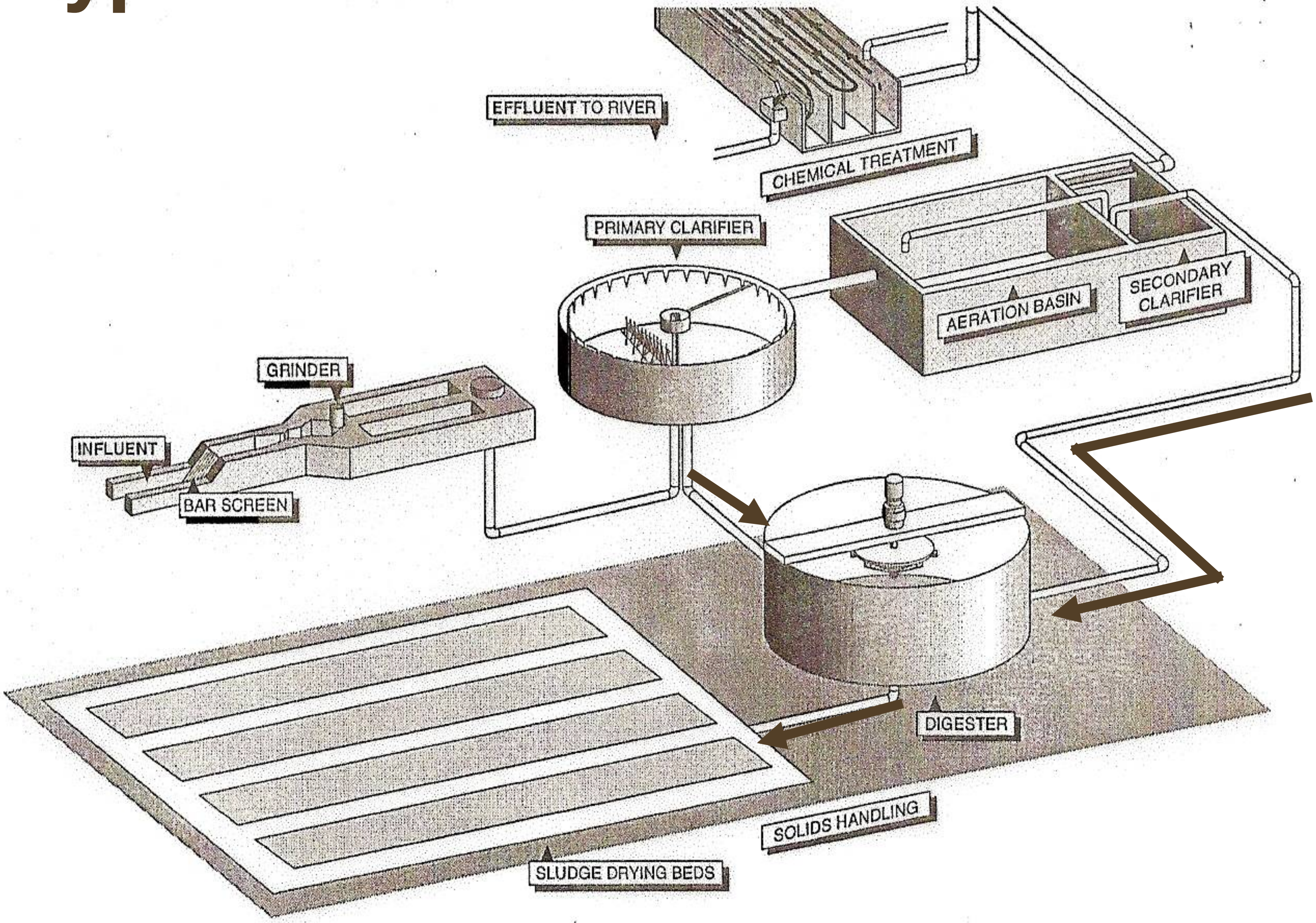
Solids Handling

Solids Handling Processes

- Removal of solids from system
- Digestion
- Thickening
- Dewatering
- Disposal or Re-use

Typical WWTP

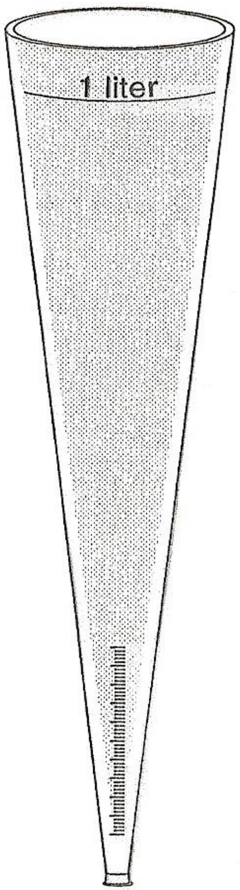


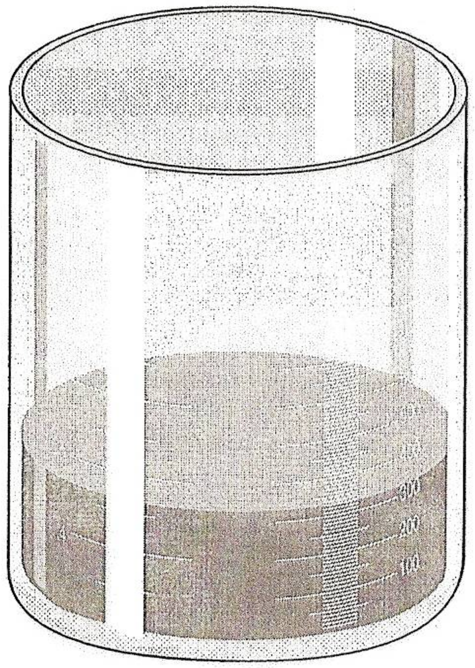
Sources of Sludge

- Households
- Commercial
- Industrial
- Septic Tank haulers

TYPES OF SLUDGE

Primary Sludge

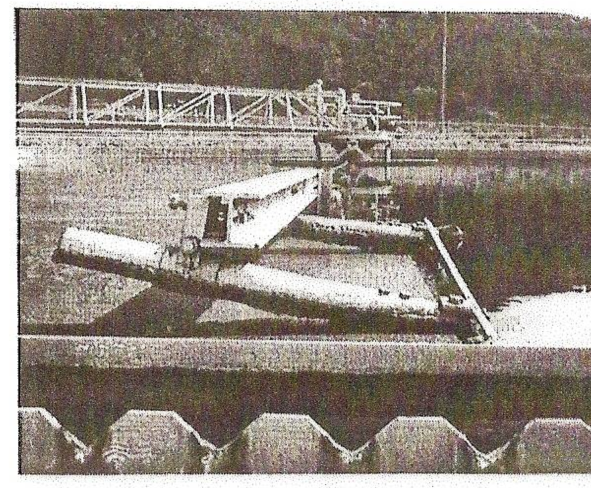


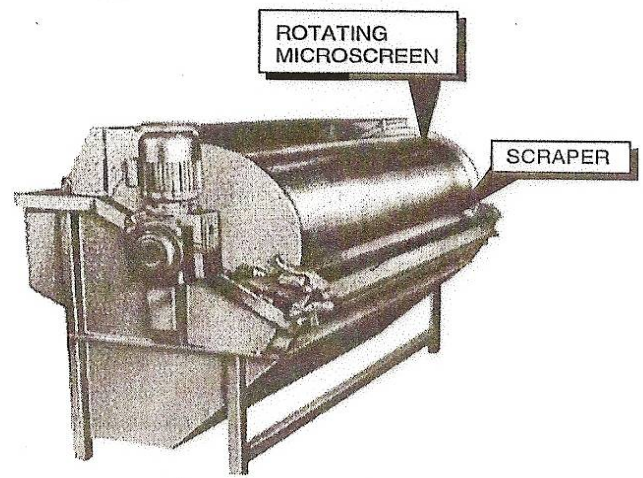


Biological sludge

From Secondary Clarifiers / Ponds

Scum





Screenings

What is Sludge?

- Material removed from waste stream

Why Treat Sludge?

- Stablize
- Reduce its volume

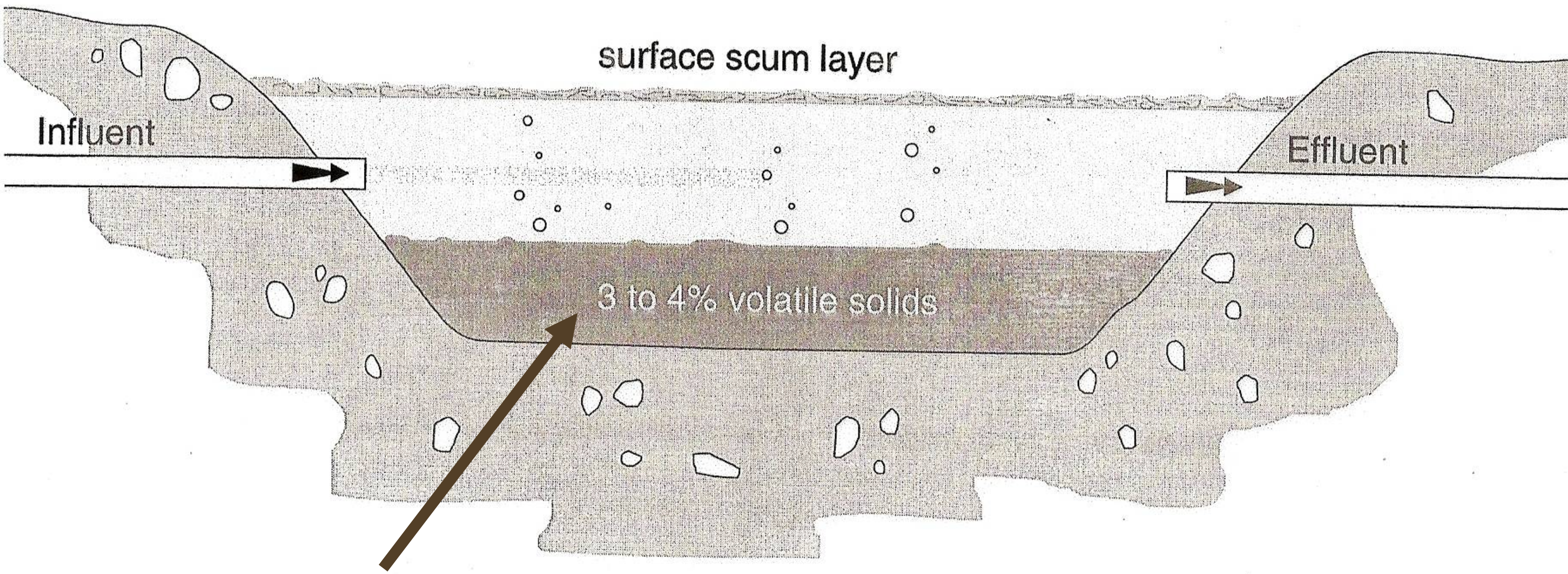
Treatment Process/Stabilization

- Aerobic digestion
- Anaerobic digestion

Results of Digestion

- Reduction in volatile solids content
- Reduction in pathogenic organisms
- Reduction in odor
- Reduction in volume
- Partial conversion to gasses
  - CO_2 –carbon dioxide
  - CH_4 - methane
  - H_2O – water vapor

Lagoon Sludge must be removed and disposed



3 to 4 % volatile solids

Anaerobically digested sludge

Removal required when sludge occupies 1/3 pond capacity

Anaerobic Digestion

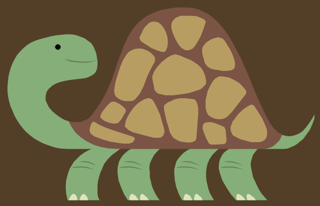
- Acid Formers (SAPROPHYTIC organisms)
  - Produce acid

- Methane Fermenters
  - Use acid
  - Only reproduce in pH range 6.6 – 7.6

Key lies in ***balance*** between rate of acid formation and methane fermentation

Three Working Temperature Ranges

- **Phychrophilic** - 10 -20 degrees C
  - – Cold-loving bacteria



Slow, inefficient digestion

Mostly CO_2, H_2S and H_2O by-products

Very little methane (CH_4)

Imhoff tanks, septic tanks, unheated digesters, lagoons

- **Mesophilic** – 20-45 degree C
  - Medium temperature loving bacteria

Common operating range for anaerobic digesters

Produces high level of methane in short time

25 – 30 days

Ideal temperature is ~35 degrees C (95 F)

Typically heated and mixed

- **Thermophilic** – 49 -57 degrees C
  - – Hot temperature loving bacteria

Organisms sensitive to temperature change

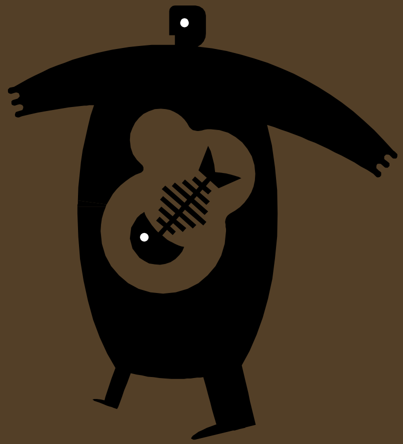
Difficulty maintaining high temperature

Poor liquid/solids separation

Few digesters operate in this range

Two-Stage Digestion

- **Mesophilic** Range (20-45 C, ideal 35 C))
- **Primary** Stage
  - – Heated and mixed
  - – 90% of gas produced
- **Secondary** Stage
  - – Storage
  - – Liquid/solids separation
  - – Supernatant withdrawal

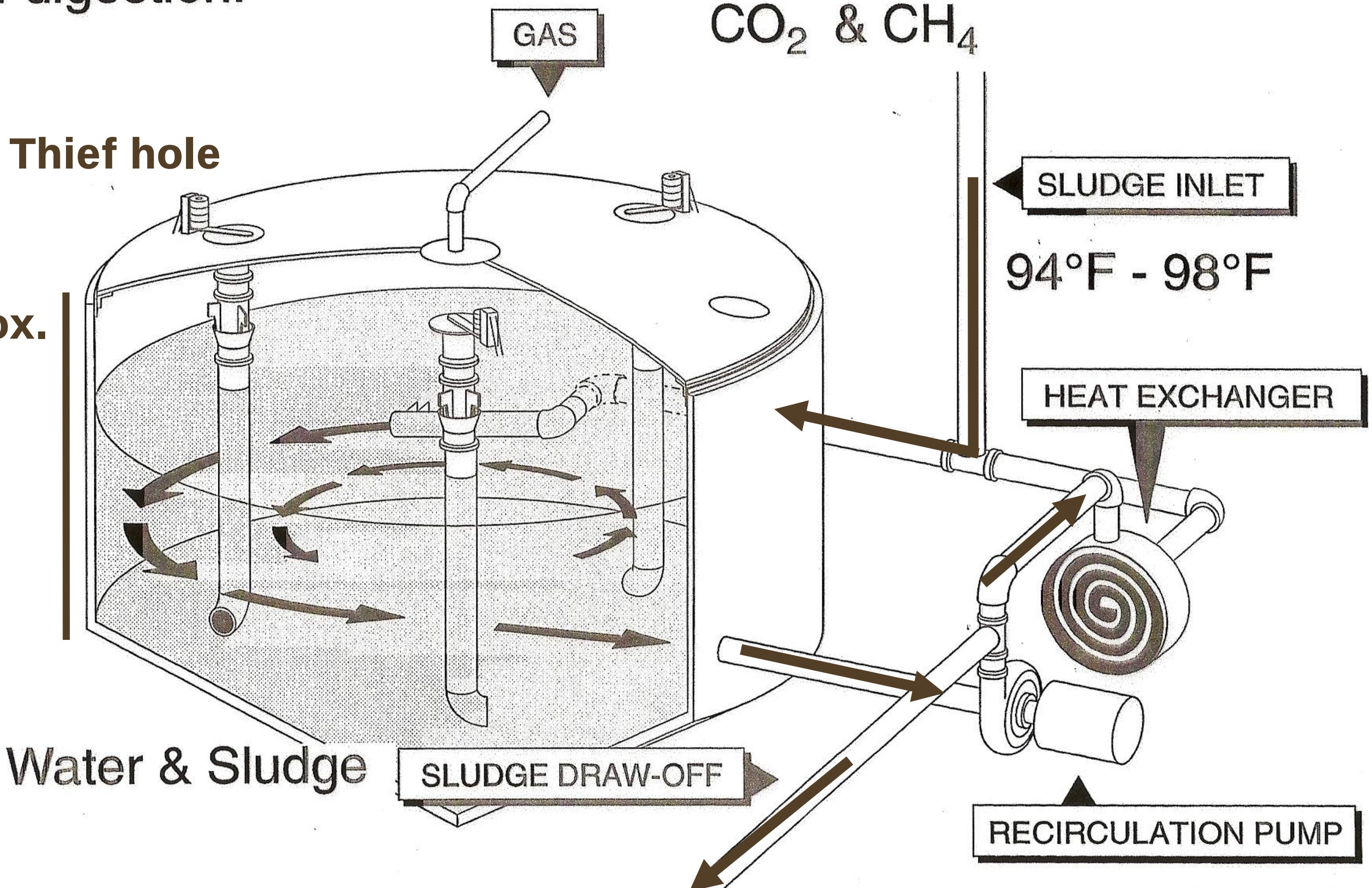


Heating & Mixing increases the rate of digestion.

ANAEROBIC DIGESTION

Thief hole

Approx. 20 ft. deep

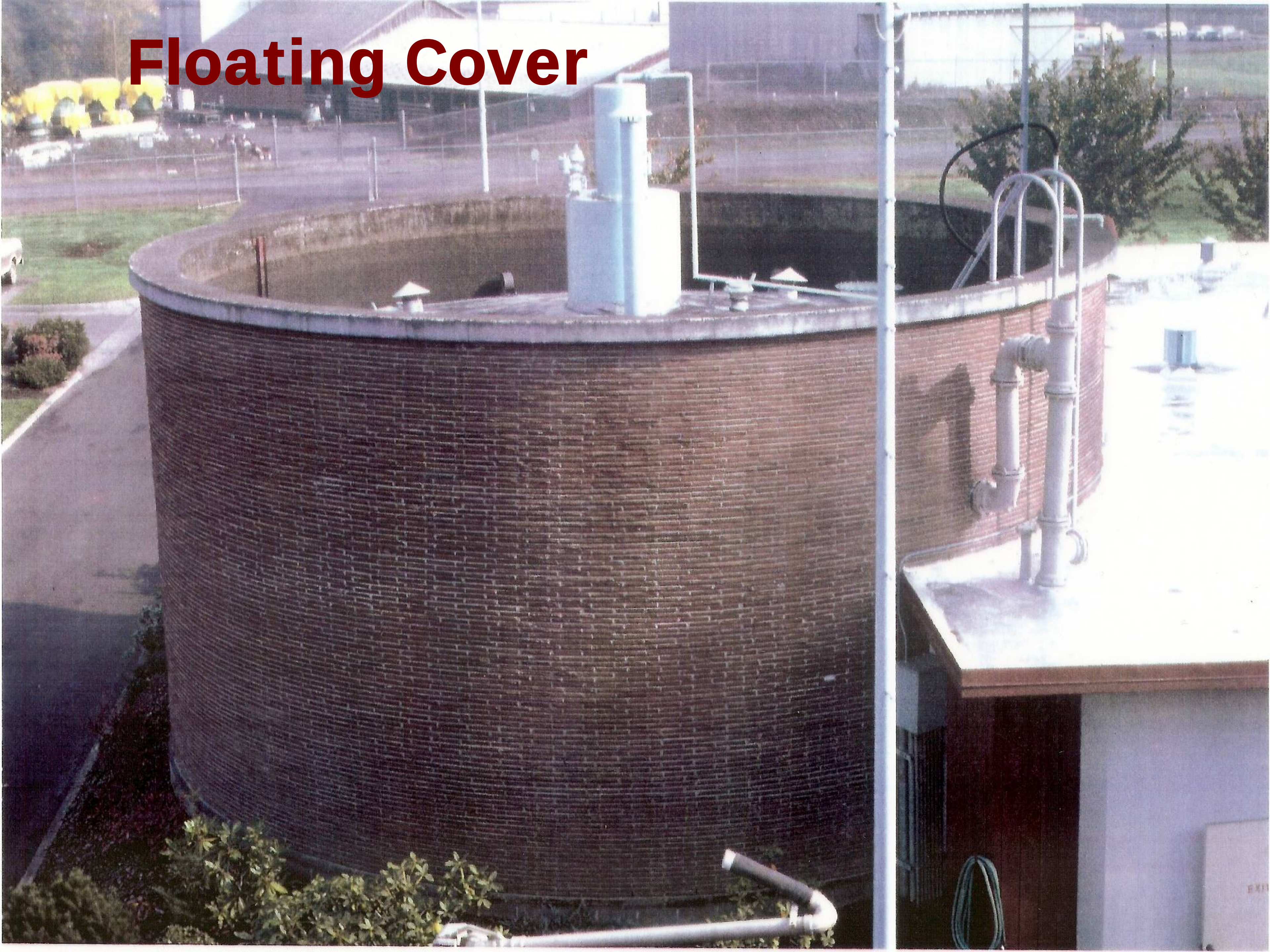


Plug valves typical

To Secondary or Drying Beds

Cast-iron or steel piping

Floating Cover



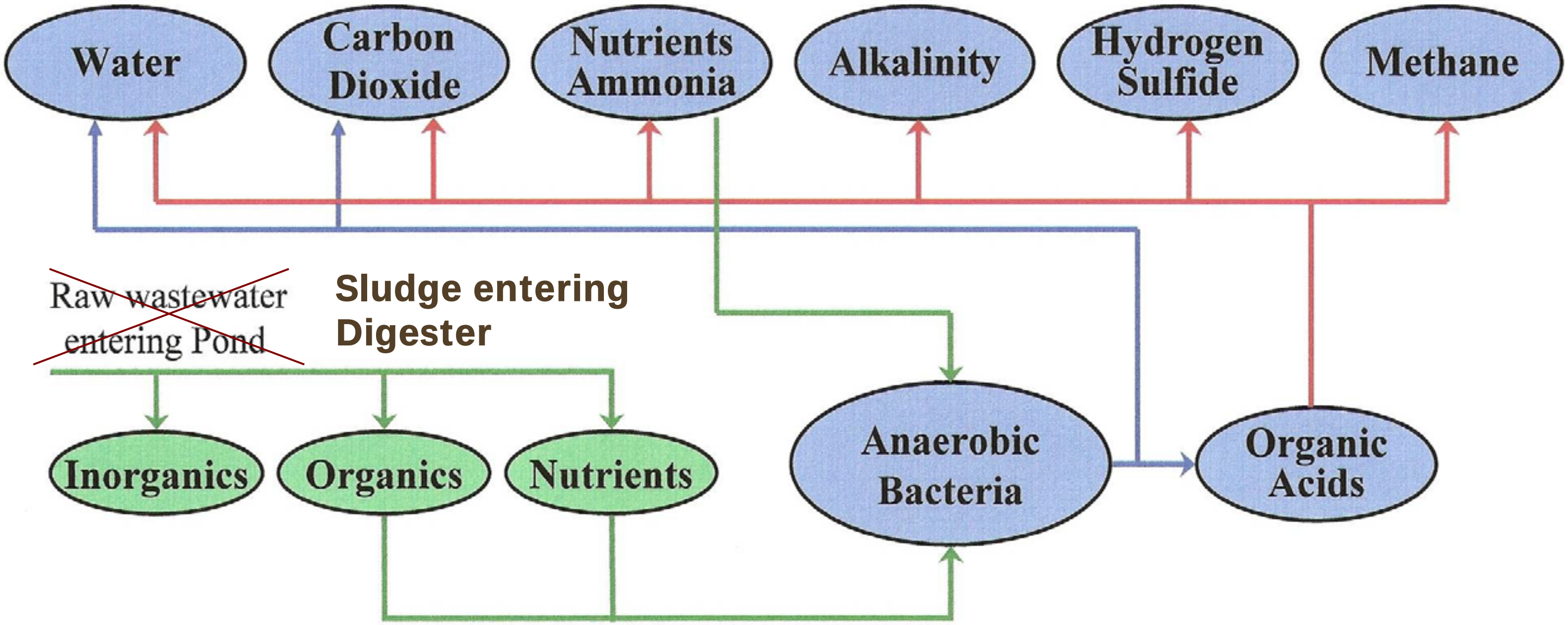
Floating Cover Warning!

- Sludge seal at cover and digester wall separates interior from outside atmosphere

- If level in digester drops too low, seal can break causing development of **explosive** methane/oxygen mixture

Fixed Cover

Anaerobic Process



Acid producing bacteria convert organic matter to volatile acids, carbon dioxide, water, and nitrogen.

Methane fermenting bacteria break down acids and other products to methane gas, carbon dioxide, hydrogen sulfide, alkalinity, and water.

Operation of Anaerobic Digesters

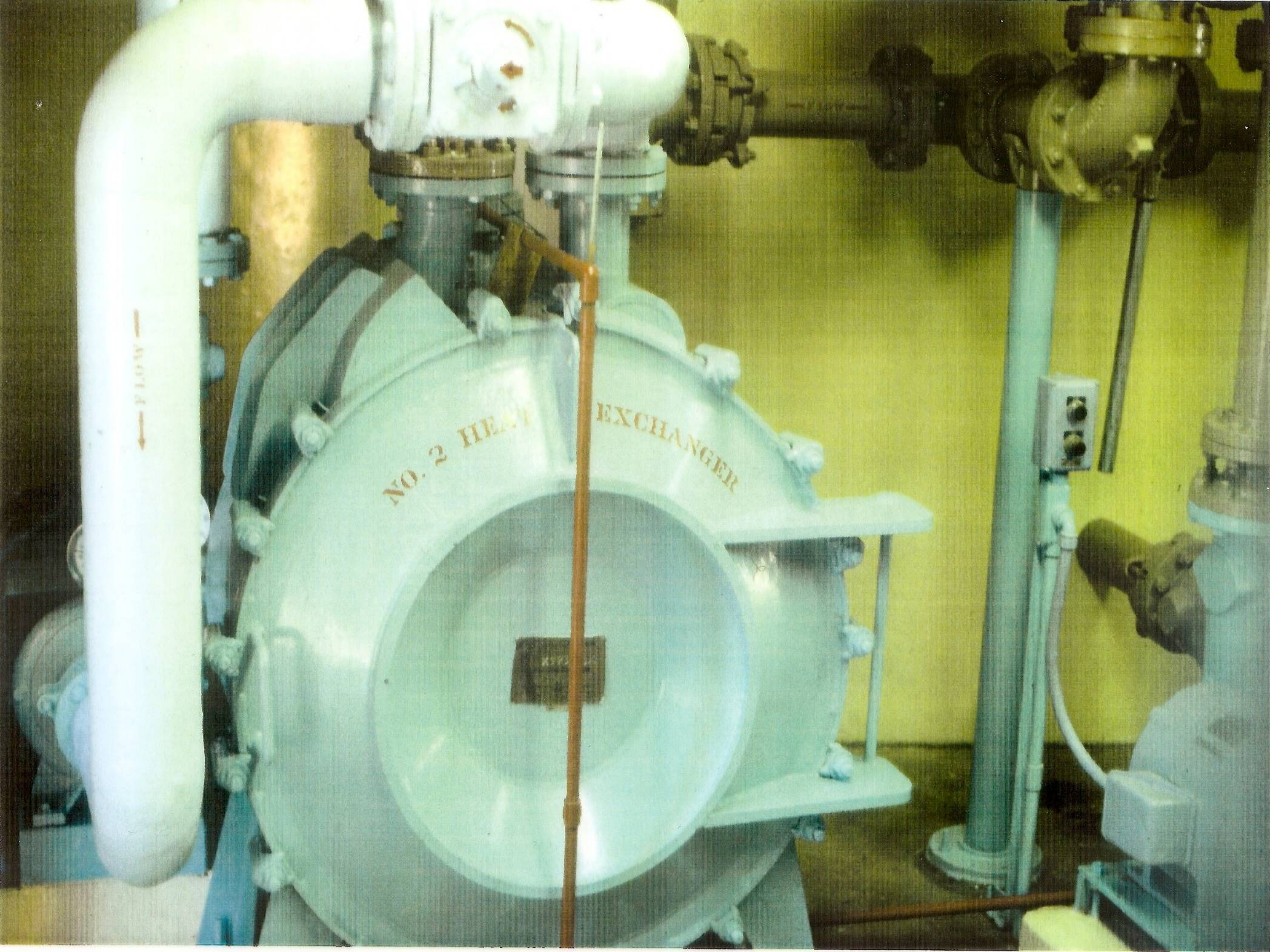
1. Maintain temperature at 95 - 98 F
2. Mix well
3. Feed digester several times a day
4. Feed as thick a sludge as possible
5. Maintain buffering capability
6. Do routine process control testing

Process Control Tests

1. Temperature
2. pH
3. Volatile Acid/Alkalinity Ratio (VA/ALK)
4. Carbon Dioxide
5. Solids Content

Temperature

- Thermometer usually in recirculation line between digester and heat exchanger
- Maintain at 95 -98 F
- ***Never*** change temperature more than 1 F per day


NO. 2 HEAT EXCHANGER
FLOW

pH

- Measure and record pH for
  - Raw (feed) sludge
  - Recirculated sludge
  - Supernatant

Maintain pH 7.0 – 7.6

Do NOT rely on pH for process control

Volatile Acid/Alkalinity Ratio

Ratio usually **<0.1** VA **: 1.0** ALK (**0.1**) or 10 times as much alkalinity as volatile acids

* A change in the VA/ALk ratio is the ***first*** indication that the digester may be going "sour"

Monitor at least weekly

Carbon Dioxide

- Good digester gas:

  30 – 35 % CO_2

  65 – 70 % CH_4

CO_2 < 42 % signals poor digestion

CO_2 < 45 % gas will not burn

Solids Content

- Analyze and Record Total & Volatile Solids:

    Raw sludge

    Recirculated sludge

    Supernatant

    Withdrawn sludge

Typical Total Solids in digester 3 – 6 %

Typical Volatile Solids reduction 50 -60 %

* Key indicator of digester performance

Troubleshooting

Problem:

This WWTP digester has no gas burning and large amounts of foam spilling over the sides.

What do you think is the cause?

Clue: Page 11-5 in your *Study Guide*

Problem:

Ammonia levels in the plant effluent have suddenly gone sky-high. Also, the digester supernatant being returned to the influent wet well is very dark with lots of solids.

What is the most likely reason for both of these problems?

Problem:

Operator on night shift fell asleep and didn’t pull sludge to the digester. The day shift operator had gassing and sludge popping up all over the primary clarifier so he quickly wasted twice as much sludge as usual to the digester to clear up the clarifier.

The lab tech reported a digester VA of 50 and an ALK of 1000. The pH was 7.0.

What is the actual VA/ALK ratio?

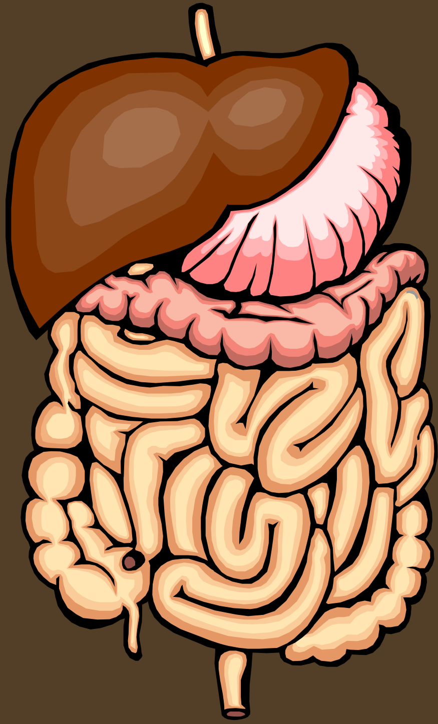
What is happening to the digester?

How do you as the 2nd shift operator correct the problem? (Effects not really seen this fast usually)

How do you prevent this from happening again? (Be creative)

Hands-On Exercise

1. Lemon juice or vinegar
2. Tums
3. pH and alkalinity test strips



Former Bayard Anaerobic Digester

Aerobic Sludge Digestion

- An extension of activated sludge process
- Sludge from activated sludge secondary clarifiers is already partially stablized
- Air and mixing provided
- No heating

Lime Stabilization

- Usually used for sludges that are not biologically stabilized
- Not a common practice for municipal facilities
- Cost prohibitive
- Lime addition raises the pH to 11.5 – 12
- Kills all organisms – halts biological activity and eliminates pathogens
- Increases the mass of sludge

Thickening & Dewatering Sludge

Purpose

- To reduce water content
- Lessen volume to store and transport

Processes

- Gravity thickeners
- Dissolved Air Flotation (DAF)
- Sludge drying beds
- Centrifuges
- Belt presses

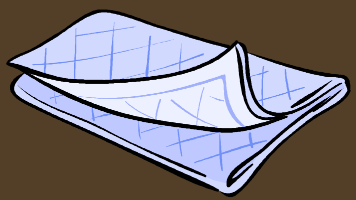
Some are located before digestion and some after digestion

Gravity Thickeners

- Units resemble secondary clarifiers
- Use force of gravity to separate solids from water
- Heavy solids will settle to bottom and be compacted by weight of overlying solids

Factors Affecting Operation

- Type of sludge being thickened
- Age of feed sludge
- Sludge temperature
- Sludge blanket depth
- Hydraulic and solids loading



Typically produce 2 - 4% solids sludge but can achieve 6% with polymers or thickening agents

Dissolved Air Flotation (DAF)

1. Small air bubbles attach to the sludge particles
2. They float to the surface
3. Sludge layer is skimmed to a hopper
4. A portion of separated water saturated with DO returns to sludge feed line to provide flotation bubbles; the rest returns to the plant flow stream

Polymers are often used to enhance process

DAF Performance Factors

- Type of sludge
- Air to Solids ratio
- Recycle rate
- Thickness of floating sludge blanket
  - Usually 6 – 8 inches deep
- Should produce effluent with TSS < 100 mg/l

See Table 11.2 on page 11-7 of the *Study Guide*

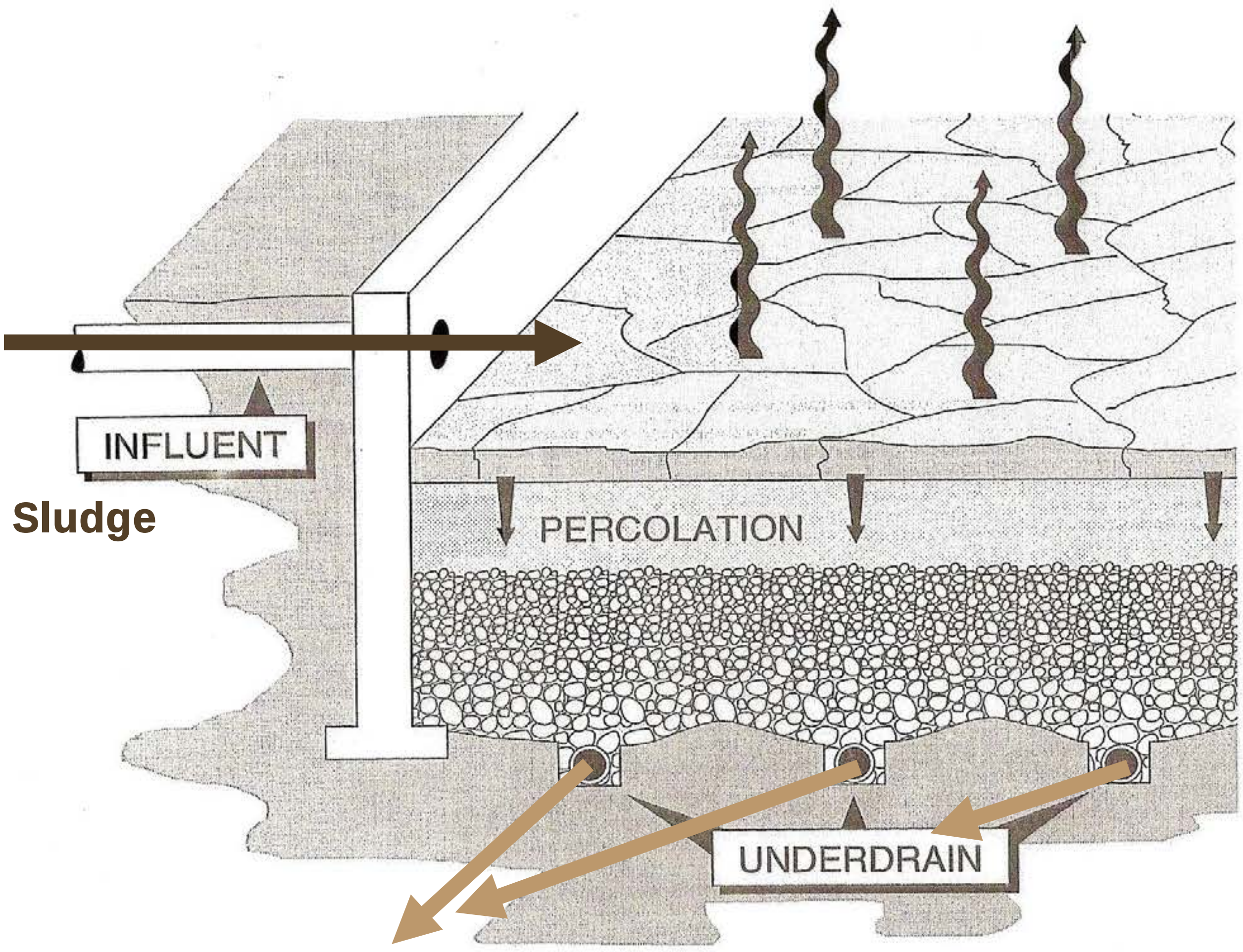
Sludge Drying Beds

- Sand Drying Beds
  - Can dry to > 95 % Total Solids
  - Typical 70 – 80 % Total Solids

- Asphalt/Concrete Drying Beds

- Vacuum Filter Beds

SAND DRYING BEDS



Sludge is poured to a Depth of about 12 inches

8 -12 inches sand

12 – 18 inches of gravel

Filtrate back to plant

Asphalt/Concrete Drying Beds

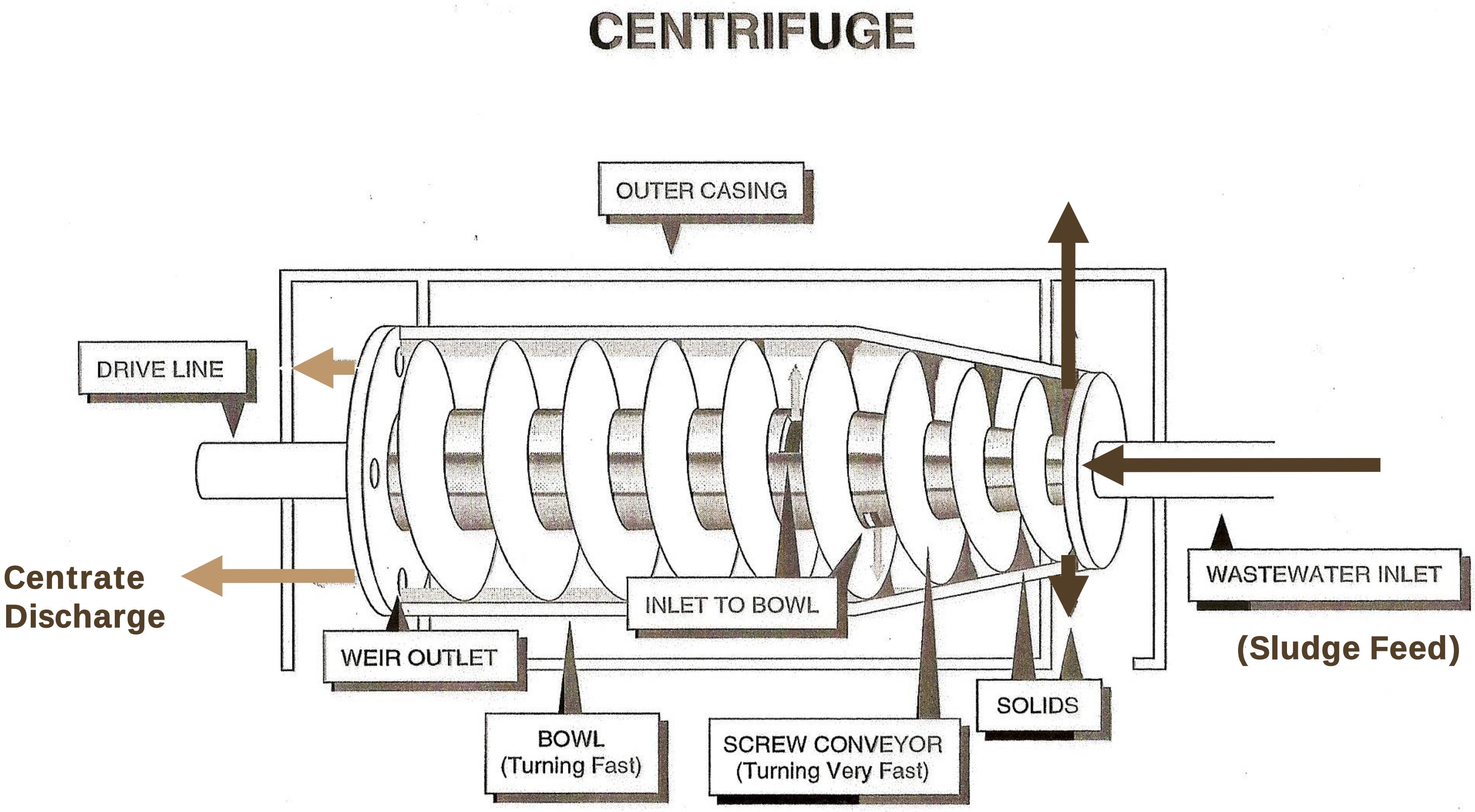
- Similar to sand drying beds
- Have hard asphalt or concrete surface
- Sludge can be poured to depth 18 – 30 inches
- Mixing equipment assists in quick drying
- Using tractor, backhoe, “Brown Bear”
- Decant tubes to remove water

Vacuum Filter Beds

- Shallow concrete basin with underdrains
- Covered with one of the following
    - Porous pumice bricks
    - Stainless steel perforated panels
    - Plastic perforated panels
- Polymer-conditioned sludge is poured
- Vacuum applied under panels to draw water to drains
- Sludge dewatered to 15 – 30 % TS in a few hours to a few days

Performance Factors

- Climate
- Depth of sludge pour
  - No more than 12 inches
  - Never "cap" a bed
- Condition of sand
  - Compacted beds require 2 -3 inches of sand be removed and replaced
- Use of Polymers
  - Can cut drying time in half



Scroll-type most prevalent in New Mexico

Performance Factors

- Type of Sludge
- Solids and Hydraulic Loading
- Bowl Speed
- Differential Scroll Speed
- Liquid Depth (pool depth)
- Sludge Conditioning

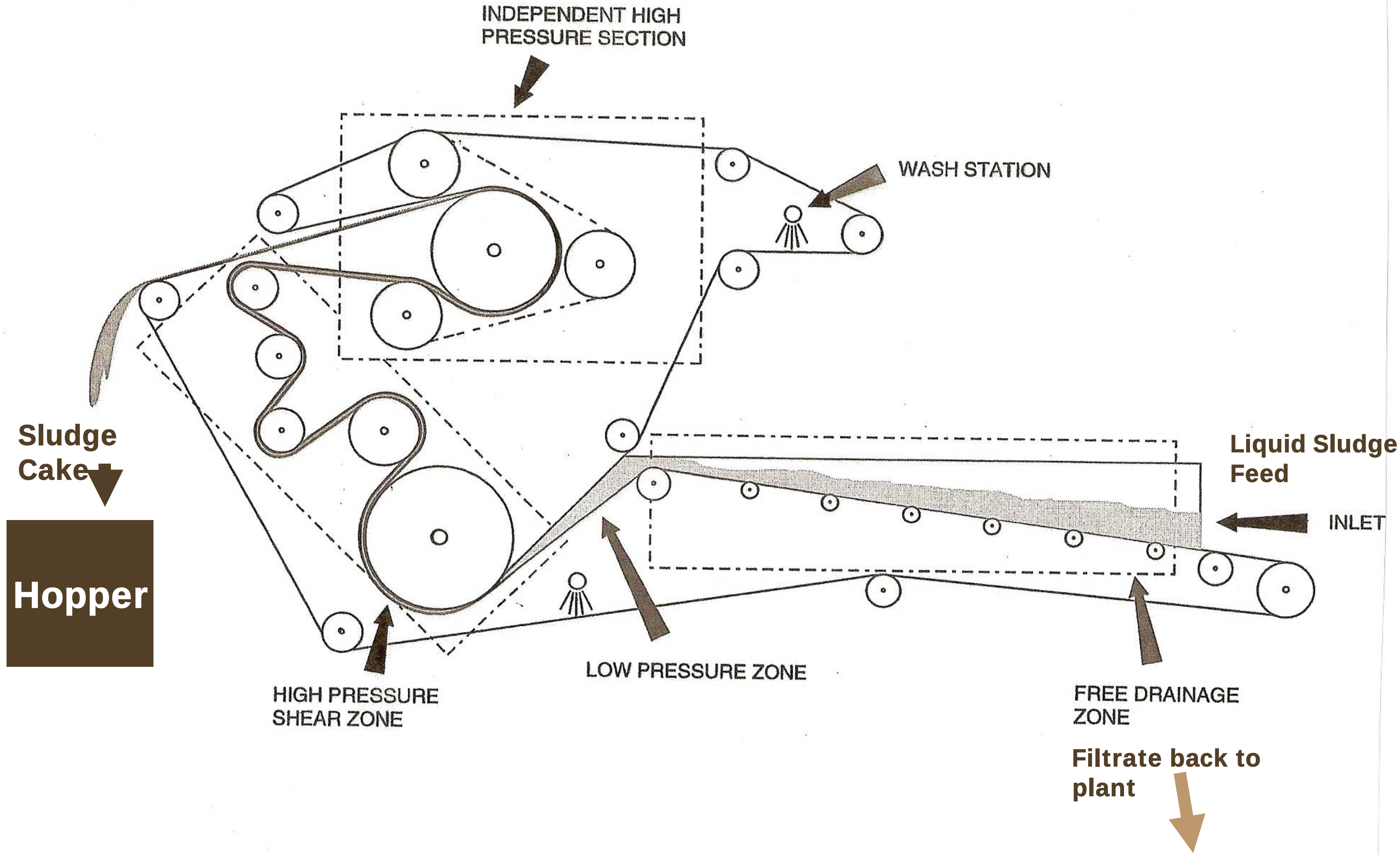

BIRD
BIRD

Belt Filter Press

- Consists of “two endless belts that travel over a series of rollers assembled on a galvanized steel frame”
- Sludge is conditioned with polymer and dewaters in a drainage area before feeding through the belts

- Water is forced out between perforated and non-perforated rollers
- Filtrate returned to plant for treatment
- Sludge cake removed from belts and conveyed to hopper
- Belts are washed to prevent clogging

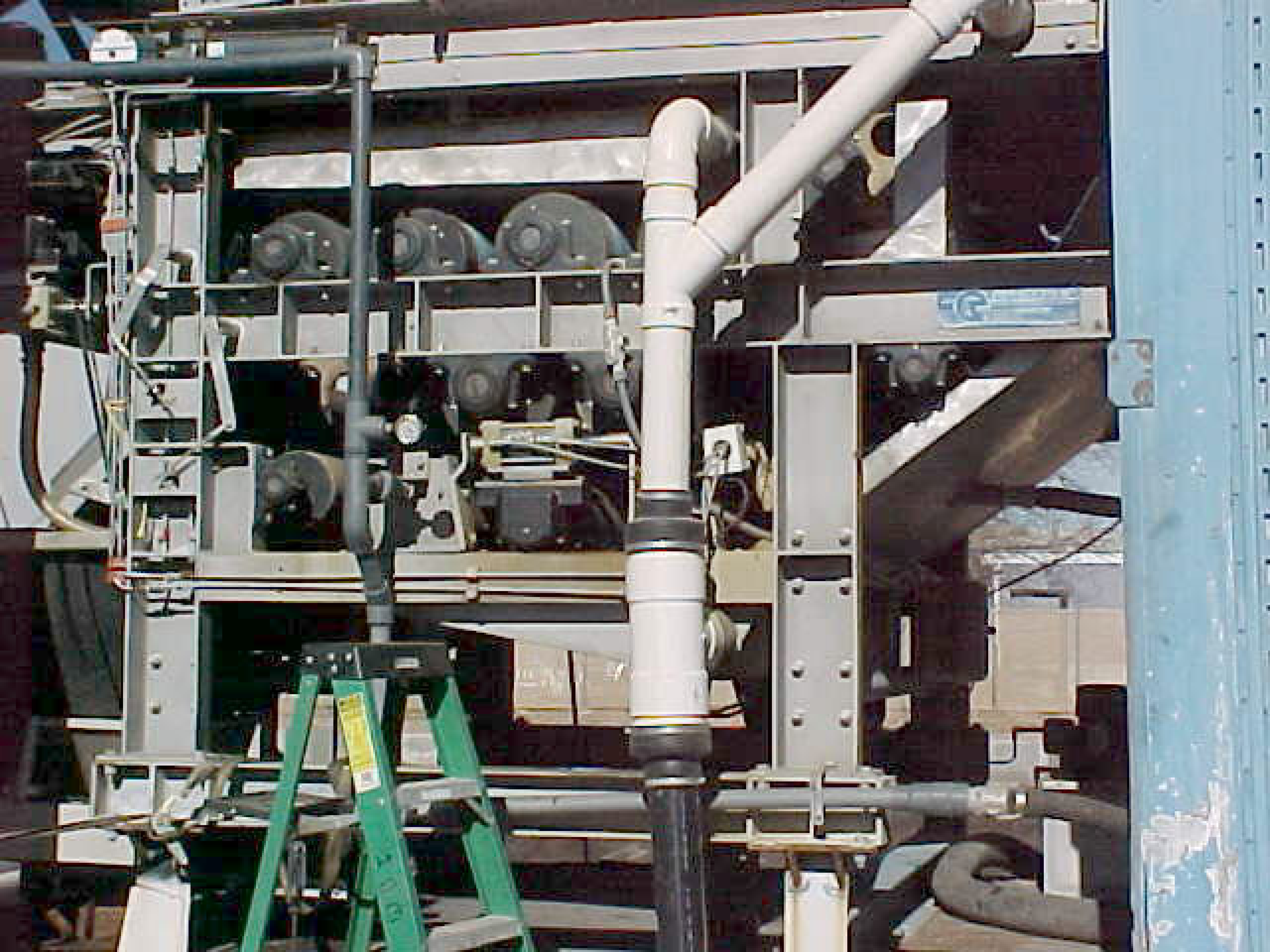
BELT PRESS

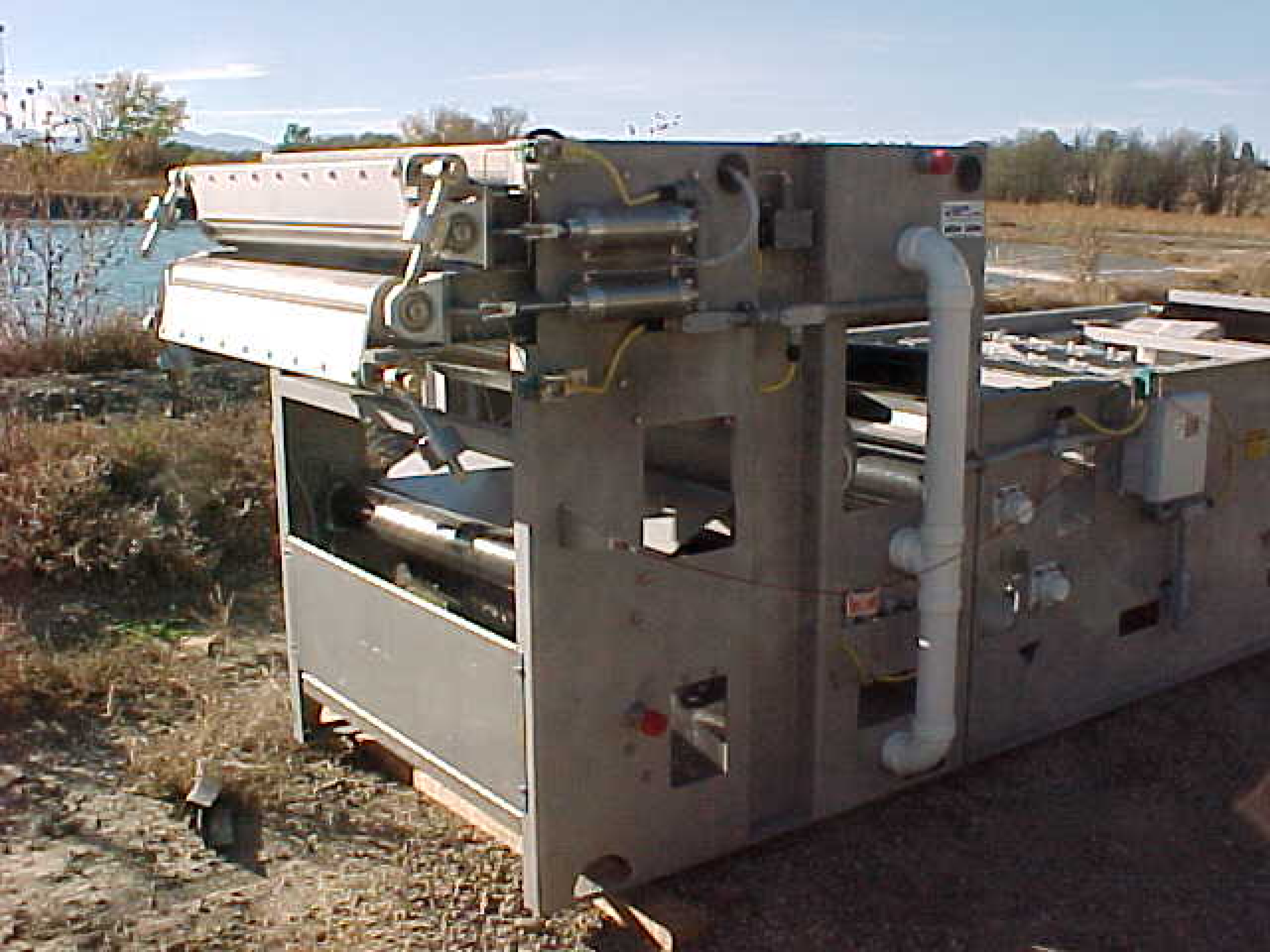

INDEPENDENT HIGH PRESSURE SECTION
WASH STATION
Sludge Cake
Hopper
Liquid Sludge Feed
INLET
HIGH PRESSURE SHEAR ZONE
LOW PRESSURE ZONE
FREE DRAINAGE ZONE
Filtrate back to plant

Belt Filter Press Performance Factors

- Sludge type/ Feed sludge changes
- Sludge conditioning/ Polymer dosage problems
- Belt
  - Tension pressure
  - Speed
  - Type

Requires close operator attention





Sludge Disposal

Must meet Federal 40 CFR 503 Regs

Must meet state Solid Waste Regs

- Land application
- Landfills
- Lagoons
- Incineration

The 503 Regulations

Overview

Reduction of pathogens

Vector attraction

Prevention or reduction of odor

Classification of Sludges

Type A Sludge

No health threat to humans and can be land applied with minimal reporting or testing

Anaerobically digested sludge

Composted sludge

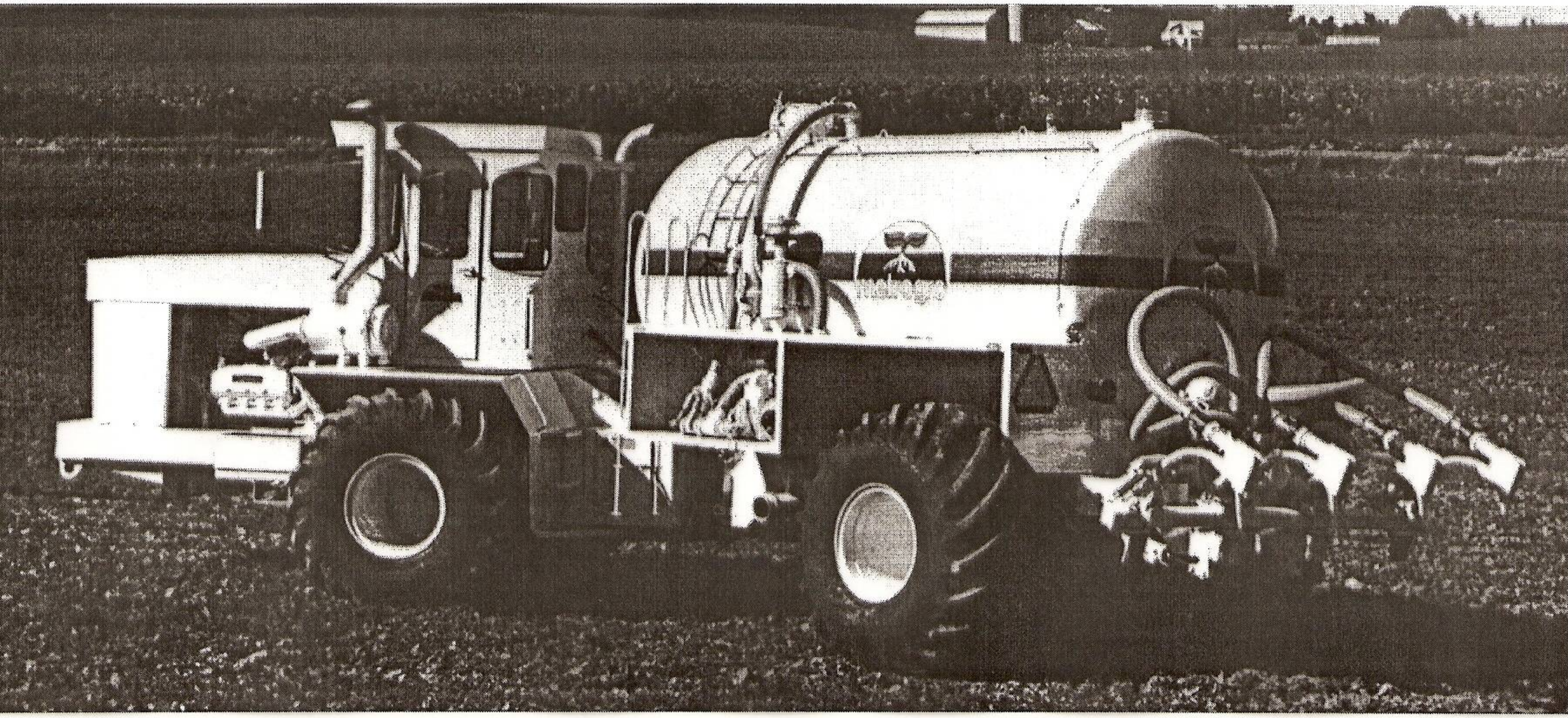
Type B Sludge

- Anaerobically digested sludge with lime stabilization
- Set-back restrictions

Type C Sludge

- Covered within 8 hours of application or injected into soil immediately upon application


WIDE LOAD



Toilet Paper Tidbits

- The *Old Farmers Almanac* began publication in 1792. Pages from these publications were often ripped out and used as toilet paper. Later editions have holes punched in them so they can be hung from a hook in outhouses.

- Newspapers were a popular choice for toilet paper in the 1700s because they were widely available.