



Headworks: The Start to Wastewater Treatment

Thursday, March 19, 2026
James Markham



*This program is made possible
under a cooperative agreement
with US EPA.*

Today's Agenda

- 01 Welcome & Introduction
- 02 What Is Headworks & Why Does It Matter?
- 03 Core Components: Screening, Grit Removal & Flow Measurement
- 04 Operations & Maintenance Considerations
- 05 How Headworks Impacts the Whole Plant
- 06 Strategic Considerations for Decision-Makers
- 07 Recap & Wrap-Up

Section 1: Welcome & Introductions



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Who we are



SOUTHWEST
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NM SCHOOL OF
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The Environmental Finance Center Network (EFCN) is a university- and non-profit-based organization creating innovative solutions to the difficult how-to-pay issues of environmental protection and environmental infrastructure.

The EFCN works collectively and as individual centers to address these issues across the entire U.S, including the 5 territories and the Navajo Nation. The EFCN aims to assist public and private sectors through training, direct professional assistance, production of durable resources, and innovative policy ideas.



Areas of Expertise



Asset Management



Rate Setting and Fiscal Planning



Leadership Through Decision-making and Communication



Energy Management Planning



Accessing Infrastructure Financing Programs



Workforce Development



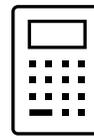
Collaborating with Other Systems



Resiliency Planning



Mapping and Data Collection



Wastewater Operator Certification



Webinar Logistics

- This session has not been submitted for pre-approval of Continuing Education Hours
- Slides will be emailed a day or two after the webinar
- Attendance certificates will be sent after the webinar is completed

Quick Poll: Who's in the Room?



Wastewater
Operator
/ Trainee or Plant
Staff



Utility Manager
or Director



Regulator or Other
Government
Official



Board Member /
Elected Official



Engineer
or Consultant



Technical
Assistance Provider

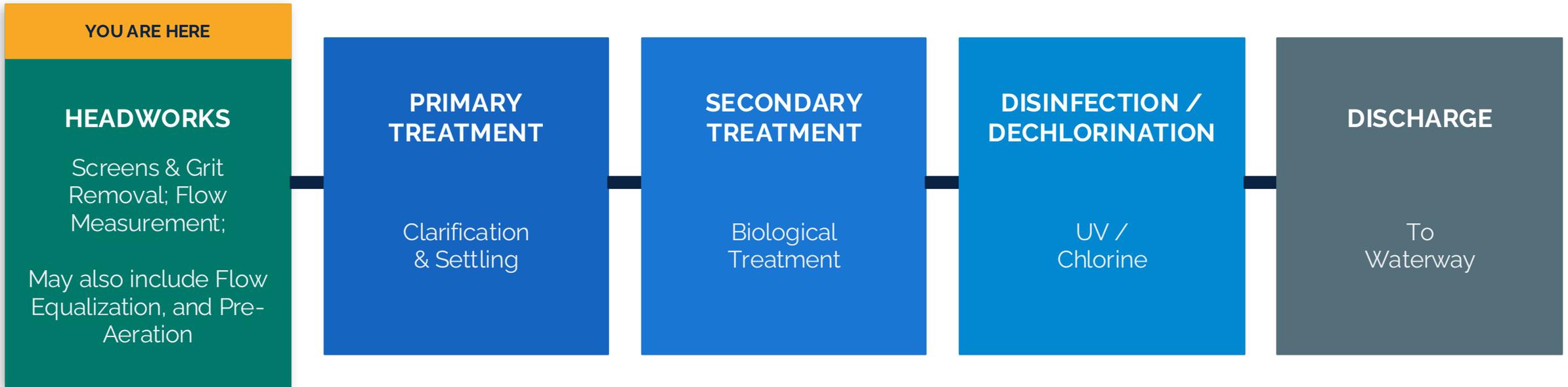
Section 2: Headworks Context & Why It Matters





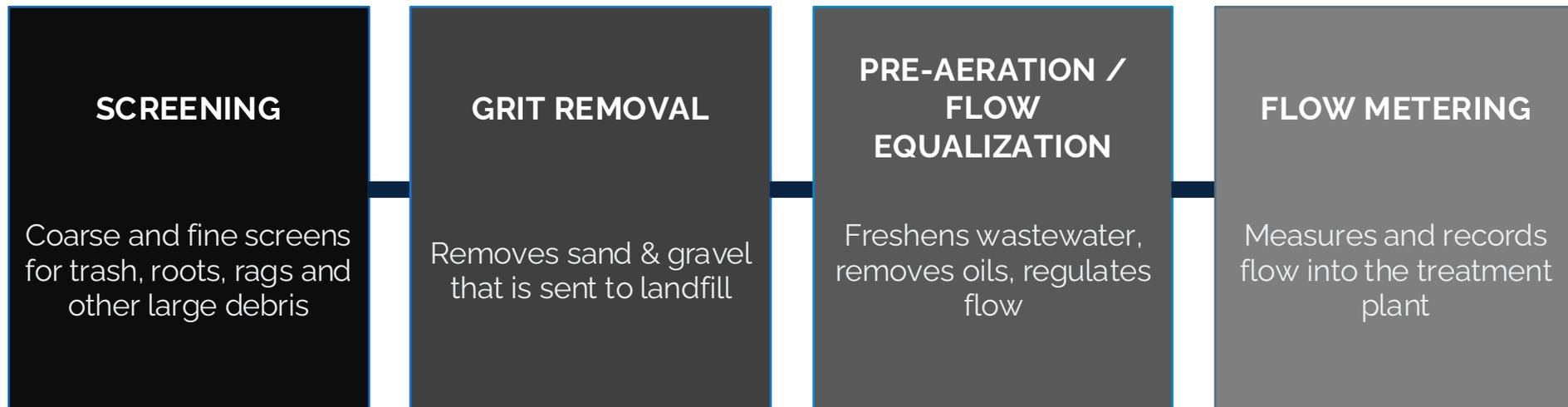


The Wastewater Treatment Train



Everything downstream depends on the headworks performing well.

A Typical Headworks Process Flow



Everything downstream depends on the headworks performing well.



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Poll Question

The First Line of Defense



Why Your Headworks Matters

- ✓ Removes large, damaging materials before they enter the treatment process
- ✓ Protects mechanical equipment throughout the entire plant
- ✓ Reduces wear, emergency downtime, and maintenance costs downstream
- ✓ Sets every downstream treatment stage up for success
- ✓ Directly supports regulatory compliance and your NPDES permit limits

What Happens When Headworks Fail?



Pump Ragging

Rags & wipes wrap impellers — pumps go offline for hours of manual cleaning



Grit Accumulation

Settles in aeration basins & digesters, reducing treatment capacity



Accelerated Wear

Abrasive grit damages pumps, pipes and all rotating equipment downstream



Process Upset

Shock loads destabilize biological treatment and reduce effluent quality



Increased Compliance Risk

Permit violations, regulatory scrutiny, potential fines



Increased Emergency Costs

Reactive repairs cost many times more than proactive maintenance

Regulatory Context

Clean Water Act

Establishes the federal framework for wastewater treatment standards across the United States.

NPDES Permits

Facility-specific permits set your effluent limits. Accurate flow reporting and treatment performance are direct requirements.

State Programs

State discharge permits also have specific effluent limits and requirements for solids handling. Your state may require headworks as part of facility design standards. Requirements vary — know yours.

Effective headworks performance is foundational to meeting permit limits — it's not optional, it's expected.

Section 3: Core Headworks Components

Screening • Grit Removal • Flow Measurement • Flow Equalization • Odor Control



Screening: Purpose & Function

What it removes:

Rags, wipes, plastics, wood, debris, and large solids entering with raw wastewater

Why it matters:

Protects pumps, pipes, and all downstream treatment equipment from clogging and damage

First physical step:

Screening is the very first treatment action that occurs when wastewater enters your plant; There may be layers of coarse and fine screens



SCREENING

Screening: Purpose & Function

What it removes:

Rags, wipes, plastics, wood, debris, and large solids entering with raw wastewater

Why it matters:

Protects pumps, pipes, and all downstream treatment equipment from clogging and damage

First physical step:

Screening is the very first treatment action that occurs when wastewater enters your plant. Screenings are disposed of, effluent drains back into treatment train.



Screening: Materials & Sizes

Materials:

Typically made from noncorrosive metal:

- Aluminum, or
- Stainless Steel

Gap Sizes:

- Between 3/8" and 2" it's a "Bar Screen"
- Over 2" it's a "Bar Rack" or "Trash Rack"

Cleaning:

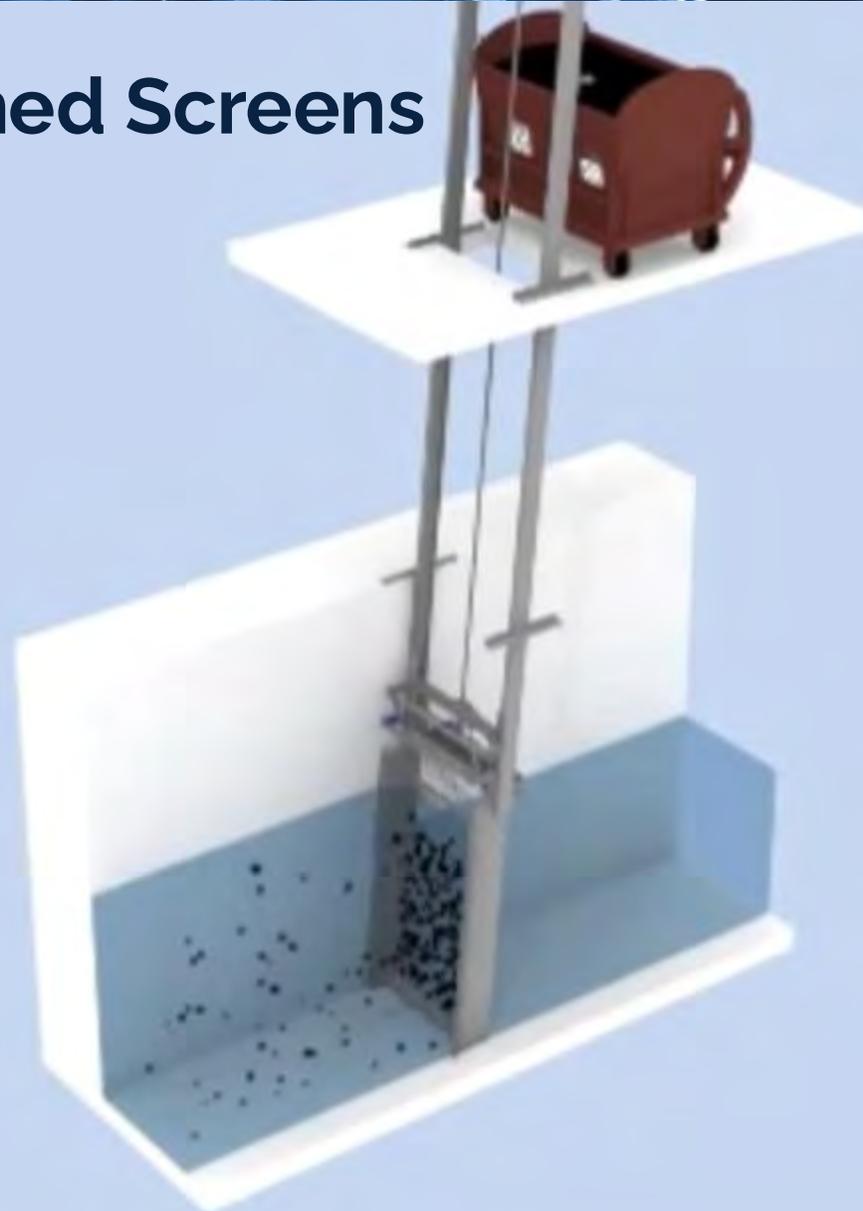
Manual or mechanical



Manually Cleaned Screens



Mechanically Cleaned Screens



Screenings ...



Screenings must drain back to influent



Screen Design Considerations

Screening Device Classification	Size Classification (range of screen opening)
Manually Cleaned Bar Screen	Coarse: 1 - 2 in
Mechanically Cleaned Bar Screen	Coarse: 0.6 - 0.3 in
Fine Bar Screen (Mechanically Cleaned)	Fine Coarse: 0.1 - 0.5 in

Coarse Solids Reduction: Purpose & Function

What it does:

Shreds rags, and other debris not captured by bar screens and leaves them in the influent flow; prepares debris for later removal; Reduces debris, but does not remove it.

Why it matters:

Protects pumps, pipes, and all downstream treatment equipment from clogging and damage

Types:

Communitors, grinders, macerators



Communitors & Grinders

What they do:

Communitors shred rags and debris, which are then left in the wastewater stream; Communitors are typically found in older treatment plants; Grinders now typically installed with lift stations

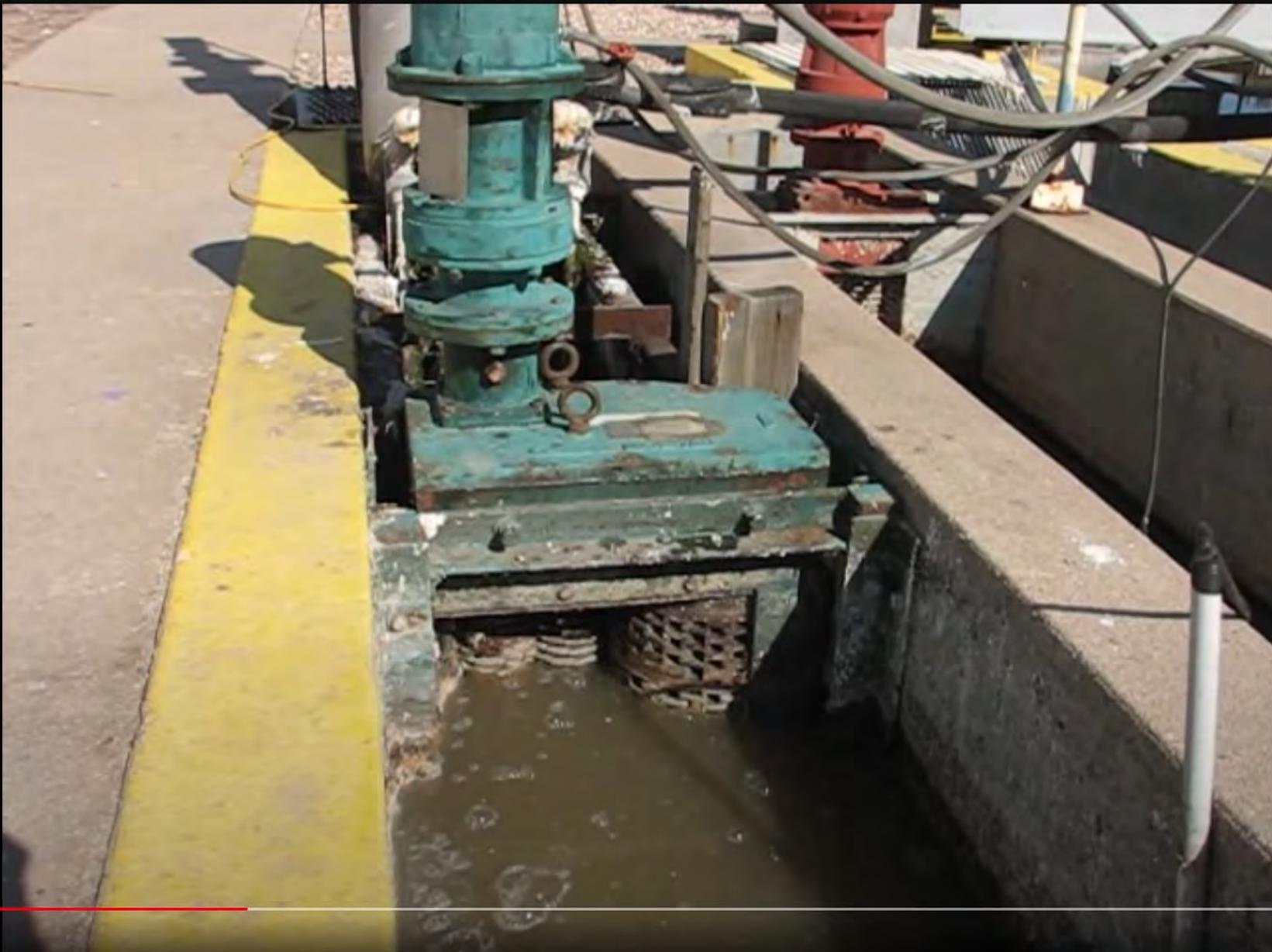
Pros:

Can take the place of bar screens; overcomes some screenings disposal issues, flies and odors

Considerations:

Require electricity to run; still need to remove shredded debris at a later stage; can clog, and be labor intensive to maintain; may still require a bypass channel with bar rack for high flow or downtime for repairs





0:02 / 0:08



Play (k)



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Dimminutor Solves Wipes Issues

Franklin Miller

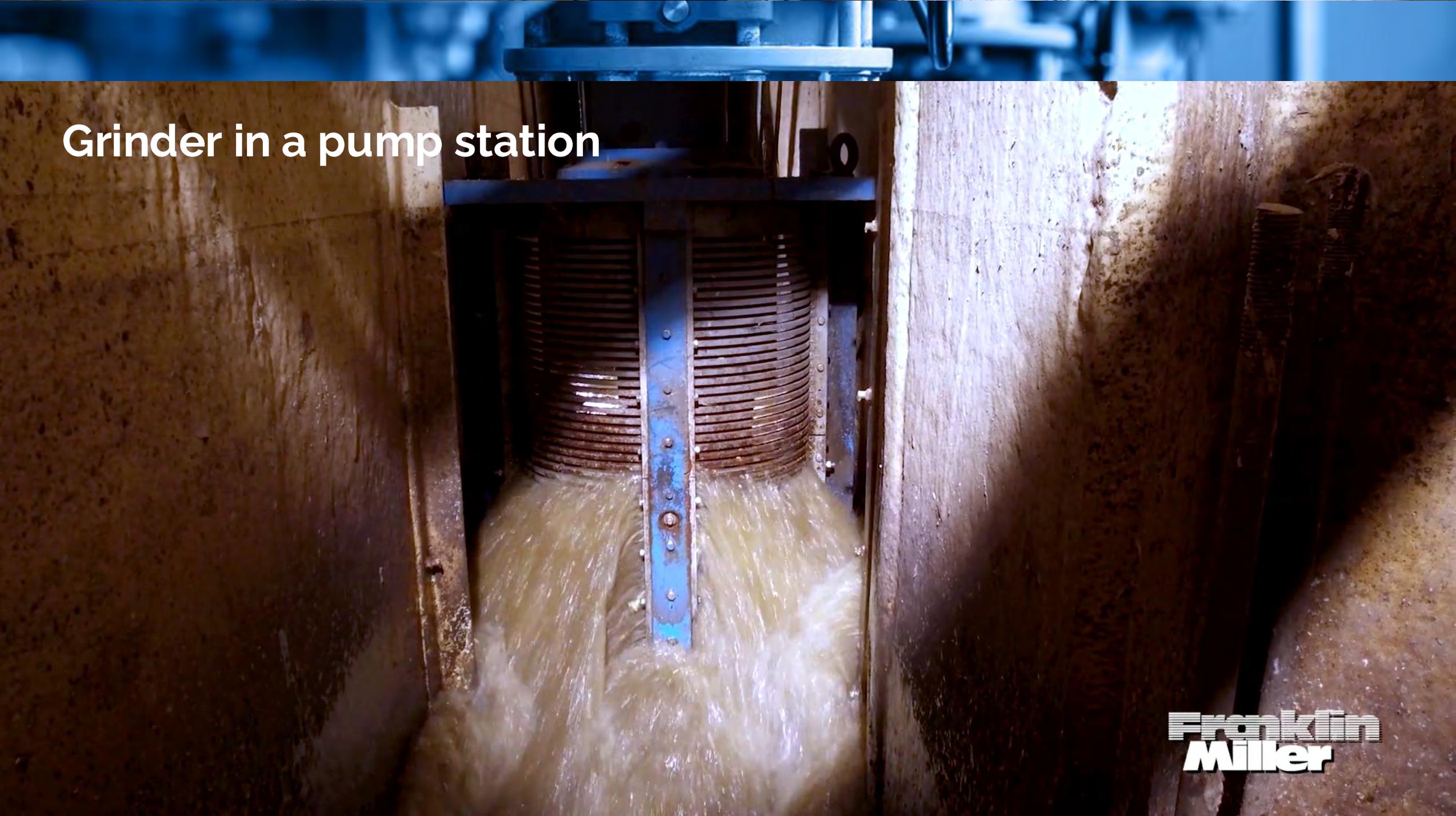
Grinder in a pump station



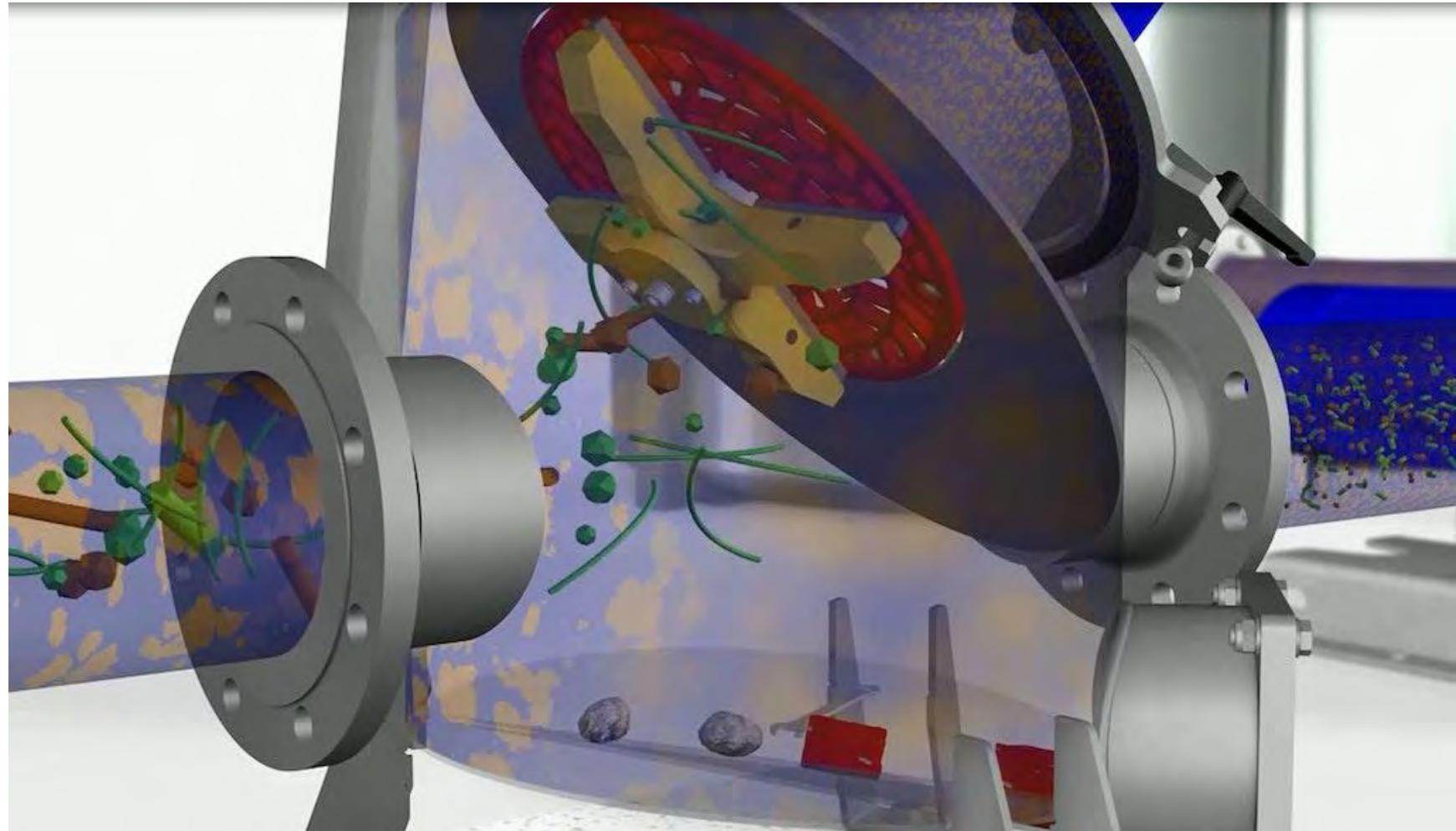
**Franklin
Miller**

Grinder in a pump station

**Franklin
Miller**



Macerators – For In-pipe Installations



Fine Screens: Purpose & Function

What it does:

Removes fine screenings not captured by bar racks (or produced by coarse screening reduction)

Why it matters:

Protects pumps, pipes, and all downstream treatment equipment from clogging and damage

Types:

Steps, Perforated Plates, Wedgewire, Static Screens, Rotary Drums



Fine Screens: Step Type



Fine Screens: Perforated Plate



Fine Screens: Perforated Plate



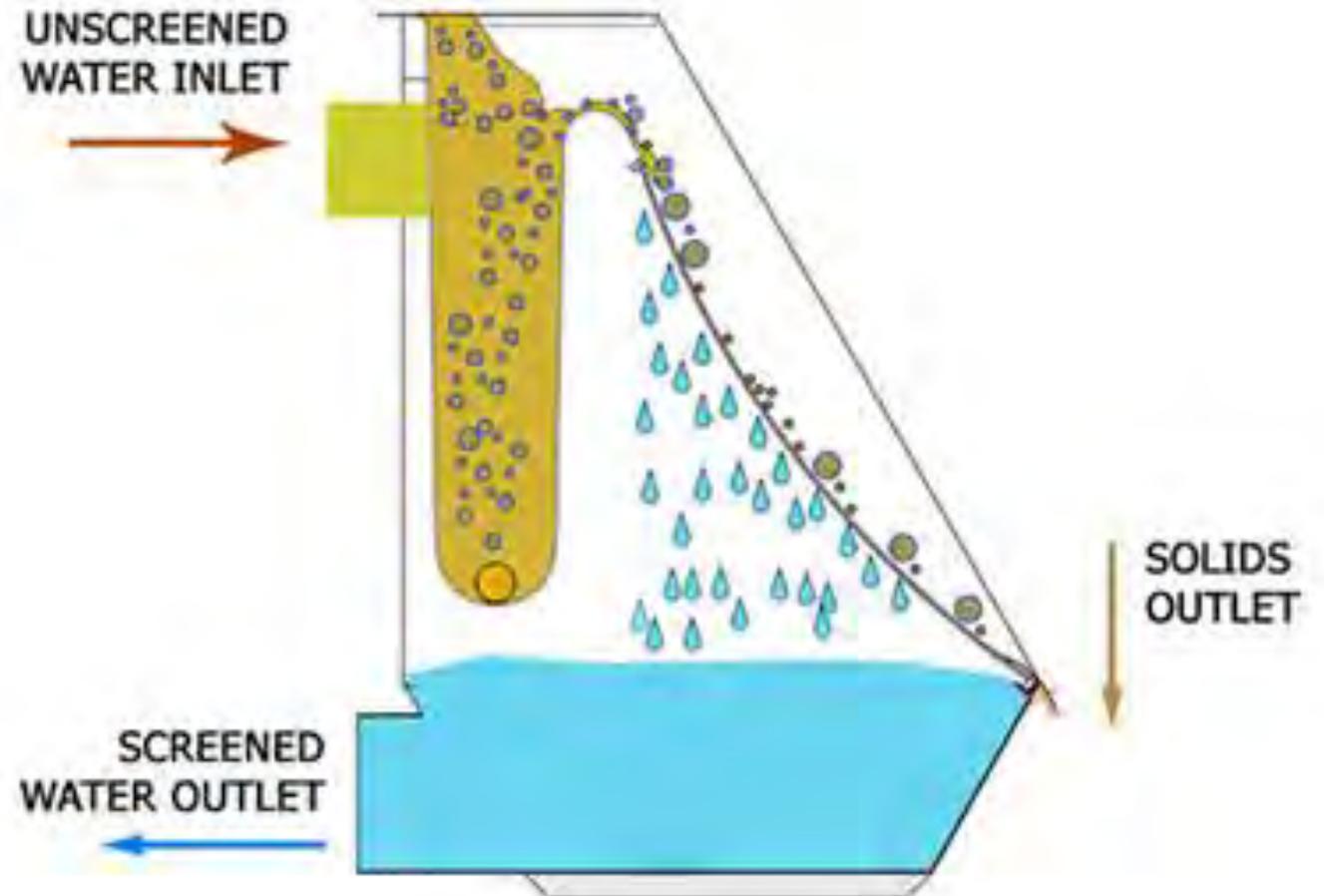
Fine Screens: Perforated Plate



Fine Screens: Wedgewire



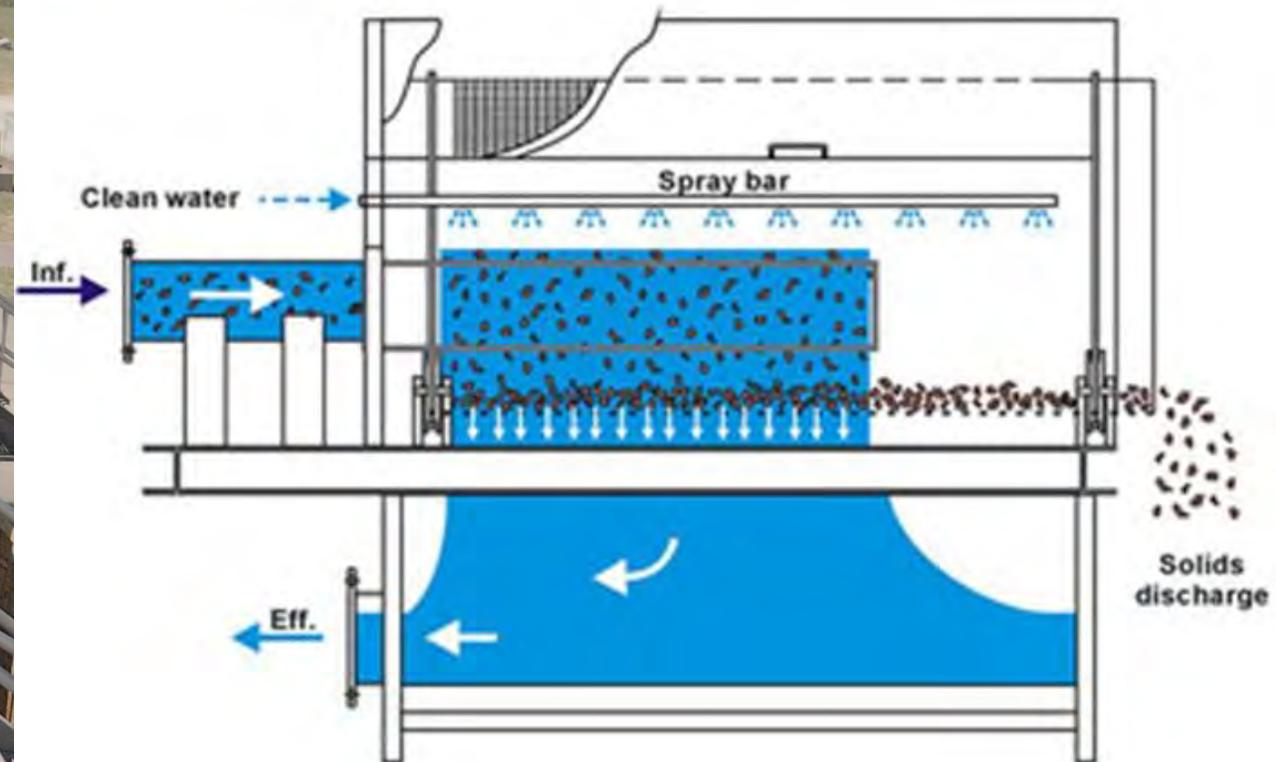
Fine Screens: Static Screen



Fine Screens: Rotary Drum



DAGYEE



Fine Screens: Design Considerations

Screening Device Classification	Size Classification (range of screen opening)
Fine Bar Screen (Mechanically Cleaned)	Fine Coarse: 0.1 – 0.5 in
Perforated Plate (Mechanically Cleaned)	Fine Coarse: 0.1 – 0.4 in
Rotary Drum (Mechanically Cleaned)	Fine Coarse: 0.1 – 0.5 in
Fixed Parabolic Fine Screen	Fine: 0.01 - 0.13 in
Rotary Drum	Fine: 0.01 - 0.13 in
Rotary Disk	Very Fine: 0.01 – 0.02 in

Screenings Handling



Grit Removal: Why It Matters

What is grit?

Sand, gravel, coffee grounds, eggshells, and small stones — heavy inorganic materials that don't break down.; Small particles larger than 0.21 mm with specific gravity of ~ 2.5



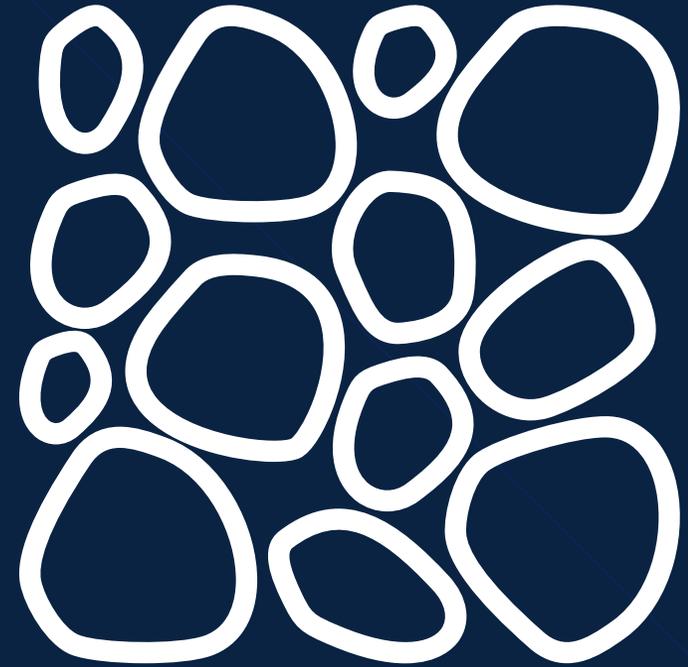
Highly abrasive — accelerates wear on pump impellers, pipe interiors, and all rotating equipment



Settles and accumulates in tanks — stealing capacity from aeration basins and digesters



Does not degrade — once inside the system, it only accumulates until costly cleanout is required



GRIT REMOVAL

Grit Removal: Grit Channels

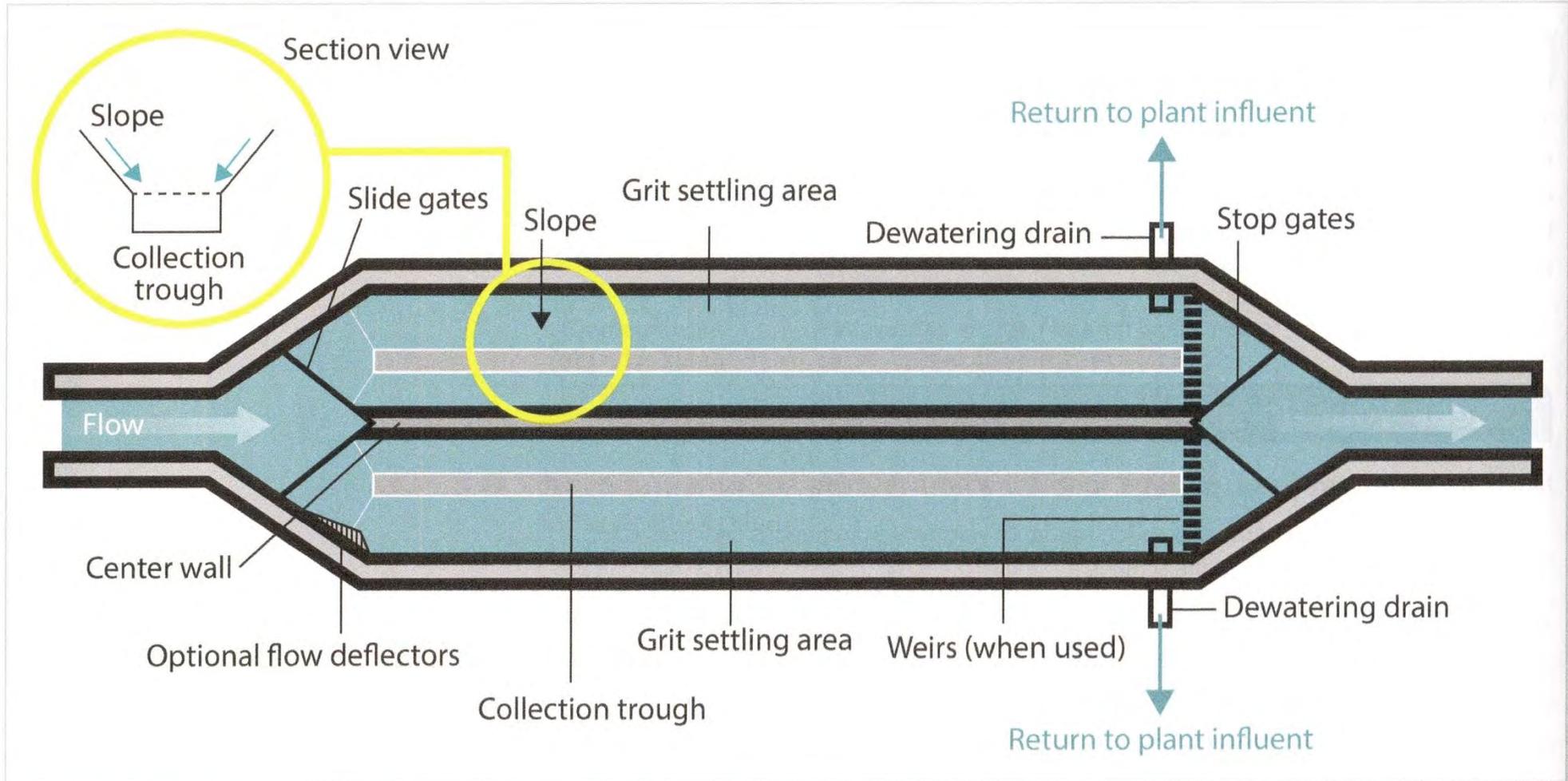


Figure 3.16 Grit channel

Grit Removal: Grit Channel Components

Component	Purpose
Settling Area	Place for grit to settle for later removal
Center Wall	Separates grit channels
Slide or Inlet Gate	Regulates number of channels in service for flow velocity
Stop or Outlet Gate	Insert to prevent backflow when cleaning
Weir	Controls channel water velocity
Grit Hopper or Grit Storage	Accumulates and stores grit before removal and disposal
Dewatering Drain	Drains channels for inspection
Drain Valve	Allows channel draining

Grit Removal: Grit Channels



Grit Removal: Grit Channels

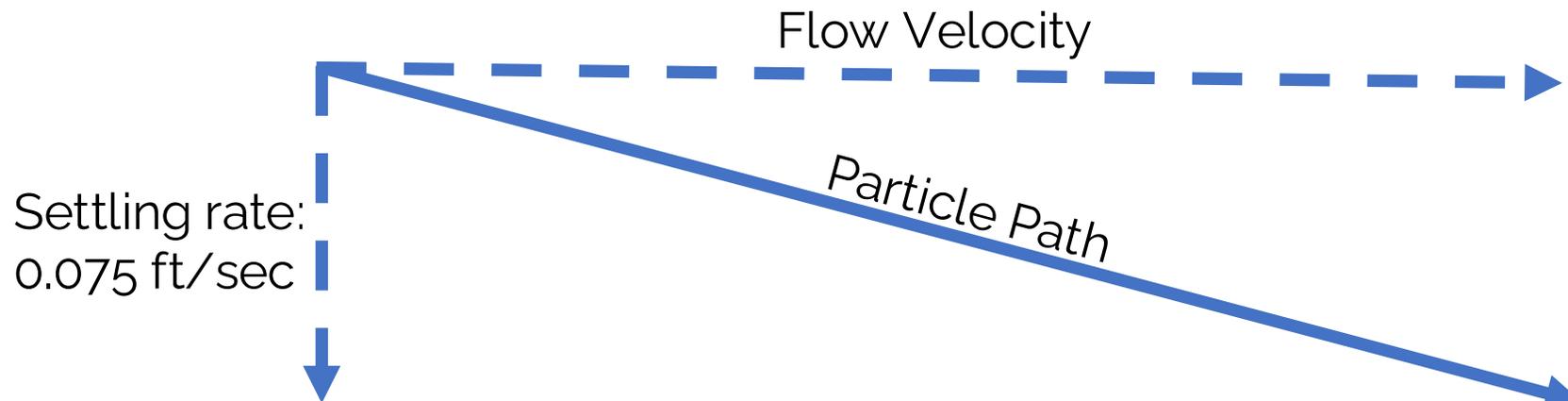


Grit Removal: Sedimentation

Designed to remove 0.2mm sized sand and heavier particles

They typically settle downward at about 0.075ft/sec

Imagine a 5 ft deep basin with 4 ft of water in it



$$\text{settling time} = \frac{\text{depth}}{\text{settling rate}}$$

$$\text{settling time} = \frac{4 \text{ ft}}{0.075 \text{ ft/sec}}$$

$$\text{settling time} = 53.3 \text{ seconds}$$

$$\text{velocity} = \frac{\text{length}}{\text{time}}$$

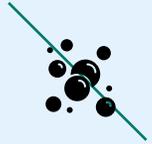
$$\text{velocity} \times \text{time} = \text{length}$$

$$1 \frac{\text{ft}}{\text{sec}} \times 53.3 \text{ sec} = 53.3 \text{ ft}$$

Grit Removal: Grit Channel Design Criteria

Item	Range Metric	Typical Metric
Detention Time	45 - 90 seconds	60 seconds
Horizontal Velocity	0.8 - 1.3 ft/s	1 ft/s
Settling Velocity (50 mesh)	9.2 - 10.2 ft/min	9.6 ft/min
Settling Velocity (100 mesh)	2 - 3 ft/min	2.5 ft/min
Headloss (% of channel depth)	30 - 40%	36%

Grit Removal: Other Options



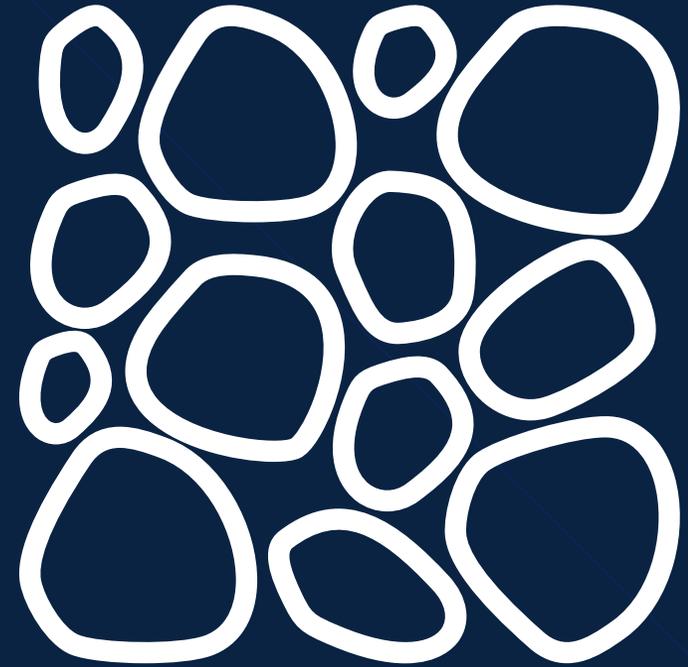
Aerated Grit Chambers



Cyclone Separators

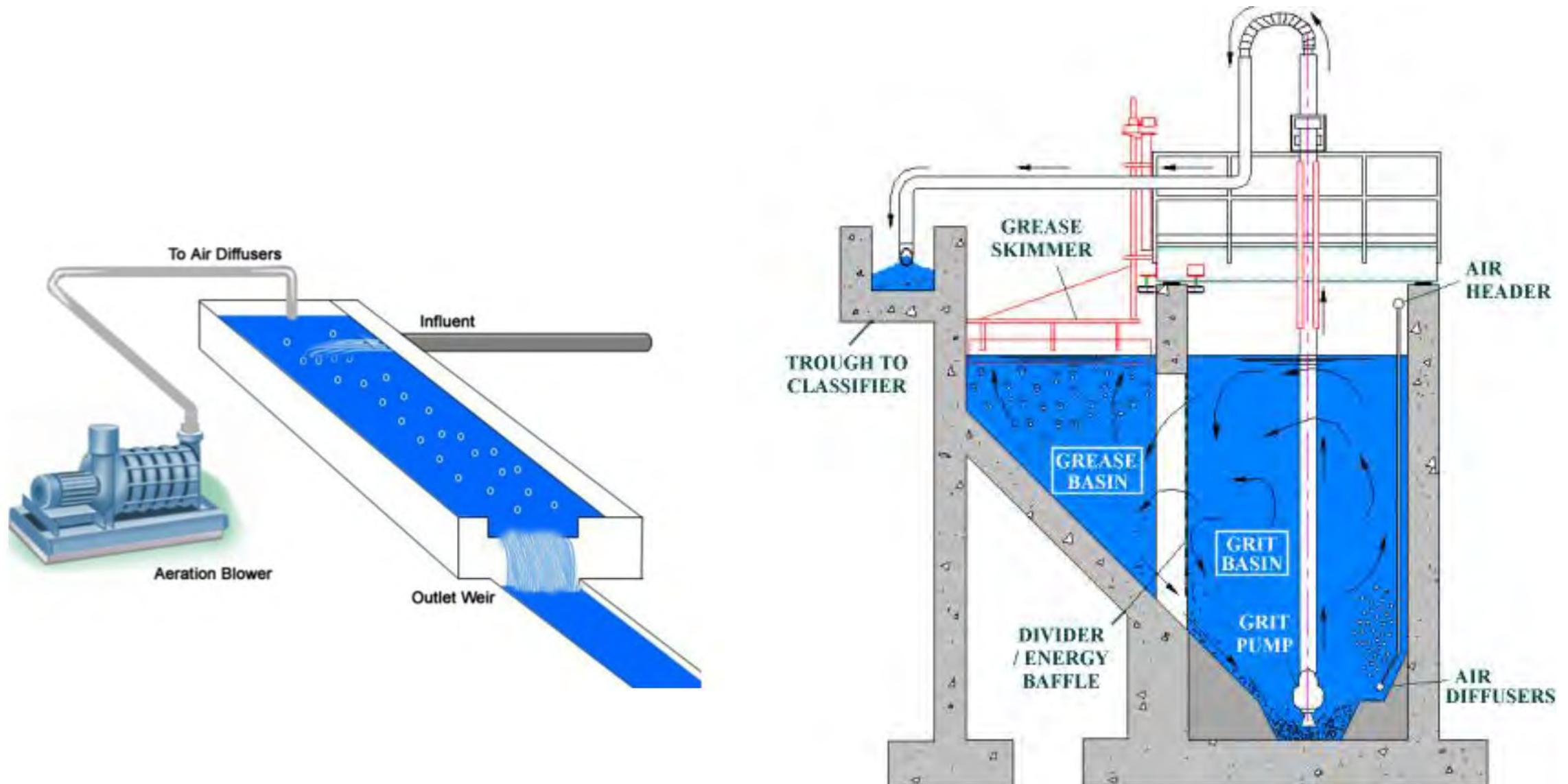


Vortex Separators



GRIT REMOVAL

Grit Removal: Aerated Grit Chamber



Grit Removal: Aerated Grit Chamber

Aeration:

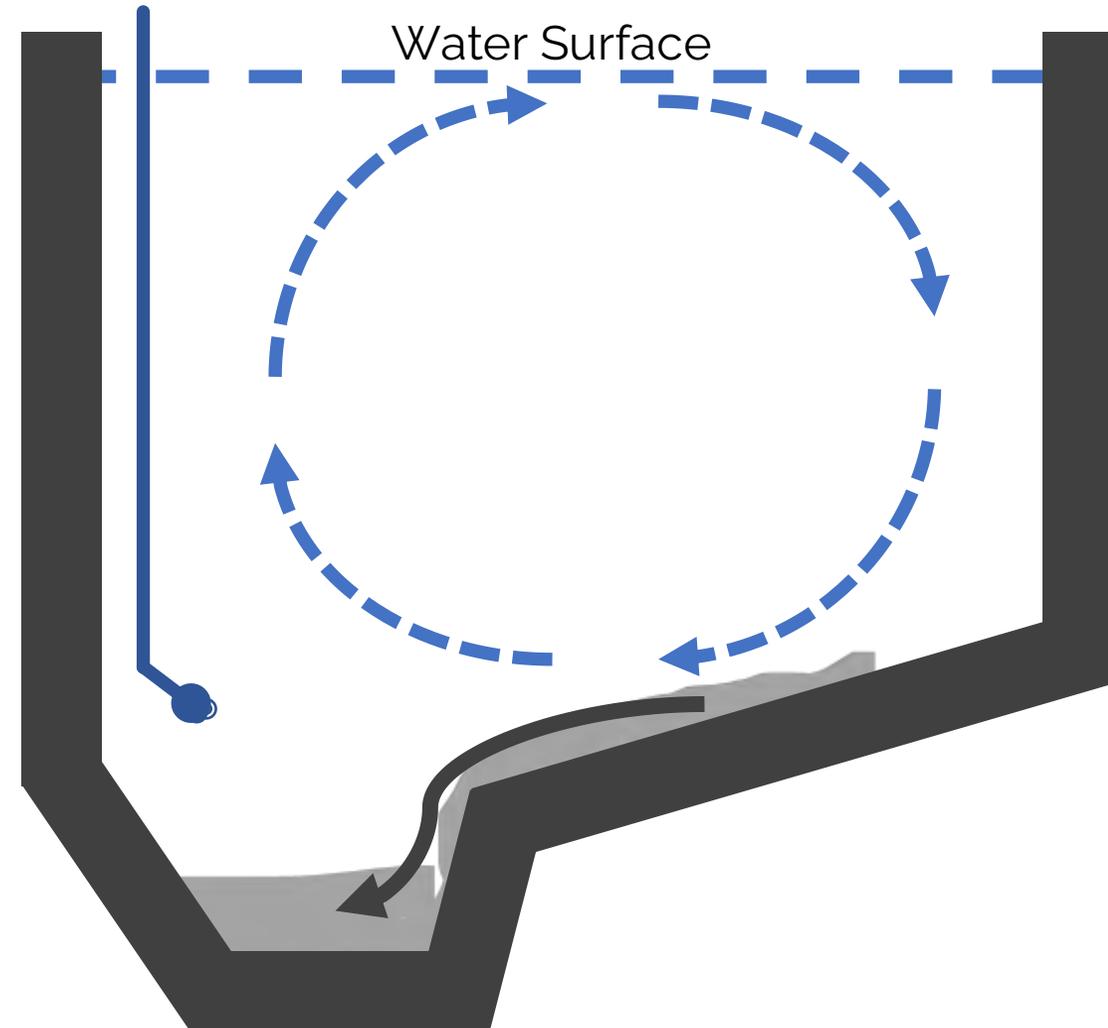
Disburses air into the wastewater to lower velocity. The air/water mixture has a lower specific gravity than water alone, causing grit to settle out better

Rolling Action:

The rolling action of the water induced by the aeration also moves grit toward the bottom faster than gravity alone

Low Detention Time :

Aerated grit chambers have low detention times – typically in the 3 to 5 minute range



Grit Removal: Cyclone Separator

Construction:

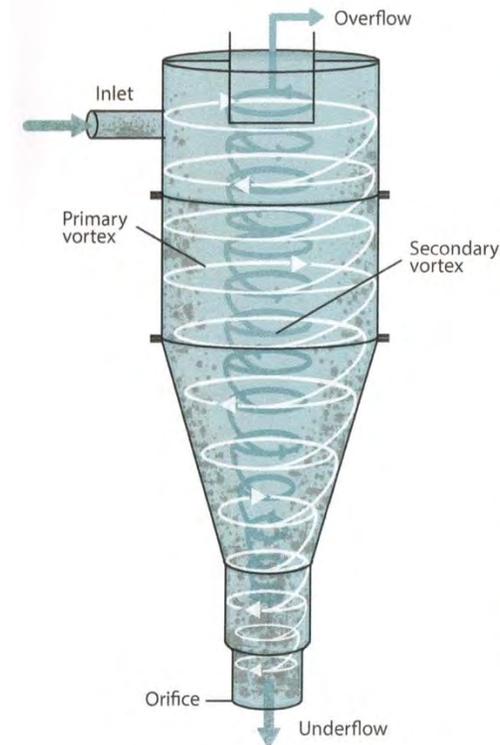
Similar to the dust collection systems in woodshops. Influent with grit enters the chamber at a tangent which creates a vortex. The grit falls to the bottom while water leaves near the tip and is returned to the plant for additional treatment

Benefits:

The cyclone separator itself doesn't have any moving parts – the stream of influent coming in creates the cyclone (note that auger disposal mechanisms do have moving parts)

Considerations:

Energy needed for pumps; still need coarse screens to prevent clogs; influent flow and pressure have to be closely monitored to ensure efficient operation;



Grit Removal: Vortex Separator

Construction & Usage:

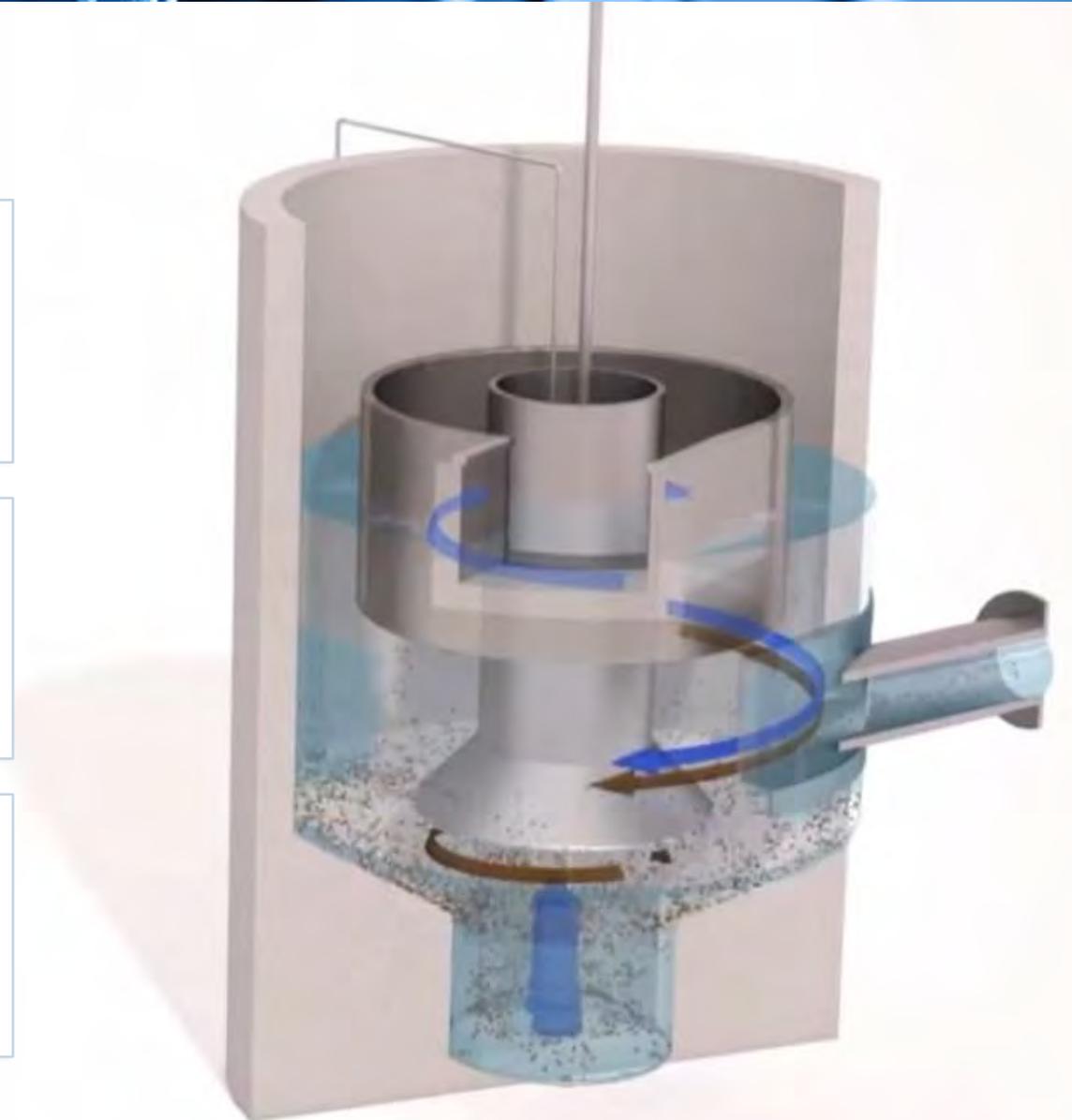
May have a grit pump at the bottom to extract accumulated grit; typically used where there is a lot of fine grit; removal up to 73% down to 0.004" (1/10 mm)

Pros:

No moving parts, consistent removal efficiency over wide flow ranges, low head loss; small footprints

Considerations:

Ideally need two units for redundancy, repairs or high flows; typically proprietary; can clog at grit sump



Grit Washing & Disposal:

Grit Washing:

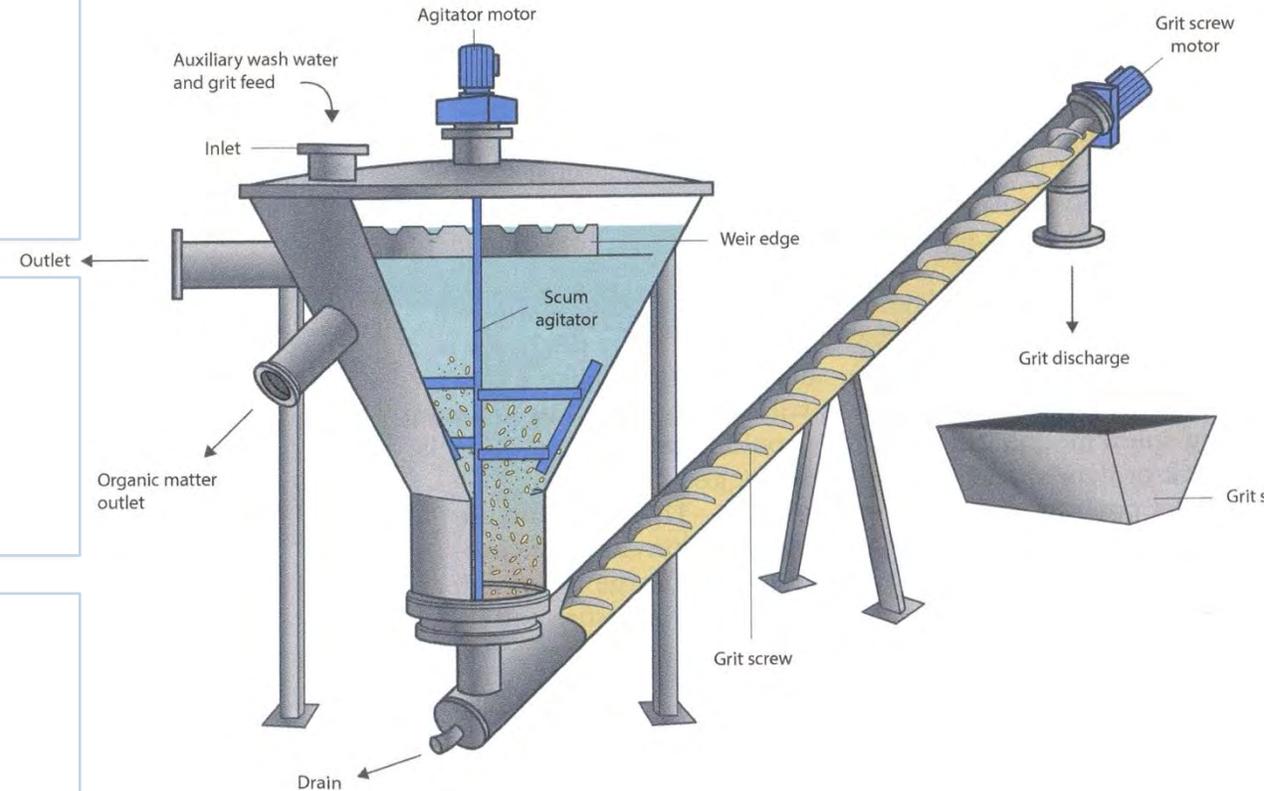
Might be necessary if flow in grit channel is low enough to allow larger quantities of organic matter to settle with grit.

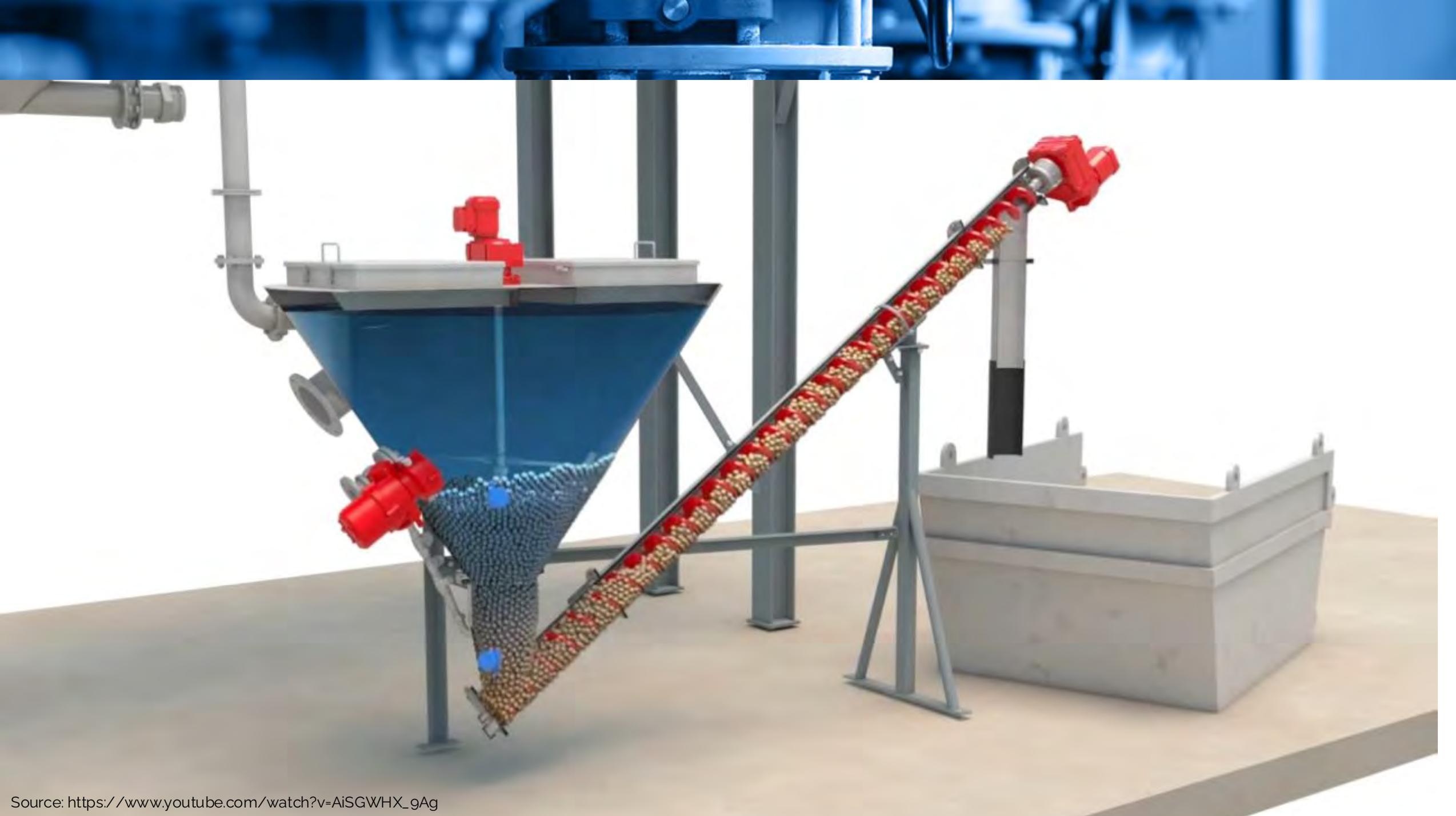
Operation:

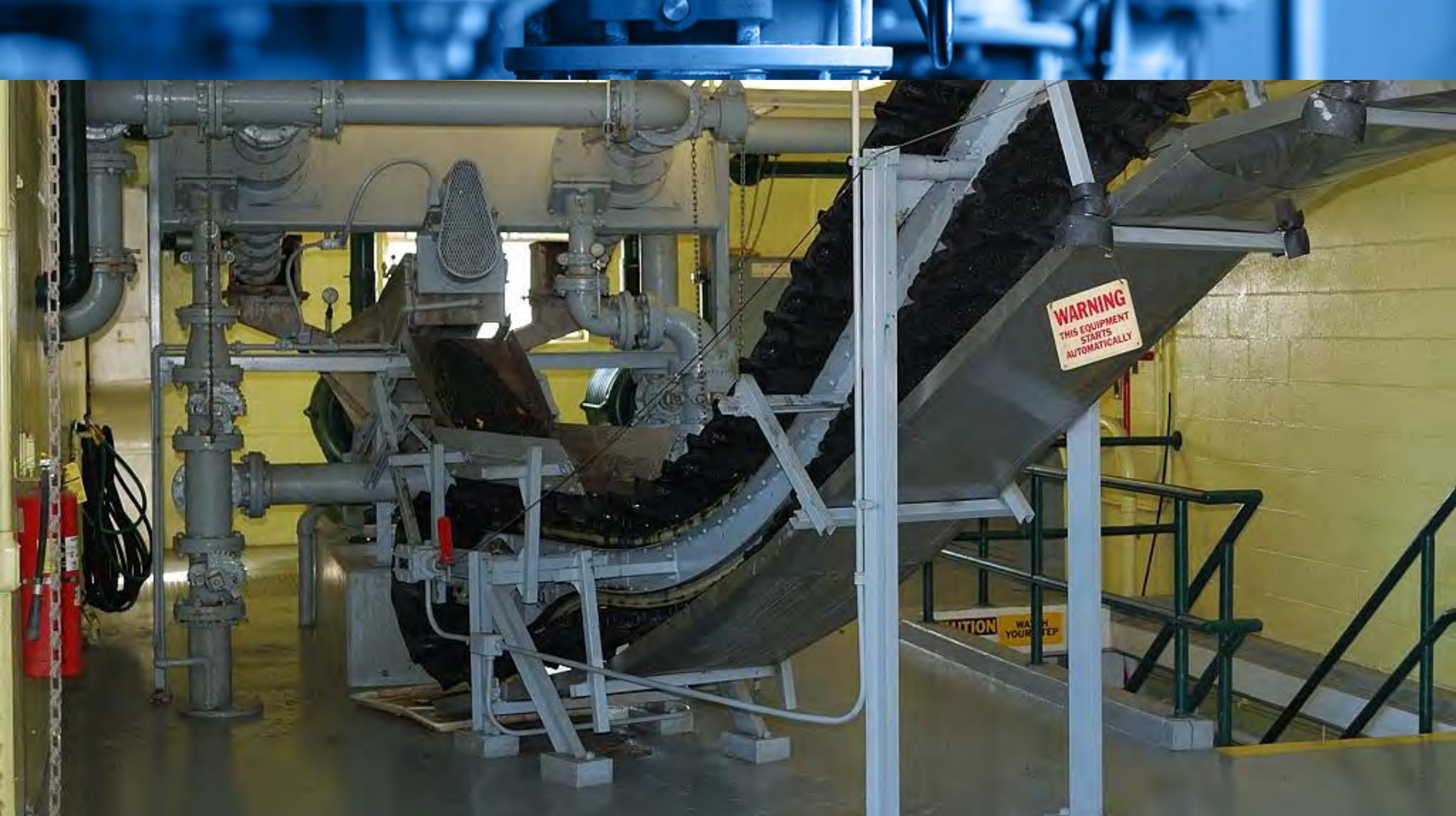
Grit is pumped into the classifier which uses centrifugal force to rinse and dewater grit. Grit is transported to disposal while liquids return to treatment train.

Considerations:

Can be part of odor control as well since organics left in the grit can decompose and cause odors and attract flies







WARNING
THIS EQUIPMENT
STARTS
AUTOMATICALLY

CAUTION WATCH YOUR STEP



DANGER
DO NOT OPERATE
WITHOUT GUARDS
IN PLACE

Waste Management
2004 91 2995



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Poll Question

Flow Measurement: Why It Matters

Compliance

NPDES permits require accurate flow reporting — it is a direct regulatory obligation at virtually every facility

Process Control

Drives chemical dosing calculations, hydraulic loading decisions, and recycle flow management

Capacity Planning

Essential for capital planning and identifying inflow & infiltration events in your collection system

Operational Insight

Wet weather spikes, peak events, and diurnal patterns reveal system behavior and health



**FLOW
MEASUREMENT**

Common Flow Measurement Devices

Parshall Flume

Open Channel

Controlled constriction creates predictable depth-to-flow relationship — depth measured upstream

★ **Robust, accurate, no moving parts**

Magnetic Flow Meter

Pressurized Pipe

Electromagnetic field measures velocity of conductive fluid — inline sensor

★ **Highly accurate; no moving parts; low maintenance**

Ultrasonic Meter

Open Channel or
Pipe

Sound waves measure flow velocity — contact or non-contact (in-line or clamp-on) configurations available

★ **Versatile, increasingly affordable**

Weirs

Open Channel

Notch creates a predictable head-flow relationship measured by a depth gauge; gauge may be manual or electronic

★ **Simple, reliable for lower flows**



Flow Equalization: Why It Matters

Process Control

Can be used to even out flow in the treatment plant from wet weather spikes, peak events and regular diurnal patterns

Design or Rehab Strategy

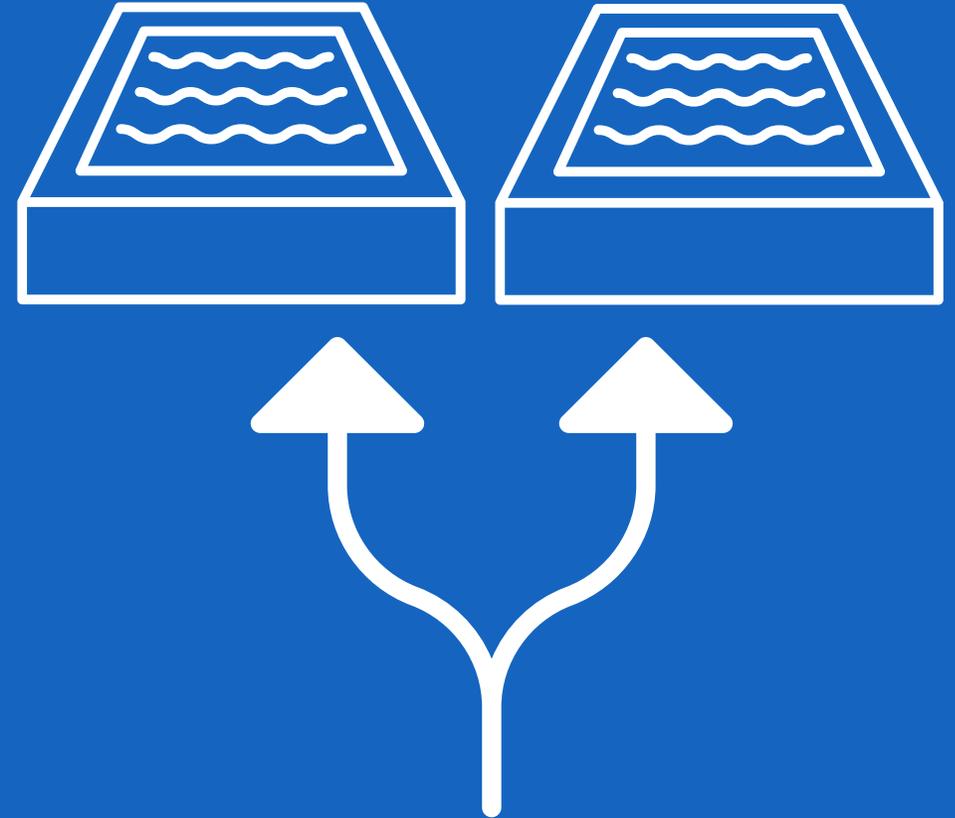
May allow for a smaller treatment plant

Design Considerations

Must be sized to account for extreme flows, particularly for combined systems

Design Considerations

Less common in the US than in Europe; Aeration is typically used so that stored volume doesn't become septic



**FLOW
EQUALIZATION & PRE-
AERATION**



Odor Control

Causes

Largely the result of organic decomposition

Typical Compounds

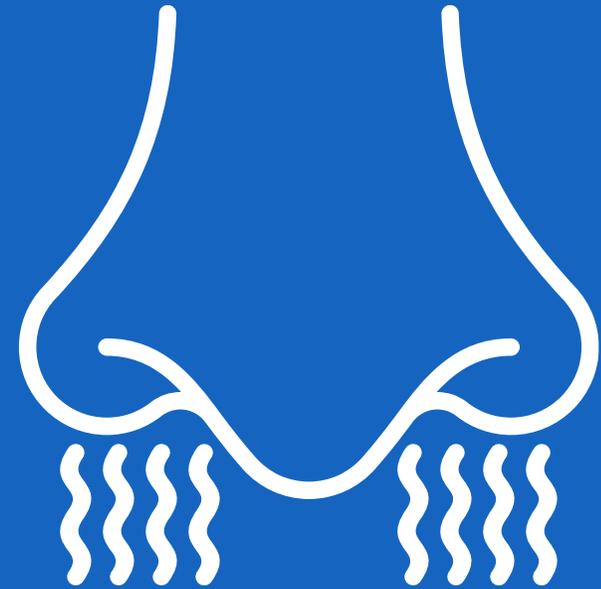
Hydrogen sulfide, ammonia, mercaptans; indole; Skatole & others

Management Strategies

Aeration, capture and treat; removing screenings frequently

Other gas byproducts are odorless

Carbon dioxide, nitrogen gas, methane, etc



ODOR CONTROL

Section 4: Operations & Maintenance Considerations

Daily inspection • Failure modes • Safety • Wet weather • Redundancy



Daily Inspection: What to Check Every Shift



Screen Operation

Is the cleaning cycle running? Rakes/steps moving freely? Any control panel alarms? Are there buildups on the racks resulting in excessive head loss?



Screenings Container

Filling at expected rate? More or less than normal signals a collection system or screen issue.



Grit System

Pump/classifier operating? Listen for unusual sounds — early mechanical warning signs.



Flow Meters

Readings consistent with expected influent patterns? No unexpected fluctuation? Sensors require maintenance; meters should be calibrated periodically.



Visual & Odor Check

Unusual foam, discoloration, debris accumulation, or odor changes?



Safety Systems & Processes

Is appropriate PPE in use? Are staff trained in emergency procedures? Are H₂S monitor readings normal? Is confined space equipment accessible and ready where necessary?

Common Failure Modes & Warning Signs

Failure Mode	Warning Sign	Root Cause
Screen Blockages	⚠ High differential head; restricted flow through screen	Cleaning cycle can't keep up with screenings volume — common during peak wet weather
Downstream Ragging	⚠ Pumps being unragged frequently; reduced pump performance	Material passing screens — wrong opening size, damage, or failed cleaning cycle
Grit Carry-Over	⚠ Grit accumulation in basins; increased turbidity	Grit bypass — undersized system, wear on equipment, or high-density grit events
Flow Meter Drift	⚠ Readings inconsistent with historical patterns	Biofouling on sensors, calibration drift, or physical damage to measuring element
Drive / Motor Failure	⚠ Screen not moving; no cleaning cycle occurring	Wear, age, or insufficient lubrication on mechanical drive components

Wet Weather & Seasonal Operations

Headworks doesn't operate at average flow – it operates at whatever flow shows up.



Rain Events

- May have much higher flows than normal during significant events if combined system or there are significant I&I problems
- Higher debris and grit loading possible – screens must keep pace
- Pre-event prep: empty containers, verify cleaning cycles



Cold Weather

- Freeze protection for exposed mechanisms is critical in some climates
- Ice on equipment – mechanical and slip hazards
- Heating system failures can shut down headworks fast



Spring Startup

- Inspect and service equipment after winter season
- Elevated I/I often brings increased grit and debris
- Good time for lubrication, calibration checks, and PM

Spare Parts & Redundancy Planning

Critical Spare Parts Inventory

- ✓ Screen rakes, teeth, and cleaning brushes
- ✓ Drive chains, sprockets, and motor components
- ✓ Grit pump impellers, wear plates, and seals
- ✓ Classifier components and ancillary parts
- ✓ Flow meter sensors and calibration equipment
- ✓ Fasteners, seals, gaskets for common wear points

Redundancy Principles

Design Standard: N+1

Most facilities design for two screen channels — one can go offline without losing headworks capability

Standby Must Be Operable

A standby screen not maintained in working condition is not redundant — test and service it regularly

Manual Screen as Backup

Even at mechanically screened plants, a manually cleaned backup provides insurance during failure

Safety is Paramount

 Headworks is one of the most hazardous areas in a wastewater plant. The requirements below are non-negotiable.

Mechanical, Shock & Gas Hazards

Mechanical and electrical equipment can pose significant hazards; Lockout/tagout procedures are mandatory.

H₂S is produced by anaerobic decomposition. Heavier than air — accumulates in channels and low-lying areas. Deadens your sense of smell at dangerous concentrations. Rapidly fatal at high concentrations.

Confined Space Entry/Water Safety

Headworks structures may have confined spaces. May require written permits, trained attendants, atmospheric monitoring before and during entry, and a rescue plan. No exceptions and no shortcuts.

Aerated basins provide little buoyancy and zero visibility; operators that fall in can sink in no time and drown before help arrives.

PPE & Monitoring Equipment

Fixed H₂S monitors plus portable monitors for anyone near or entering confined spaces.

Appropriate respiratory protection, gloves, and eye protection are required at all times in active headworks areas.

Floatation devices should be available at basins.



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Poll Question

Section 5: How Headworks Performance Impacts the Whole Plant

The downstream domino effect



Downstream Protection: The Domino Effect



Influent Pumps

Ragging wraps impellers — requires shutdown, manual cleaning, and accelerated component wear. Emergency repairs can be very expensive



Aeration Basins

Grit settles at the bottom — reduces effective treatment volume, covers diffusers, and reduces aeration efficiency across the basin.



Digesters

Grit and debris accumulate — reduces available digester volume and can damage mixing equipment over time.



Dewatering Equipment

Rags and debris cause accelerated wear on belt presses and centrifuges — reducing throughput capacity and equipment life.

Real Cost of Headworks



REACTIVE — When Headworks Fails

Emergency pump repair	\$5K or more per event
Aeration basin grit cleanout	Significant expense and downtime
Digester cleanout (grit/rag)	Could require significant capital expense
Regulatory fines (permit violation)	May be significant
Unplanned labor and overtime	Ongoing burden on employees and budget



PROACTIVE Approach



Regular inspections & cleaning



Spare parts inventory maintained



Timely component replacement



Operator training & awareness



Capital planning for end-of-life

Proactive headworks maintenance costs a fraction of reactive failure. The math is always clear.

Section 6: Capital Planning

Strategic Considerations for Decision Makers



Capital Planning & Equipment Lifecycle

Equipment	Typical Service Life	Capital Planning Action
Mechanical Screens	10–25 years	Track age and condition; plan replacement before emergency failure occurs
Grit Removal Systems	20–45 years	Monitor removal efficiency; upgrade when performance or parts availability declines
Flow Metering Equipment	Sensors: 5–20 yrs	Budget for sensor replacement cycles; include calibration verification annually



Asset Management Tip

Even a simple spreadsheet tracking headworks equipment age, condition, and maintenance history gives you a foundation to plan replacements proactively rather than reactively. An Asset Management Plan that is kept up to date is an even better option.

Funding Opportunities for Headworks Improvements

State Revolving Fund (SRF)

Low-Interest Loans

EPA Clean Water SRF — low-interest loans for eligible wastewater infrastructure. Headworks improvements almost always qualify.

USDA Rural Development

Grants & Loans

Water & Environmental Program — particularly valuable for rural utilities. Offers both grant and loan financing for water and wastewater projects.

State-Specific Programs

Varies by State

Many states have additional funding mechanisms beyond federal programs. Contact your state program office early in the planning process.

Start conversations with your state SRF program office early — before designs are finalized. Favorable financing can significantly reduce the burden on your ratepayers.

Funding Opportunities for Headworks Improvements



Section 7: Wrapping up

Key takeaways – Q & A



Key Takeaways

01

Headworks is the foundation — what happens here affects the entire treatment process, not just the front end

02

The critical components: screening, grit removal, and flow measurement (with equalization and pre-aeration) — each has a distinct, essential function

03

Proactive maintenance is a fraction of reactive repair costs — the math always favors prevention

04

Your headworks data tells a story about your collection system and facility health — pay attention to it

05

Capital planning and available funding make headworks upgrades achievable — start before equipment fails



Q & A

CONTACT INFORMATION



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