



Operator Certification: Solids Handling Part 1 - Mechanical Solids Separation

Wednesday, March 31, 2026

Your trainers for today:



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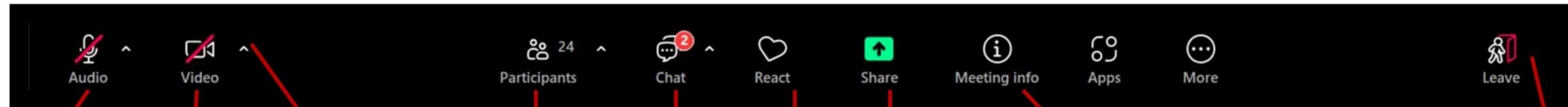
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This training series is funded by the EPA

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- All attendees will see a black horizontal bar on their screen
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Participants

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WPI/ABC Operator Certification

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Q Search ...

Standardized Wastewater Treatment Operator Exams

Wastewater Treatment Operator Need-to-Know Criteria

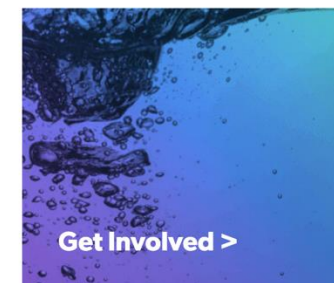
Need-to-Know Criteria outline the content that will be covered on WPI's standardized examinations provided through [ABC Testing](#), a WPI service.

- [Wastewater Treatment Operator Class I](#)
- [Wastewater Treatment Operator Class II](#)
- [Wastewater Treatment Operator Class III](#)
- [Wastewater Treatment Operator Class IV](#)

Wastewater Treatment Operator Formula/Conversion Table

WPI standardized exams are administered with a Formula/Conversion Table containing mathematical formulas and common abbreviations that may be present on the exam.

- [Wastewater Treatment Operator Formula/Conversion Table](#)



Schedule for 2025:

Date	Topic
1/20/26	Concept and math review Session
2/3/26	Disinfection Part 1 (chlorination/dechlorination) + related math
2/17/26	Disinfection Part 2 - UV and other methods
3/3/26	WW Math Part 3 (Flow, Detention Time)
3/17/26	WW Math Part 4 (BOD Math /Advanced WW Math)
→ 3/31/26	Solids Handling Part 1 (Mechanical Solids Separation)
4/14/26	Solids Handling Part 2 (Solids Handling)
4/28/26	Sampling
5/12/26	Regulations (NPDES Permits and Discharge Limitations)
5/26/26	Treatment System Maintenance
6/9/26	Lab Procedures/Analysis/Interpretation
6/23/26	Using Technology in daily operations (SCADA, Computer, Tablets, CMMS, AI, etc.)
7/7/26	Course Review Session

<https://swefc.unm.edu/home/op-cert-trainings/>



Wastewater Training Schedule

Please note all times are local to CNMI and Guam. The times in American Samoa are one day earlier at 11 am.

Session	Date	Training Topic & Link to Recording (click to view)	Supporting Materials (click to download)
1	6/25/2025	Program Overview, Test Format, Study & Test Tips	PPT slides
2	7/9/2025	Treatment Overview	PPT slides
3	7/23/2025	WW Math Part 1 (Areas & Volumes)	PPT slides
4	8/6/2025	WW Math Part 2 (Flow Rates & Detention Times)	PPT slides
5	8/20/2025	Collection Systems – Gravity systems	PPT Slides
6	9/3/2025	Collection Systems – Pumping & Force Mains	PPT Slides
			Collection Systems (Grades 1 – 2) Course #401
			Tech Brief – Reading Centrifugal Pump Curves
			Grundfos E-cademy – Pump Selection Basics
7	9/17/2025	Collection System Maintenance	PPT Slides
8	10/1/2025	Operator Safety/OSHA/Chemical Safety & Inventory	PPT Slides
9	10/15/2025	Preliminary Treatment	PPT Slides
10	10/29/2025	Primary Treatment: Sedimentation	PPT Slides
11	11/12/2025	Fixed-Film Media	PPT Slides
12	12/2/2025	Activated Sludge Part 1	PPT Slides
13	12/16/2025	Activated Sludge Part 2	PPT Slides
14	1/20/2026	Concept and Math Review Session	PPT Slides
15	2/3/2026	Disinfection Part 1 (chlorination/dechlorination) + related math	PPT Slides
16	2/17/2026	Disinfection Part 2 – UV and other methods	PPT Slides
17	3/3/2026	WW Math Part 3 (Flow, Detention Time)	PPT Slides
18	3/17/2026	WW Math Part 4 (BOD Math /Advanced WW Math)	PPT Slides

Sign in for every session to ensure you get credit for attending



US Territories Water & Wastewater Operator Certification
Virtual Training Series Group Attendance Sheet

Session Title: _____
Session Date: _____
Training Location: _____

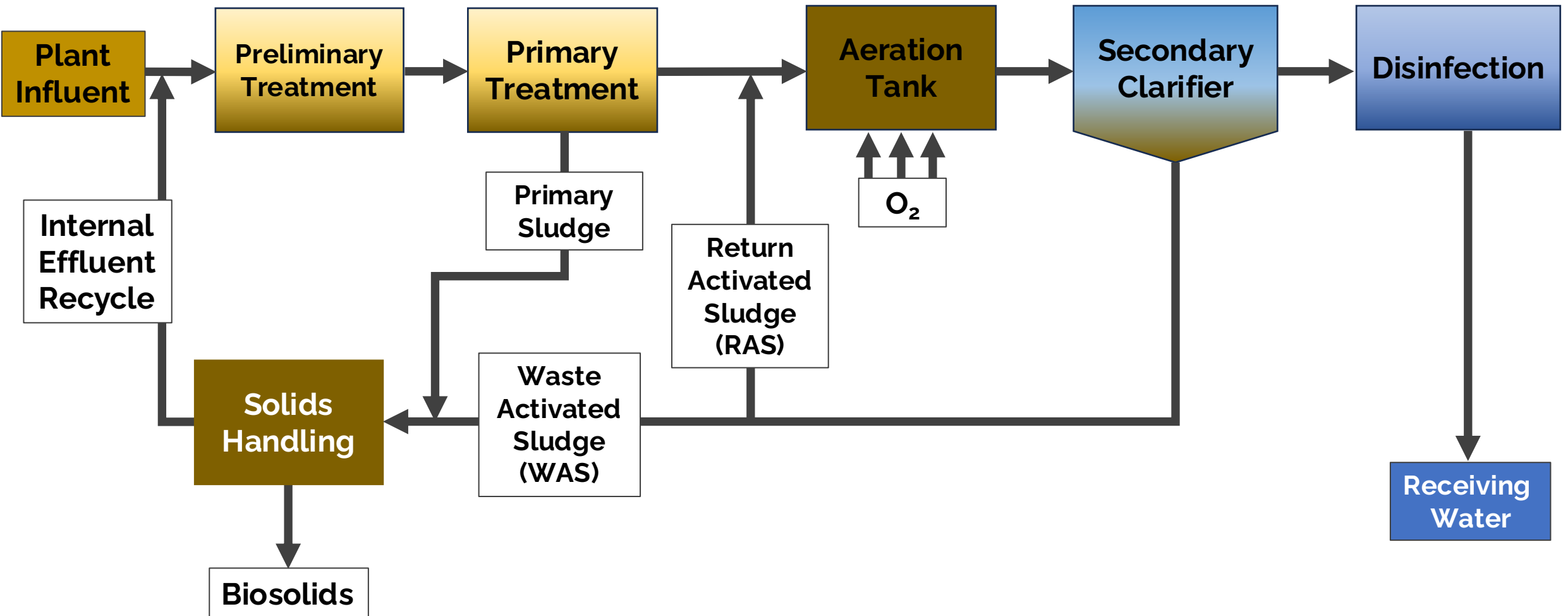
Attendee Name	Attendee Signature	Arrival Time	Departure Time

I hereby certify that the individuals listed above attended the referenced training session.

Name: _____
Signature: _____
Title: _____
Date: _____

Some review to start
with...

Wastewater Flow Schematic



Preliminary Treatment

Screenings and Grit

Coarse Screenings



Fine Screenings



Grit Removal

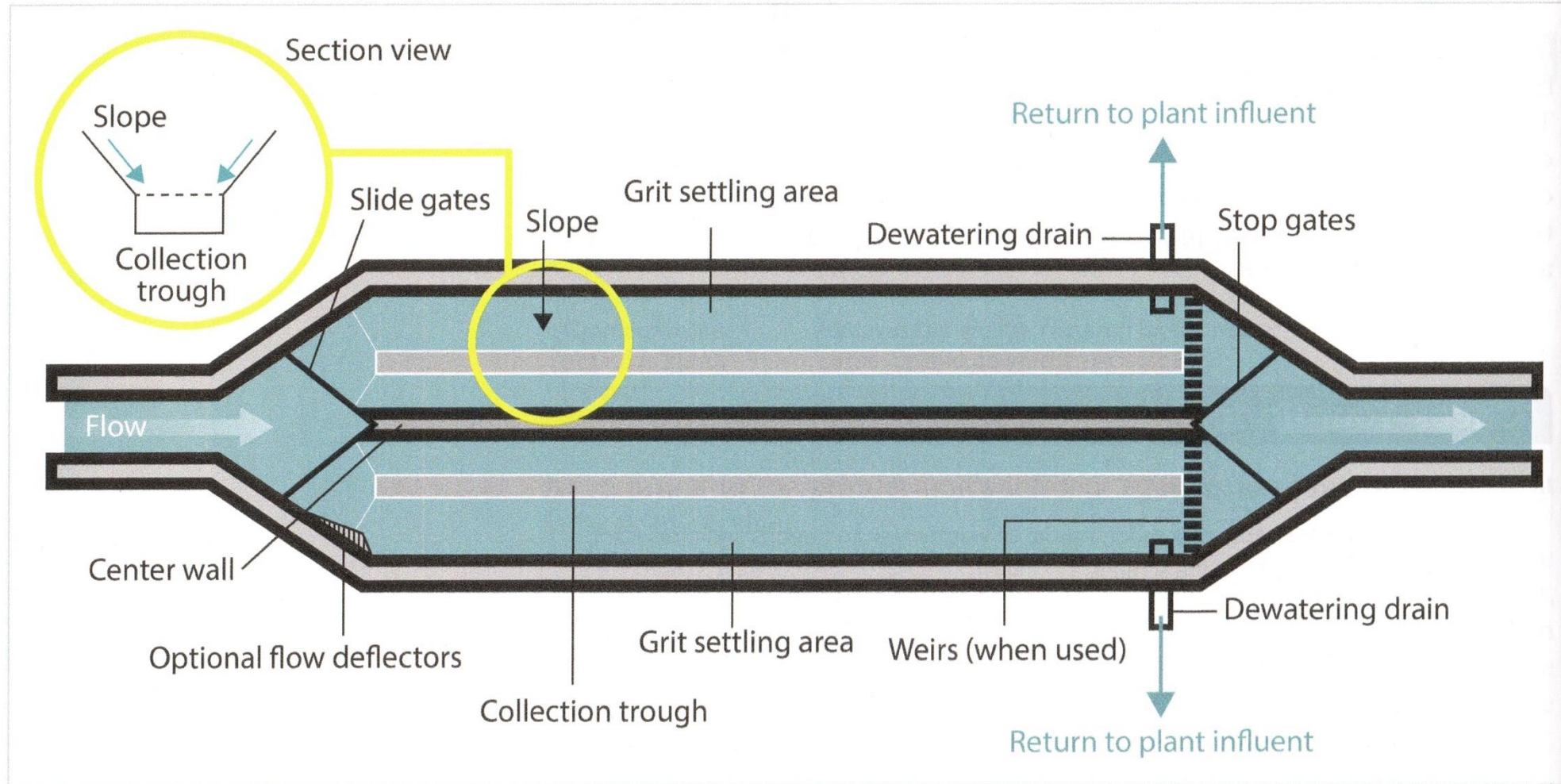
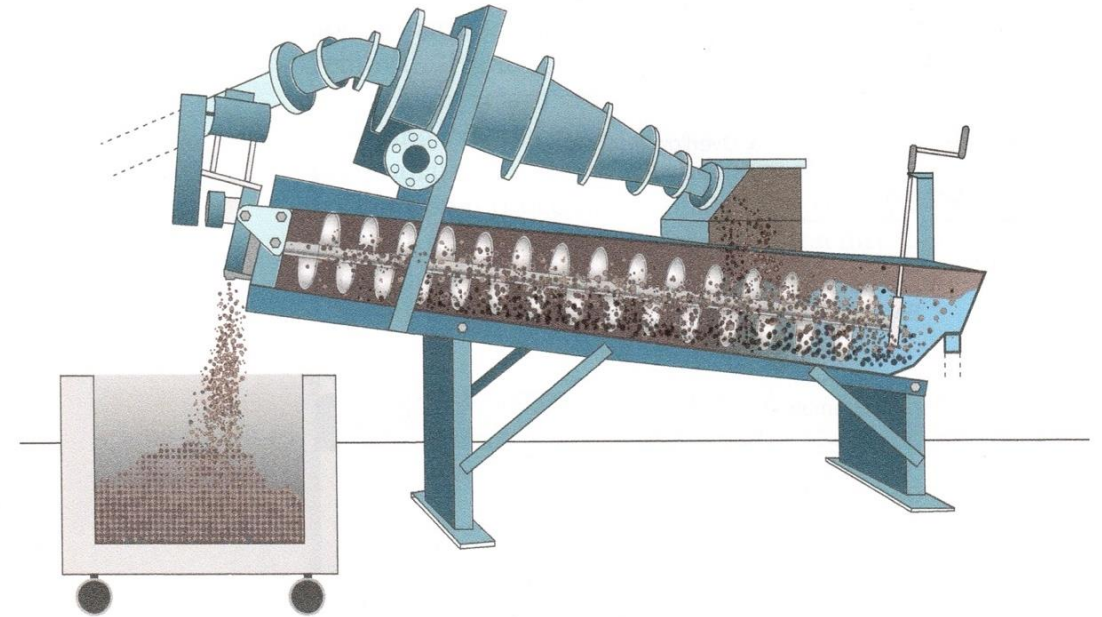
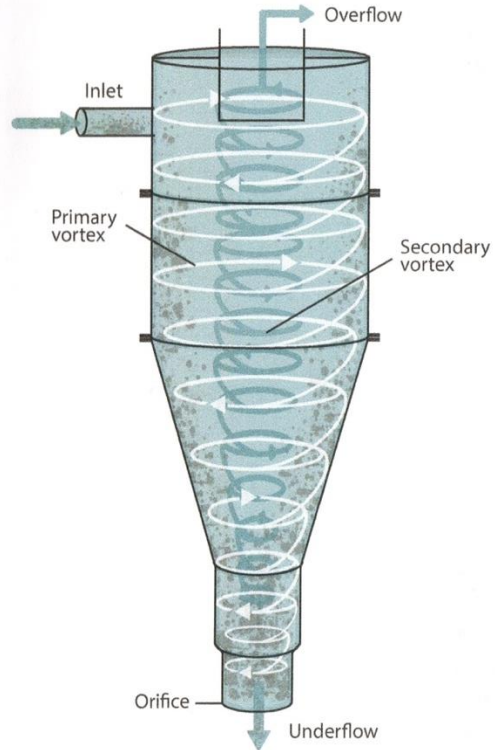
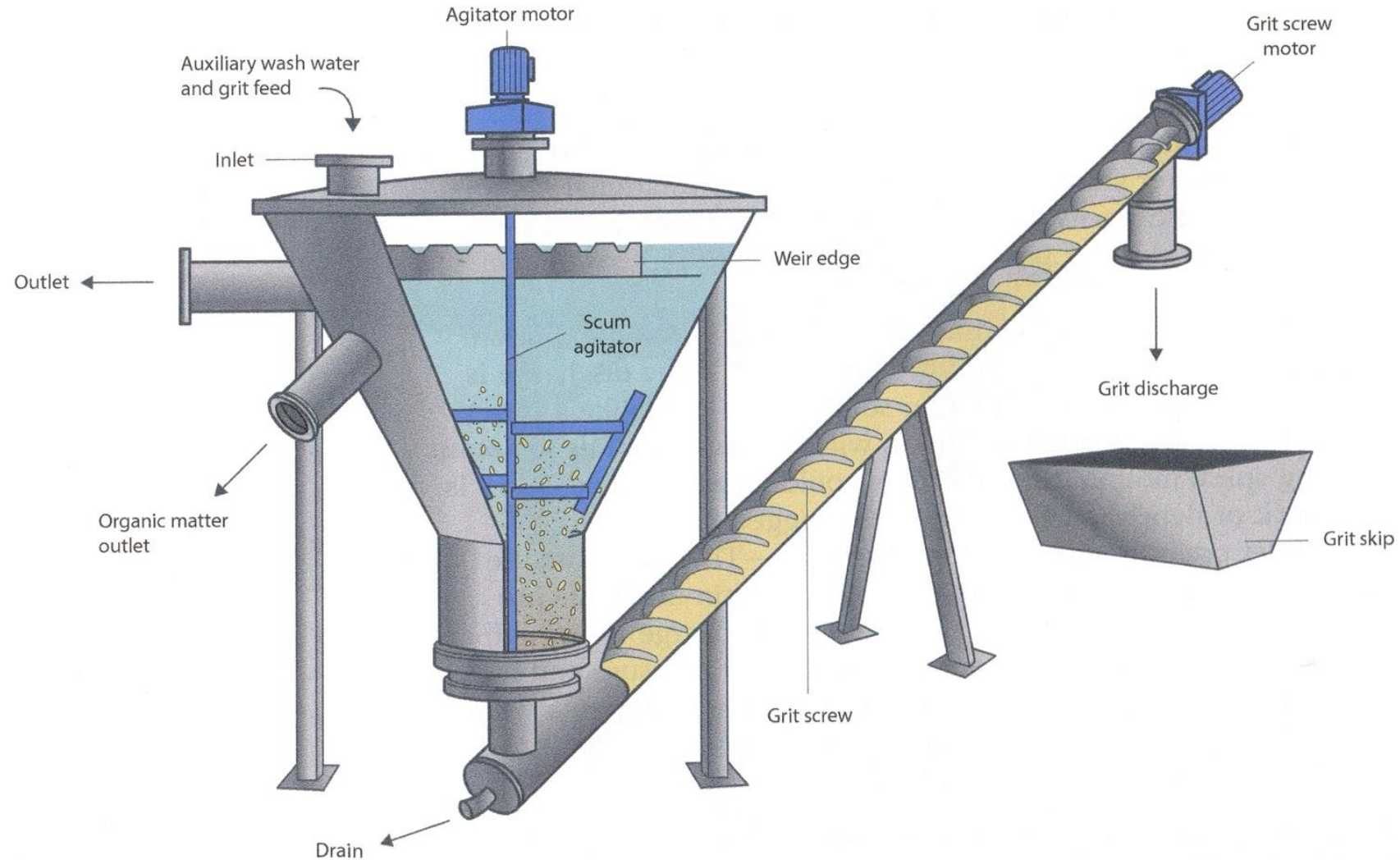


Figure 3.16 Grit channel

Removal Devices: Cyclone Separator



Grit Washing and Disposal (Classifiers)



Grit and Screenings Handling

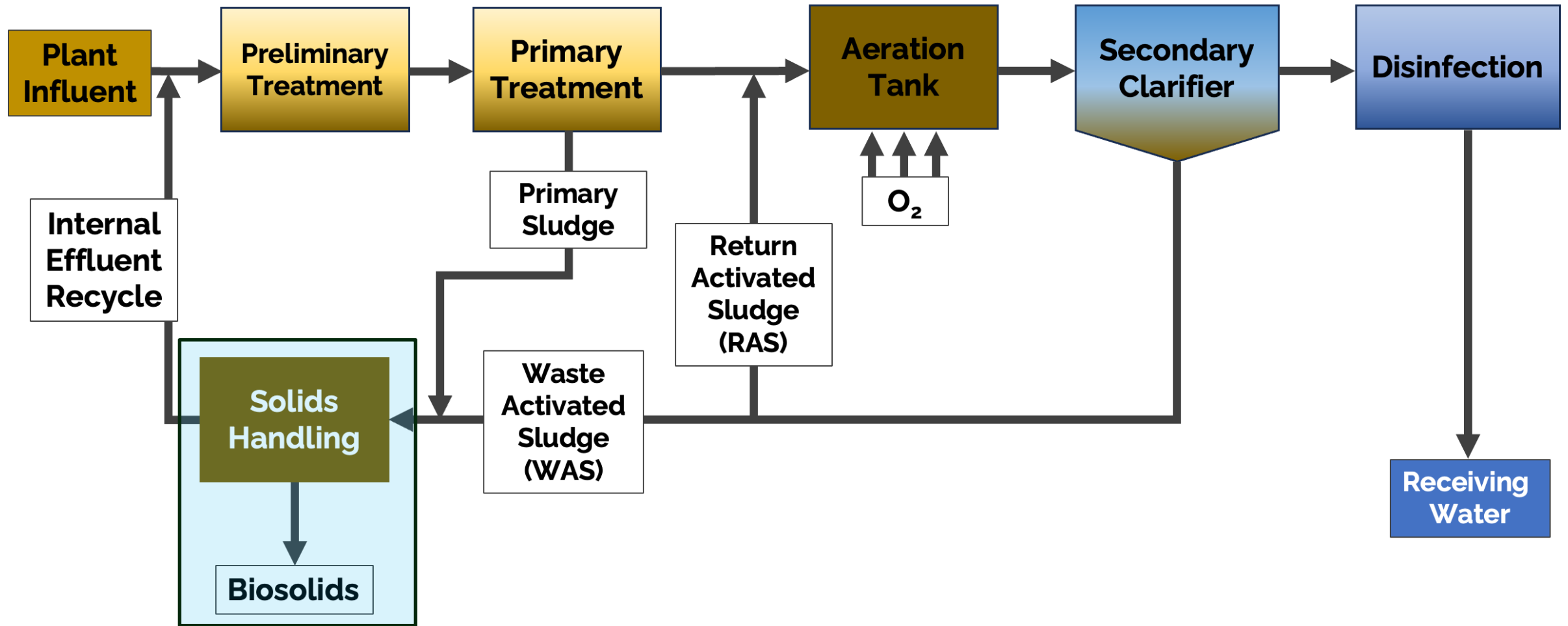


These aren't the solids
we're looking for.

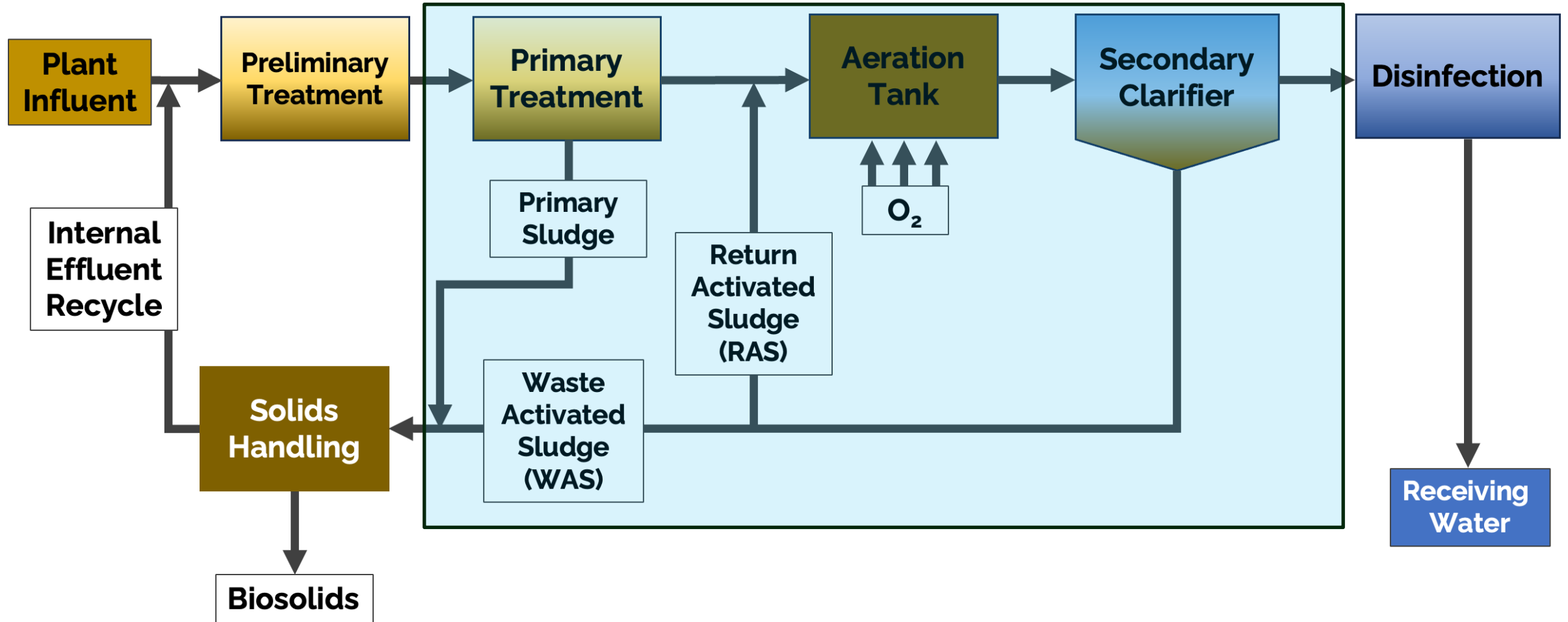
Biosolids Sources

Here comes the sludge ...

Wastewater Flow Schematic



Wastewater Flow Schematic



Primary Clarifier Sludge



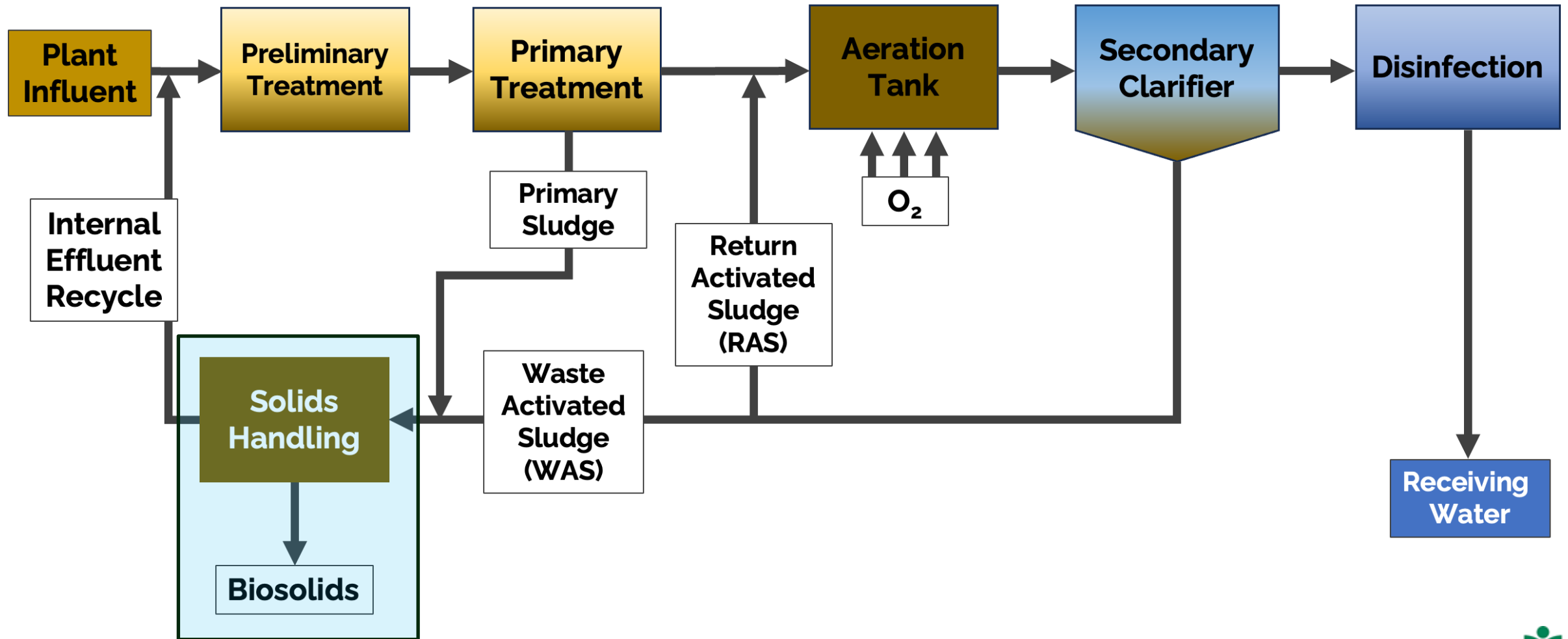
Secondary Clarifier WAS



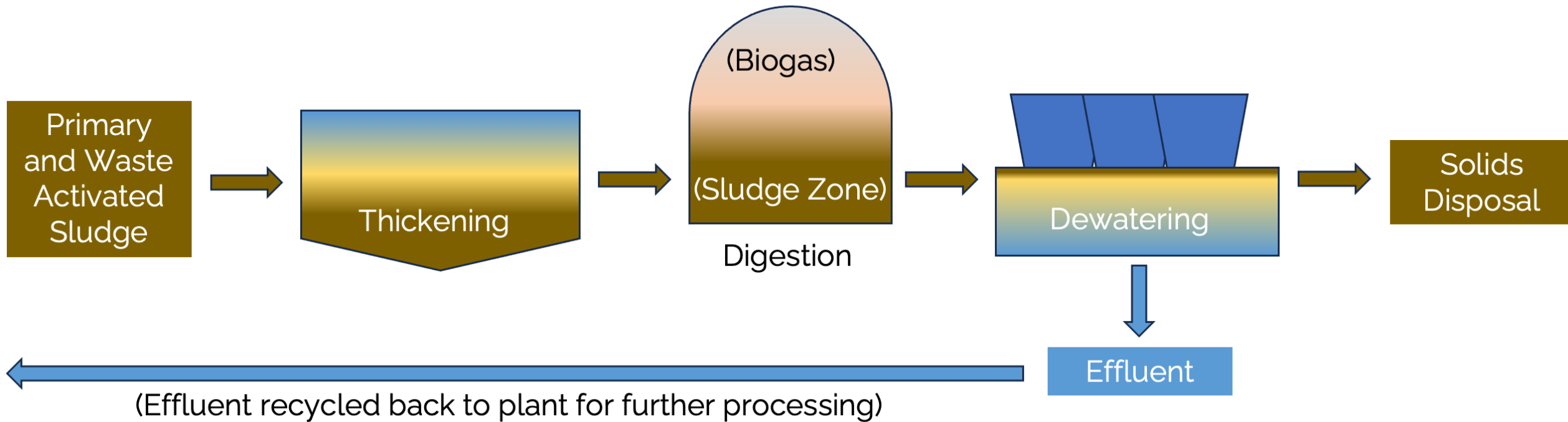
Solids Handling

Overview

Wastewater Flow Schematic



Solids Handling Stages



Solids Handling Stages

Thickening – reducing the sludge volume

Digestion - breaking down the sludge with
micro-organisms

De-Watering – removing the water from the
solids

Disposal or Reuse – the end of the line

Solids Handling Stages

Digestion - breaking down the sludge with micro-organisms

Disposal or Reuse – the end of the line

Thickening

(It's just what it sounds like)

Why is thickening
necessary?

Primary Sludge

Typically, contains 95-97 % water, 3 to 5% solids.

Every pound of primary sludge is suspended in between 20 and 30 pounds of water

Secondary Sludge

Secondary sludge typically varies between 2% and less than 1% solids

Every pound of secondary sludge is suspended in between 50 to 150 pounds of water

If you didn't remove
water, your digestion
equipment would have
to be **larger.**

Advantages

Improved digester performance

Construction cost savings: smaller sludge volume = smaller required digestion facilities

Reduction in heating costs: digesters may need heating, the smaller they are, the cheaper that is

Let's do some math together:

If your primary clarifier produces 3,000 gallons of sludge per day with a solids concentration of 3%, what's the weight of the solids produced per day?

Water = 8.34 lbs/gal

$$\text{Dry Sludge Solids} \left(\frac{\text{lbs}}{\text{day}} \right) = \text{Sludge volume} \left(\frac{\text{gal}}{\text{day}} \right) \times 8.34 \frac{\text{lbs}}{\text{gal}} \times \frac{\% \text{ solids}}{100\%}$$

$$\text{Dry Sludge Solids} \left(\frac{\text{lbs}}{\text{day}} \right) = 3,000 \left(\frac{\text{gal}}{\text{day}} \right) \times 8.34 \frac{\text{lbs}}{\text{gal}} \times \frac{3\%}{100\%}$$

$$\text{Dry Sludge Solids} \left(\frac{\text{lbs}}{\text{day}} \right) = 750.6 \left(\frac{\text{lb}}{\text{day}} \right)$$

Let's do some math together:

What would the volume of sludge be if you increased the solids concentration from your primary clarifier to 5%

Water = 8.34 lbs/gal

Dry Sludge Solids = 750.6 lbs/day

$$\text{Dry Sludge Solids} \left(\frac{\text{lbs}}{\text{day}} \right) = \text{Sludge volume} \left(\frac{\text{gal}}{\text{day}} \right) \times 8.34 \frac{\text{lbs}}{\text{gal}} \times \frac{\% \text{ solids}}{100\%}$$

$$750.6 \left(\frac{\text{lbs}}{\text{day}} \right) = \text{Sludge volume} \left(\frac{\text{gal}}{\text{day}} \right) \times \left[8.34 \frac{\text{lbs}}{\text{gal}} \times \frac{5\%}{100\%} \right]$$

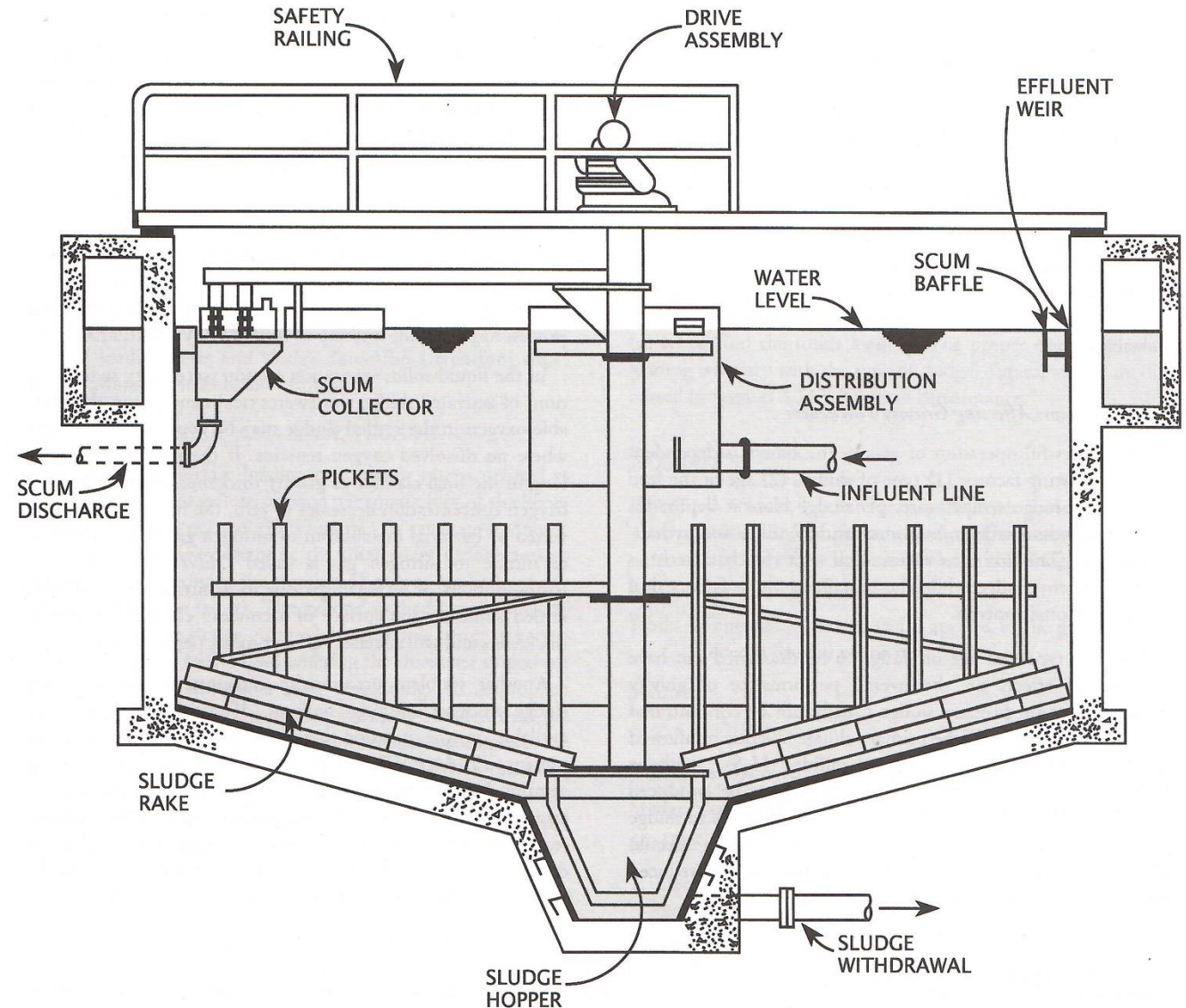
$$\text{Sludge volume} \left(\frac{\text{gal}}{\text{day}} \right) = \frac{750.6 \text{ lbs/day}}{8.34 \frac{\text{lbs}}{\text{gal}} \times \frac{5\%}{100\%}}$$

$$\text{Sludge volume} \left(\frac{\text{gal}}{\text{day}} \right) = 1800 \frac{\text{gal}}{\text{day}}$$

Gravity Thickeners

Does this
look kind
of familiar?

It's a
sedimentation
process.



Sedimentation



Analogous to snowfall

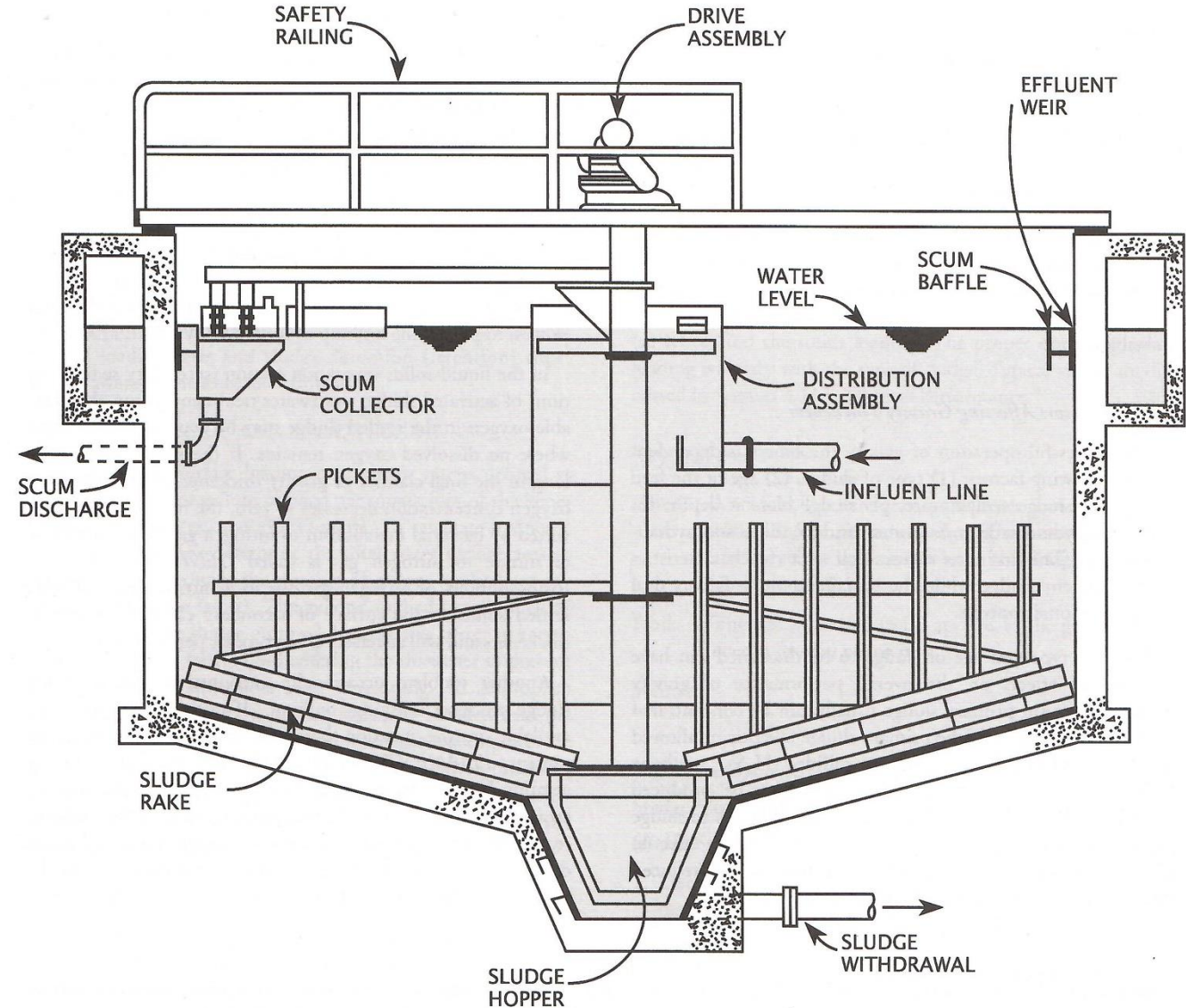


Look at a snowglobe



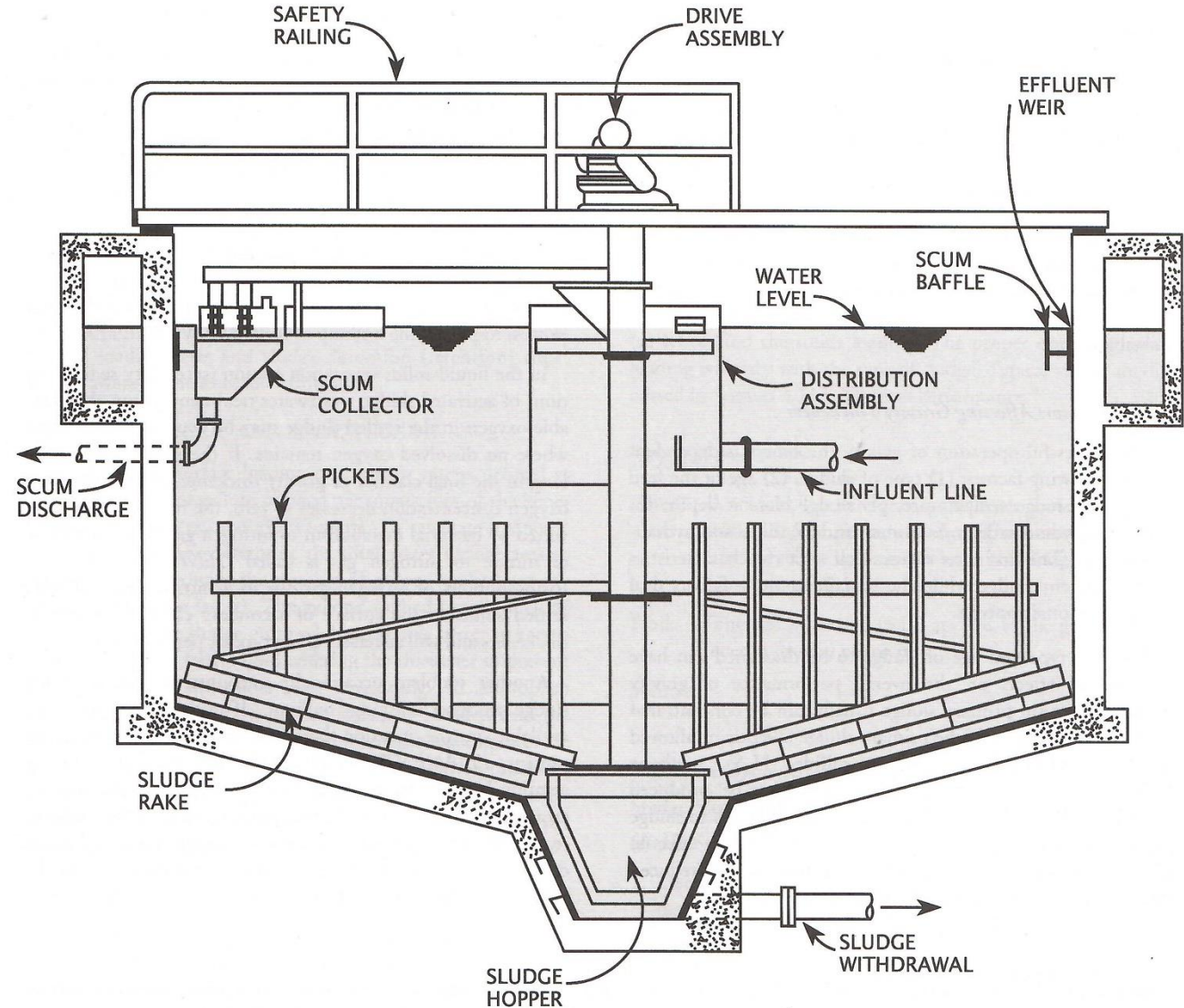
Gravity Thickener Components

1. Inlet and distribution assembly
2. Sludge rake
3. Pickets
4. Overflow weir
5. Scum removal equipment



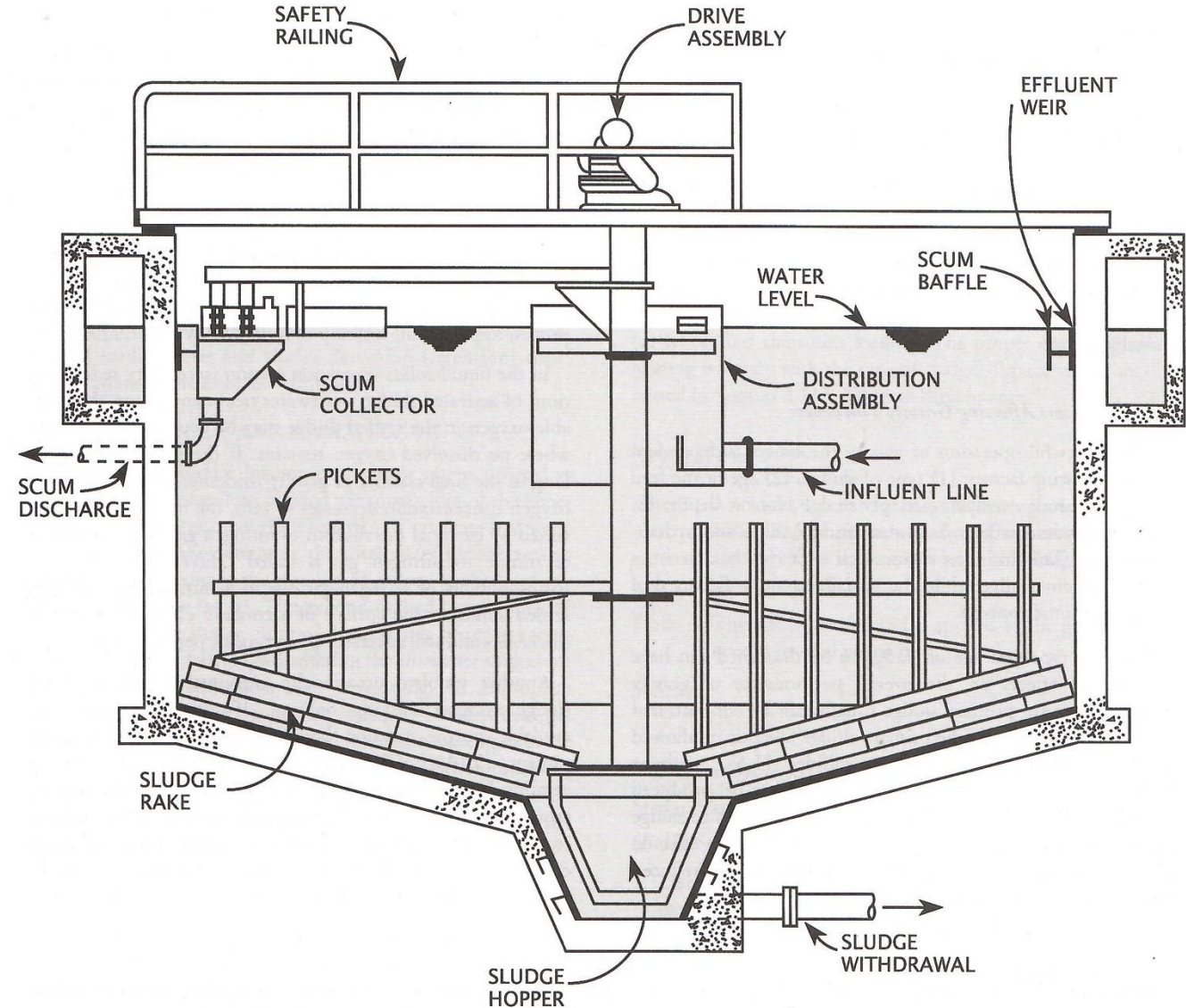
Operational Factors

1. Sludge type
2. Age of feed sludge
3. Sludge temperature
4. Sludge blanket depth
5. Solids and hydraulic detention time
6. Solids and hydraulic loading



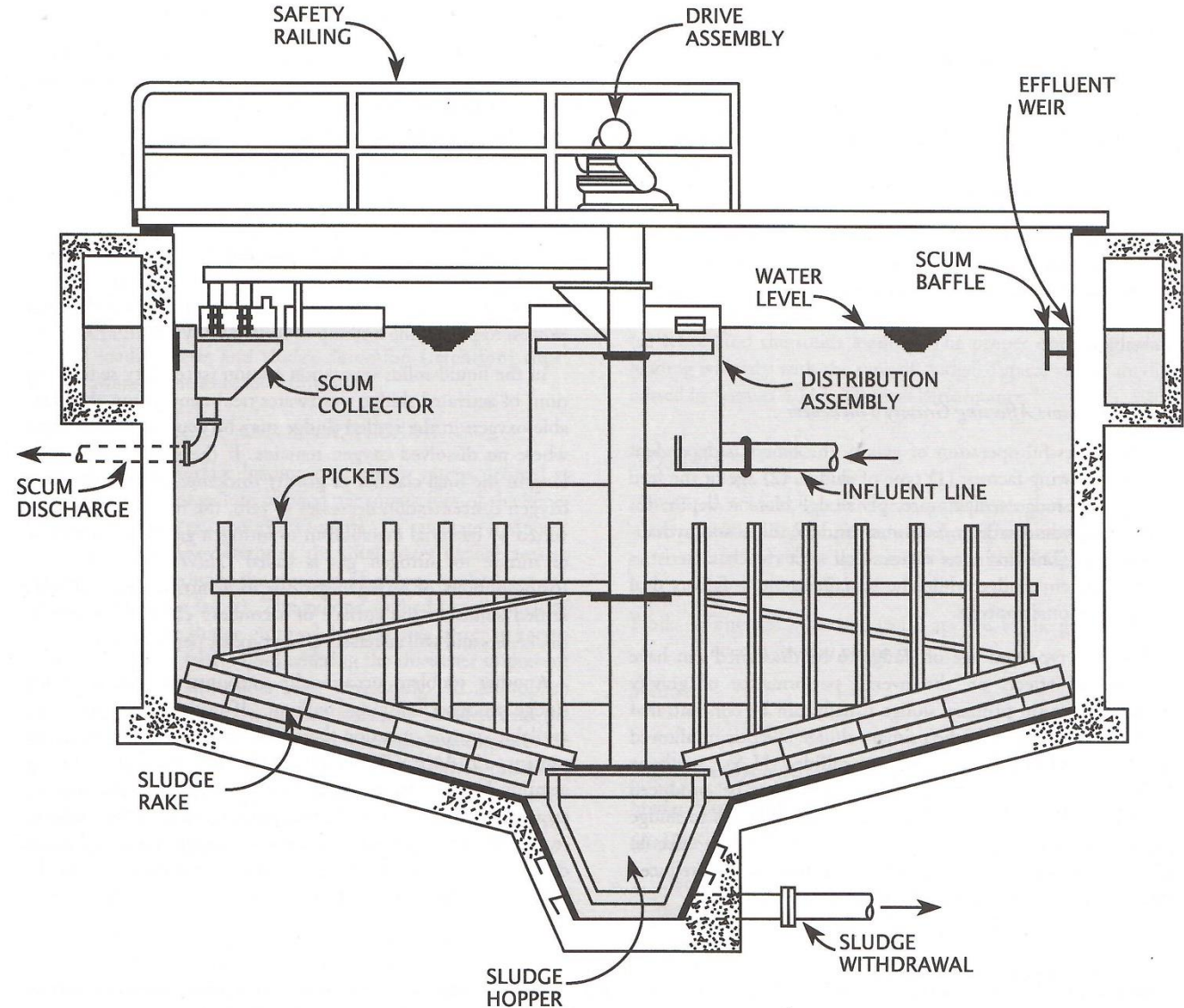
Sludge Characteristics (Type)

1. Gravity thickening works best with primary sludge
2. Fresh sludge can be concentrated to the highest degree
3. Septic sludge can result in gasification (CO_2 , CH_4 , H_2S)



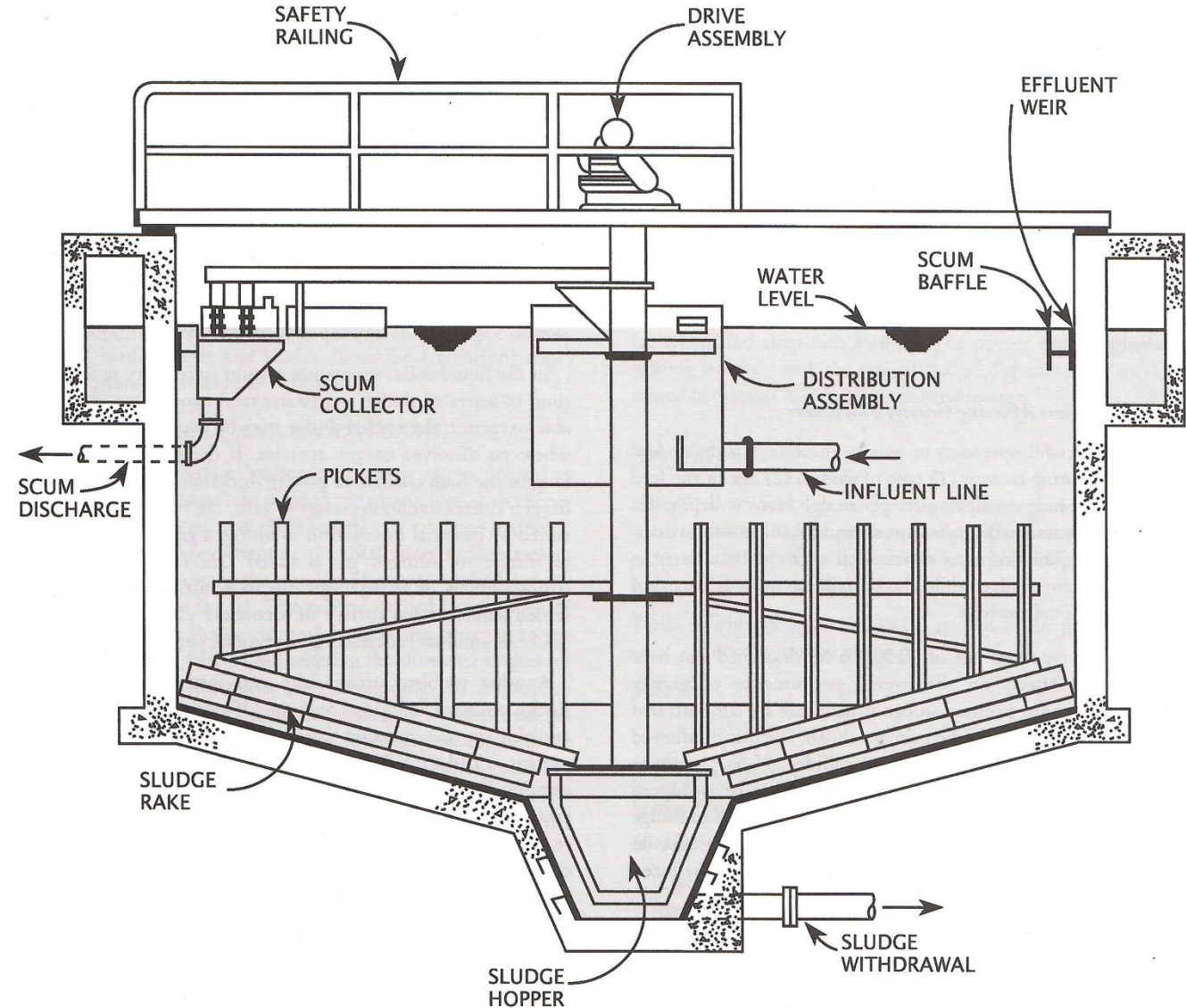
Sludge Characteristics (Type)

1. Secondary sludge is less dense & settles slower
2. Biosolids are 85-90% water (bound in the cells)
3. Solids are typically finer than primary solids



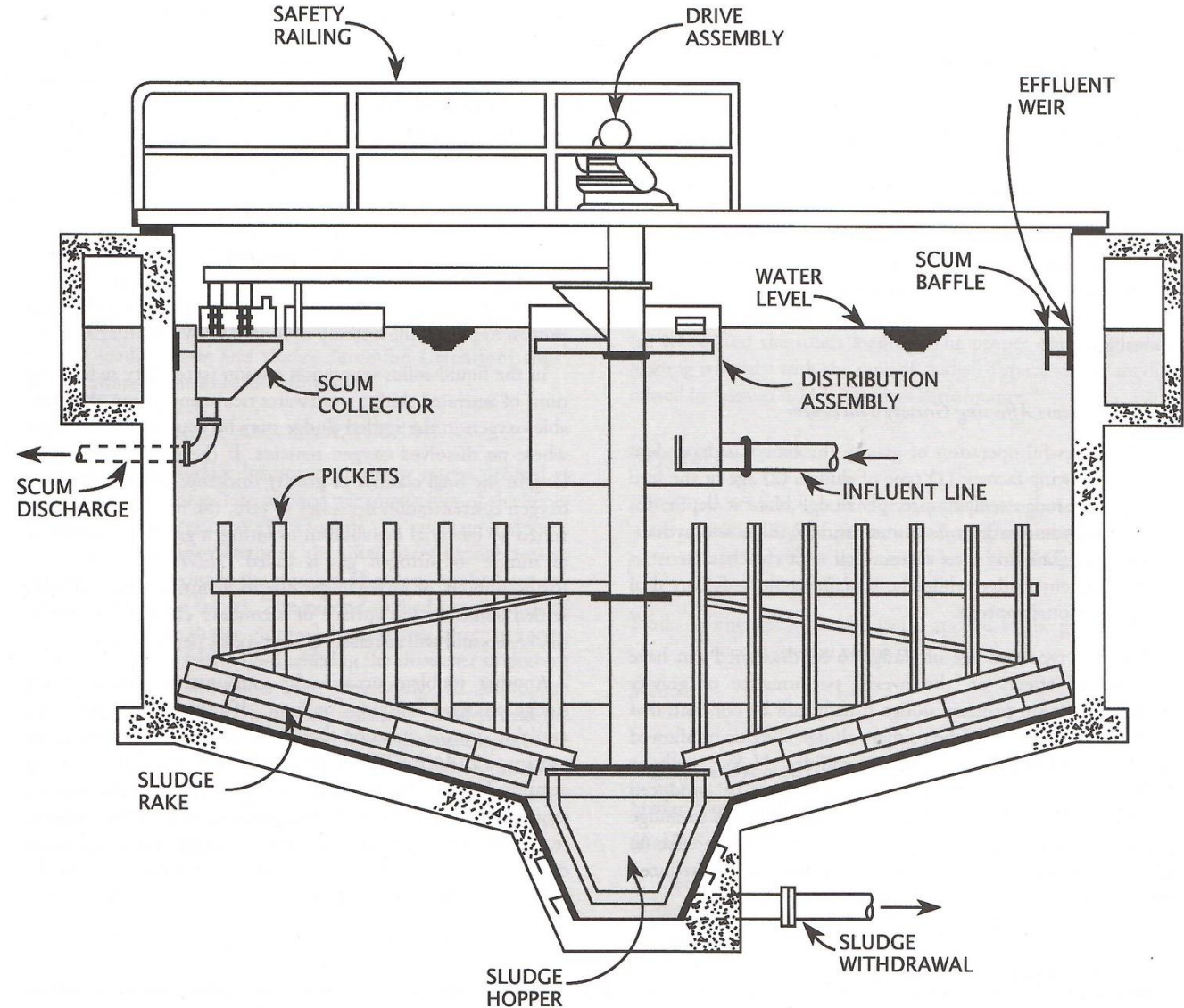
Sludge Characteristics (Age)

1. If sludge is held too long dissolved O_2 may be depleted
2. Denitrification can result creating nitrogen gas (gasification)
3. Filamentous organism growth can decrease settleability of sludge



Sludge Characteristics (Temp)

1. As sludge temperature increases so does biological activity
2. Gasification and sludge rising increases
3. Sludge removal rates tend to increase in summer and decrease in winter



Gravity Thickener Op Guidelines

Sludge Type	Solids Loading (lbs/day/ft ²)	Thickened Sludge %
Separate		
• Primary Sludge	20 - 30	8 - 10
• Activated Sludge	5 - 8	2 - 4
• Trickling Filter	8 - 10	7 - 9
Combined		
• Primary & Activated Sludge	6 - 12	4 - 9
• Primary & Trickling Filter	10 - 20	7 - 9

Gravity Thickener Op Guidelines

Sludge Type	Hydraulic Loading Rate (GPD/ft ²)
• Primary Sludge	400 - 800
• Activated Sludge	100 - 200
• Combined Primary & Activated Sludge	150 - 300

Hydraulic loading rates may be achieved by blending secondary effluent with the sludge entering the thickener.

Higher flows of fresh liquid will help prevent septic conditions and odors from developing



Poll Question

Gravity Thickener Op Guidelines

Sludge detention time can be controlled by varying the sludge blanket depth

The S/V (sludge/volume) ratio – or ratio of sludge blanket volume divided by the volume of sludge pumped from thickener – is typically between 0.5 and 2.0 days

$$\frac{S}{V} \text{ ratio (days)} = \frac{\text{Sludge Blanket Volume (gal)}}{\text{Volume of Sludge pumped } (\frac{\text{gal}}{\text{day}})}$$

Gravity Thickener Op Guidelines

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$$\frac{S}{V} \text{ ratio (days)} = \frac{\text{Sludge Blanket Volume (gal)}}{\text{Volume of Sludge pumped } (\frac{\text{gal}}{\text{day}})}$$

If more sludge enters than leaves, the blanket volume will INCREASE

If more sludge leaves than enters the blanket volume will DECREASE



Poll Question

Calculate the S/V Ratio

$$\frac{S}{V} \text{ ratio (days)} = \frac{\text{Sludge Blanket Volume (gal)}}{\text{Volume of Sludge pumped } (\frac{\text{gal}}{\text{day}})}$$

If:

- The sludge blanket volume is 28,200 gallons, and
- Sludge flow IN to the thickener is 100 GPM at 3% concentration
- Sludge flow OUT of the thickener is 40 GPM at 7% concentration

What is the S/V ratio?

$$\frac{S}{V} \text{ ratio (days)} = \frac{28,200 \text{ (gal)}}{40 \text{ gal/min} \times 1440 \text{ min/day}} = \frac{28,200 \text{ gal}}{57,600 \text{ gal/day}} = 0.5 \text{ days}$$

Calculate Thickener Solids Removal Efficiency

$$\text{Efficiency (\%)} = \frac{\text{Influent SS, } \left(\frac{\text{mg}}{\text{L}}\right) - \text{Effluent SS } \left(\frac{\text{mg}}{\text{L}}\right) \times 100\%}{\text{Influent SS } \left(\frac{\text{mg}}{\text{L}}\right)}$$

If:

- Flow **IN** to the thickener is 30 GMP at 3% concentration (30,000 mg/L),
- Effluent flow **OUT** of the thickener is at 0.15% concentration (1,500 mg/L)

What is the Solids Removal Efficiency of the thickener?

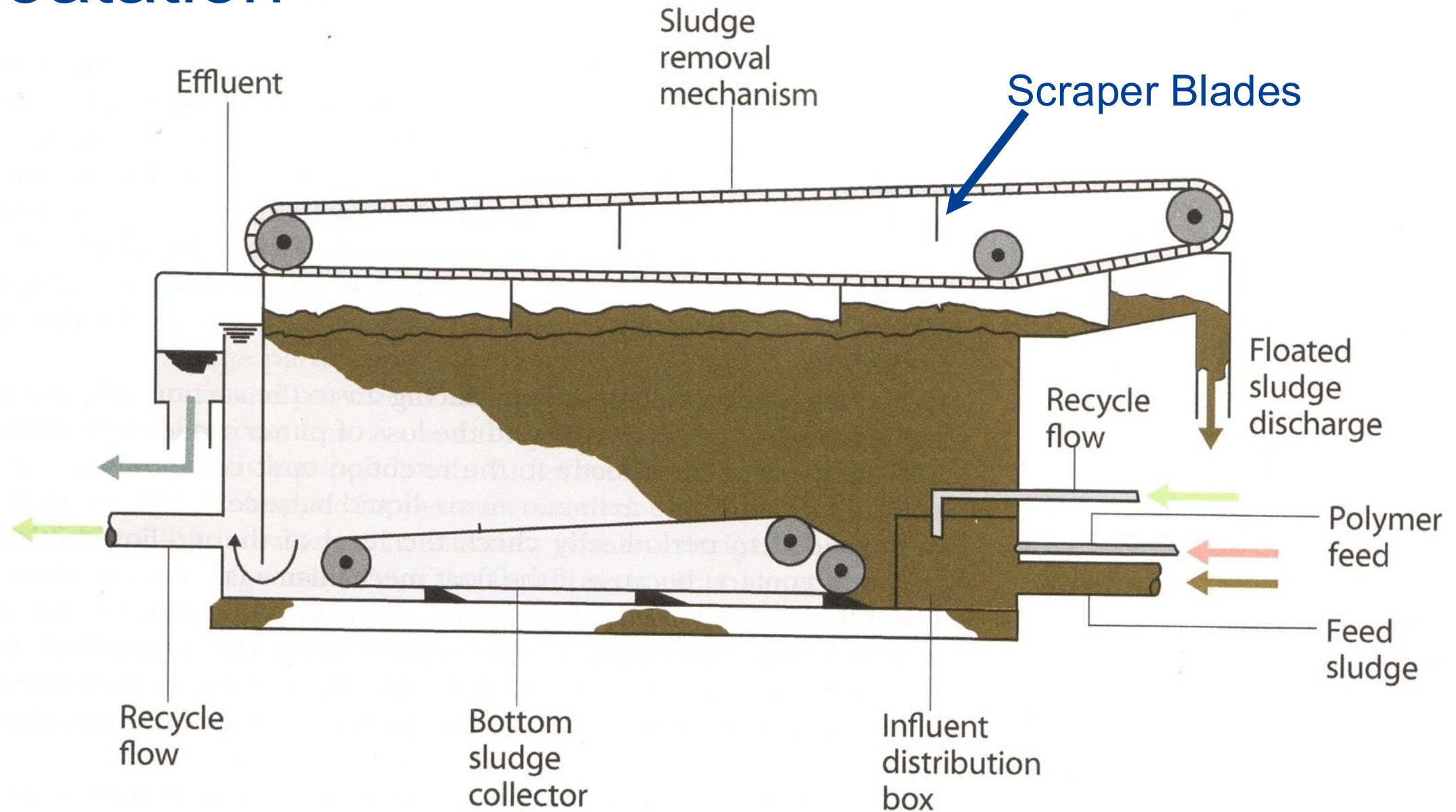
$$\text{Efficiency (\%)} = \frac{30,000 \frac{\text{mg}}{\text{L}} - 1,500 \frac{\text{mg}}{\text{L}} \times 100\%}{30,000 \frac{\text{mg}}{\text{L}}} = 95\%$$

$$\text{Or} \quad \text{Efficiency (\%)} = \frac{3 - 0.15 \times 100\%}{3} = 95\%$$

Other Thickening Methods

DAF, Centrifuges, Belts, Filtration, Drums

Floatation



Four Floatation Methods

- **Dispersed Air Floatation** – Bubbles are generated by mixers or diffused aerators
- **Biological Floatation** – using gasses generated by biological activity to float solids
- **Dissolved Air (Vacuum) Floatation** – where the effluent is aerated at atmospheric pressure and released under vacuum
- **Dissolved Air (Pressure) Floatation** – where the effluent is aerated under pressure and released at atmospheric pressure

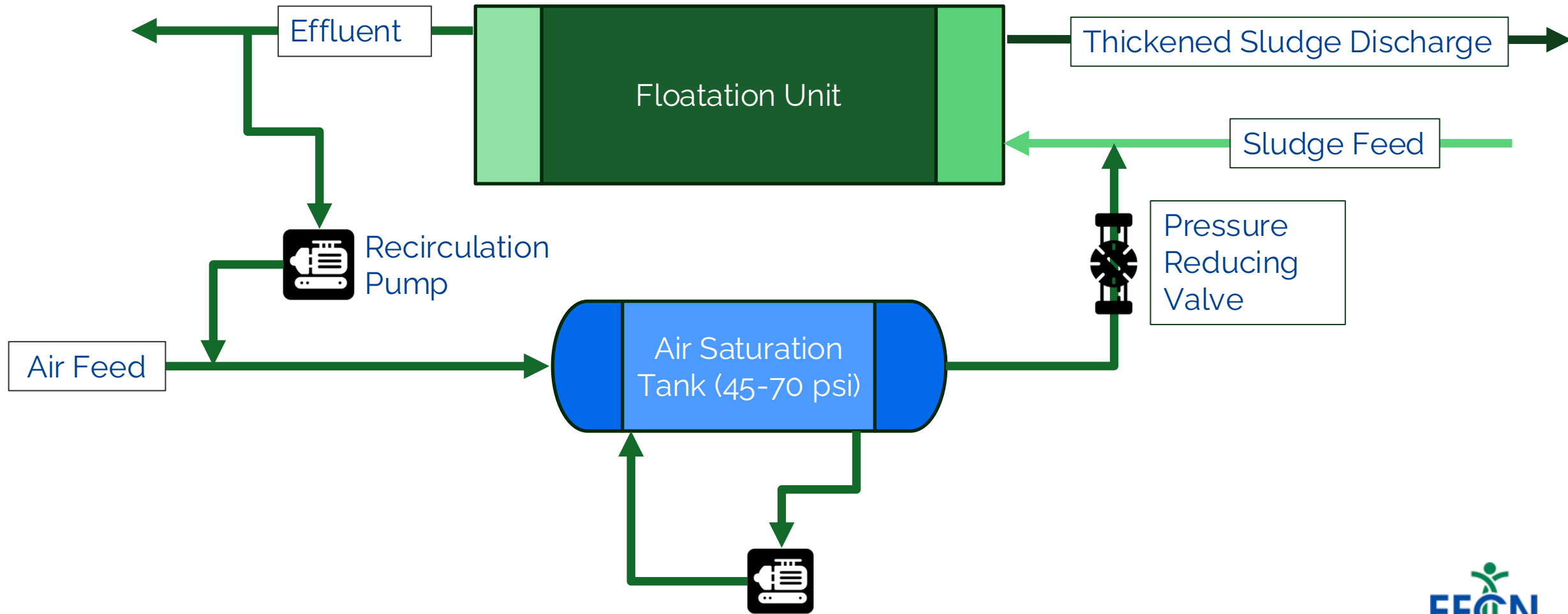
Floatation



3 Pressure Floatation Methods

- **Full-Flow Pressure Floatation** – entire sludge influent flow is pressurized and released into DAF unit
- **Partial-Flow Pressure Floatation** – some of the sludge influent flow is pressurized and released into DAF unit and some sludge is released directly into the DAF unit without pressurization
- **Recycle-Flow Pressure Floatation** – part of the effluent flow, or other water flow source is recycled, pressurized and released into the DAF

Recycle Flow Schematic





Air to Solids Ratio

$$\frac{A}{S} = \frac{\text{Air, lbs}}{\text{Solids, lbs}}$$

Assume DAF Unit receives:

- 100 GPM of WAS at a concentration of 9,000 mg/L, and
- Air at 5 CFM (cubic feet per minute)

What's the A/S Ratio?

$$\frac{A}{S} = \frac{\text{Air, lbs}}{\text{Solids, lbs}} = \frac{5 \frac{\cancel{\text{ft}^3}}{\cancel{\text{min}}} \times 0.075 \frac{\text{lbs}}{\cancel{\text{ft}^3}}}{100 \frac{\cancel{\text{gal}}}{\cancel{\text{min}}} \times 8.34 \frac{\text{lbs}}{\cancel{\text{gal}}} \times \frac{0.9\%}{100\%}} = \frac{0.375 \text{ lbs air}}{7.5 \text{ lbs solids}} = 0.05 \frac{\text{lbs air}}{\text{lbs solids}}$$

Operational Guidelines

	Without Polymer Addition	With Polymer Addition
Solids Loading (lbs/day/ft ²)	9.6 – 24	24 – 48
Hydraulic Loading (GPM/ft ²)	0.5 – 1.5	0.5 – 2.0
Recycle %	100 – 200	100 – 200
Air/Solids Ratio (lb/lb)	0.01 – 0.10	0.01 – 0.10
Minimum Influent Solids Concentration (mg/L)	5,000	5,000
Float Solids Concentration (%)	2 – 4	3 – 5
Solids Recovery (%)	50 – 90	90 – 98

Some DAF Troubleshooting

Issue	Options
Float blanket too thick	Increase flight speed; check solids loading, lower flow rate if possible
Float blanket too thin	Decrease flight speed, check solids loading, increase flow rate if possible
Good effluent but thin float	A/S is too low, increase air input; check compressors
Poor effluent but thin float	Pressure may be too low or high Recycle pump may be inoperative Re-aeration pump may be inoperative Check chemical system Loading may be excessive

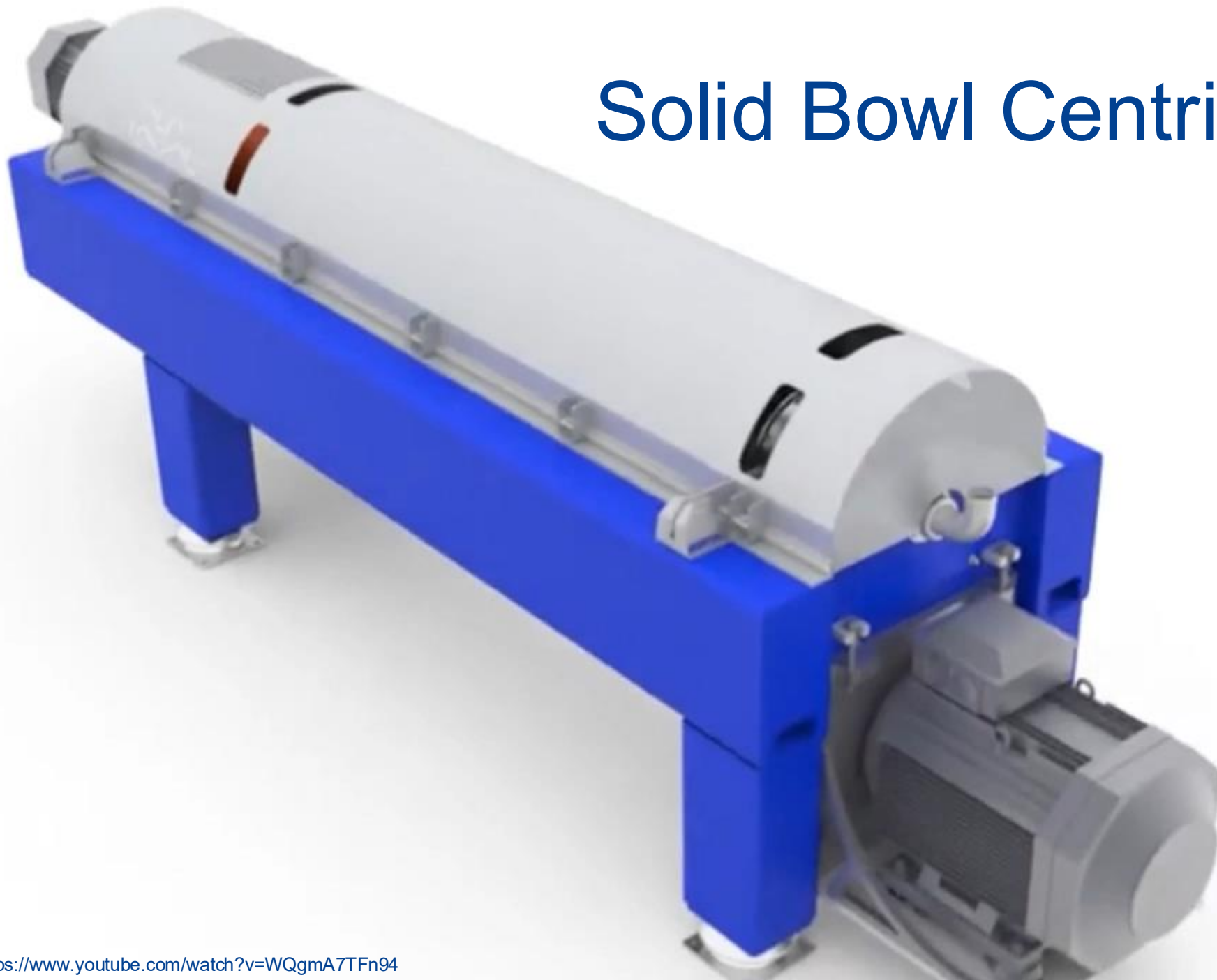
Centrifuges



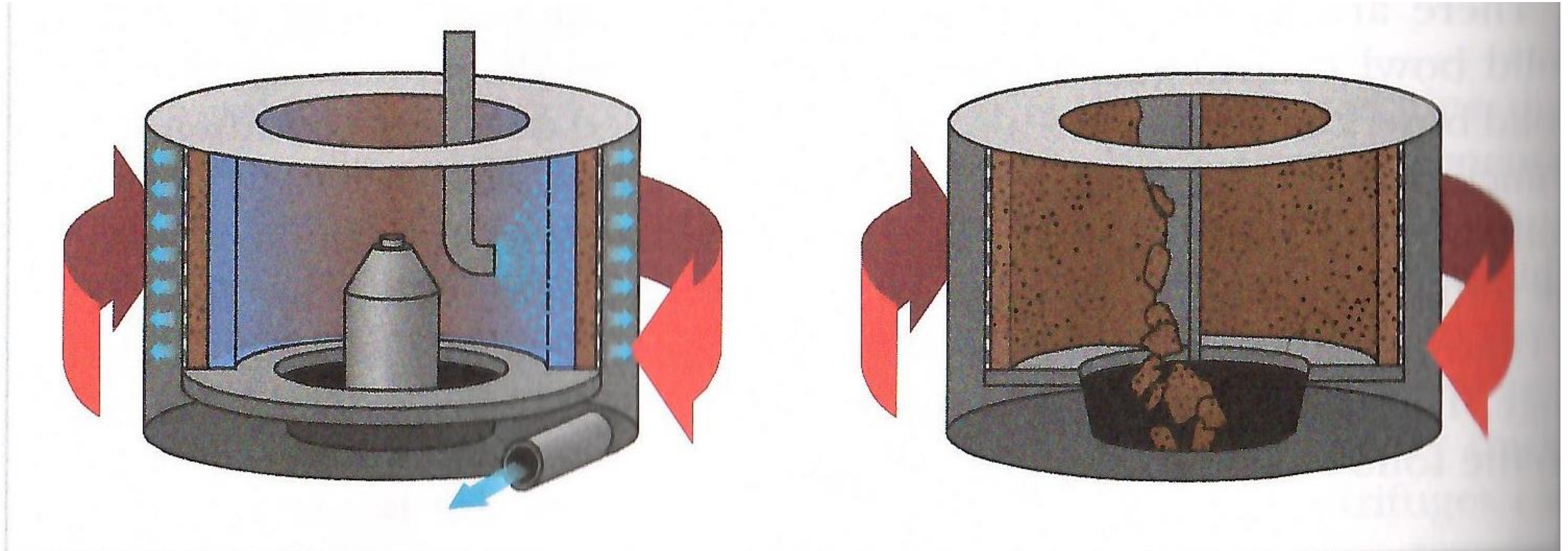
Centrifuges



Solid Bowl Centrifuge



Basket Centrifuge



Alfa Laval AS-H Belt Thickener

Gravity Belt Thickeners



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Source: Alfa Laval, https://www.youtube.com/watch?v=sAqKflyW_Uw



PowerDrum (PDR)

Thickener Comparison

Method	Sludge Type	Use & Success
Gravity Thickener	Untreated Primary	Common, excellent results
	Untreated Primary & WAS	Often used, better for small plants
	WAS	Rare, poor solids concentration
Dissolved Air Floatation (DAF)	Untreated Primary & WAS	Limited use – results similar to gravity thickeners
	WAS	Common, but decreasing due to cost
Solid Bowl Centrifuge	WAS	Often used in medium to large plants, good results 4-6% solids concentration
Gravity Belt Thickener	WAS	Often used in medium to large plants, good results 3-6% solids concentration
Rotary Drum Thickener	WAS	Limited use, in medium to large plants, good results 5-9% solids concentration

Digestion

The short version
(More on this in Part 2)

De-watering

More Volume Reduction – Filtration, Belts, Presses, Centrifuges

Drum Vacuum Filter

Belt Filter Press



Belt Filter Press



Belt Filter Press



Belt Filter Press

Alfa Laval AS-H Belt Press G3
2-belts and 12 rollers



© 2014 Alfa Laval

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Source: Alfa Laval, <https://www.youtube.com/watch?v=eBbPIxkYfPI>

Other Dewatering Presses

Screws & Rotary Mechanisms

Screw Presses

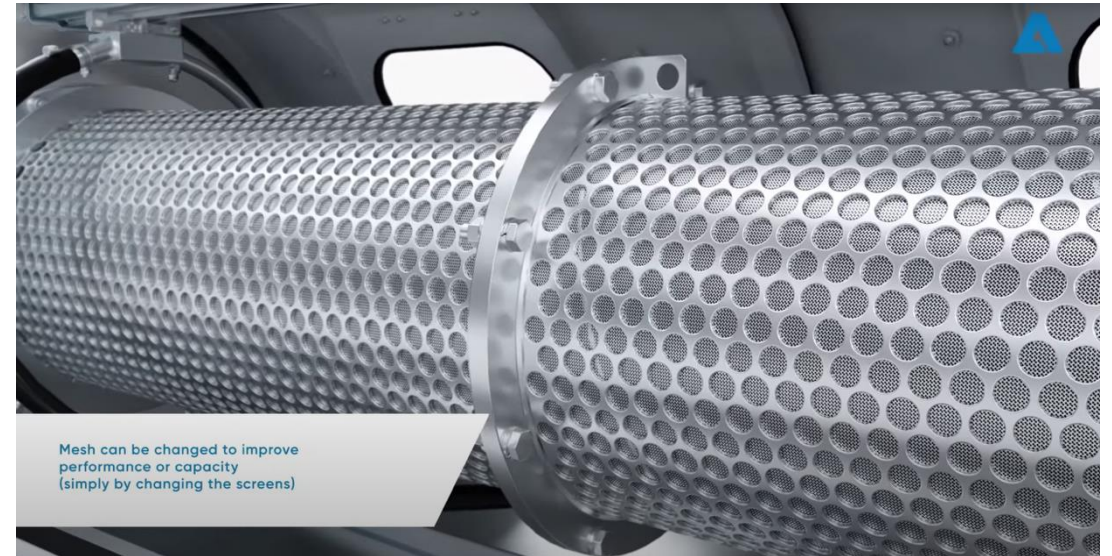
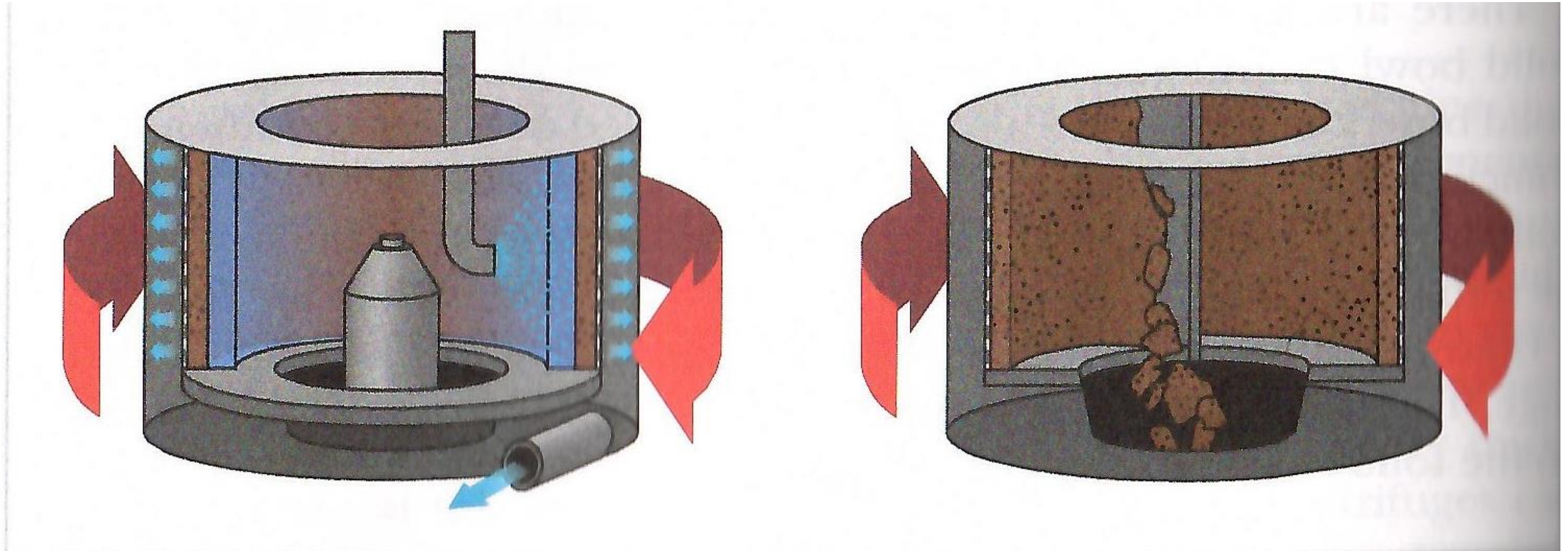


Image Source: Andritz: <https://www.youtube.com/watch?v=6rEnmdwgtg>

Solid Bowl Centrifuge



Basket Centrifuge



Questions?



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