Comparison of Options for Biosolids Dewatering

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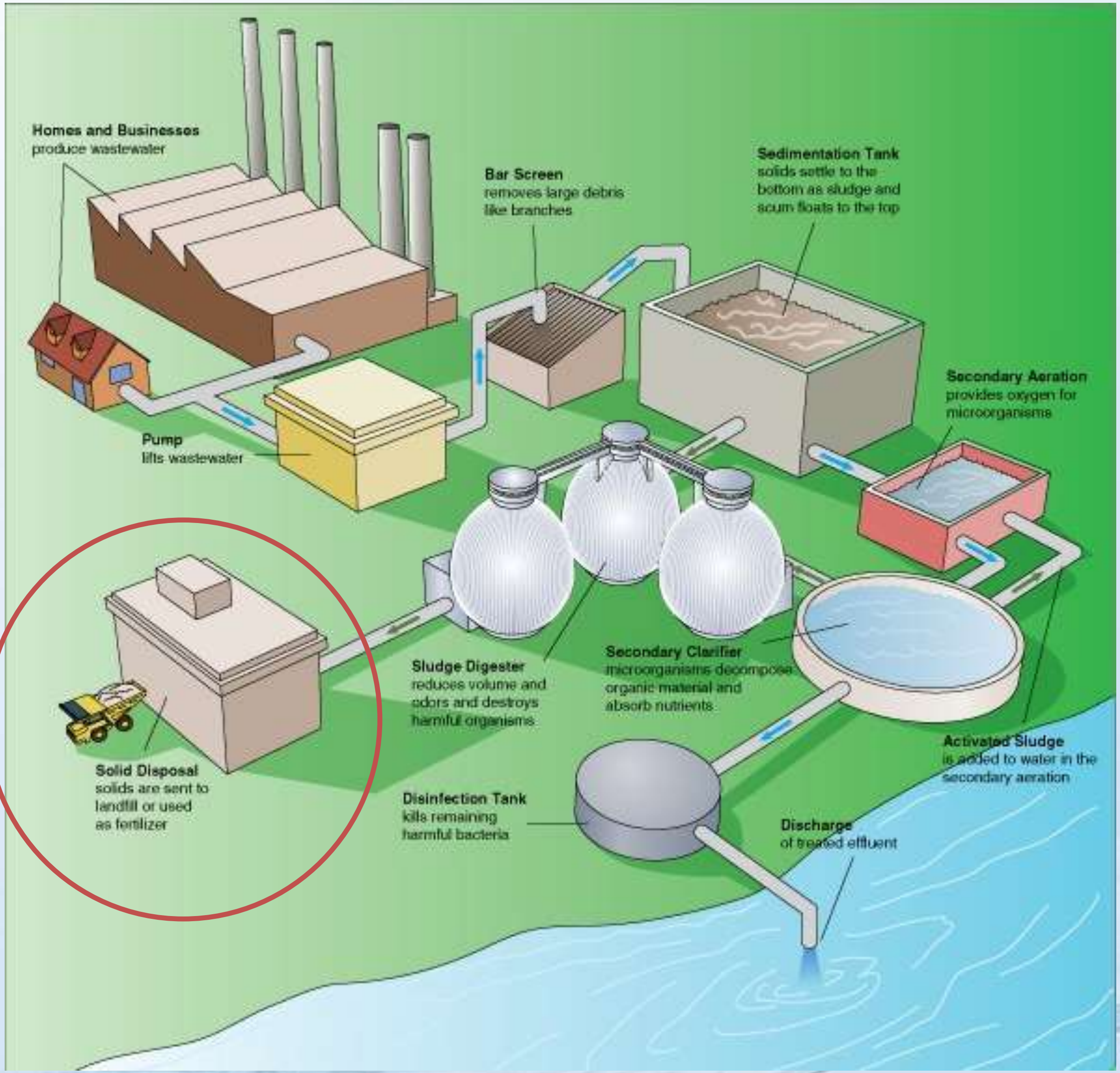
Agenda

- Dewatering Overview and Purpose
- Math of Dewatering
- Process Effects on Dewatering
- Key Plant Criteria
- Technology Overview: BFP, Screw, and Centrifuge
  - Process
  - Operation Parameters
  - Critical and Routine Maintenance
- Technology Comparison Summary

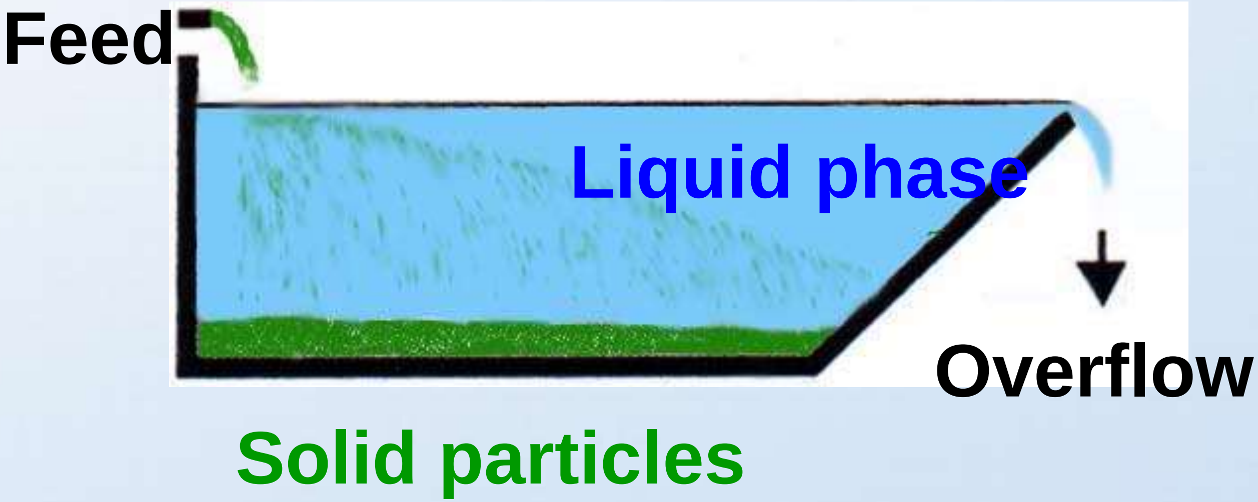
Why do we dewater biosolids and where does it fit in?

DEWATERING OVERVIEW AND PURPOSE

Biosolids Dewatering Process



Essential Function of Dewatering



Why Dewater?

Why Dewater?

- Hauling costs drastically affect choice to dewater and what technology to use:
  - How far away is the disposal site?
    - Is Landfill an Option? Not in Washington
    - Class B Application Sites? Eastern OR/WA
    - Class A Reuse? Local options year round?
      - Composting/Drying
  - Is there future legislation that may change the decision you make today?
- Hauling Costs vs Dewatering Costs
  - It is cheaper to haul less water rather than more.
  - It is NOT cheaper to produce a product with less water.

DEWATERING MATH

Dewatering Terms

- **Hydraulic Loading Rate (gpm):**
  - Sludge feed flow.
- **Solids Loading (lbs/day or hr):**
  - Solids fed per day or per (operating) hour to unit.
- **Operating Hours:**
  - How long each day the unit is processing solids (doesn't include start up or shutdown time)
- **Cake Dryness (%):**
  - Total solids percentage in dewatering unit solids discharge.
- **Capture Efficiency (%):**
  - percentage of solids retained in cake
- **WAS:PS Ratio (##:##):**
  - Ratio of WAS to PS on a MASS basis

Dewatering Math

- Total solids:

$$TS\% = \frac{Solids\ concentration\ (\frac{mg}{L})}{10{,}000}$$

- Solids loading rate:

$$\frac{Lbs}{hr} = Flow\ rate\ \left(\frac{gallons}{minute}\right) \times 8.34\frac{lbs}{gallon} \times TS\% \times 60\frac{minutes}{hour}$$

Ex: 140 gpm @ 4% solids = 140 x 8.34 x 0.04 x 60 = 2,800 lbs/hr

- Operating hours:

$$\frac{\left(Solids\ Loading\ Rate\frac{Lbs}{Day} \times 7\frac{Days}{Week}\right)}{Unit\ Capacity\frac{Lbs}{Hour} \times N\frac{Days}{Week}} = T_{Operation\ Hours}\frac{Hours}{Day}$$

- Capture efficiency:

$$\frac{C_{cake} \times (C_{feed} - r \times C_{filtrate})}{C_{feed} \times (C_{cake} - C_{filtrate})} = \%$$

Where r (recycle) = $\frac{Q_{feed}+Q_{washwater}}{Q_{feed}} = \%$

What happens upstream that affects dewatering?

PROCESS EFFECTS ON DEWATERING

Process Effects on Dewatering

Increase

- Anaerobic digestion
- Chemical additions
  - Ferric chloride
  - Lime

Decrease

- Aerobic digestion
- Biological Phosphorus Removal
- Fine screening
- FOG*

KEY PLANT CRITERIA

Dewatering Unit Specifications

- General plant processes (screening, activated sludge, digestion, etc)
- Ratios
  - WAS:PS
  - VS:TS
- Hydraulic and Solids Loading Rate
  - Average Annual, Maximum Month, and Maximum Week
- Operating Hours
  - Fully automated? 24/7? 7/5?
- Desired Cake Dryness

Dewatering Unit Specifications

- Sludge is very specific to the plant. In general, industry numbers are just averages for the industry.
  - Leverage this data and similar facilities to determine realistic performance goals
- Recommend:
  - Send in sludge samples to multiple vendors
  - Full sized pilot test with multiple vendors
    - Using a smaller unit than what will be installed doesn't help as dewatering doesn't "scale".
- Dewatering unit performance difficult to enforce; sludge can always, "change".

TECHNOLOGY OVERVIEW: BELT FILTER PRESS

Operation Animation

Overall Performance

Parameter	Belt Filter Press
Cake Dryness	16 to 22%
Power Consumption	up to 10 HP
Operating Speed	Relatively low
Polymer Use	8 to 16 lbs/DT
Capture Efficiency	95%+
Solids Loading Rate	500 to 1000 lbs/hr per meter width
Wash Water Use	Continuous; 50 to 100% of solids flow
Sludge Sensitivity	High
Odor	High; Open to atmosphere
Noise	Medium
Operator oversite	High

Operation Parameters

Parameter	Effect
Hydraulic Loading Rate increase	Cake dryness decreases
Solids Loading Rate increase	Cake dryness increases
Polymer Feed Rate increase	Cake dryness increases(1) Capture increases(1)
Polymer Type	Polymer efficacy
Belt Speed increase	Throughput increases Cake dryness decreases
Belt Tension increase	Cake dryness increases Capture decreases Belt wear increases Belt blinding

Notes:
(1) General trend. There is a peak “efficiency” for polymer dosage.

Maintenance

- Routine:
  - Daily:
    - General inspection
    - Check bearing lubrication (20-30 of them)
    - Belt wash down
  - Every 4 months (3000 hours):
    - Replace belts, change seals, replace doctor (belt cleaning) blade
  - Annually:
    - Replace wear strips and worn rollers
- Major Considerations
  - Walkway around unit should allow access to bearings, removing belts, and rollers
  - Crane (or portable hoist) necessary to remove rollers

TECHNOLOGY OVERVIEW: SCREW PRESS

Operation Animation

Overall Performance

Parameter	Screw Press
Cake Dryness	16 to 22%
Power Consumption	up to 8 HP
Operating Speed	Very Low (0.1 to 2 RPM)
Polymer Use	10 to 20 lbs/DT
Capture Efficiency	Depends on MFR; 95%+
Solids Loading Rate	up to 1200 lbs/hr
Wash Water Use	Intermittent; up to 15% of solids flow
Sludge Sensitivity	High; especially flow
Odor	Low; enclosed
Noise	Low
Operator oversite	Low

Operation Parameters

Parameter	Effect
Hydraulic Loading Rate increase(2)	Cake dryness decreases
Solids Loading Rate increase	Cake dryness increases
Polymer Feed Rate increase	Cake dryness increases(1) Capture increases(1)
Polymer Type	Polymer efficacy
Screw Rotation Speed increase	Throughput increases Cake dryness decreases

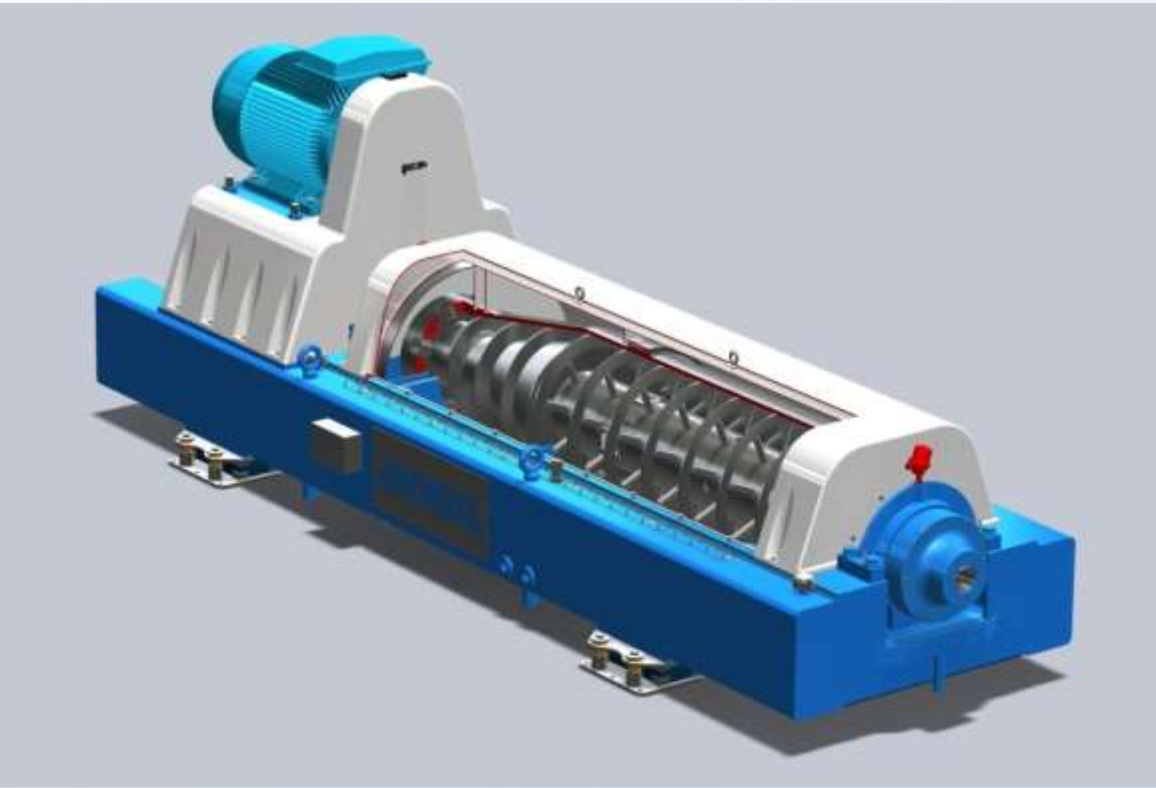
Notes:

(1) General trend. There is a peak “efficiency” for polymer dosage.

(2) Screw presses prefer constant feed (i.e. progessing cavity pumps) at constant screw rotation rates. Deviation from this significantly affects performance. Unit can be automated to increase or decrease screw speed as feed rate changes.

Maintenance

- Routine:
  - Daily:
    - General inspection
  - Weekly:
    - Unit washdown
  - Annually:
    - Replace scrapers/brushes, and spray bar brushes
    - Inspect spray nozzles
  - Every two years:
    - Replace spray nozzles, bearings (2), seals
    - Service counter pressure device
- Major Considerations
  - Walkway around unit should allow access to bearings and cover



TECHNOLOGY OVERVIEW: CENTRIFUGE

Operation Animation

Overall Performance

Parameter	Centrifuge
Cake Dryness	18 to 26%
Power Consumption	100+ HP
Operating Speed	High; up to 3,600 RPM
Polymer Use	15 to 30 lbs/DT
Capture Efficiency	95%+
Solids Loading Rate	up to 4500 lbs/hr
Wash Water Use	At shutdown only; up to 50-70% of solids flow for 15 minutes
Sludge Sensitivity	Low
Odor	High; enclosed
Noise	High
Operator oversite	Low

Operation Parameters

Parameter	Effect
Hydraulic Loading Rate increase	Cake dryness decreases
Solids Loading Rate increase	Cake dryness decreases
Polymer Feed Rate increase	Cake dryness increases(1) Capture increases(1)
Polymer Type	Capture
Pond level increase (deepen)	Cake dryness decreases Capture increases
Torque increases	Cake dryness increases; linear
Differential Speed increases	Capture increases Cake dryness decreases

Notes:
(1) General trend. There is a peak “efficiency” for polymer dosage.

Maintenance

- Routine:
  - Daily:
    - General inspection
    - Check for unusual noise or vibration
  - Every 3-4 months:
    - Grease bearings; gearbox lubrication change, check belt tension
  - Annually:
    - Replace bearings: drives, scroll thrust, gear box
    - Replace spray nozzles
    - Replace belts.
- Major Considerations
  - Routine maintenance should NOT be ignored.
  - Walkway around unit should allow access to bearings and cover
  - Monorail or bridge crane needed to replace bowl assembly

TECHNOLOGY COMPARSION SUMMARY

Technology Summary

Parameter	Belt Filter Press	Screw Press	Centrifuge
Cake Dryness	16 to 22%	16 to 22%	18 to 26%
Power Consumption	up to 10 HP	up to 8 HP	100+ HP
Operating Speed	Relatively low	0.1 to 2 RPM	3,600 RPM
Polymer Use	8 to 16 lbs/DT	10 to 20 lbs/DT	15 to 30 lbs/DT
Capture Efficiency	95%+	Depends on MFR	95%+
Solids Loading Rate	up to 1000 lbs/hr per meter width	up to 1200 lbs/hr	Up to 4500 lbs/hr
Wash Water Use	High	Low	Lowest
Sludge Sensitivity	High	High	Low
Odor	Open	Enclosed	Enclosed
Noise	Medium	Low	High
Operator oversite	High	Lowest	Low

Example Sizing Scenario

	Screw Presses	Belt Filter Presses	Centrifuges
Size/Model	Huber RoS3 Q800 (largest unit)	2-meter	Nominal 30-inch bowl
Hydraulic Capacity, gpm	55	220	300
Solids Loading Capacity, lb/hr	700*	2000	4500
No. Units for Operation During Manned Hours (7/5)	8	**3**	**2**
No. Units for Continuous Operation/Unmanned Hours (24/7)	**2**	N/A	**1**

NOTE:

(1) 7/5 Operation assumes an 8-hour manned shift with 1 hour for startup and shutdown. Dewatering 5 days per week.

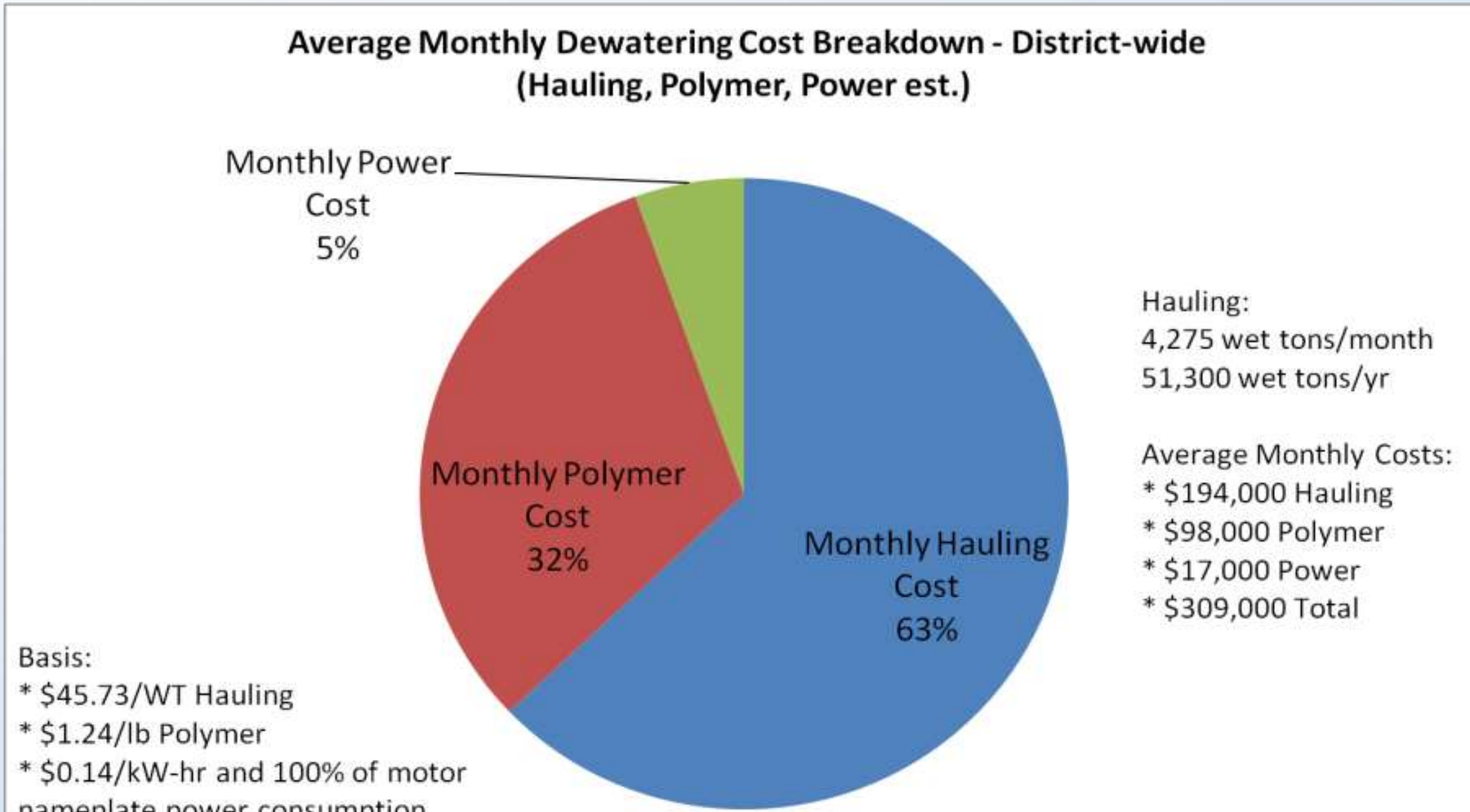
(2) 24/7 Operation is essentially continuous operation during manned and unmanned hours. Actual operating time depends on solids production and may be less than 24 hours/day. Dewatering 7 days/week.

What to Pick?

- Centrifuge
  - High solids loading
  - Low footprint
  - Large hauling costs
- Screw Press
  - Small plant
  - Continuous operation
- Belt Filter Press
  - Daily operation
  - Low concentration sludge
  - Prefer preventative maintenance vs catastrophic

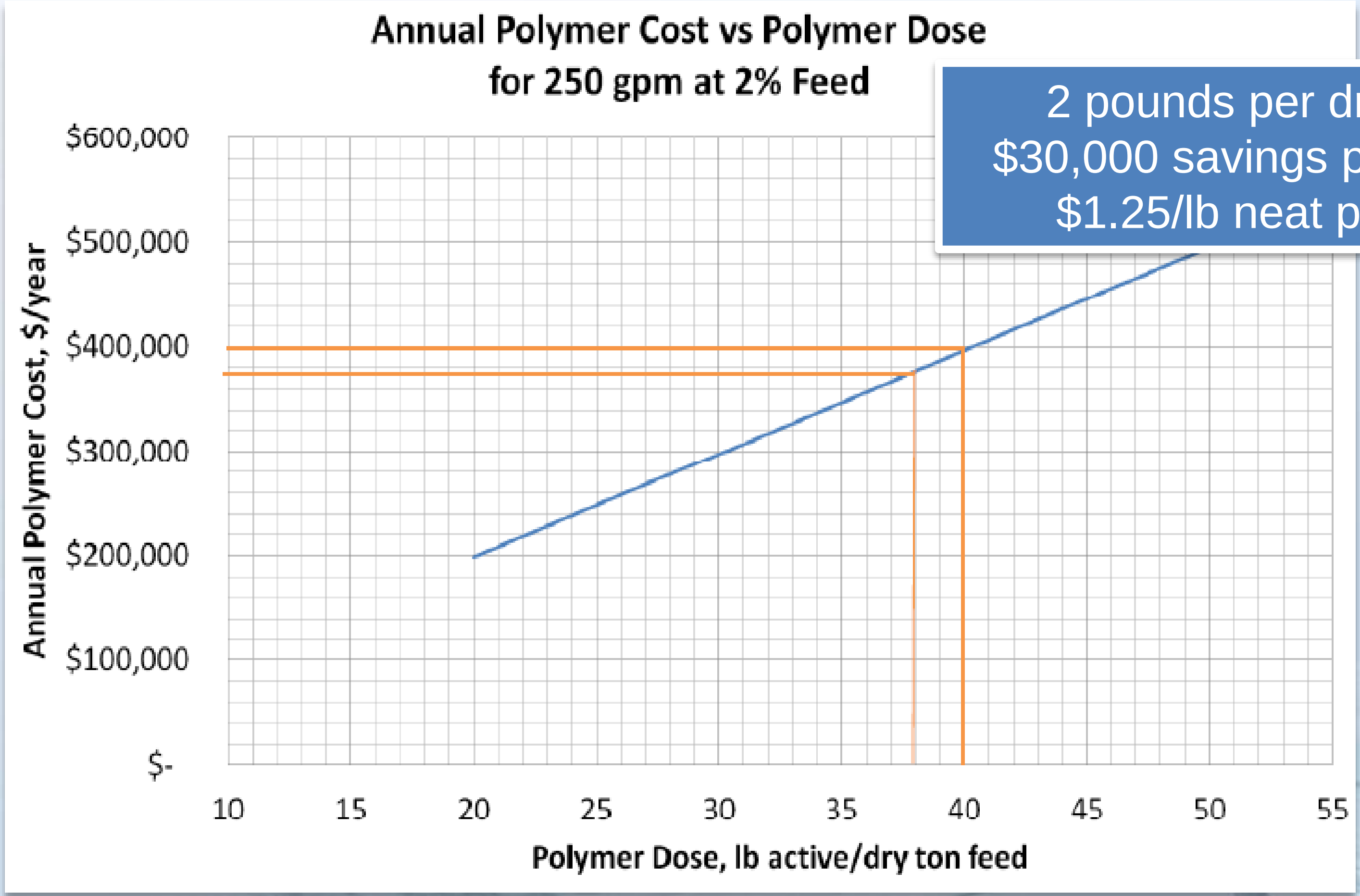
WHY OPTIMIZE?

Example Dewatering Costs Breakdown



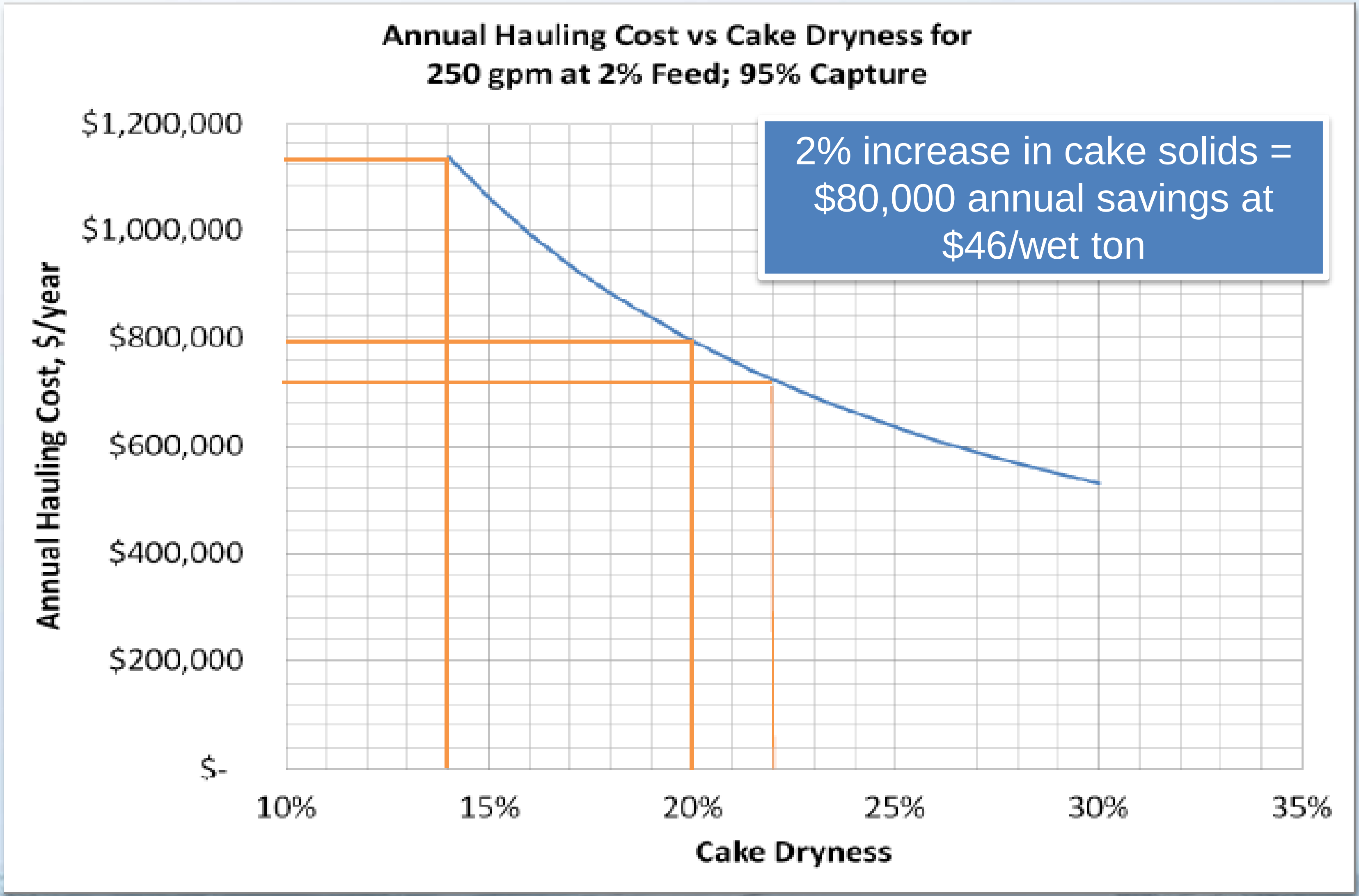
Annual Dewatering Cost = $3.7M

Optimizing Polymer Can Save Money



2 pounds per dry ton = $30,000 savings per year at $1.25/lb neat polymer

Optimizing Cake Can Save More Money



Optimization Is Continuous

Questions?

Thank you for being an operator.

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