Jacobs Challenging today. Reinventing tomorrow.

Key Decisions in Dewatering Facility Design

September 22, 2023

Matt Berg, PE
Matt.Berg@jacobs.com

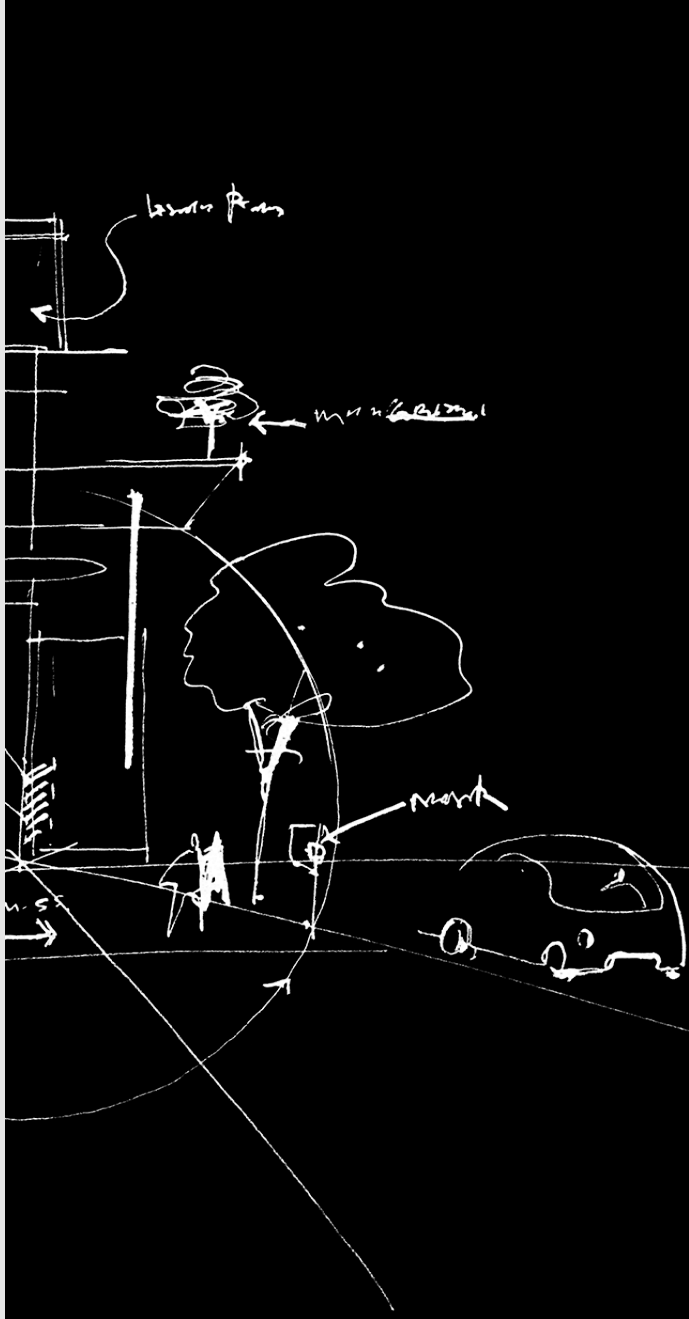
Discussion Topics

- Sizing Decisions:
  - Flow/load projections
  - Design Condition
  - Level of redundancy
- Equipment and Technology:
  - Type of dewatering equipment
  - Polymer system elements
  - Type of conveyance
  - Level of automation
  - Odor Control
- Layout Considerations:
  - Safety/operator access
  - Storage and loadout
  - Building considerations
- Decision Analysis

What is the state of the practice?

Which technologies are worth considering?

How can someone approach making these decisions?



Sizing Decisions

Sizing-1: Flow/Load Projections

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
Cake Solids:			
23	22	% Solids	Cake Solids Concentration
57	57	lb/cu ft	Cake Density
Cake Production:			
155,479	195,692	dry lb/d	
675,995	889,511	wet lb/d	
28,166	37,063	wet lb/hr	
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids

Sizing-1: Flow/Load Projections

- Define future target year
- Dewatering is different than headworks
- Average Annual versus Max Month or Max Day

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
Cake Solids:			
23	22	% Solids	Cake Solids Concentration
57	57	lb/cu ft	Cake Density
Cake Production:			
155,479	195,692	dry lb/d	
675,995	889,511	wet lb/d	
28,166	37,063	wet lb/hr	
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids

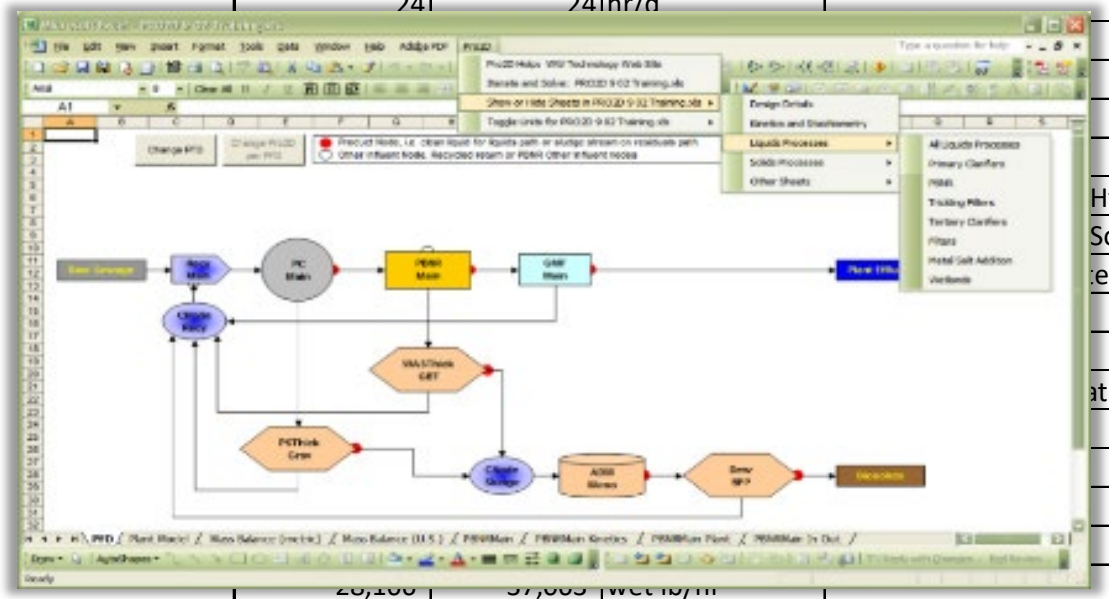
Sizing-1: Flow/Load Projections

- Consider start-up and future conditions
- Equipment and piping is not oversized
- Space for future units

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
Cake Solids:			
23	22	% Solids	Cake Solids Concentration
57	57	lb/cu ft	Cake Density
Cake Production:			
155,479	195,692	dry lb/d	
675,995	889,511	wet lb/d	
28,166	37,063	wet lb/hr	
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids

Sizing-1: Flow/Load Projections

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
			Hydraulic-Based Sizing
			Solids-Based Sizing
			ed (round up)
			ation
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids



Reliable solids projections need:

- Historical data
- Calibrated wastewater process model
- Coordination with planning staff for anticipated growth growth and service area.
- Consider future process changes

Sizing-2: Factors Affecting the Number of Units Needed

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
Cake Solids:			
23	22	% Solids	Cake Solids Concentration
57	57	lb/cu ft	Cake Density
Cake Production:			
155,479	195,692	dry lb/d	
675,995	889,511	wet lb/d	
28,166	37,063	wet lb/hr	
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids

Operation Schedule has large cost impact

- 24/7
- 8 hrs/day; 4 days/week

Pre-Dewatering Storage:

- Reduces equipment size
- Handle unforeseen peaks
- Existing "wide spots" or new tanks.
- Consider cost/benefit of adding storage

Sizing-2: Factors Affecting the Number of Units Needed

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
Cake Solids:			
23	22	% Solids	Cake Solids Concentration
57	57	lb/cu ft	Cake Density
Cake Production:			
155,479	195,692	dry lb/d	
675,995	889,511	wet lb/d	
28,166	37,063	wet lb/hr	
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids

Solids vs Hydraulic Loading:

For dewatering, solids loading is typically limiting (different for thickening).

Sizing-3: Redundancy

Best practice includes redundant equipment to accommodate down time for maintenance and repairs.

Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
			ke Solids Concentration
			ke Density
			orage Capacity of Final Biosolids

Consider a standby unit for every 1-5 duty units.

# Duty Units	# Standby Units	Total # Units
1	1	2
5	1	6
6	2	8
9	2	11
10	3	13

Each facility is unique:

- Design for < "top speed"
- Staffing, maintenance, and operation practices.
- Lead time for common spare parts and manufacturer repair availability and location relative to the facility.
- Dewatering feed storage.

Sizing-4: Cake Storage

- Wide spot between dewatering and end use.
- Impacts equipment operation schedule

May be necessary for:

- The type of end use contract
- Backup/emergency plans

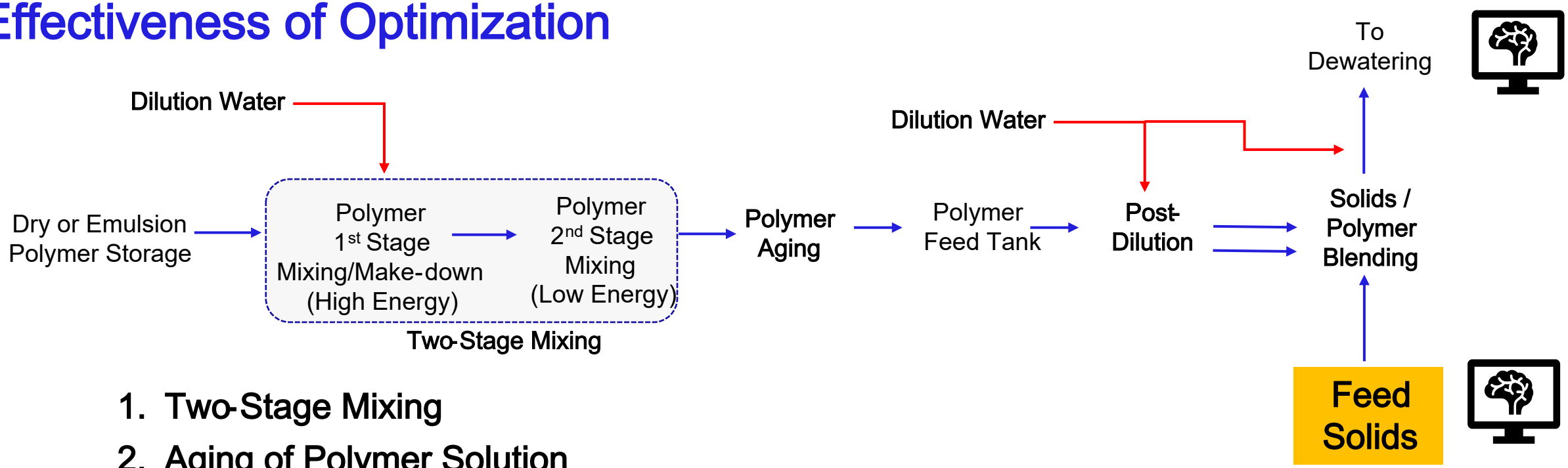
Average Annual in Start-up Year	Maximum 30-Day in Design Year	Units	Description
Biosolids Production:			
163,662	205,992	dry pounds/day	2045 Biosolids Production
3.6	3.4	% Solids	Feed Solids Concentration
Dewatering Equipment Run Times:			
24	24	hr/d	
7	7	d/wk	
Dewatering Units:			
140	160	gpm/unit	Hydraulic Loading
2,500	2,900	lbs/hr/unit	Solids Loading
2.7	3.0	units	# of Duty Units using Hydraulic-Based Sizing
2.7	3.2	units	# of Duty Units using Solids-Based Sizing
4		units	# of Duty Units-Selected (round up)
1		units	# of Standby Units
Cake Solids:			
23	22	% Solids	Cake Solids Concentration
57	57	lb/cu ft	Cake Density
Cake Production:			
155,479	195,692	dry lb/d	
675,995	889,511	wet lb/d	
28,166	37,063	wet lb/hr	
439	578	cu yd/d	
494	650	cu ft/hr	
Cake Storage:			
2	2	days	Storage Capacity of Final Biosolids

Equipment and Technology

Type of Dewatering Equipment

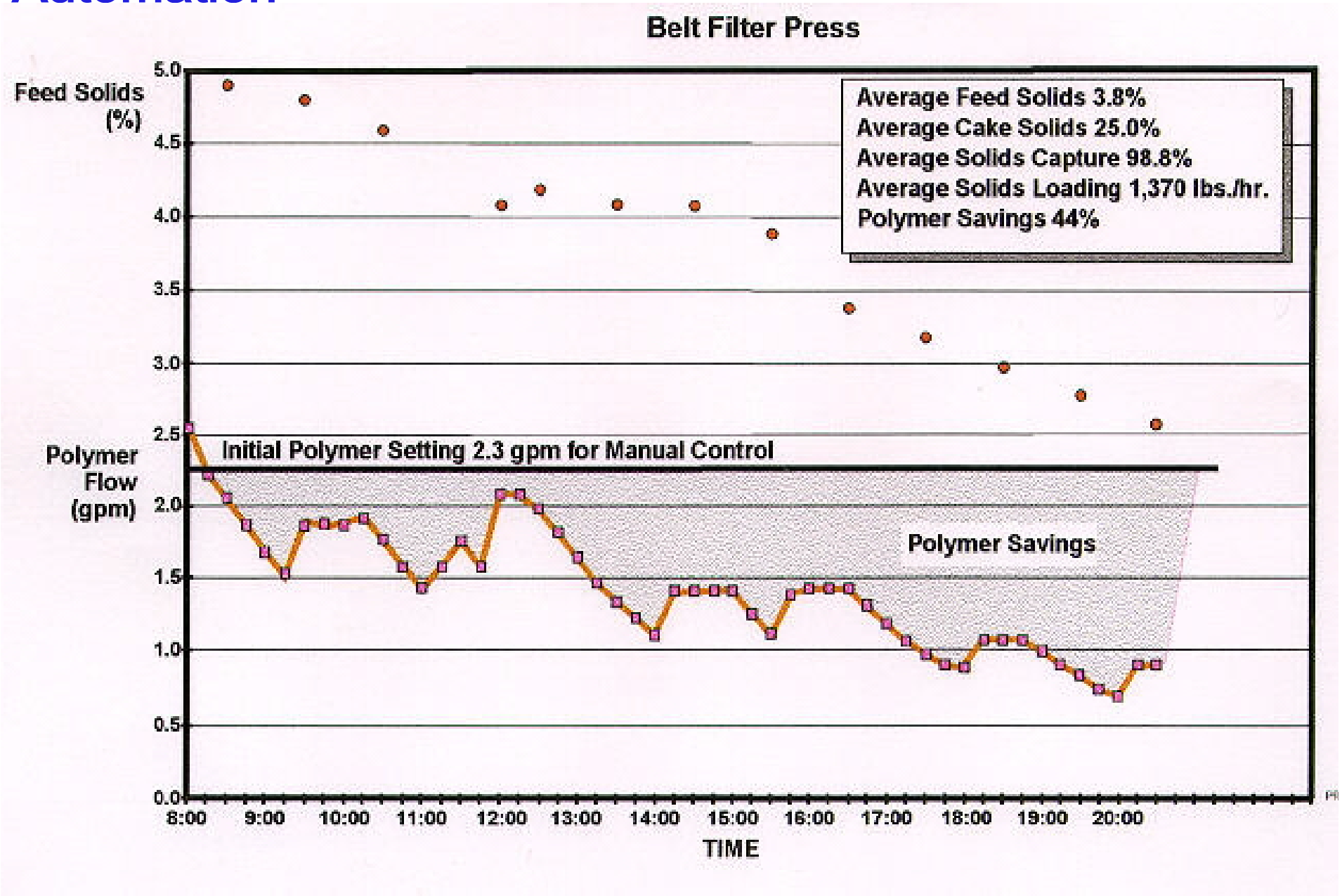
- Centrifuge
  - Minimal odor, housekeeping, operator attention, footprint
  - High speed/energy consumption and sophisticated major maintenance
- BFP
  - Simple operation and lots of operator control
  - Requires washwater
  - Needs enclosures for odor containment
- Screw press
  - Low power requirements
  - Lower hydraulic capacity (more units required ➔ larger footprint)
- Hydraulic piston press
  - High solids cake concentration
  - Limited experience

Evaluate Elements of the Polymer System for the Cost Effectiveness of Optimization

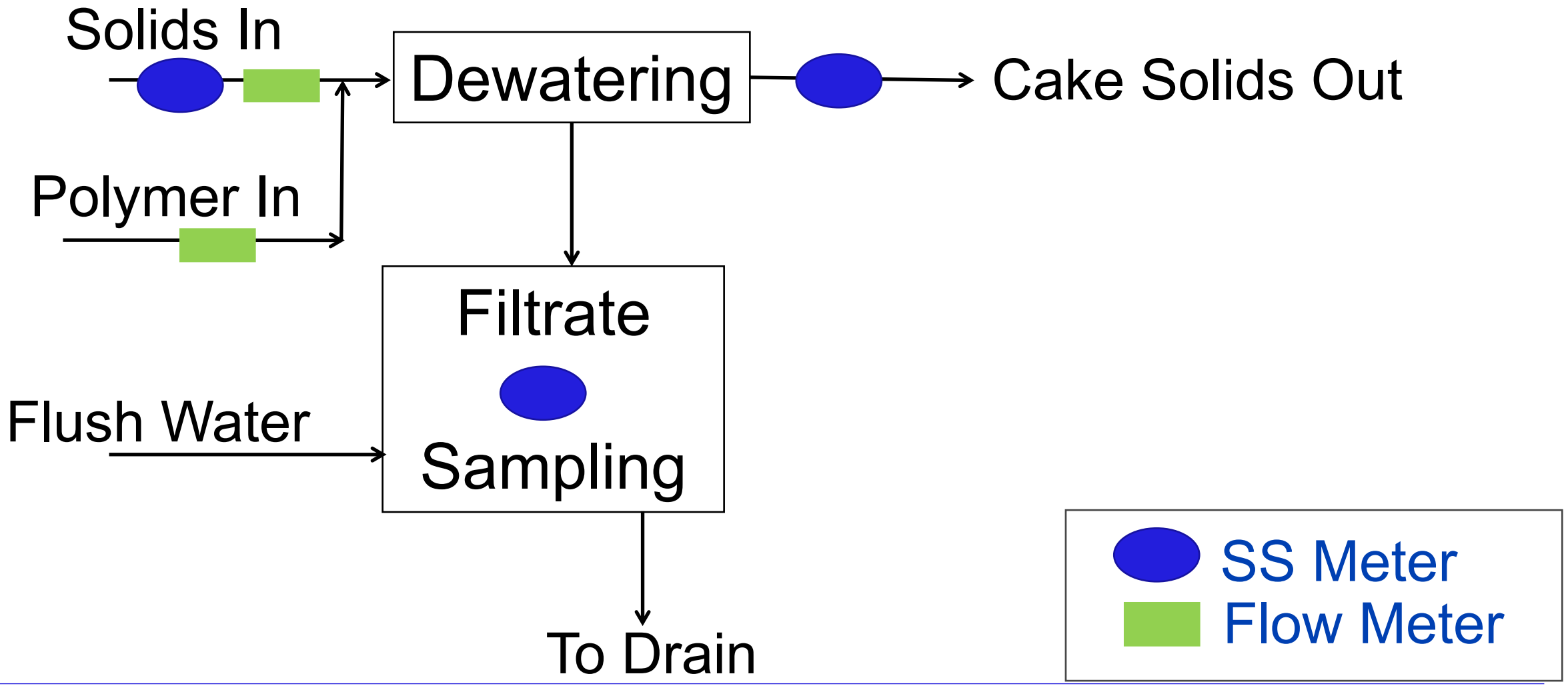


1. Two-Stage Mixing
2. Aging of Polymer Solution
3. Effective Solids/Polymer Blending
4. Dilution and Feed System:
    a) Allows polymer feed solution in the optimal range
    b) Provides multiple feed solution and dilution application points for flexibility
    c) Mitigate loss of effectiveness due to poor dilution water quality
5. Strategic automation to optimize dewatering performance

Level of Automation



Level of Automation



Cake Transport Options

- Each has appropriate applications, advantages, disadvantages, and maintenance considerations
- Screw Conveyors
  - Shafted
  - Shaftless
  - Vertical shaftless
- Belt Conveyors
  - Troughed
  - Cleated
- Cake Pumps
  - Progressing Cavity Bridge-Breaker
  - Hydraulically-Actuated Piston

Odor Control

- Considerations:
  - Define your goals: Staff safety onsite, neighbor complaints offsite
  - Limit amount of staff operation time in direct contact with equipment
    - Type of equipment
    - Level of automation, including cameras
  - Type of equipment:
    - Already enclosed: Centrifuges, Screw Presses, Hydraulic Piston Presses
    - BFPs:
      - Can increase air changes per hour if desired
      - Can enclose with hinged hoods over gravity zone
      - Can also enclose with removable panels on sides

Layout Considerations

Designers need to think like operators to consider operator access and safety

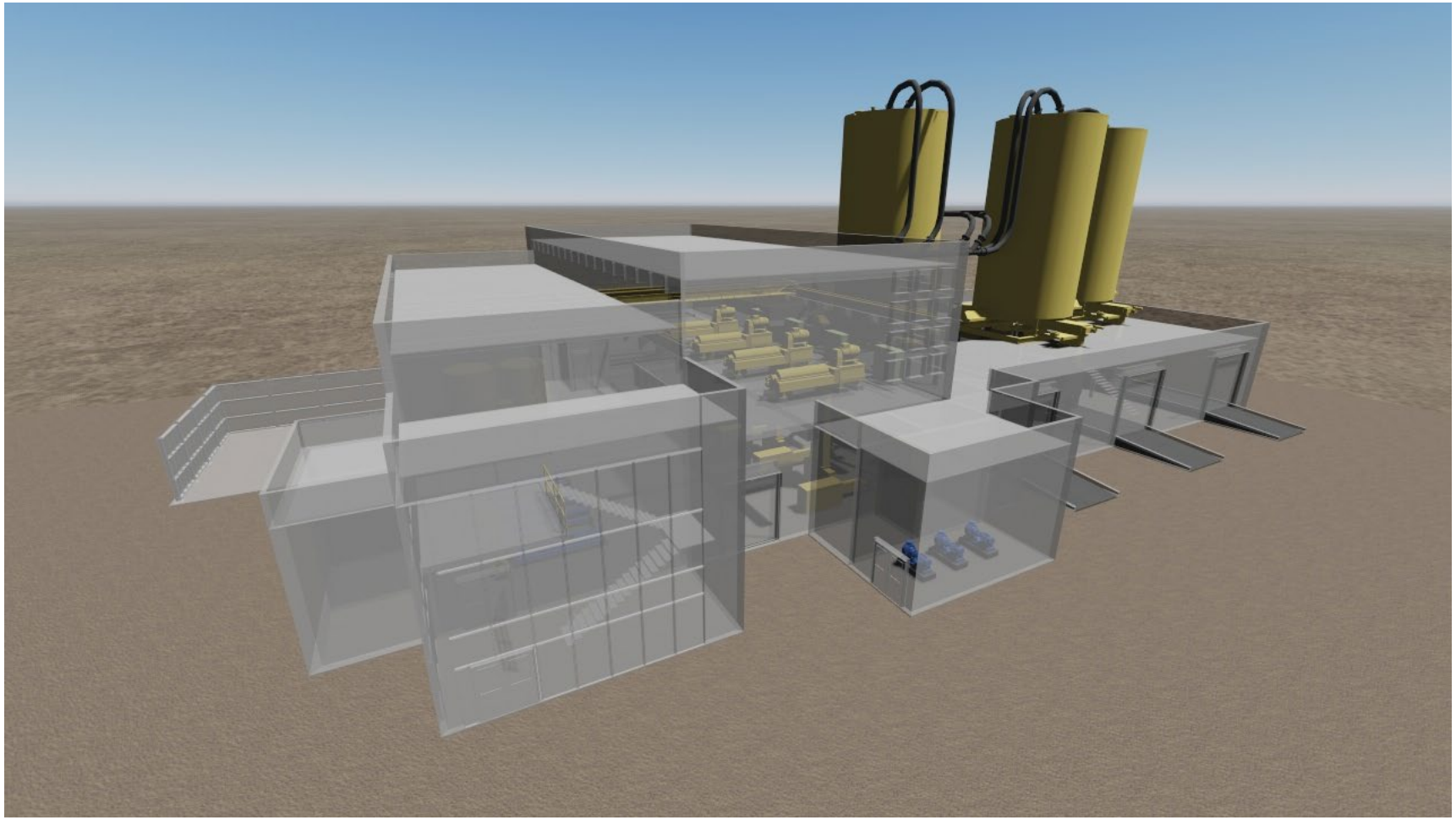
- Operator-friendly layout
  - Access around drives and motors
  - Overhead crane for easy removal of major equipment for repair
  - Laydown space for removal of major equipment items
  - Good ventilation
  - Low noise with acoustic wall panels if necessary
  - Great lighting

Storage and Loadout

- Cake hoppers or direct to trucks/pad
- Automatic truck loading systems
  - Discharge rates can be controlled
    - Fill trucks in 5 to 20-minutes
  - Precision truck loading system
    - Load cells/ level sensors
    - Proven controls
    - Within 200 pounds of set weight
    - Multiple discharge points per truck → no need to relocate truck to load
    - Truck drivers can operate
    - Minimal housekeeping

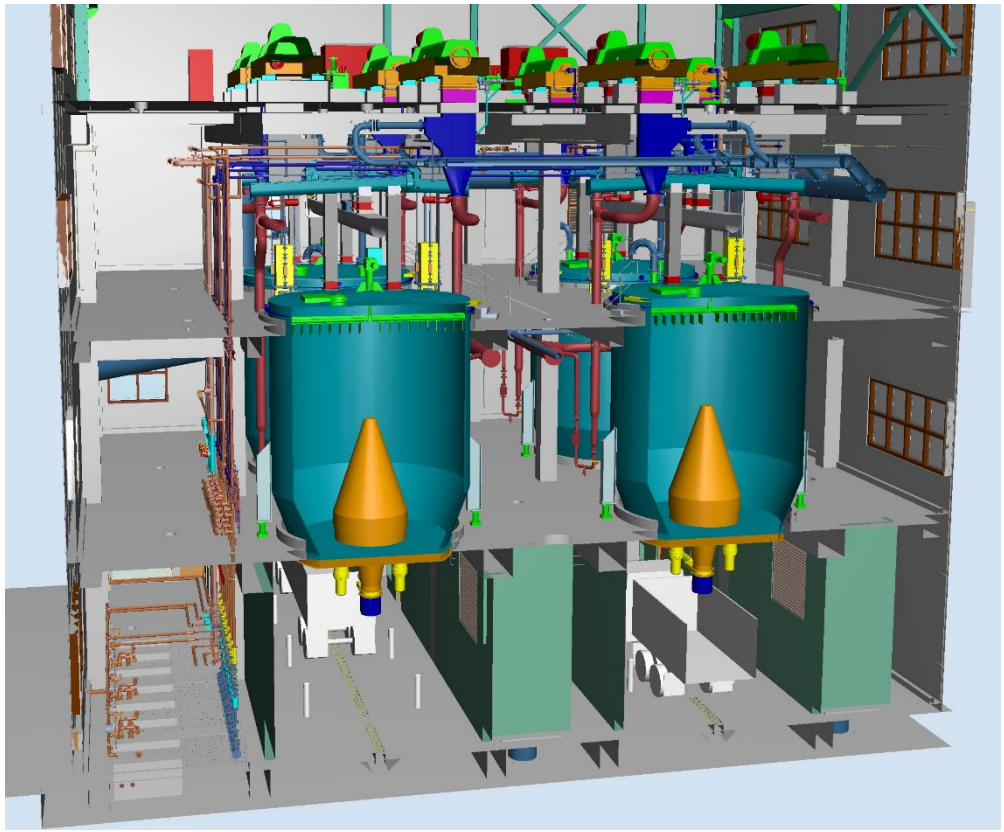
Building Considerations

Traditional Layout Requires Conveyance of Cake from Dewatering Units to Cake Storage



Building Considerations

When feasible, a 3-story concept provides low O&M costs and easy truck loading



- Advantages:
  - Cake drops by gravity to storage silo/ bin/ hopper then to trucks
  - Less energy cost
  - More simple maintenance (least cake conveyance)
  - Smaller footprint
- Disadvantages:
  - Tall building
  - Upfront capital cost
- Other considerations:
  - Operator viewing
  - Hoistways for major equipment
  - Best for polymer storage and feed equipment to be on ground level for easiest delivery

Decision Process

Tools that Can Help Support Decisions

- Sizing Decisions:
  - Flow/load projections
  - Design Condition
  - Level of redundancy

- Data analysis—Appropriate elimination of outliers
- Risk analysis—Evaluate the likelihood of encountering specific scenarios
- Sensitivity analysis—Determine whether the outcome changes if specific criteria were to be weighed differently

- Equipment and Technology:
  - Dewatering equipment
  - Polymer system
  - Type of conveyance
  - Level of automation
  - Odor Control

- Traditional project delivery, lowest bid—Design around the largest sized equipment
- Equipment pre-selection—Bid process with manufacturers, can include monetary and non-monetary criteria

- Layout Considerations:
  - Safety/operator access
  - Storage
  - Truck scales/loadout
  - Building considerations

- Cost/benefit models/analyses:
  - Define mutually exclusive criteria
  - Establish weighting factors based on collective head-to-head or average of individual staff evaluation
  - Compare benefit score to capital and/or life cycle cost
  - Can include consequence evaluation—define best and worst feasible outcomes for alternatives

Questions/Comments?

Jacobs Challenging today. Reinventing tomorrow.

Key Decisions in Dewatering Facility Design

September 22, 2023

Matt Berg, PE

TACWA