Alternatives and Optimization Strategies for Sedimentation Basin Sludge Collection

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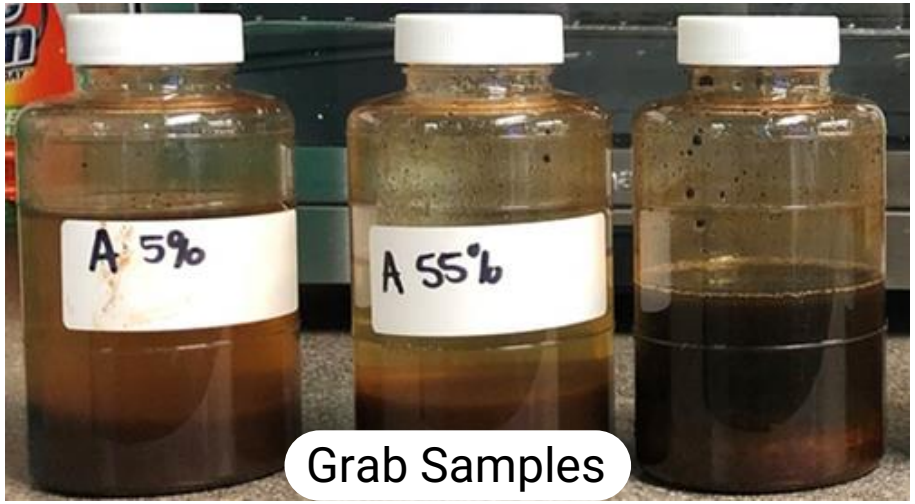
Hazen

Sed. Basin Sludge Collection – Set and Forget?

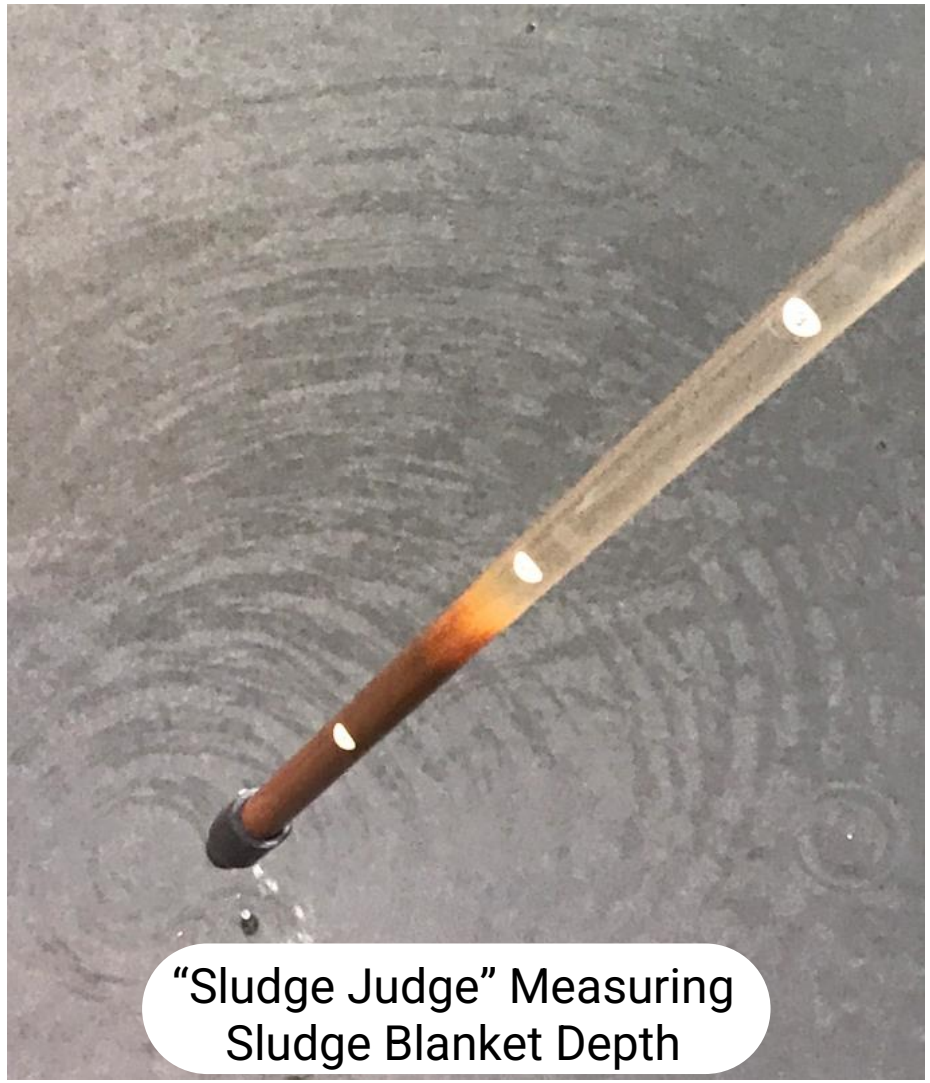
Not so fast!

- Monitor and optimize sludge collection to:
  - **Prevent anoxic sludge**
  - **Improve settled water quality**
  - **Avoid overloading residuals processes**

Anoxic Sed. Basin Solids



Grab Samples



"Sludge Judge" Measuring Sludge Blanket Depth

Discussion Topics

- Sludge Collection Alternatives:
  - **Fixed grid orifice system**
  - **Reciprocating scraper**
  - **Flexible hose traveling suction header**
  - **Hoseless traveling suction header**
- Hydraulic Considerations
- Which System to Use?
- Why Optimize Sludge Collection?
- Case Study
  - **Data Collection**
  - **Optimization Strategies**
  - **Outcomes**

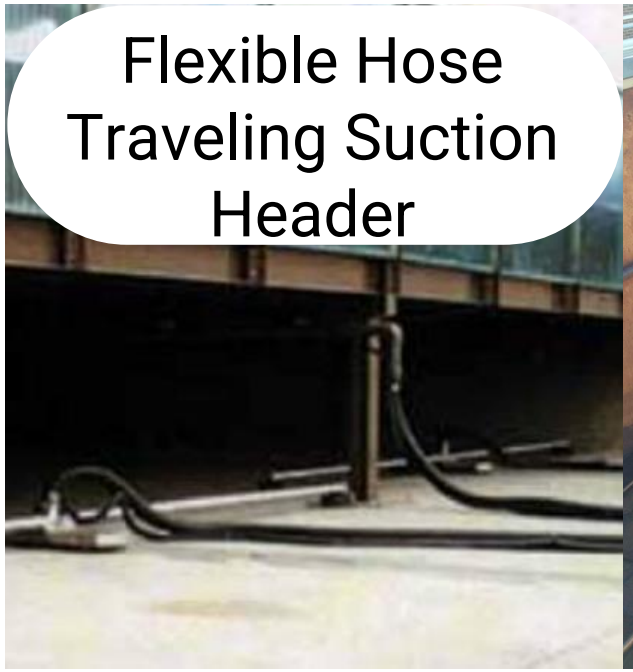

E.M. Johnson WTP

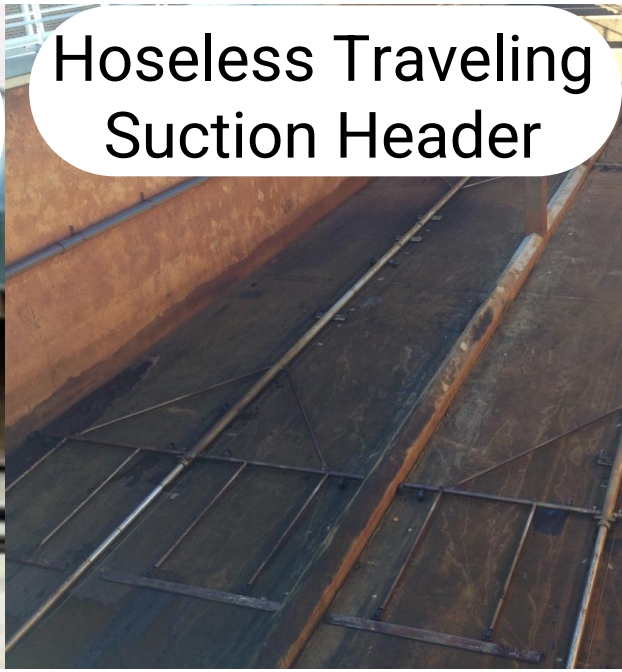
Sedimentation Basin Sludge Collection

- Methods for sludge removal:
  - **Traditional methods - slow, labor intensive, impacts operations**
  - **Automatic methods with varying degrees of optimization capability**

Alternatives for Sludge Collection

Fixed Grid Orifice





Courtesy of Ovivo

Fixed Grid Orifice System

- Removes settled solids as they move across the sedimentation basin floor
- Orifices on the pipes are oriented towards the flow path
- Grid spacing pattern denser at the influent end and less dense closer to the effluent
- Only moving parts are drain valves installed along collection headers

Fixed Grid Orifice System

Advantages	Considerations
No drive equipment to mount outside the basins	Pilot testing required to prove effectiveness with ferric solids
Besides valve actuators, no moving parts are required	Floor obstructions during maintenance and cleaning
Collection grid easily designed to avoid structural obstacles	Higher cost compared to other alternatives
Minimal equipment maintenance	Lower capacity for optimization
Thermoplastic construction offers corrosion resistance	Technology moving away from fixed systems

Reciprocating Scraper System

- Scrapers push solids to common draw off point, optional cross-collectors to sump
- Blades ~2 ft apart, each stroke ~2.5 ft
- Key Features:
  - **Drive assembly**
  - **Pivot assembly**
  - **Scraper assembly**
  - **MOV plug valve**
- Some Manufacturers:
  - **WesTech Zickert Shark**
  - **JMS Mega-SCRAPER**
  - **MRI Ultra-Scraper**

Reciprocating Scraper

Reciprocating Scraper System

- Scraper blades push sludge on forward movement
- Blades slip underneath sludge layer on return movement.

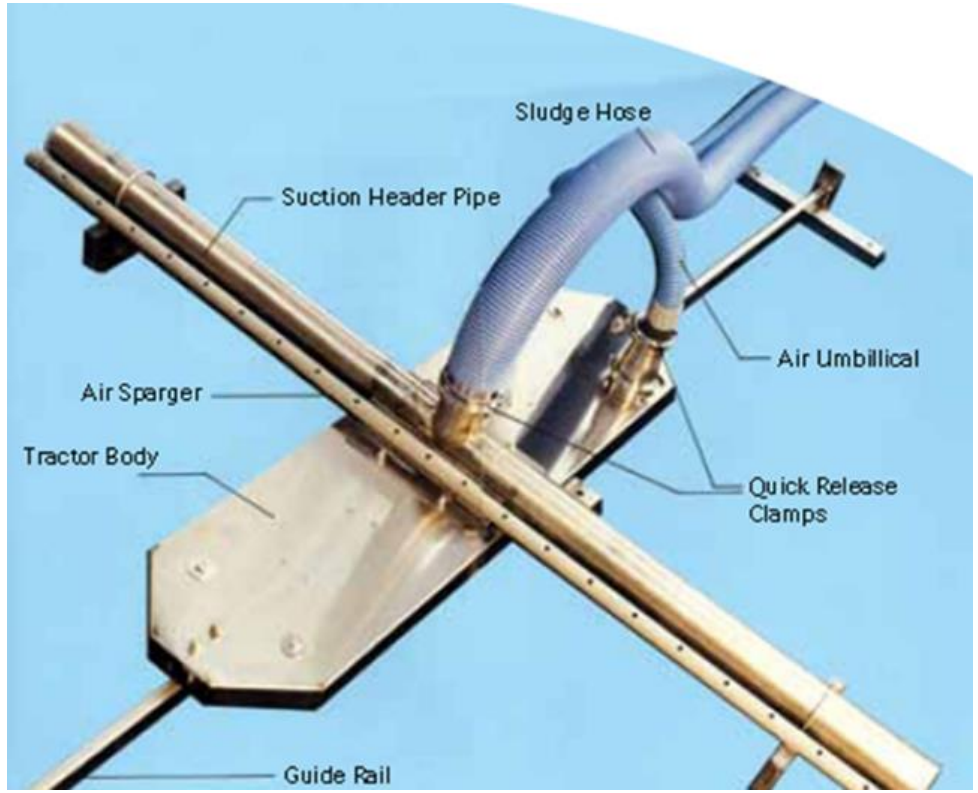
Courtesy of WesTech

Reciprocating Scraper System

Advantages	Considerations
Scraper blades fit around structural obstacles	Significant floor obstructions
Complete basin coverage	Requires sludge collection area
Low profile	Torque on blades under a thick sludge blanket
Minimal travel distance	Lower capacity for optimization
No orifices	

Flexible Hose Traveling Suction Header

- Moves across basin floor
- Collects sludge via downward facing orifices in suction header
- Two headers, each travels half the basin length
- Propulsion via compressed air or cable drive
- Key Features:
  - **Drive assembly**
  - **Suction header**
  - **MOV plug valve**
  - **Guide rail**
  - **Sludge hose**
- Some Manufacturers:
  - **Ovivo Trac-Vac**
  - **Brentwood SedVac**
  - **Xylem Leopold CT2**
  - **Westech Sludge Sucker**



Courtesy of Ovivo

Flexible Hose Traveling Suction Header

Advantages	Considerations
Minimal equipment on basin floor	Hose connections can snag
Limited structural modifications	Equipment can come off center guide rail
Low profile	Longer basins may need coupled hoses
Proven technology for utilities using ferric coagulants	Harder to work around obstacles
	Potential orifice clogging

Courtesy of Ovivo

Hoseless Traveling Suction Header

- Moves across basin floor
- Collects sludge via downward facing orifices in suction header
- Hoseless, telescoping suction sludge removal
- Two headers, each travel half the length of the basin
- Some designs include plow blade in front of laterals to impart energy to sludge blanket
- Uses walls and rigidity of central pipe to keep system on track

Courtesy of JMS

Hoseless Traveling Suction Header

- Key Features:
  - **Drive assembly**
  - **Suction header**
  - **MOV plug valve**
  - **Telescoping assembly**
  - **Guide walls**
- Some Manufacturers:
  - **MRI Hoseless Cable-Vac**
  - **JMS Mega VAC**

Courtesy of MRI

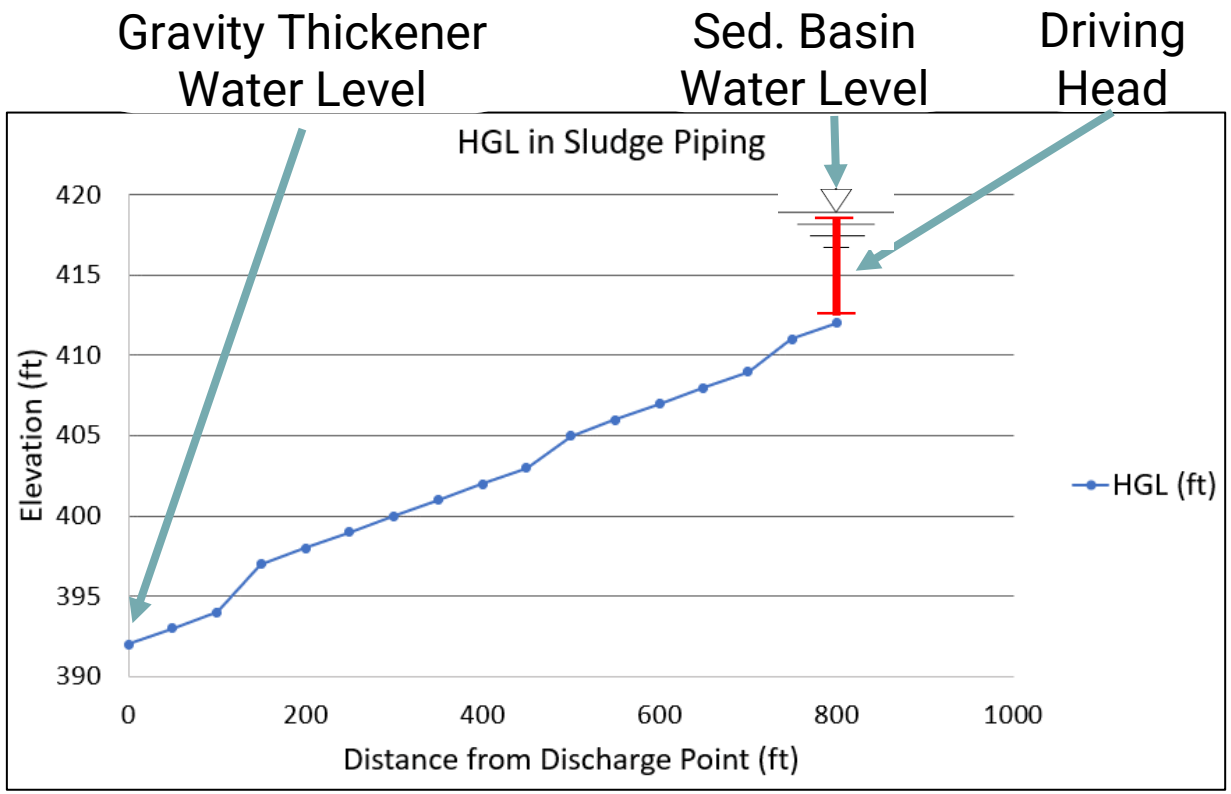
Hoseless Traveling Suction Header

Advantages	Considerations
Telescoping sludge collection pipe avoids need for hoses	Walls needed to guide headers
Minimal equipment on basin floor	Harder to work around obstacles
Low profile	Potential orifice clogging
Higher capacity for optimization	

Courtesy of MRI

Hydraulic Considerations

- Driving head from the sedimentation basin dictates sludge flow
- Limited driving head can result in low flows and poor sludge removal
  - **Manufacturers recommend a minimum of 7 ft driving head for hoseless systems**
- Excessive driving head results in high flows and dilute sludge
  - **Incorporate a way to restrict flow (valve).**



How to Decide Which System to Use?

- No silver bullet – each utility has unique needs and challenges
- Considerations during selection process:
  - **Maintenance requirements**
  - **Hydraulic limitations**
  - **Operator familiarity**
  - **Structural obstacles / conflicts**
  - **Type of coagulant**
  - **Desire for optimization capabilities**
  - **Budget**

Why Optimize Sludge Collection?

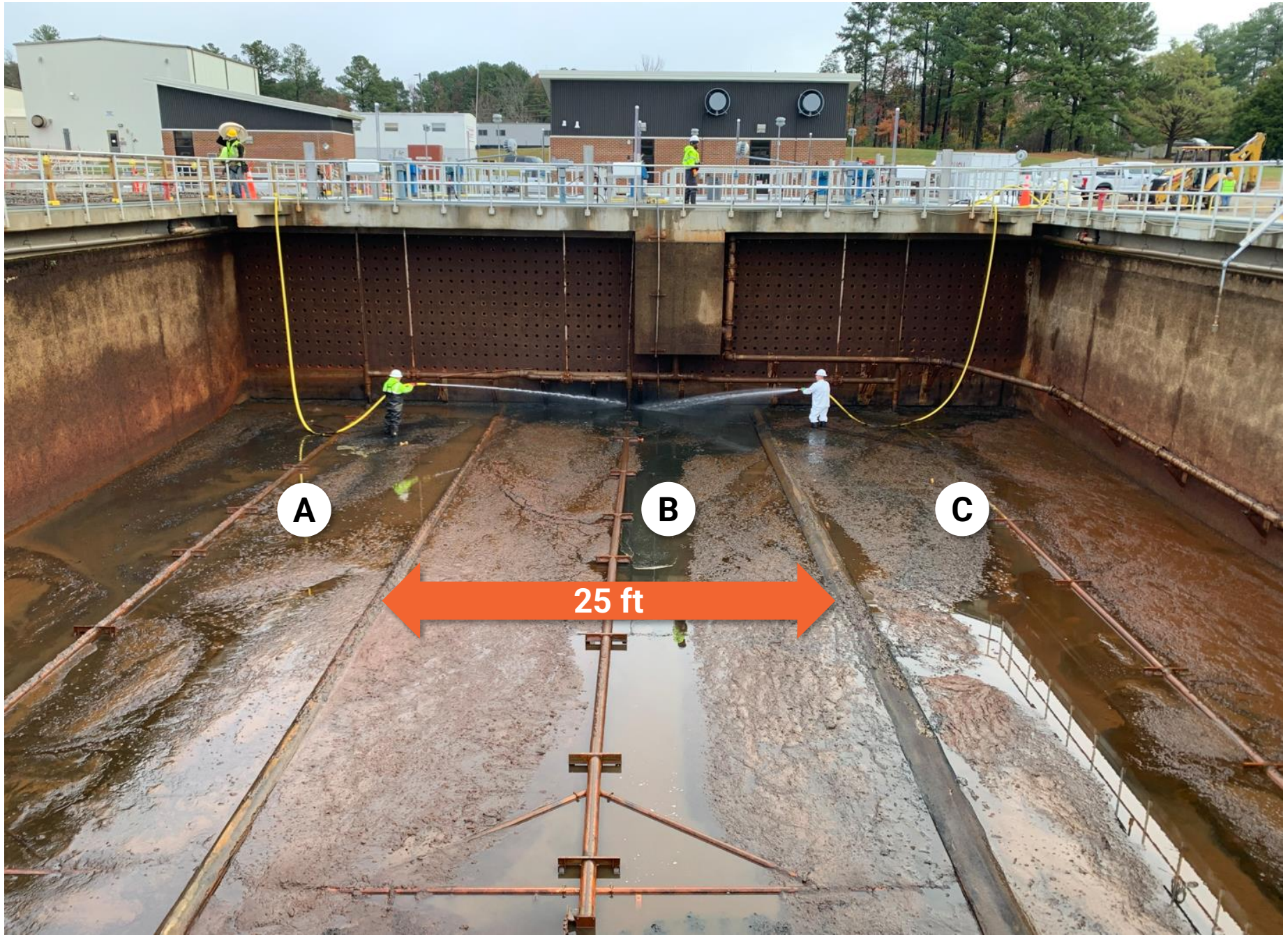
- Control sludge blanket depth to prevent sludge from going anoxic
  - **Thick, anoxic sludge is more difficult to remove**
  - **Anoxic sludge can degrade settled water quality**

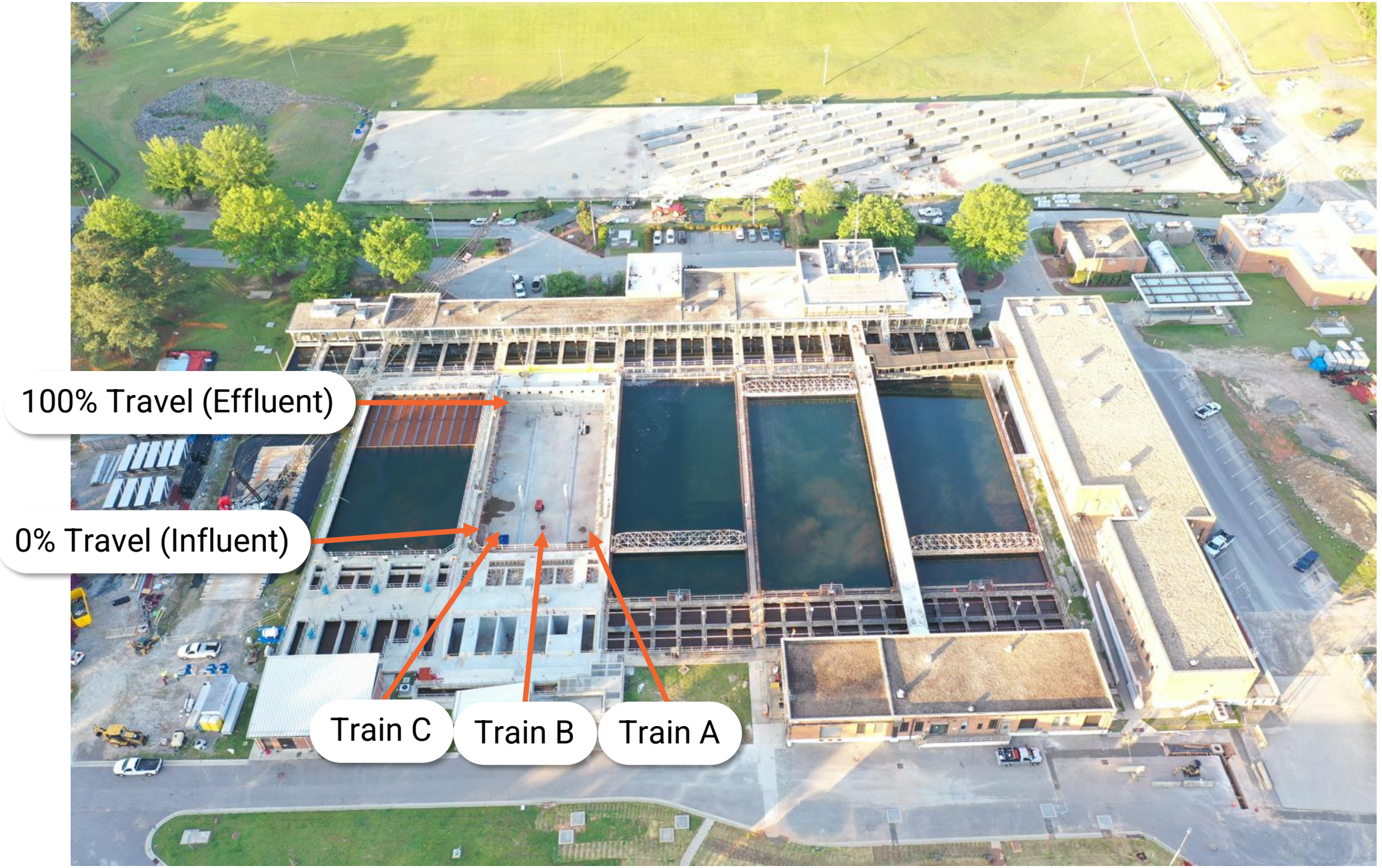
- Reduce floc carryover to downstream processes
  - **Improve settled water turbidity**

- Optimize residuals handling processes
  - **Send sludge with consistent % solids**
  - **Avoid overloading residuals processes with water**
  - **Avoid sending over-thick sludge that reduces operational efficiency**

Case Study

- E.M. Johnson WTP: 86 MGD → 120 MGD
- Upgrading existing rapid mix, flocculation, and sedimentation basins
  - **High rate settling technology (plate settlers)**
  - **New sludge collection system (hoseless suction header)**
- Upgraded processes at Basin 5 first to pilot new technologies
- Applying lessons learned at Basin 5 to Basins 1-4 (construction ongoing)


A
B
C
25 ft


100% Travel (Effluent)
0% Travel (Influent)
Train C
Train B
Train A

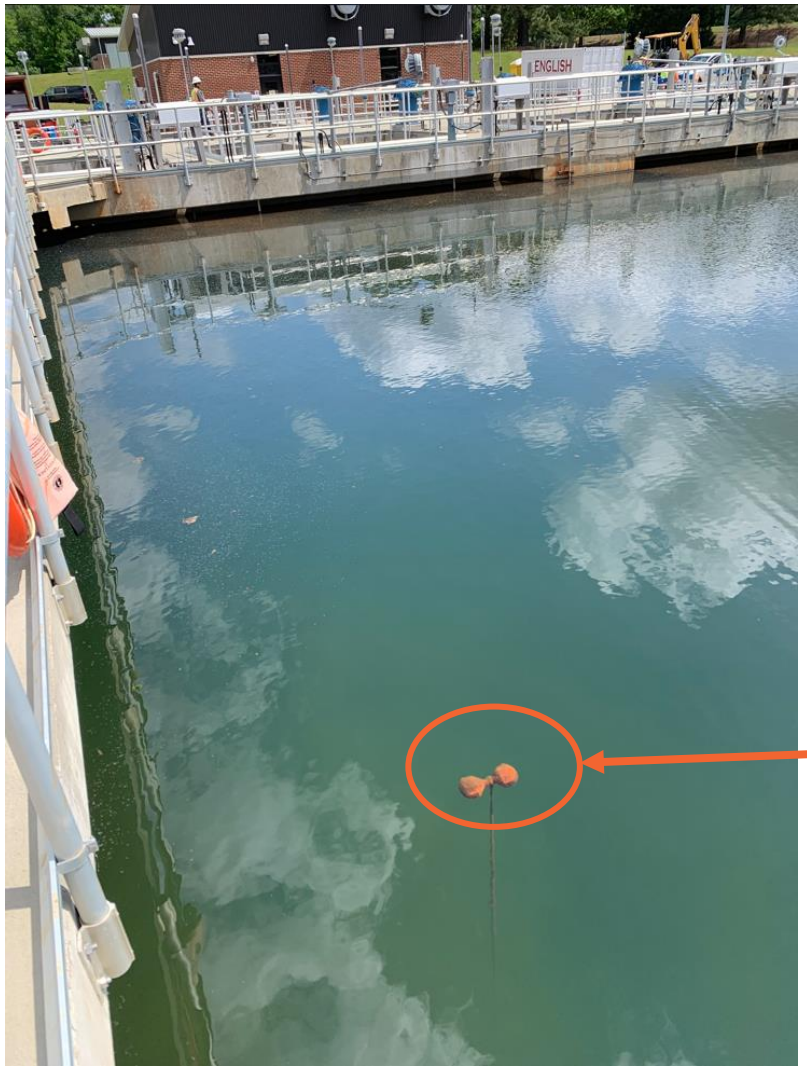
Optimization at E.M. Johnson

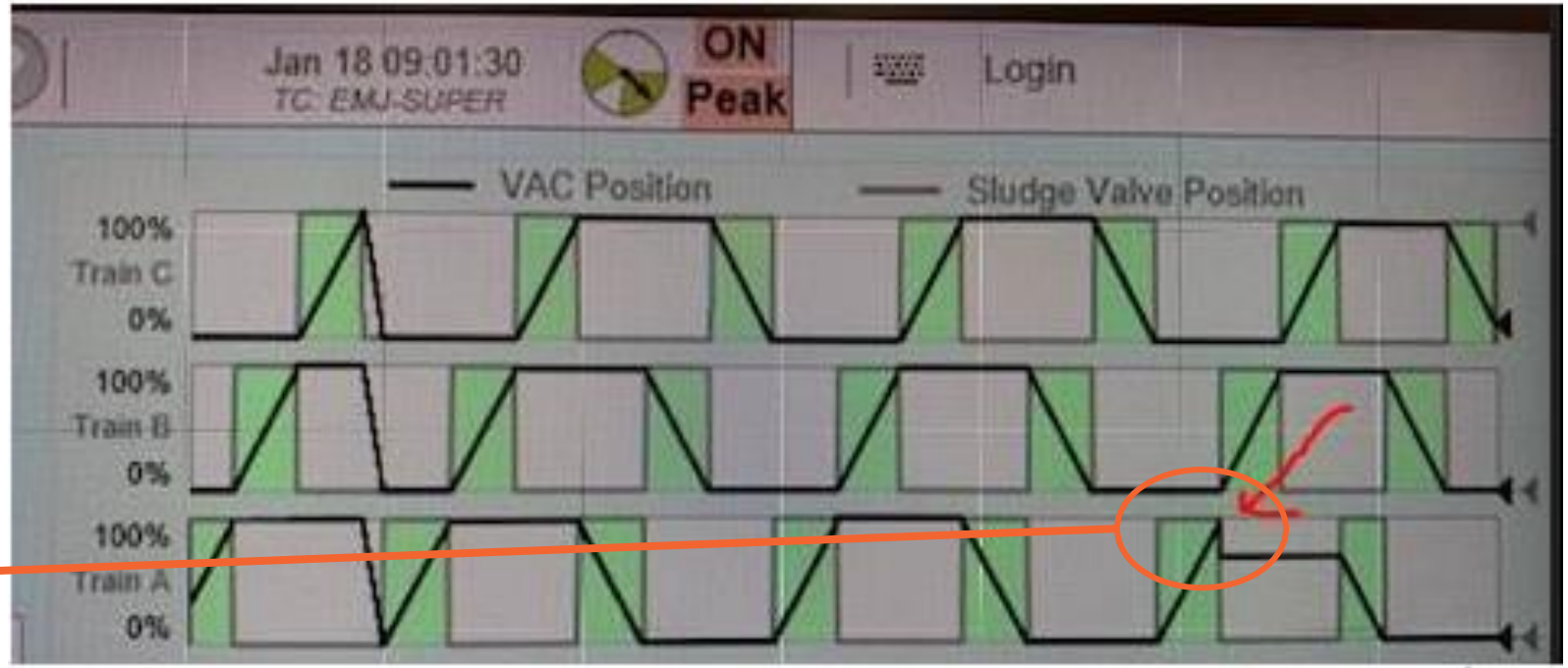
- Defined sludge collection “zones”
- Travel speed (VFD)
- Dwell time
- Withdrawal valve % open
- Cleaning cycles 1x per week

Zone 2: 60–100% - 3 fpm travel speed

Zone 1: 0–60% - 1 fpm travel speed

Optimization at E.M. Johnson

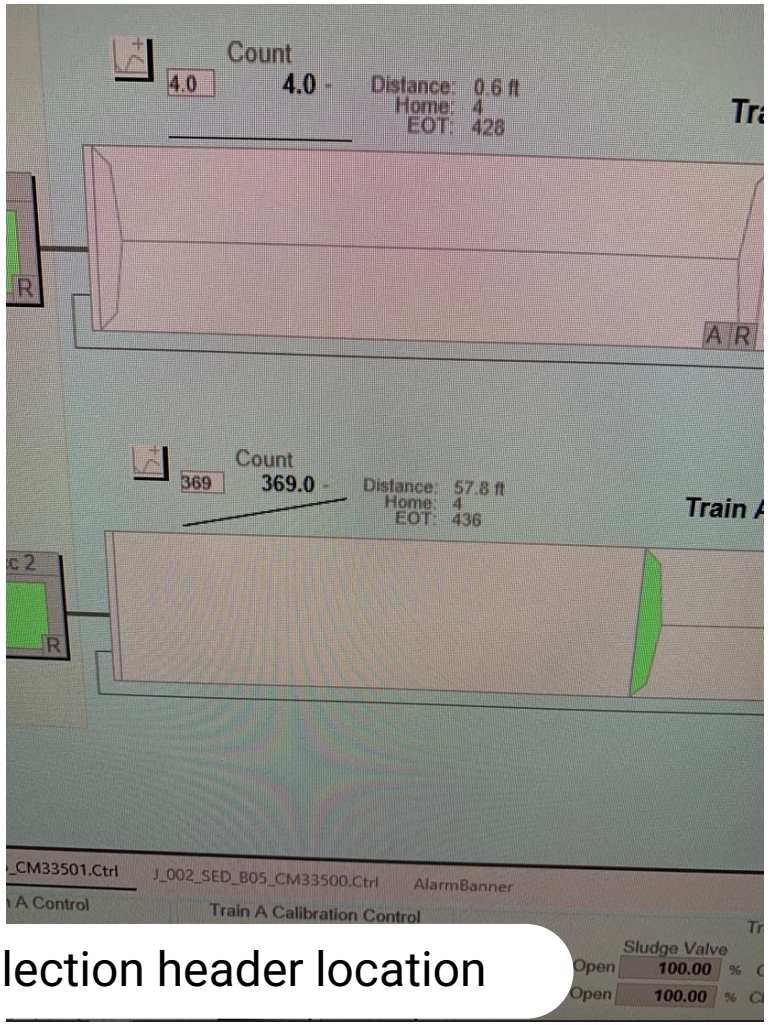




Increased visibility into collection header location

Optimization at E.M. Johnson

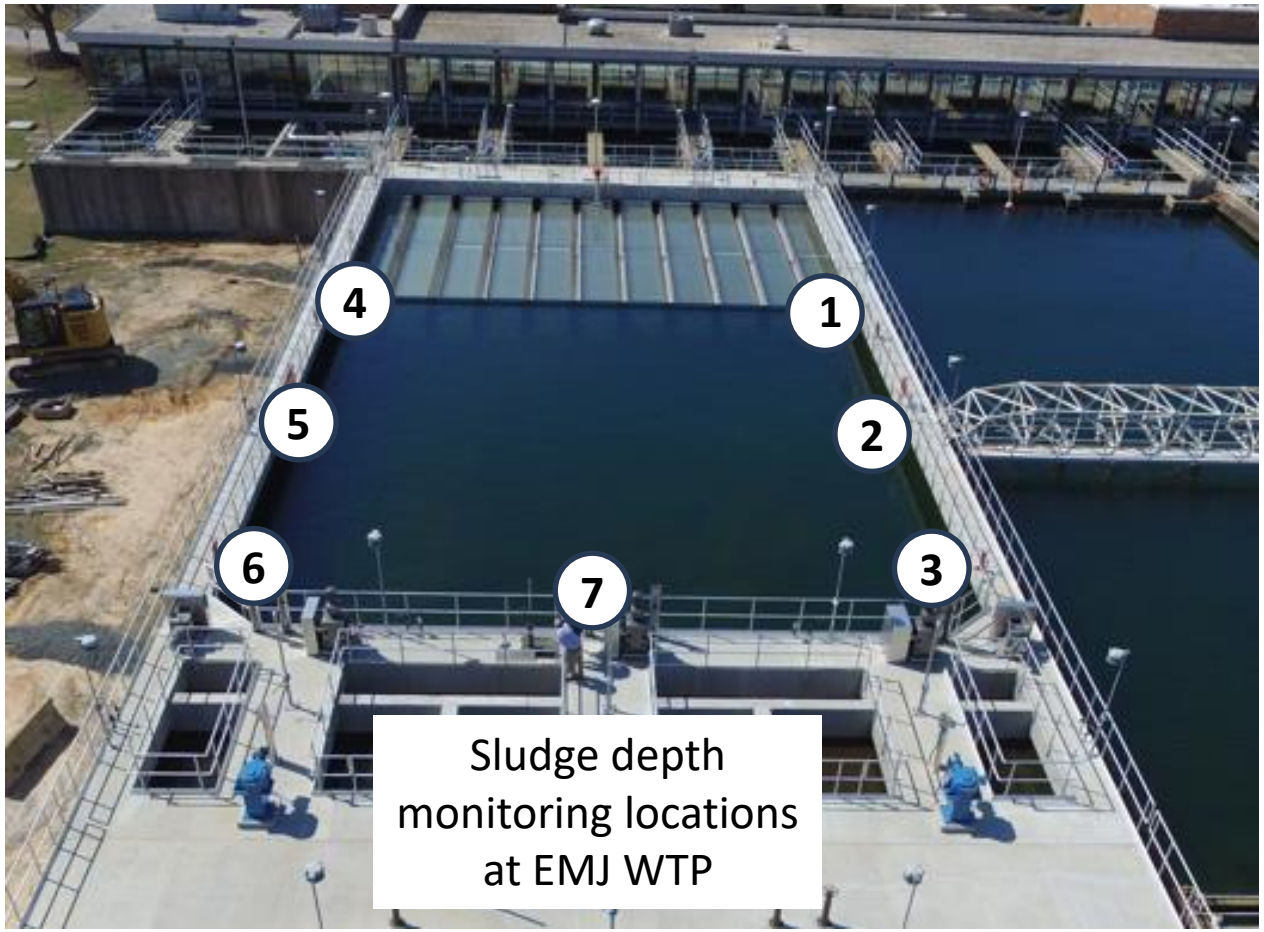
Increased visibility into collection header location



Home Proximity Switch

Data Collection

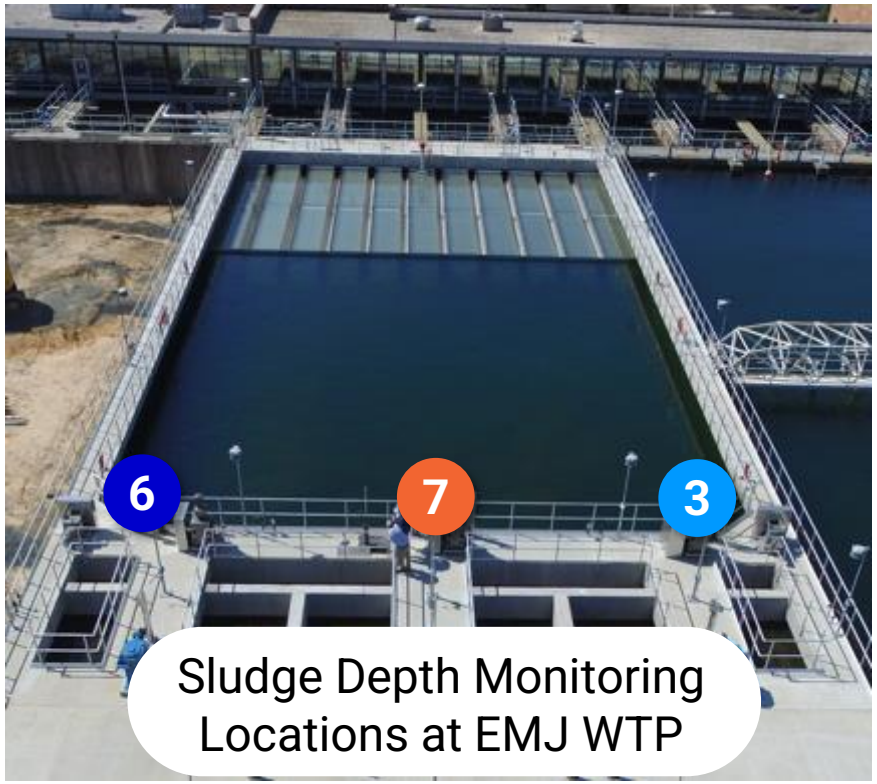
- Sludge levels measured daily at 7 locations across Basin 5
- Sludge depth data maintained in a PowerBI dashboard for visualization



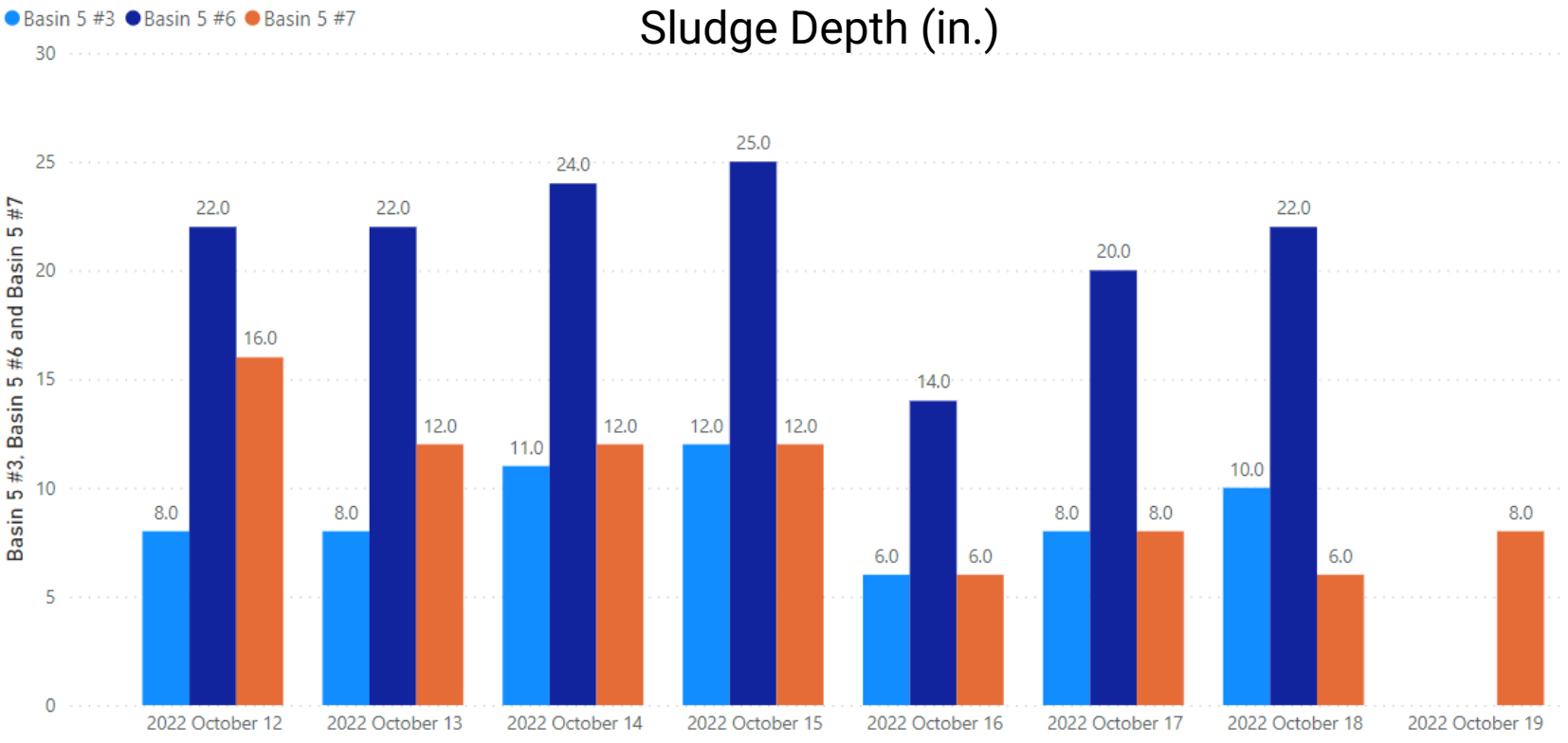
Sludge depth monitoring locations at EMJ WTP

Data Collection

- Goal to keep sludge depth <35”, good sludge quality



Sludge Depth Monitoring Locations at EMJ WTP



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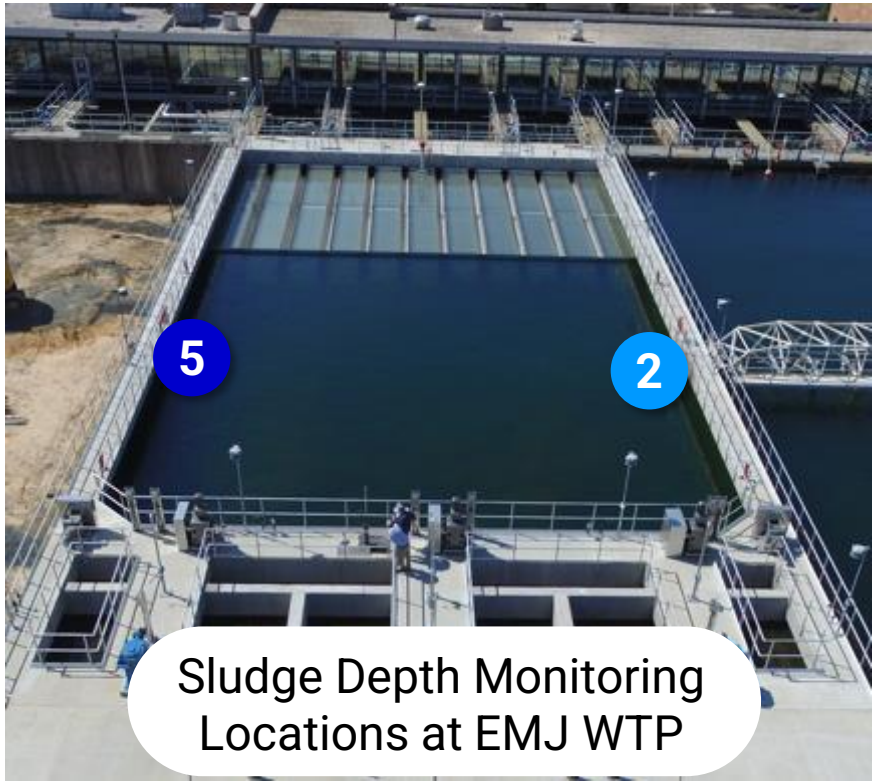

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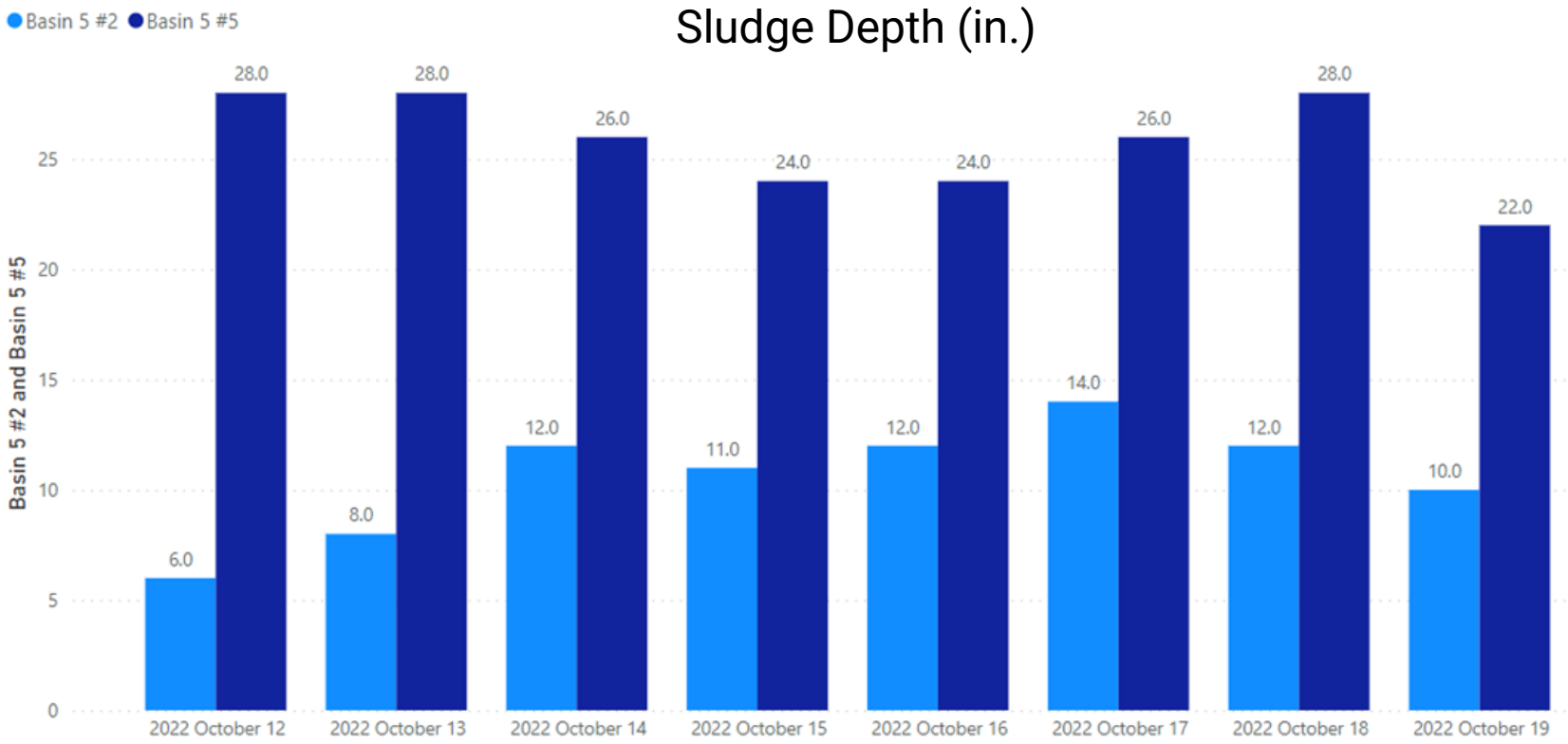

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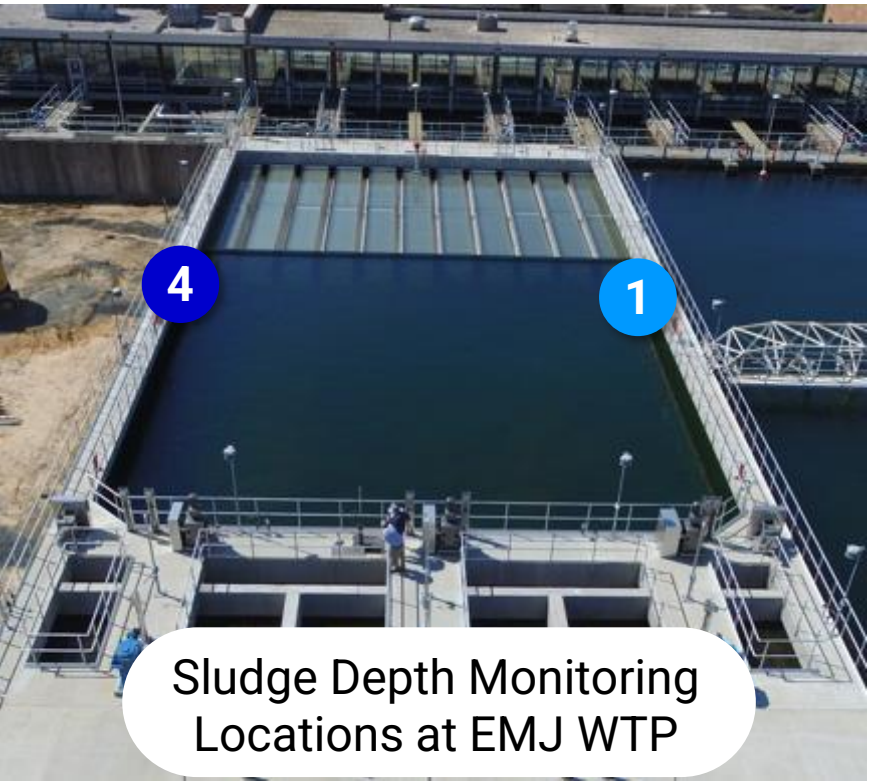
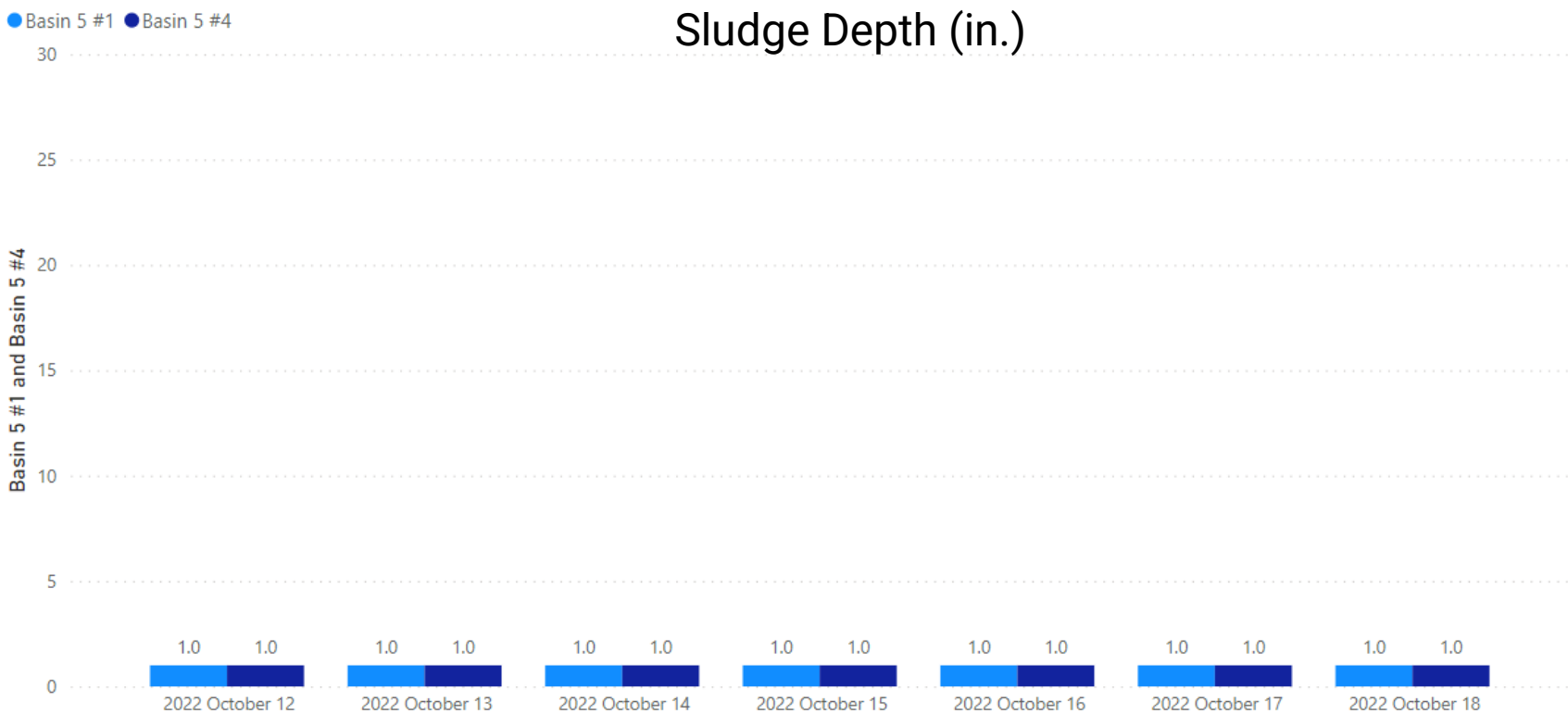
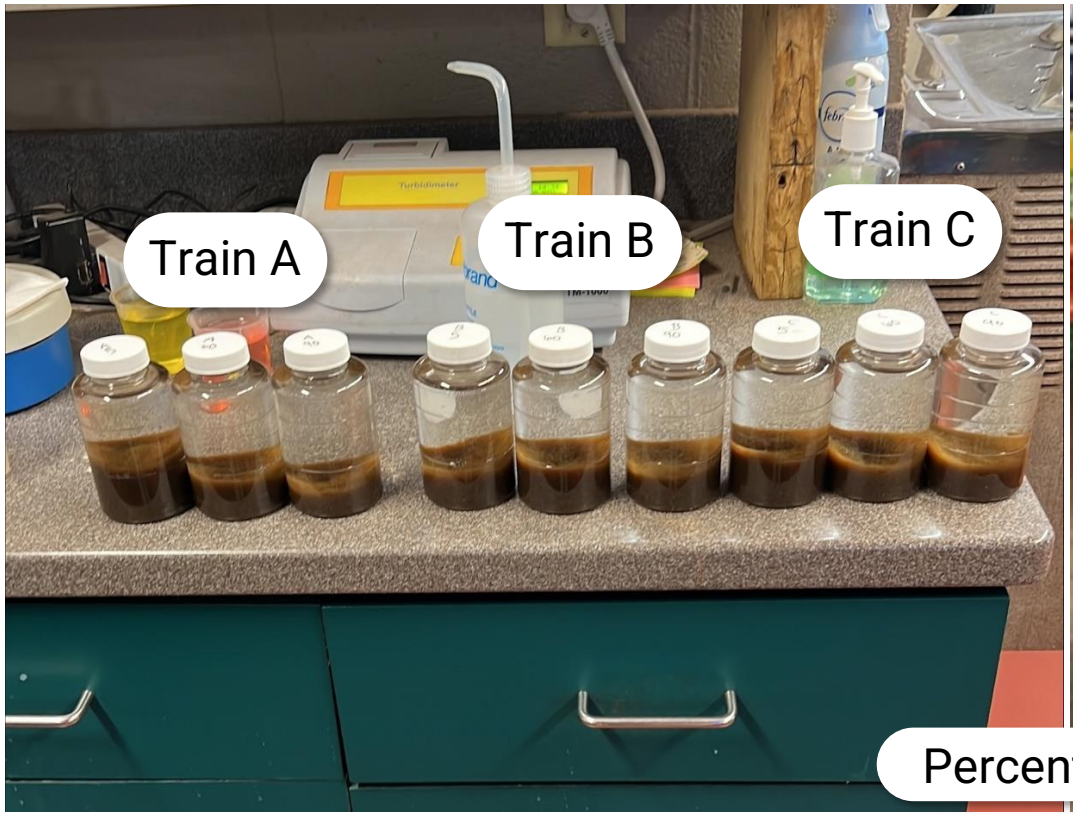
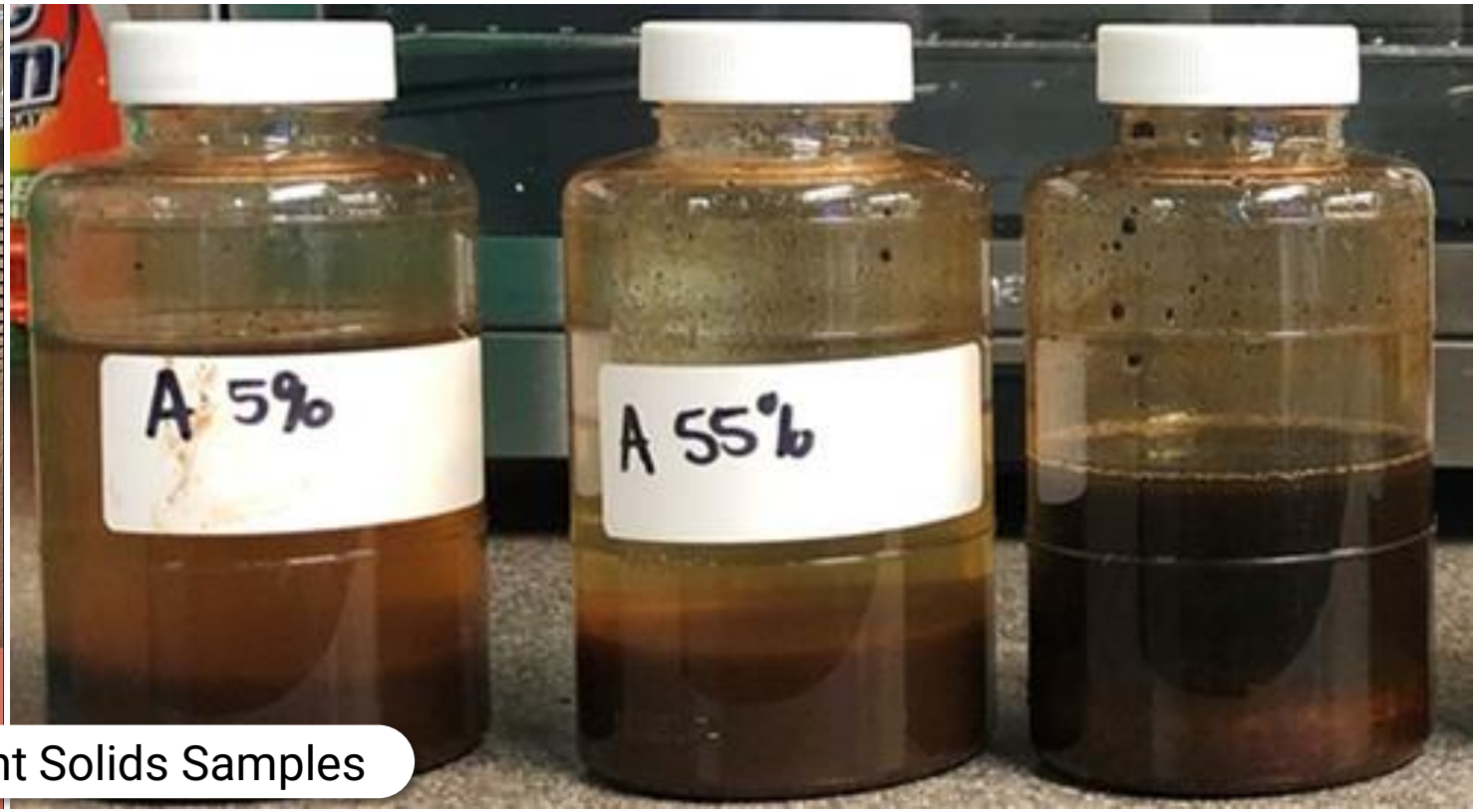




Data Collection

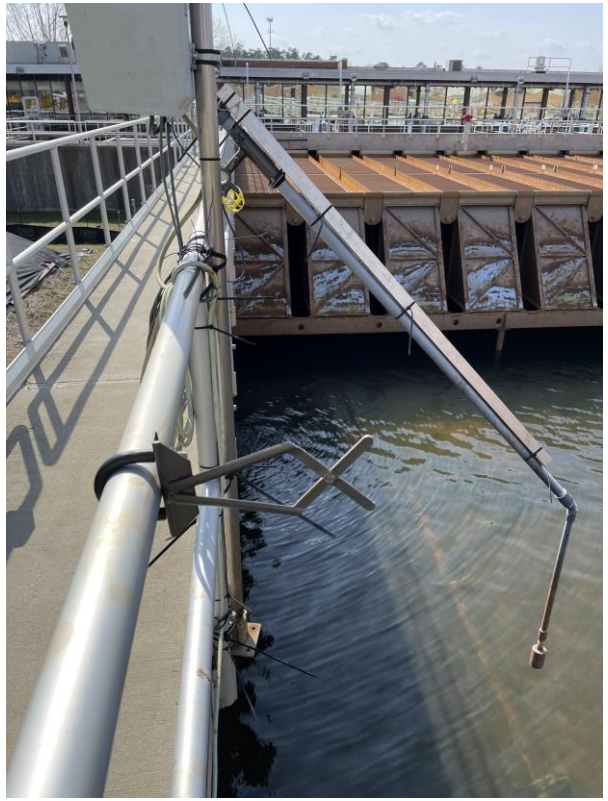
- E.M. Johnson occasionally collects sludge samples from different positions in the basin to measure % solids

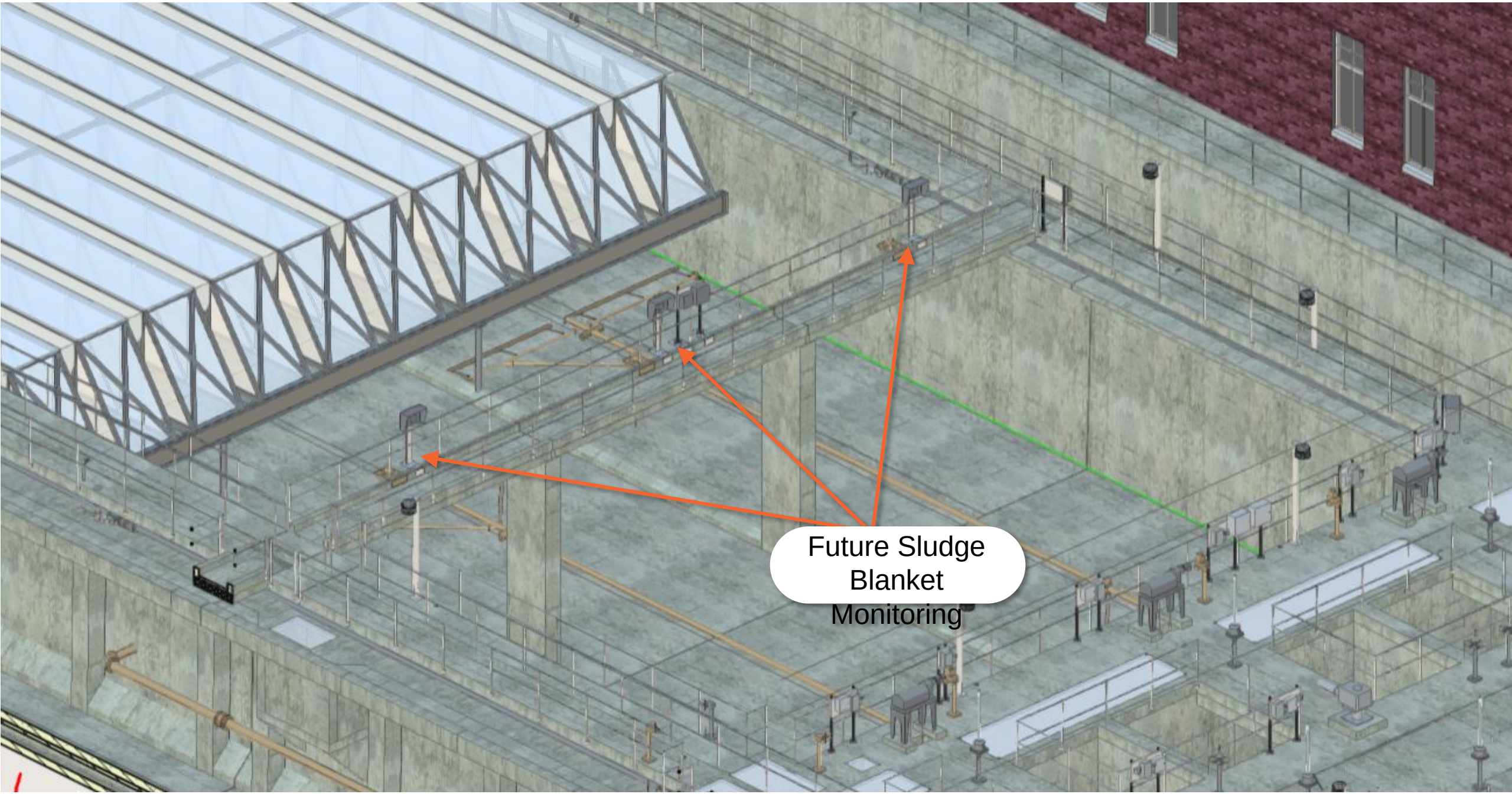




Data Collection

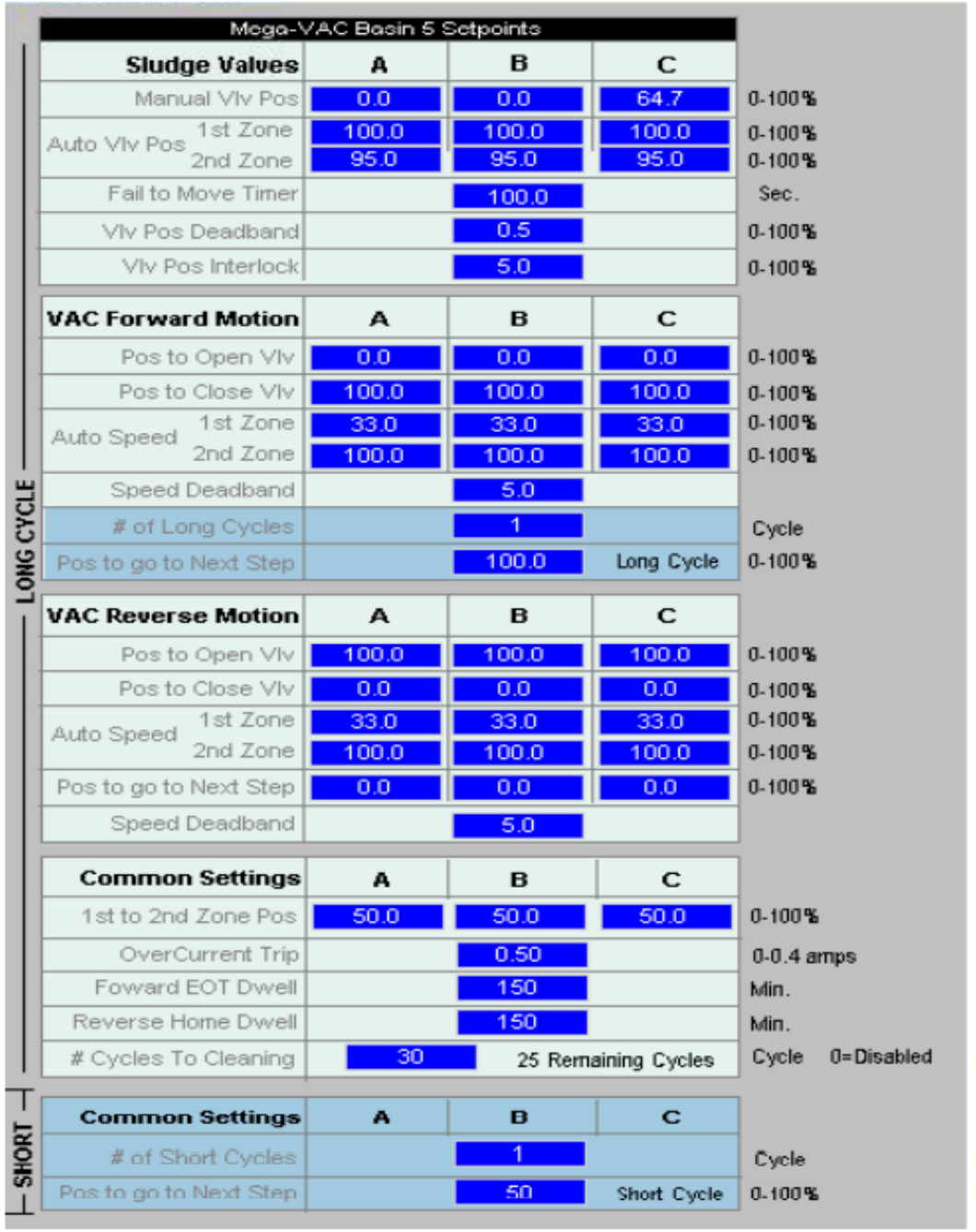
- Transitioning from manual sludge blanket measurement with “sludge judge” sampler to online, continuous monitoring




Future Sludge Blanket Monitoring

Optimization at E.M. Johnson

- E.M. Johnson WTP is unique in that it uses a PLC to control the sludge removal system instead of a manufacturer-provided control box



Mega-VAC Basin 5 Setpoints

LONG CYCLE

Sludge Valves	A	B	C	
Manual Vlv Pos	0.0	0.0	64.7	0-100%
Auto Vlv Pos 1st Zone	100.0	100.0	100.0	0-100%
Auto Vlv Pos 2nd Zone	95.0	95.0	95.0	0-100%
Fail to Move Timer		100.0		Sec.
Vlv Pos Deadband		0.5		0-100%
Vlv Pos Interlock		5.0		0-100%

VAC Forward Motion	A	B	C	
Pos to Open Vlv	0.0	0.0	0.0	0-100%
Pos to Close Vlv	100.0	100.0	100.0	0-100%
Auto Speed 1st Zone	33.0	33.0	33.0	0-100%
Auto Speed 2nd Zone	100.0	100.0	100.0	0-100%
Speed Deadband		5.0		
# of Long Cycles		1		Cycle
Pos to go to Next Step		100.0	Long Cycle	0-100%

VAC Reverse Motion	A	B	C	
Pos to Open Vlv	100.0	100.0	100.0	0-100%
Pos to Close Vlv	0.0	0.0	0.0	0-100%
Auto Speed 1st Zone	33.0	33.0	33.0	0-100%
Auto Speed 2nd Zone	100.0	100.0	100.0	0-100%
Pos to go to Next Step	0.0	0.0	0.0	0-100%
Speed Deadband		5.0		

Common Settings	A	B	C	
1st to 2nd Zone Pos	50.0	50.0	50.0	0-100%
OverCurrent Trip		0.50		0-0.4 amps
Foward EOT Dwell		150		Min.
Reverse Home Dwell		150		Min.
# Cycles To Cleaning	30	25 Remaining Cycles		Cycle 0=Disabled

SHORT

Common Settings	A	B	C	
# of Short Cycles		1		Cycle
Pos to go to Next Step		50	Short Cycle	0-100%

Outcomes for E.M. Johnson

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- Generally, keep sludge blanket under 35”
- Average settled water turbidity 0.60 NTU at a flow rate of 18 MGD/basin
- Sedimentation basin sludge maintained around 0.5% solids
  - **Not so thick than it becomes anoxic and hard to remove**
  - **Not so thin that overly dilute sludge results in high volumes for the gravity thickener to process**
  - **Optimizes residuals polymer performance**

Questions?

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