Inducing Continuous Flow Densified Activated Sludge in Full Scale Systems

Three Case Studies

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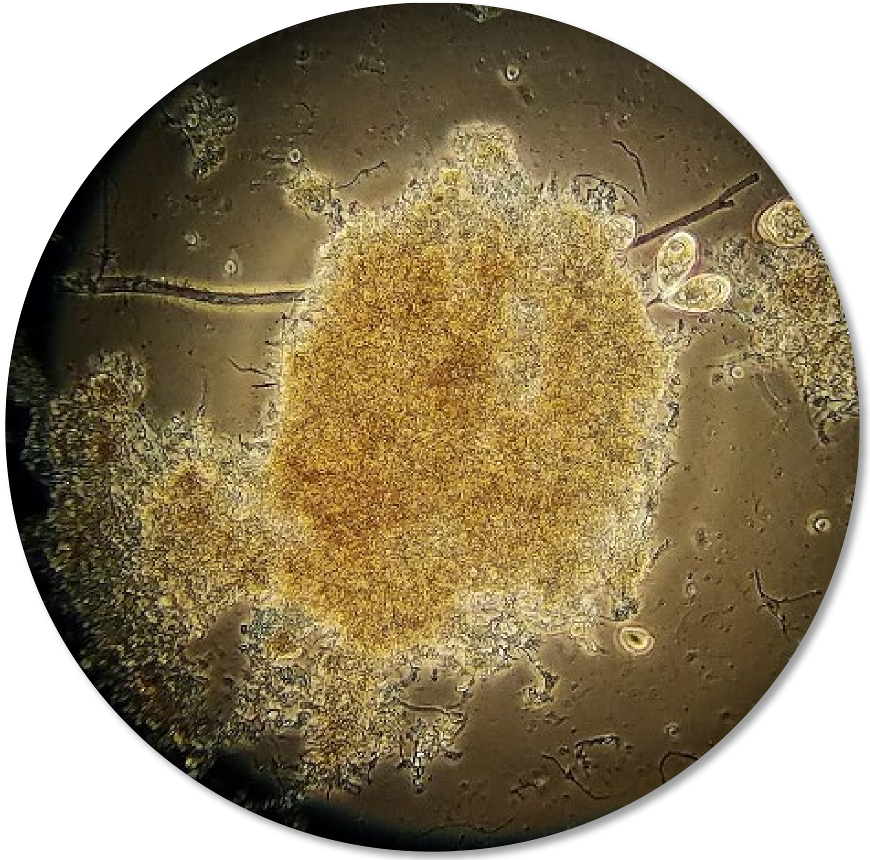
DRIVING FORWARD

What Are We Talking About Today?

- What is Densified Activated Sludge (DAS) and Why do I Care?
- Case Study A – *Impact of Biological Selector on Enhanced Settleability*
- Case Study B - *Impact of Biological Selector and Basin Configuration on DAS Settleability*
- Case Study C - *Inducing DAS Using Biological and Physical Selection*

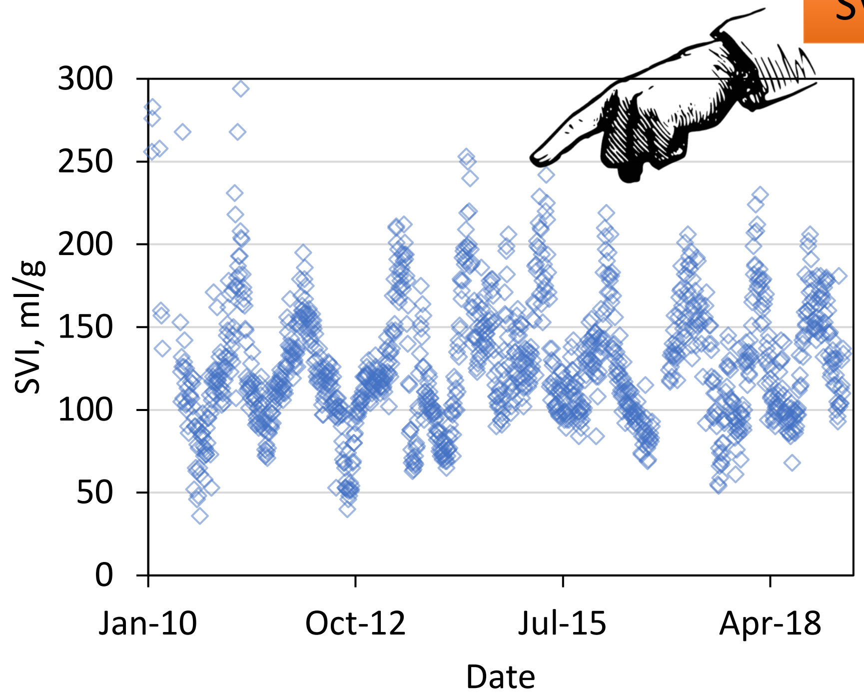


What is Densified Activated Sludge (DAS) and Why Do I Care?

Need to Cost Effectively Increase Capacity Driving Utilities to Consider DAS

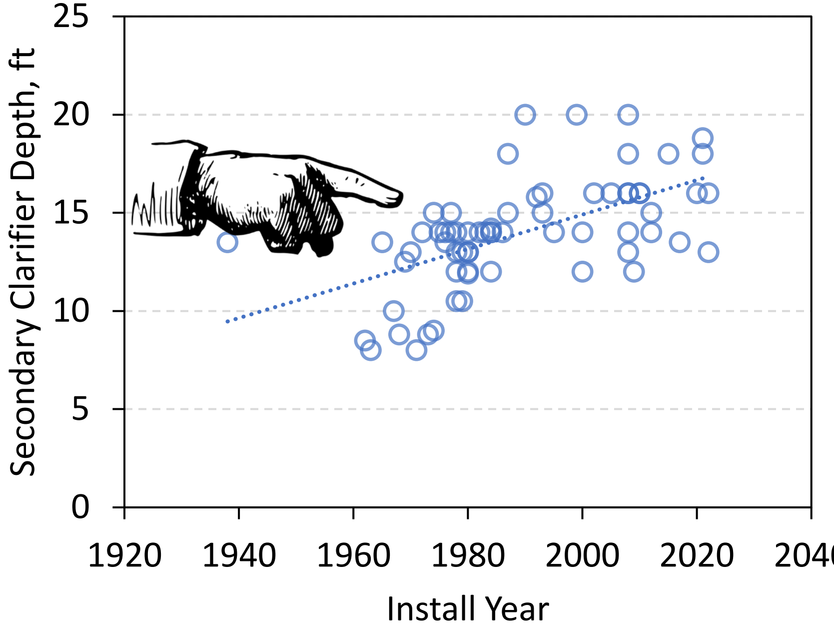
$$$

SVI can greatly influence capacity



Typically means more infrastructure and deeper clarifiers

Addressing the sludge characteristics is the key



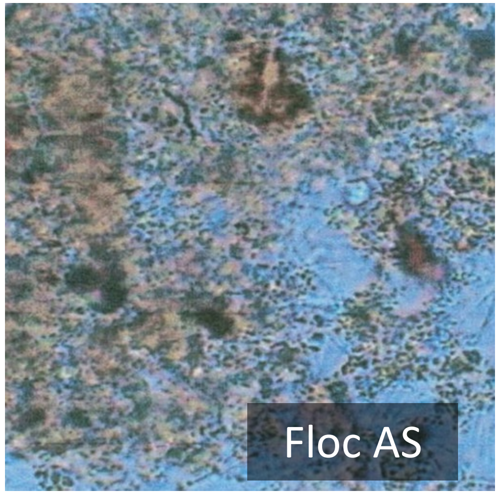
Data Source: Metro Water Recovery

Data Source: David Kinnear, Brian McNamara

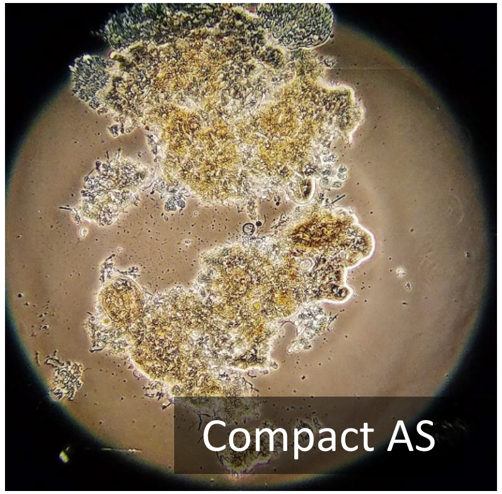
Densified Activated Sludge is Aggregated Floc

Granules making up aerobic granular sludge are to be understood as aggregates of microbial origin, which do not coagulate under reduced hydrodynamic shear, and which subsequently settle significantly faster than activated sludge flocs

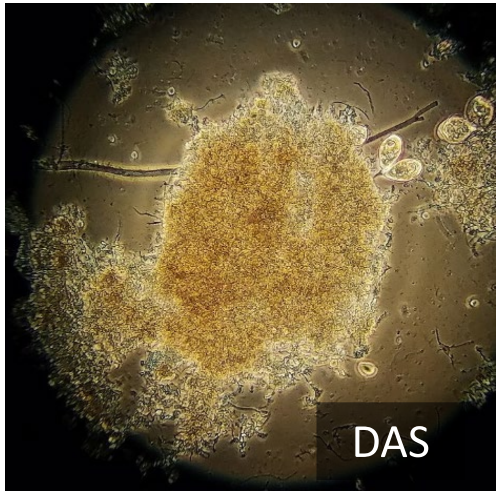
Enhanced settleability



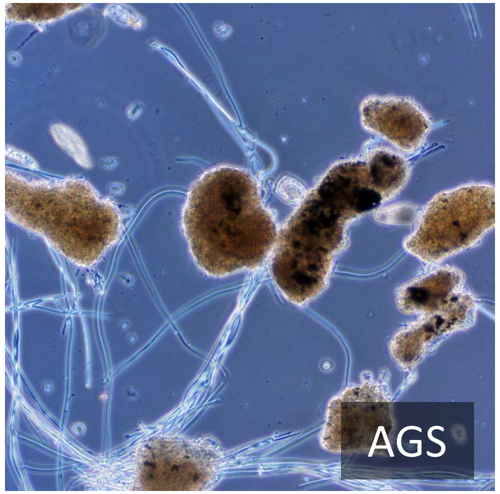
SVI_{30} 80 to 300



SVI_{30} 80 to 120



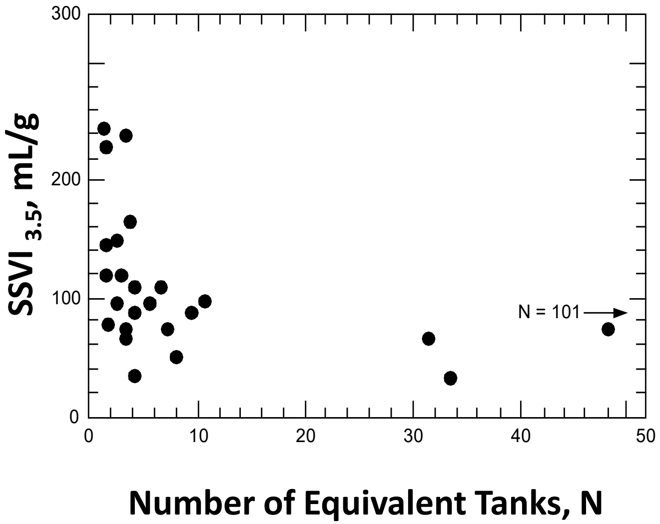
$SVI_{30} < 100$



$SVI_{30} < 50$

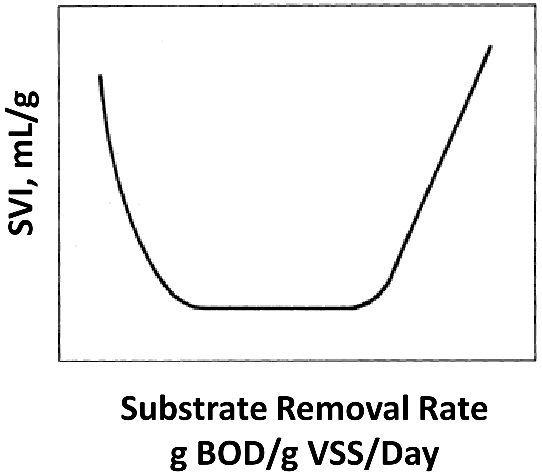
Densified Activated Sludge Incorporates Known Settleability Concepts With Physical Selection Pressures

E. J. Tomlinson and B. Chambers, The effect of longitudinal mixing on the settleability of activated sludge. Technical Report TR 122, Water Research Centre, Stevenage, England, 1978.



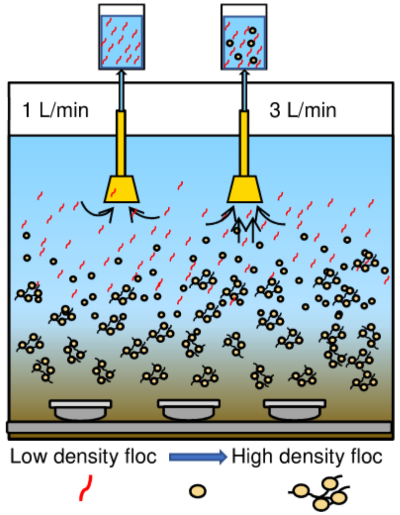
1. Plug flow conditions

Sezgin et al (1978) A Unified theory of activated sludge bulking, Journal of Water Pollution Control Federation 50(2)

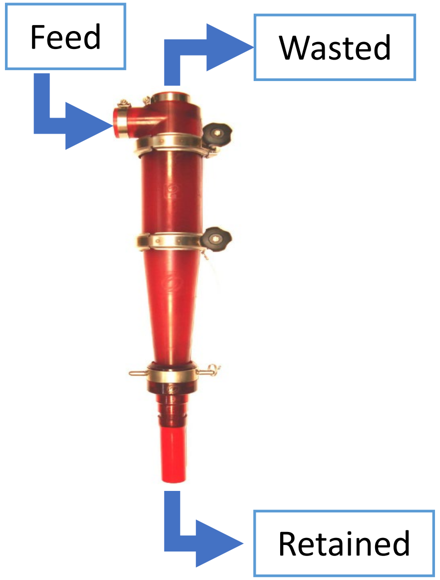


2. Selector zone design and loading

Maltos, R. A., Holloway, R. W., & Cath, T. Y. (2020). Enhancement of activated sludge wastewater treatment with hydraulic selection. Separation and Purification Technology, 250, 117214.

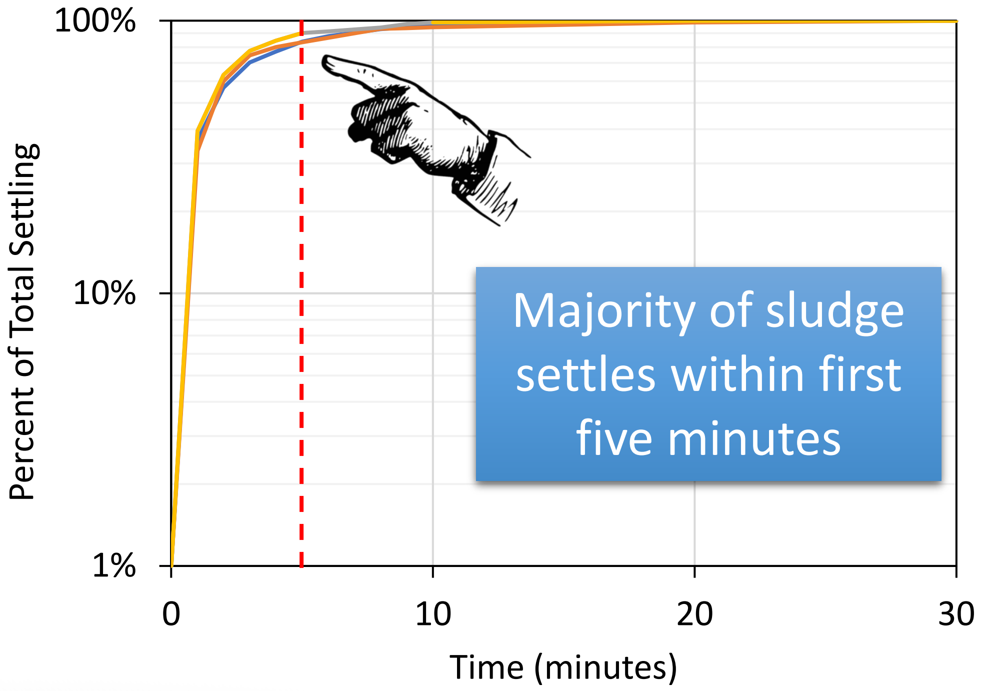


World Water Works.

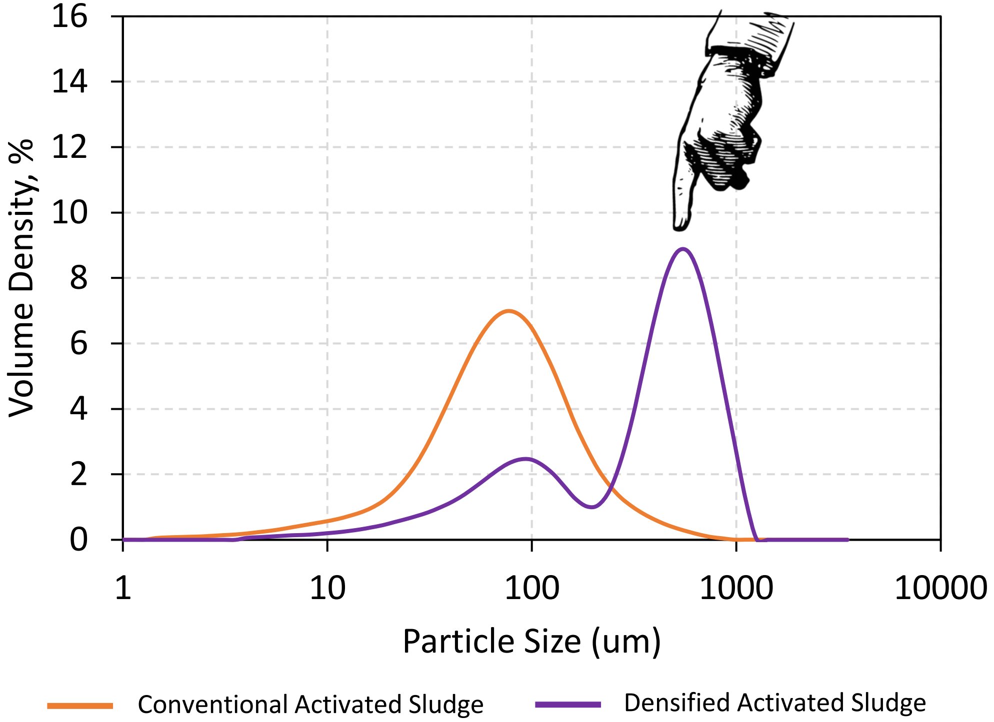


3. Physical selection

What Are Characteristics of Densified Activated Sludge?



Presence of MLSS larger than 200 µm

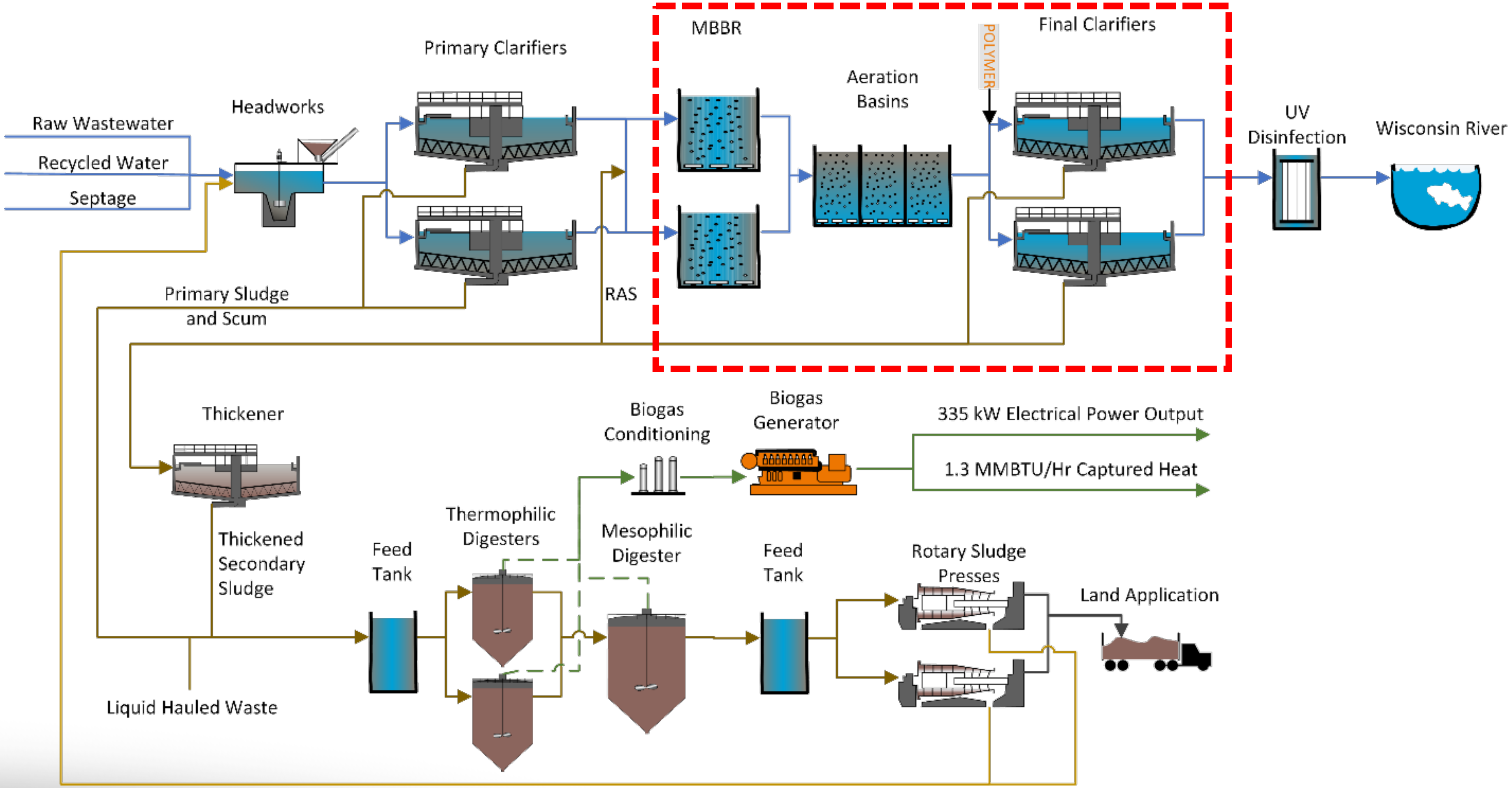


Case Study A
Impact of Biological Selector on Enhanced Settleability

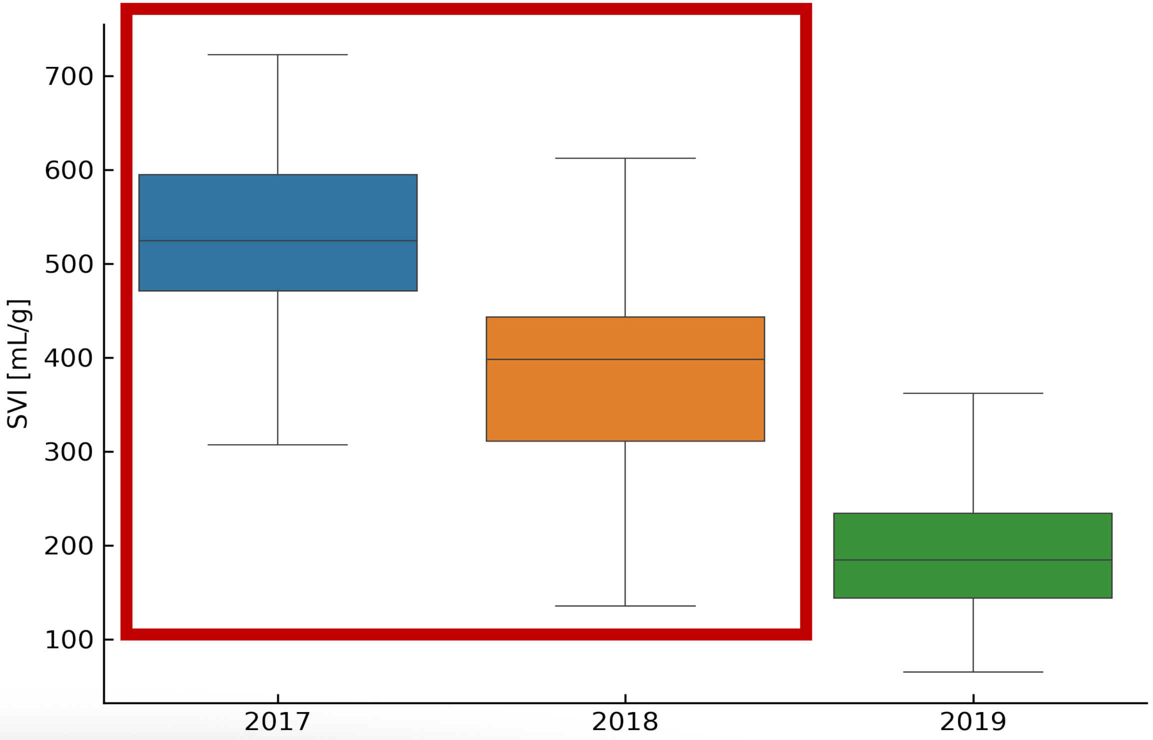
Wisconsin Rapids WWTP

- Serves ~40,000 PE
- Average flow: 3.5 mgd
- Peak day flow: 12 mgd
- Goal to improve effluent quality

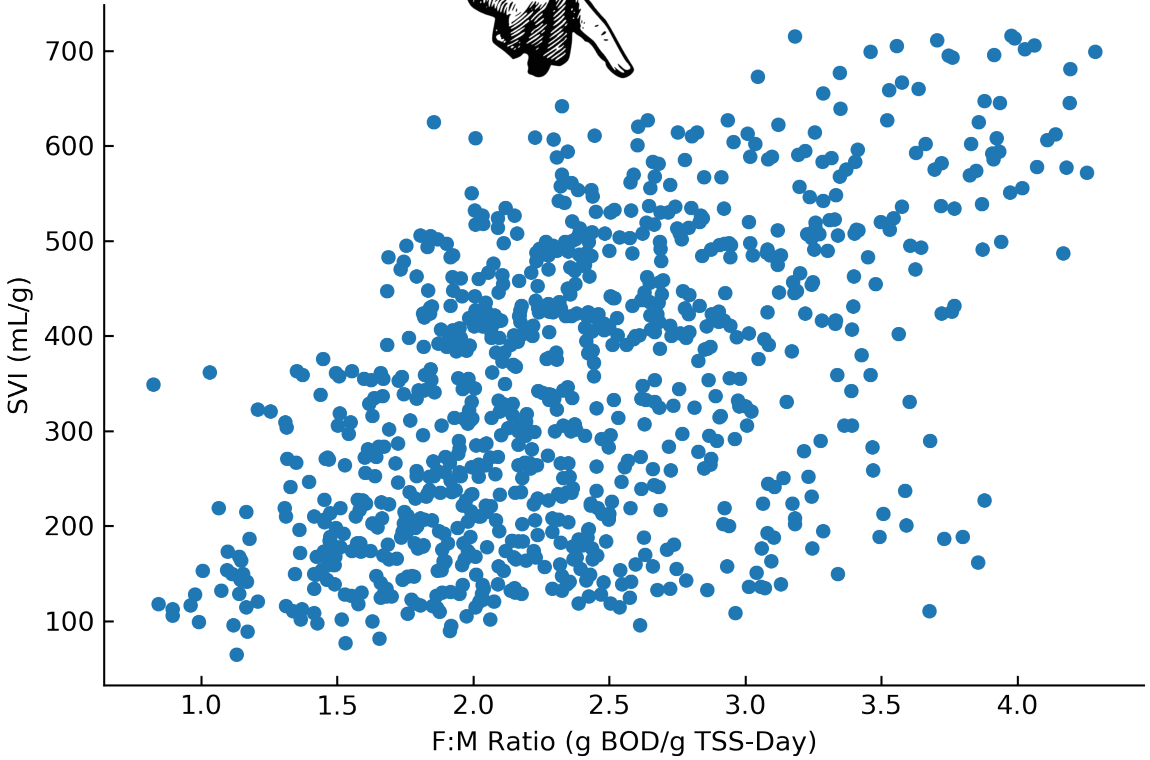
Wisconsin Rapids WWTP Process



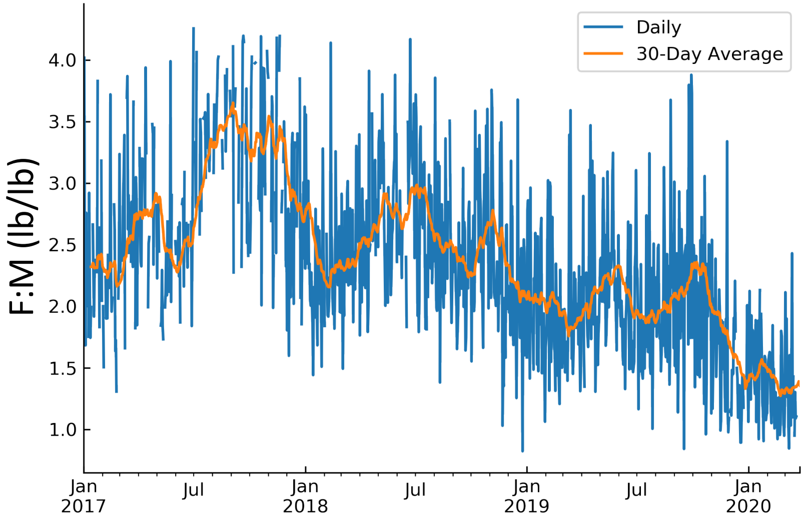
Wisconsin Rapids Settleability Typically Poor

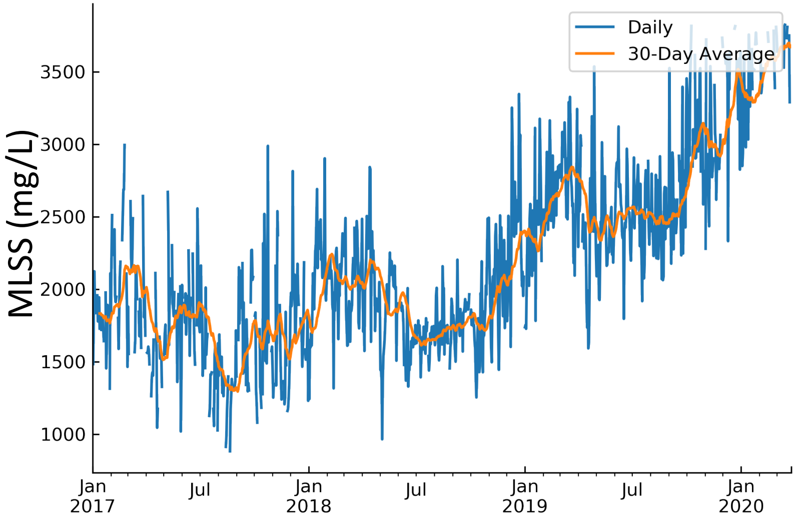


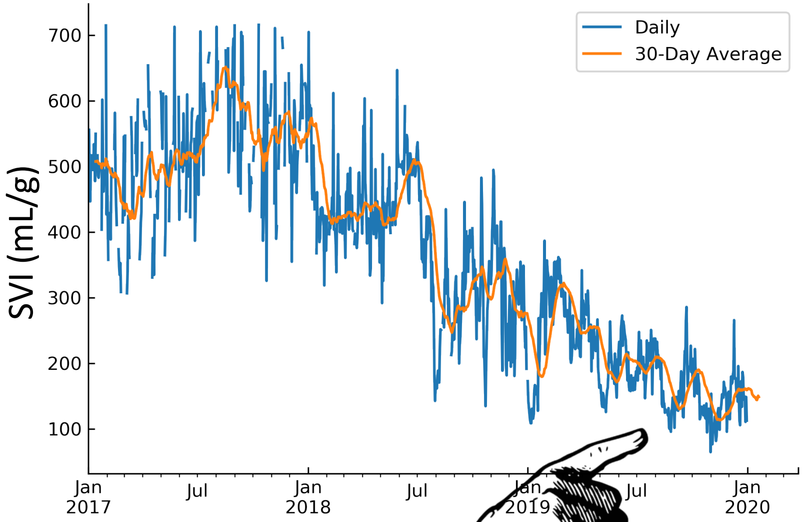
High loadings to selector zones

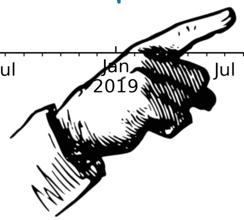


Controlling F:M and SRT Improved SVI









Reduced selector F:M

Increased solids inventory

Goal was to reduce carbon bleedthrough

Lowest settleability at F:M < 2.0 lb BOD/lb TSS/d

Case Study B
Impact of Biological Selector and Basin Configuration on DAS Settleability

TRA Central Regional Wastewater System

- Serves ~1.5 million PE
- Flow: 164 mgd
- Unexpected settleability changes negatively effect effluent quality

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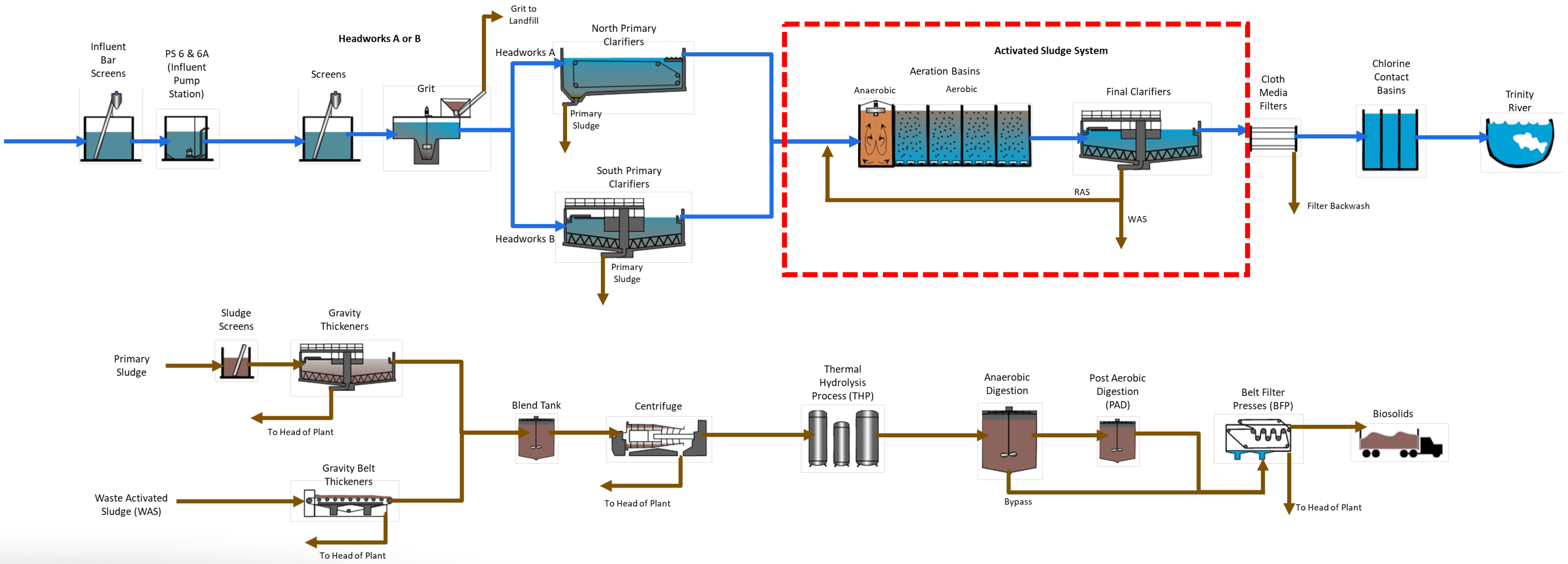
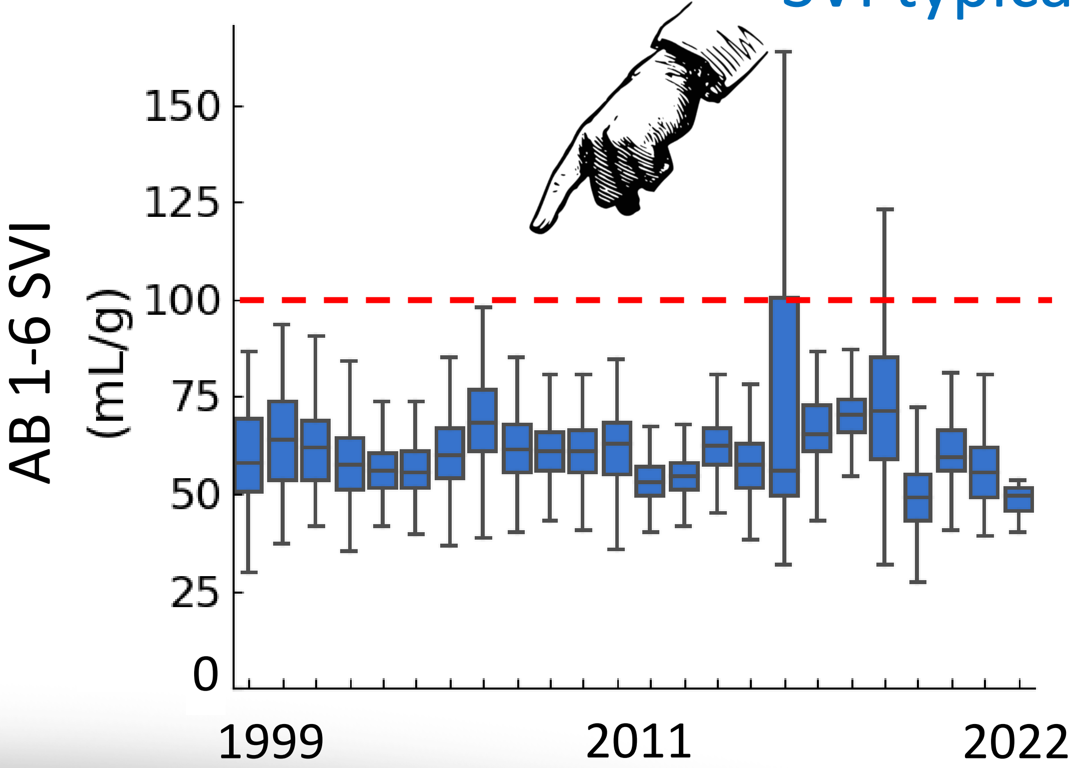
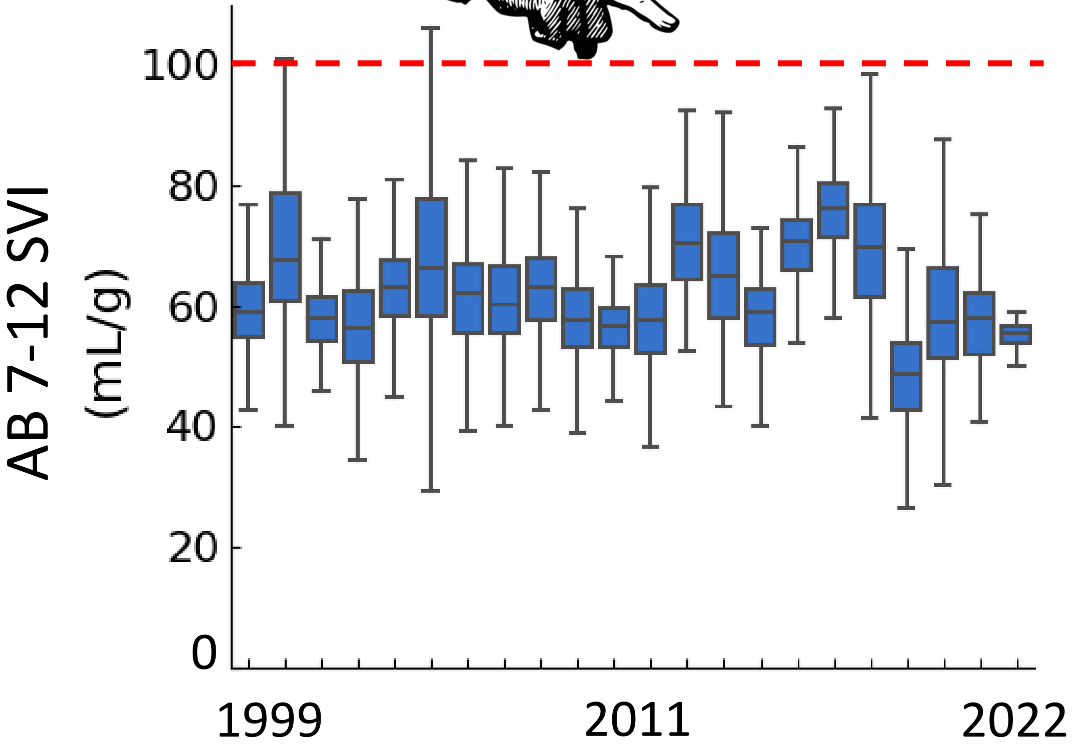
Central Regional Wastewater System Process



SVI Typically Low Due To Presence of DAS in System

SVI typically < 100 mL/g

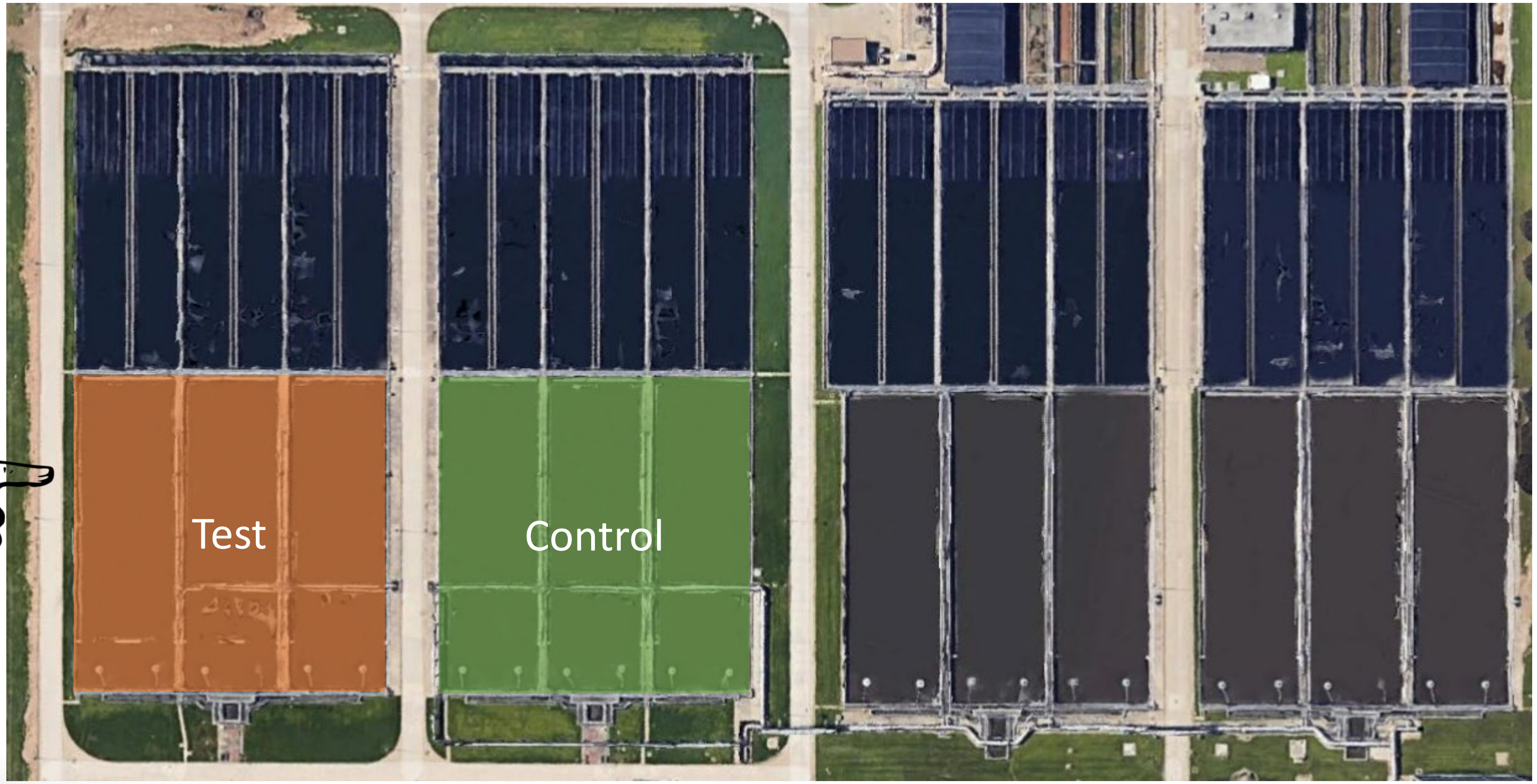




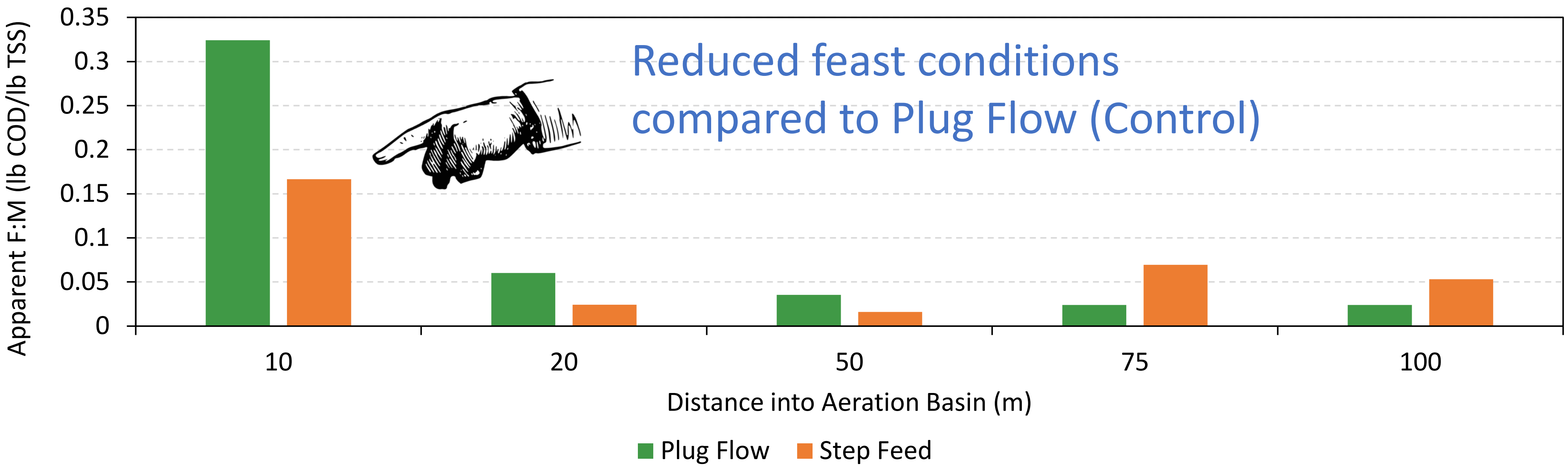
What is the Impact of F:M and Basin Configuration on Settleability?

Operated Test basins in step-feed mode for 4 weeks to compare with Control basins operating in plug flow mode

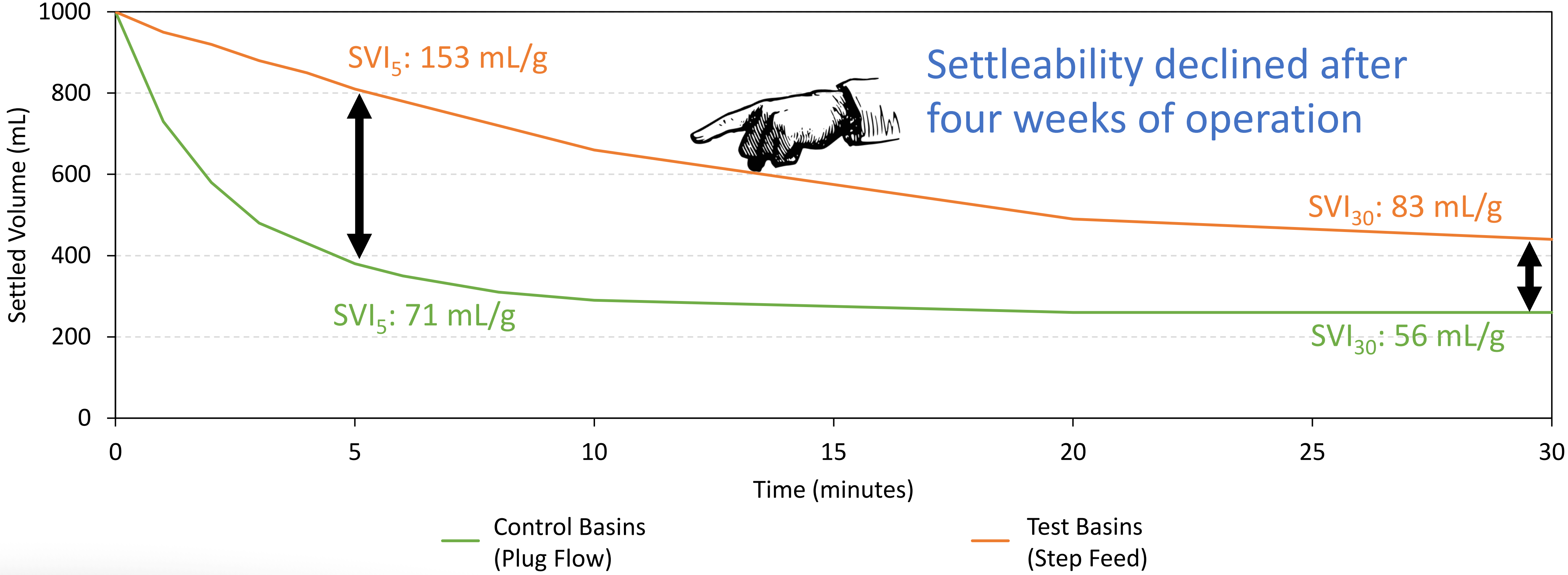
30% of primary effluent fed at ~60% of basin length



Step Feed Influences Distribution of Carbon



Basin Configuration Influences Settleability

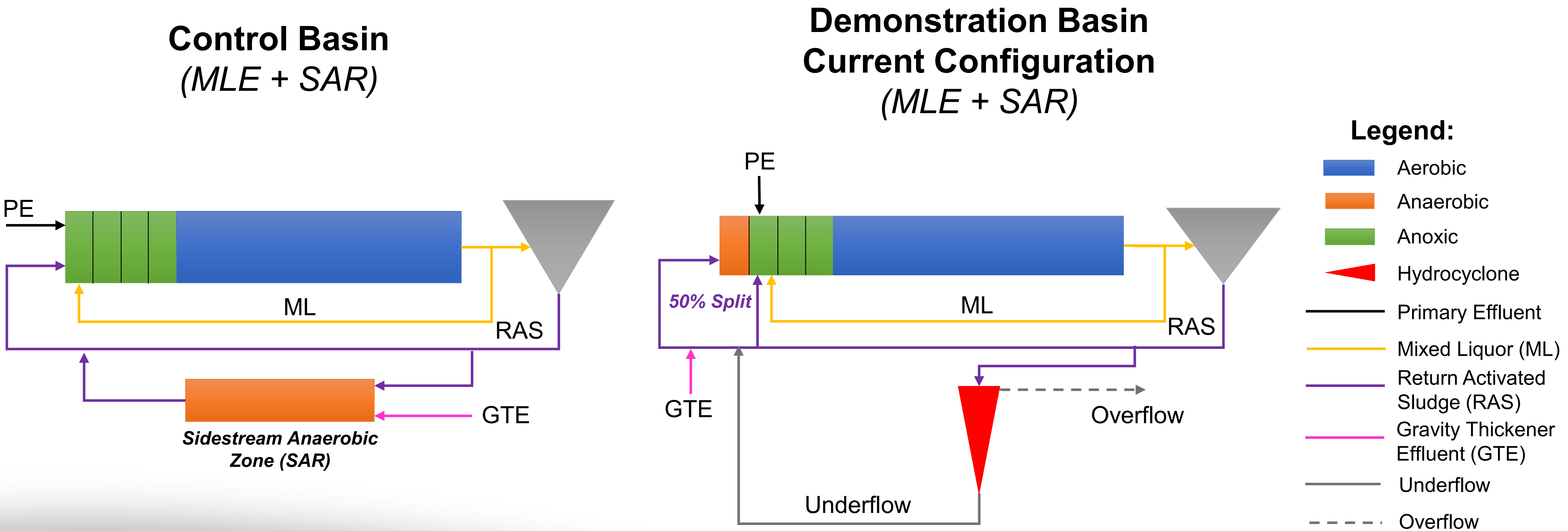


Case Study C
Inducing DAS Using Biological and Physical Selection

Robert W. Hite Treatment Facility

- Serves 2.0 million PE
- Flow: 225 mgd
- Two liquid treatment trains
- Expansion required to continue improving effluent quality
- Shallow clarifiers and limited real estate to expand

Demonstration System Uses Selector Zones and Selective Wasting



Demonstration Testing Timeline

AO configuration
High anaerobic feast achieved in Z1 and Z2 using combination of PE and GTE

High Anaerobic Pressure – but limited N Removal

A2O Configuration
High anaerobic feast achieved in Z1 and Z2 using combination of PE and GTE

High Anaerobic Pressure with improved N Removal due to IMLR

MLE-SAR Configuration
Minimal anaerobic feast condition with GTE*

High anoxic feast* with PE due to IMLR

Comingle/Restart

Comingle/Restart

Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9
6/5/2018 to 11/5/18	11/5/2018 to 3/18/2019	3/18/19 to 4/15/19	10/7/2019 to 1/19/20	6/1/20 to 11/16/20	11/16/20 to 1/22/21	1/22/21 to 4/4/2021	4/5/2021 to 11/9/2021	11/15/21 to Present
AO with traditional wasting (wasting from RAS)	**AO** with InDense NSI to Z1 GTE in NSI	**AO** with InDense GTE to Z1 PE to Z2	**A2O** with InDense GTE to Z1 PE to Z1 MLR to Z3	**MLE** with InDense GTE to Z1 PE to Z2 MLR to Z2	**A2O** with InDense GTE to Z1 PE to Z1 MLR to Z3	**A2O** with InDense GTE to Z1 PE to Z2 MLR to Z3 RAS split to Z1 and2	**MLE** with InDense GTE to Z1 PE to Z2 MLR to Z2 RAS Split Z1 and Z2	**MLE** with InDense GTE to Z1 PE to Z2 MLR to Z2 RAS Split Z1 and Z2

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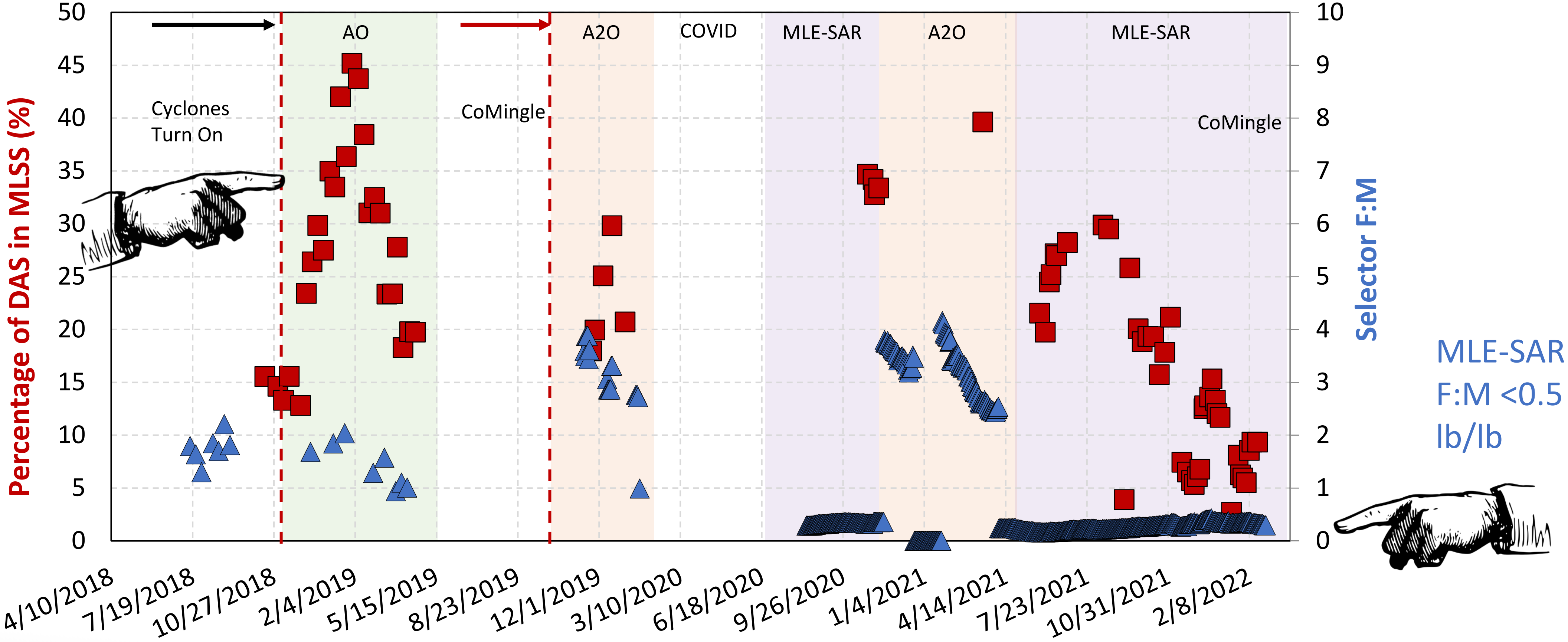
Selector F:M Influences %DAS in MLSS

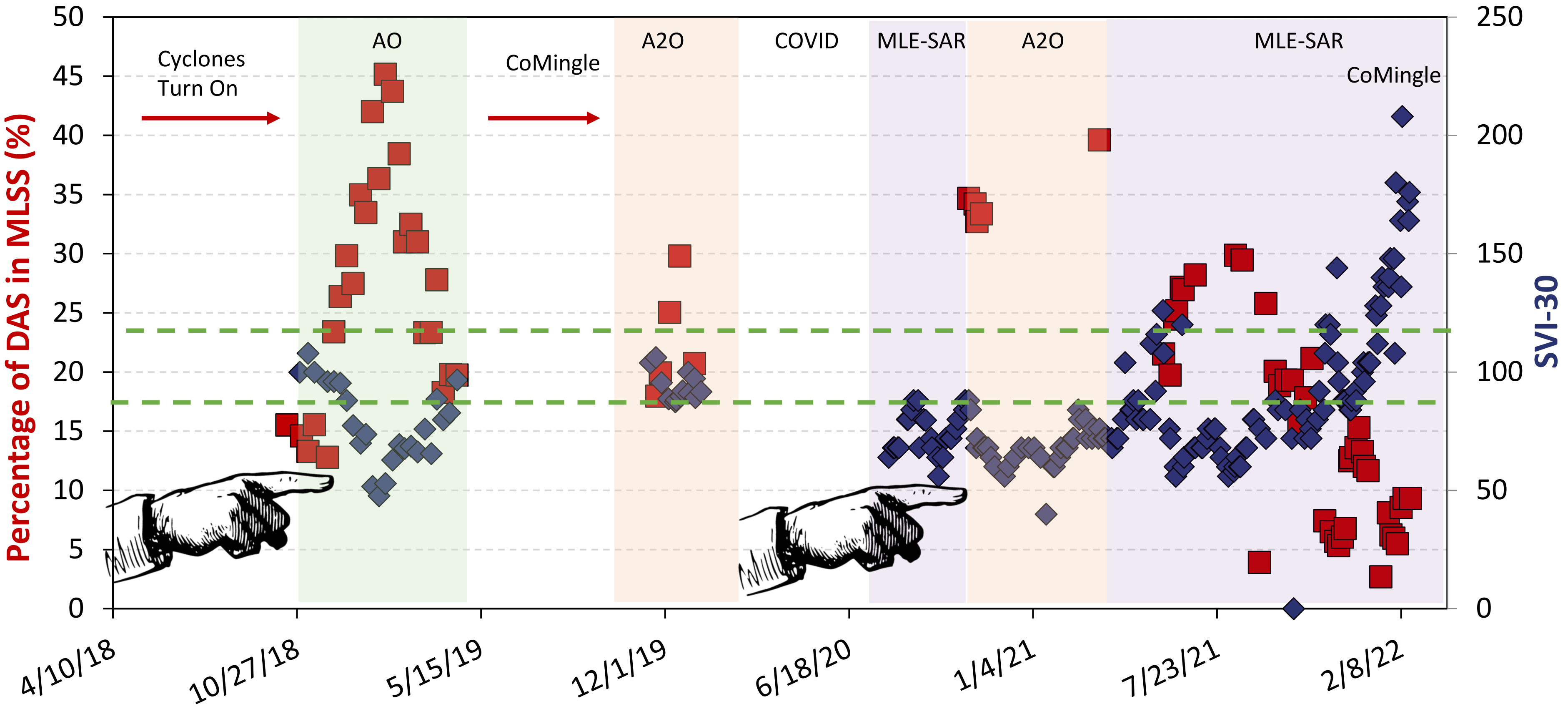
High fraction of DAS when selector F:M >1.0 lb/lb



AO Configuration A2O Configuration MLE-SAR Configuration

MLE-SAR F:M <0.5 lb/lb

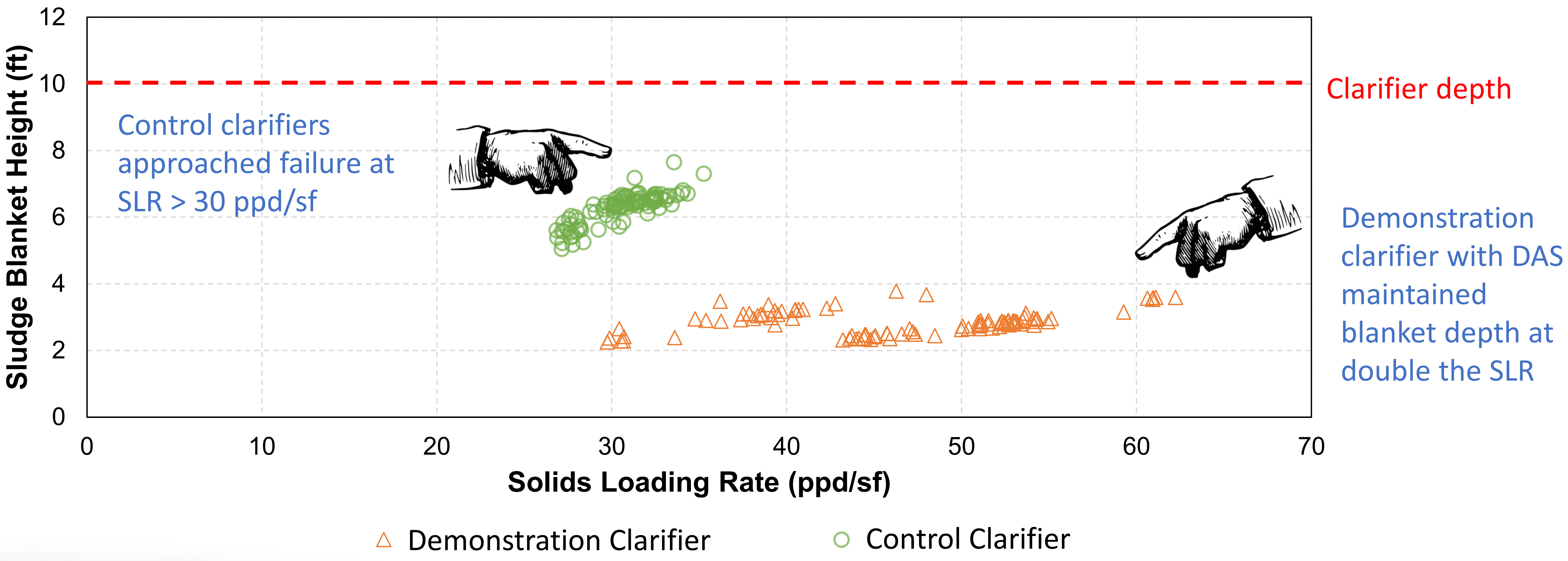
Settleability Influenced by %DAS in MLSS



Desired SVI of <100 mL/g occurred when DAS% >15%

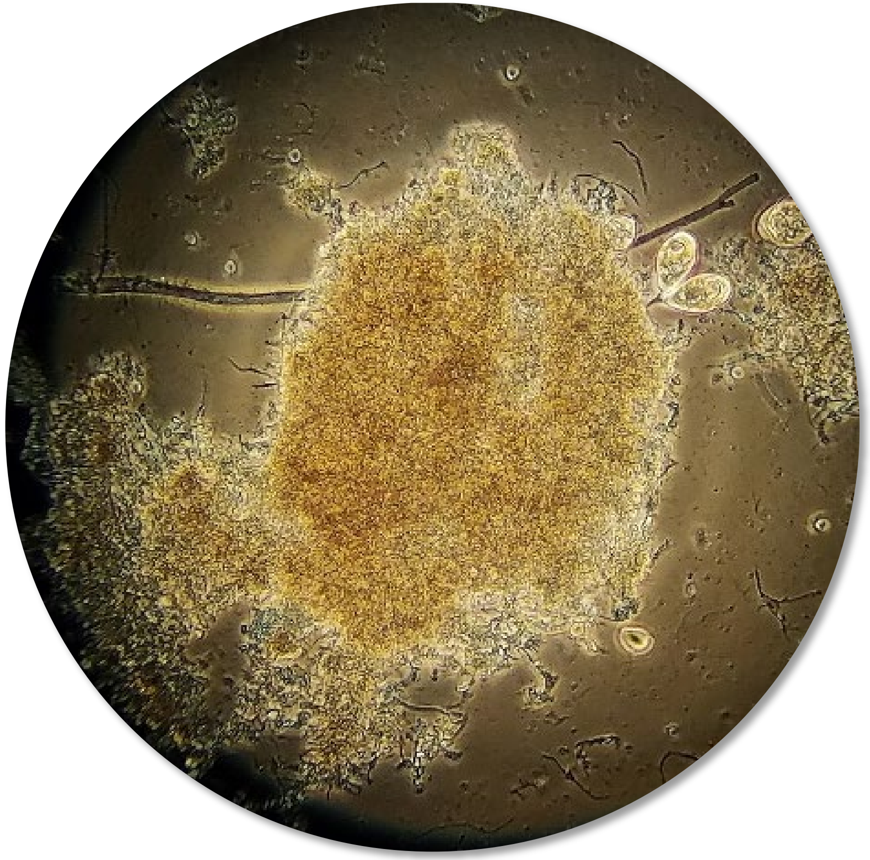
AO Configuration A2O Configuration MLE-SAR Configuration

DAS Impacts on Process Intensification



Summary

- Three case studies evaluated
- Goal of DAS is to enhance settleability
- Key observations
  - Basin configuration influences enhanced settleability
  - Selector zone loading influenced enhanced settleability and amount of DAS present
  - Inducing DAS in an existing system is viable and has beneficial impacts



Acknowledgements

Robert W Hite Treatment Facility Case Study

METRO WATER RECOVERY

- Dr. Rudy Maltos
- Blair Wisdom
- Dan Freedman
- Liz Werth
- Anna Scopp

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- Isaac Avila

Hazen

- Will Martin
- Ron Latimer
- Alonso Griborio
- Wendell Khunjar

Central Regional Wastewater System Case Study

TRINITY RIVER AUTHORITY OF TEXAS

- Theodore Chan
- Mike Young

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- Eric Redmond
- Caitlin Ruff

Wisconsin Rapids Wastewater Treatment Plant Case Study

WISCONSIN RAPIDS CITY OF WISCONSIN RAPIDS

- Derek Budsberg
- Ryan Geifer

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- Patrick Dunlap
- Leon Downing

Metro Water Recovery Team

Trinity River Water Authority Team

THANK YOU

Isaac Avila
Black & Veatch
Wastewater Process Engineer
AVILAIL@bv.com

Dr. Rudy Maltos
Metro Water Recovery
Wastewater Process Engineer
RMALTOS@MetroWaterRecovery.com

Eric Redmond
Black & Veatch
Wastewater Process Engineer
EREDMOND@bv.com

Chris Debarbadillo
Black & Veatch
Plant Optimization Practice Leader
DEBARBADILLOC@bv.com

Dr. Leon Downing
Black & Veatch
Global Practice Leader Nutrient Removal and Recovery
DOWNINGL@bv.com

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