World water works

Clean Water and Energy from Wastewater

Densification of Solids for Improved Plant Performance

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Do more with less!

PRESENTATION OUTLINE

1. What and Why?
2. Definitions
3. Background /Application
4. Technology
5. Case Studies

Sludge densification

- AGS – Activated Granular Sludge
  - batch selection
- BAS – ballasted activated sludge
- MOB – mobile organic biofilm
- Hydrocyclones – gravimetric selection

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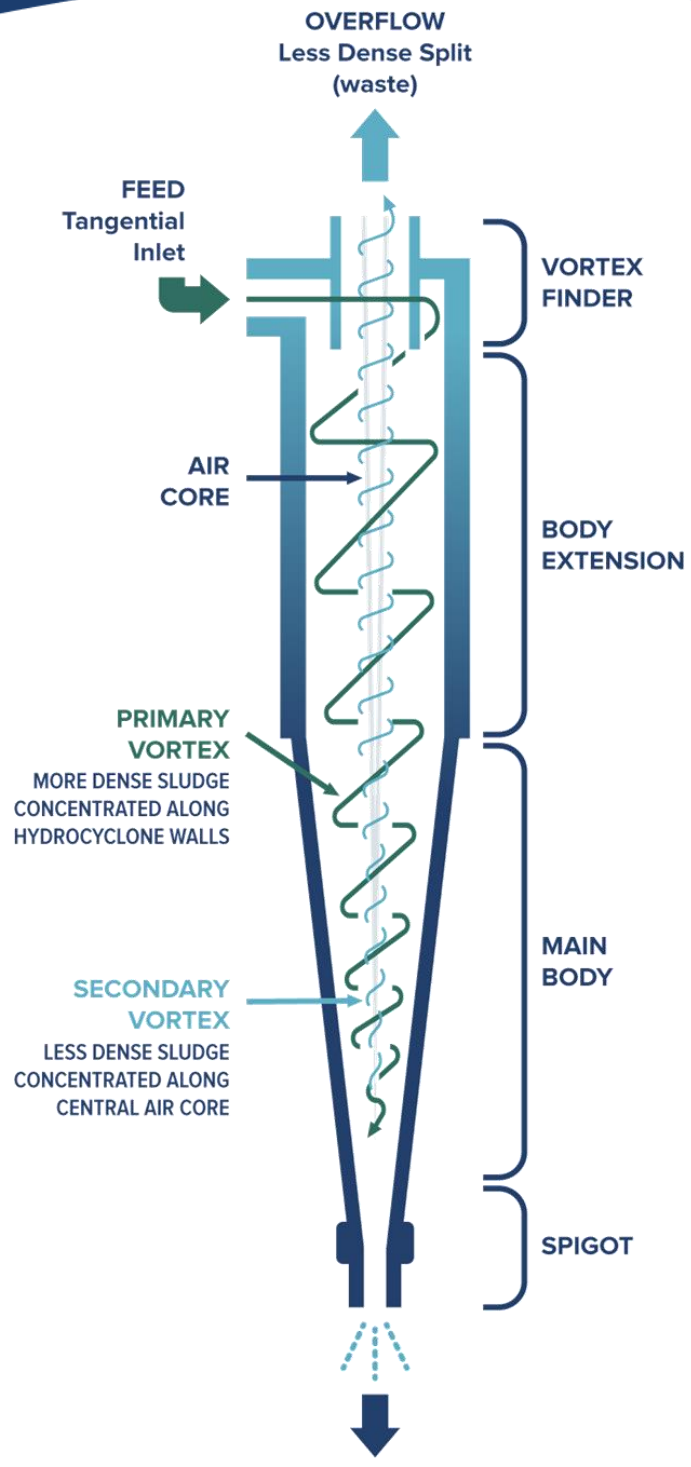
What is gravimetric selection?

In the simplest terms we are separating the heavier / denser material from the lighter fraction.



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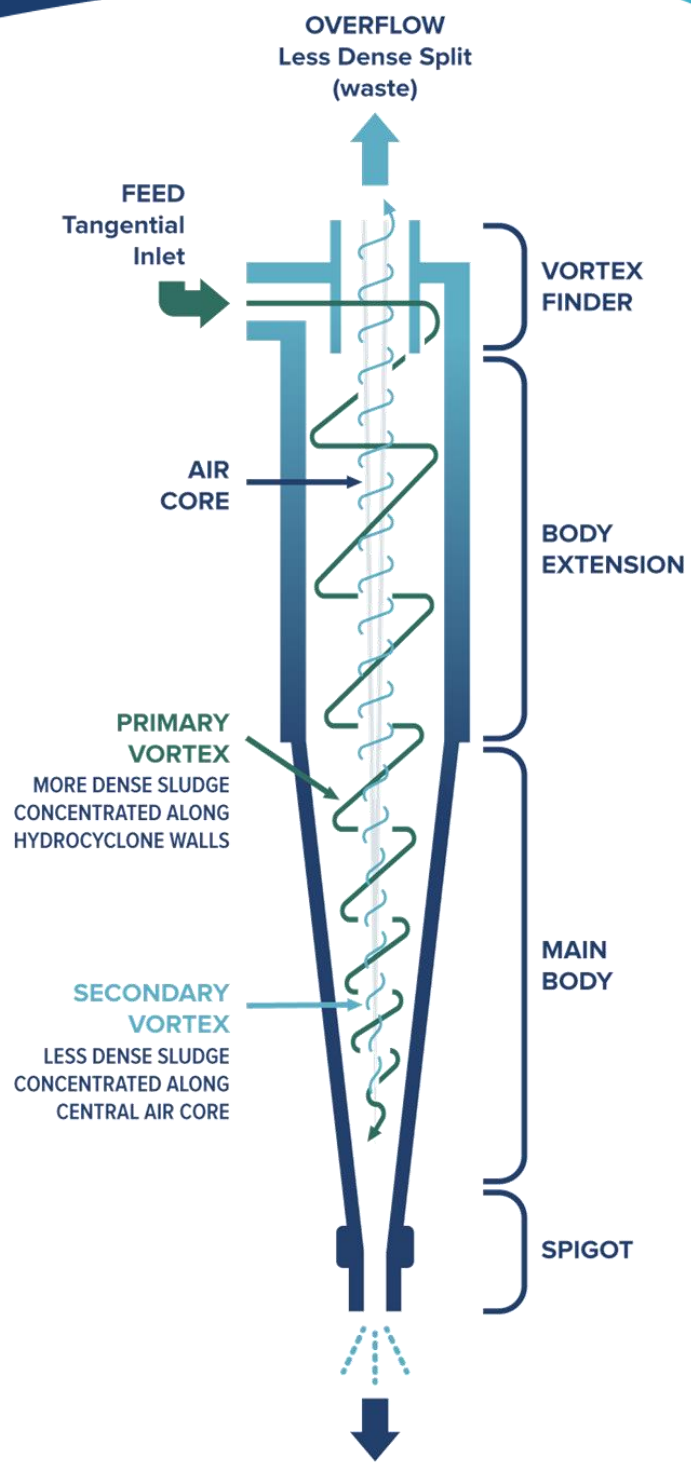
Clean Water and Energy from Wastewater

Why gravimetric selection?

By retaining the heavier biomass we can:

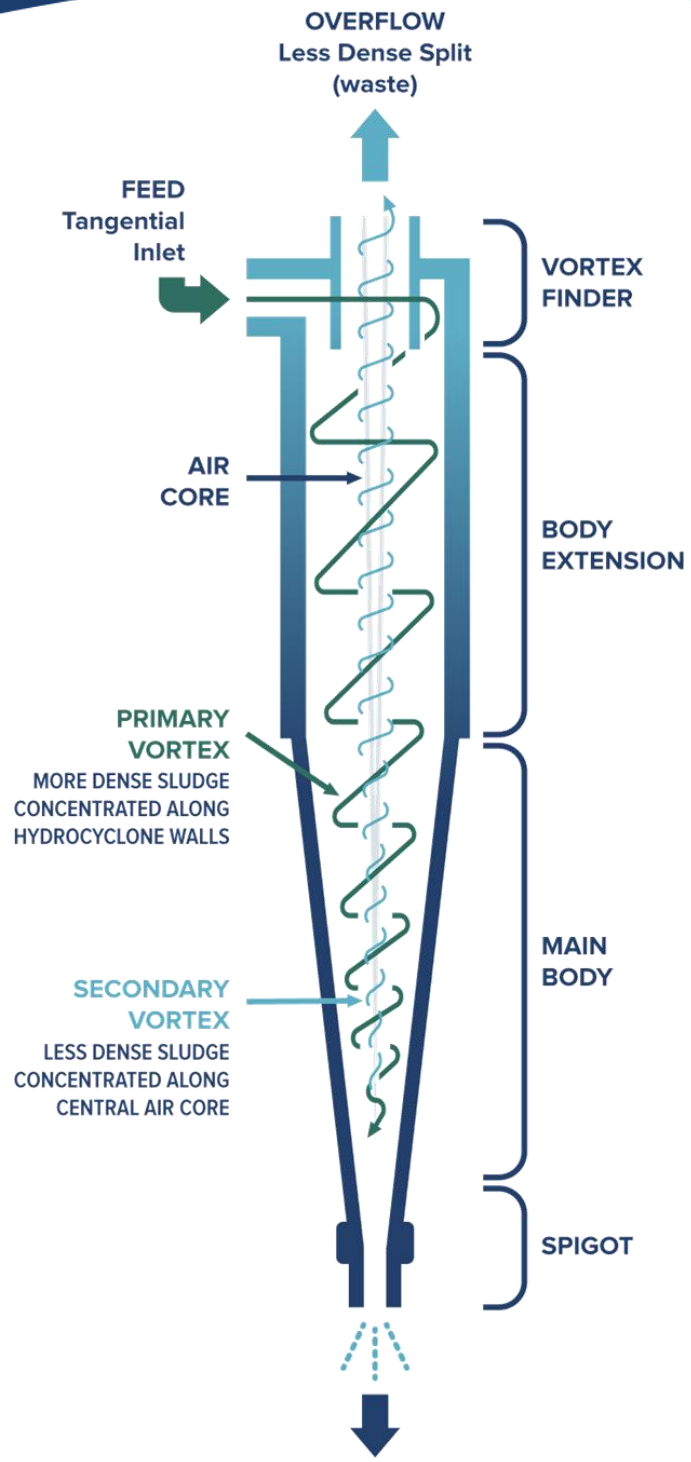
- Increase clarifier solids throughput
- Improve SVIs (year round)
- Enhance BNR (N and P)



Definitions:

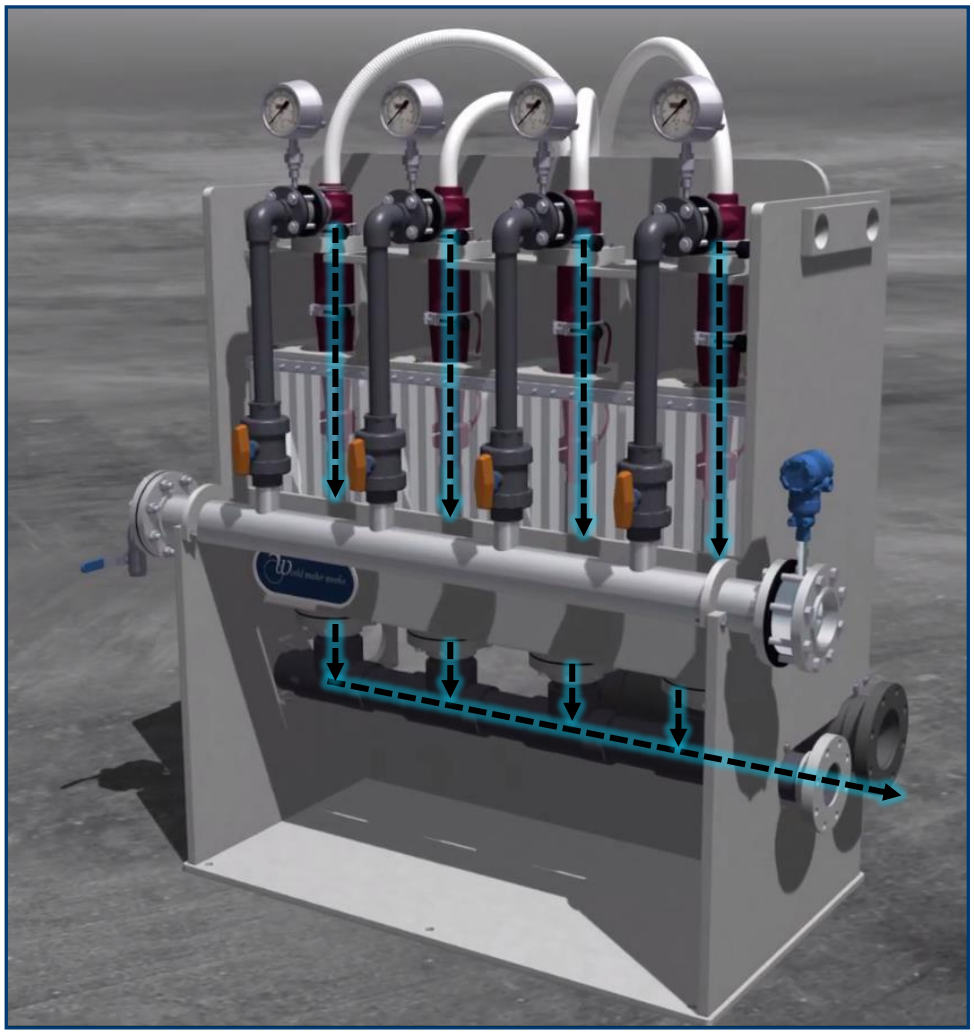
Overflow – lighter fraction to be wasted to solids handling

Underflow – heaver / denser material (RAS)

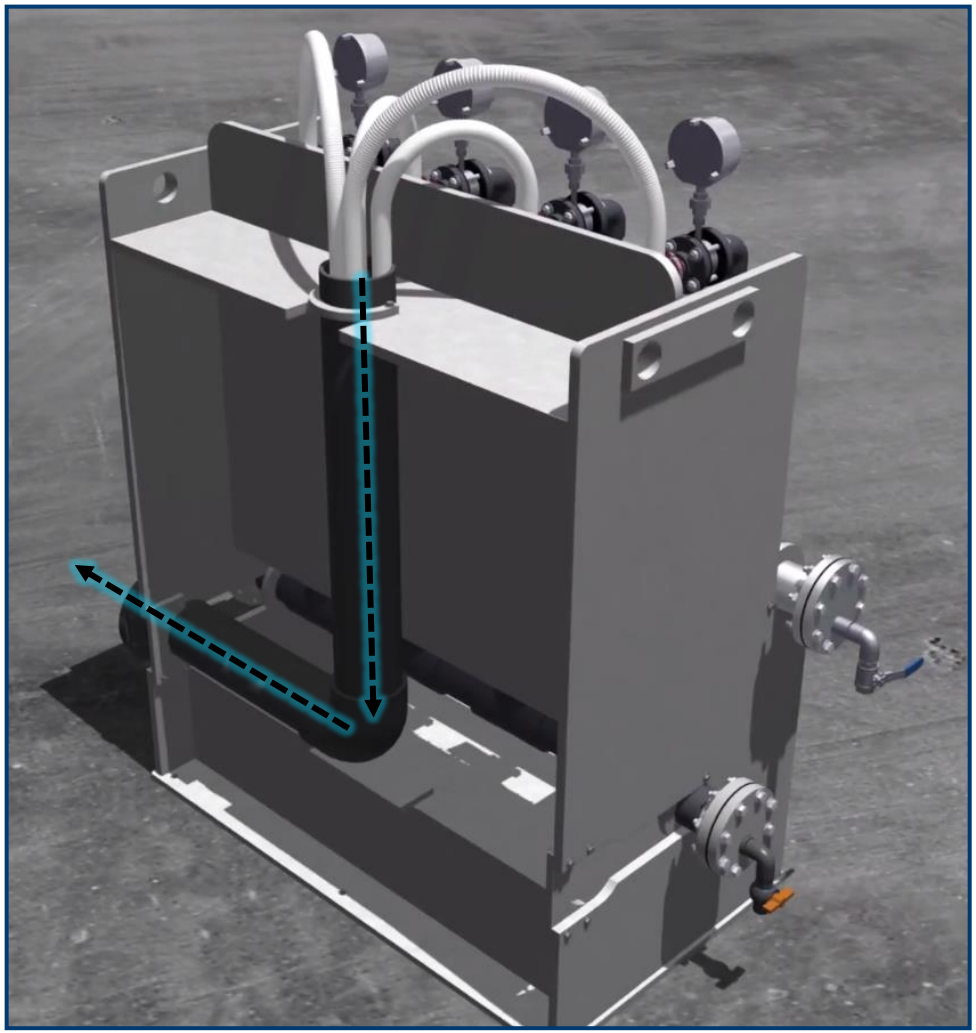


System Overview

Skid Flow Paths

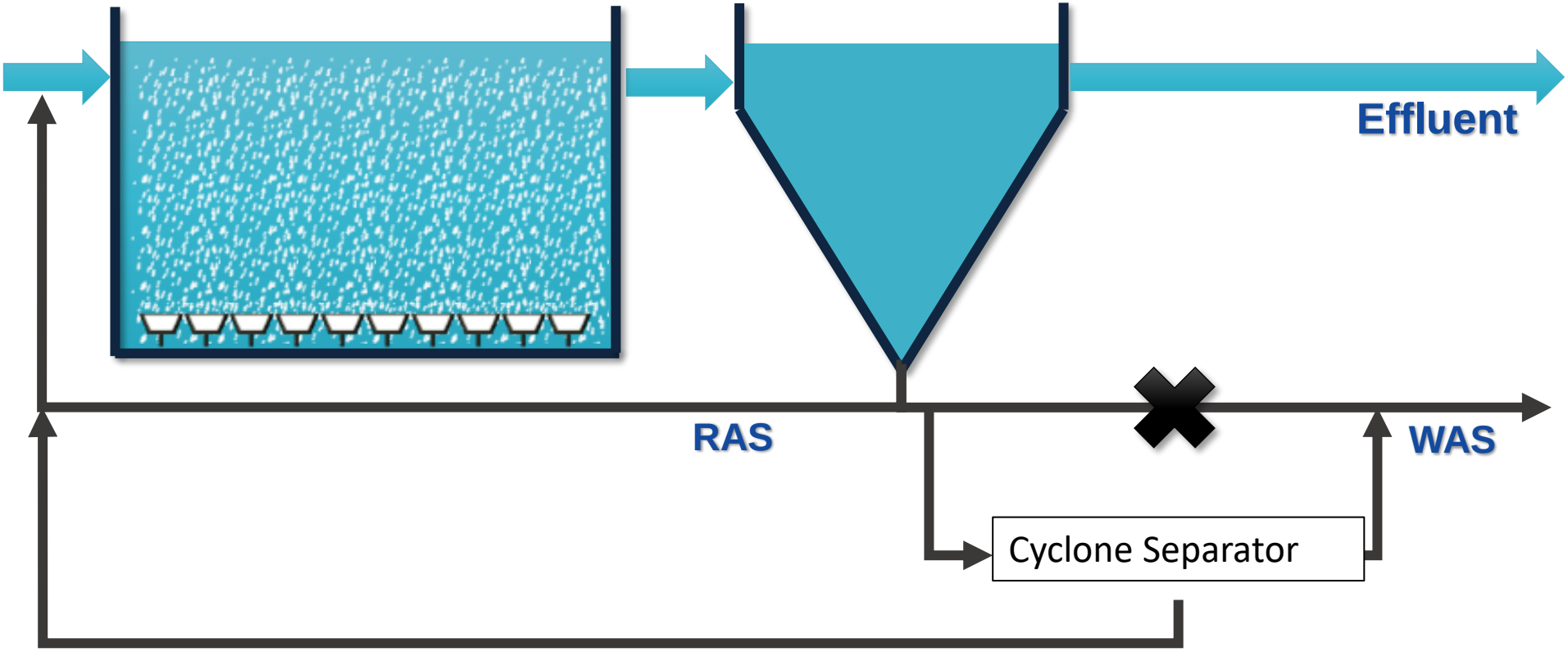


UNDERFLOW



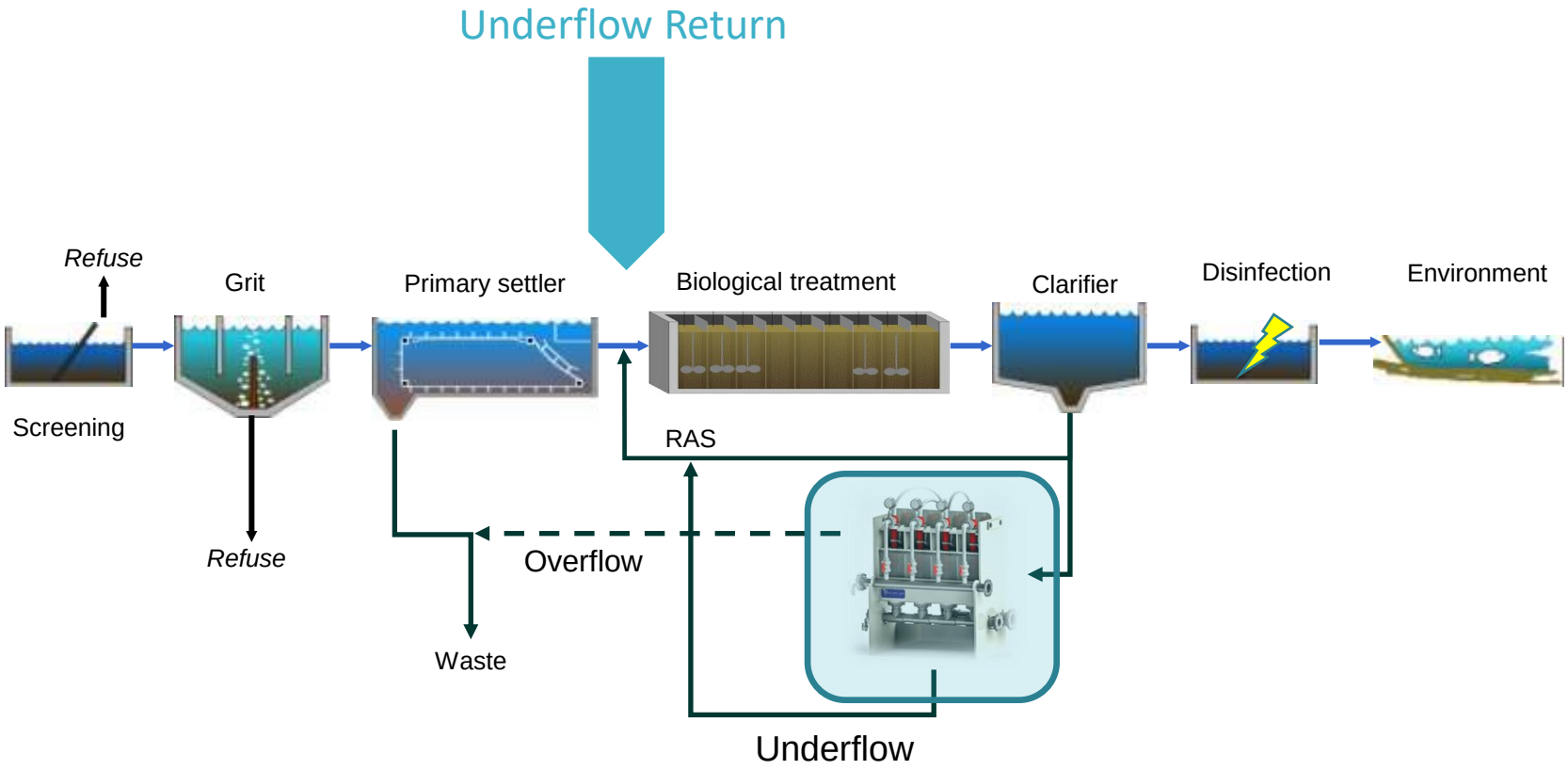
OVERFLOW

Process Flow: Clarifier Wasting



- **WAS WASTING: >500,000 GPD Total Plant Flow**

Clarifier Wasting Application



System Overview

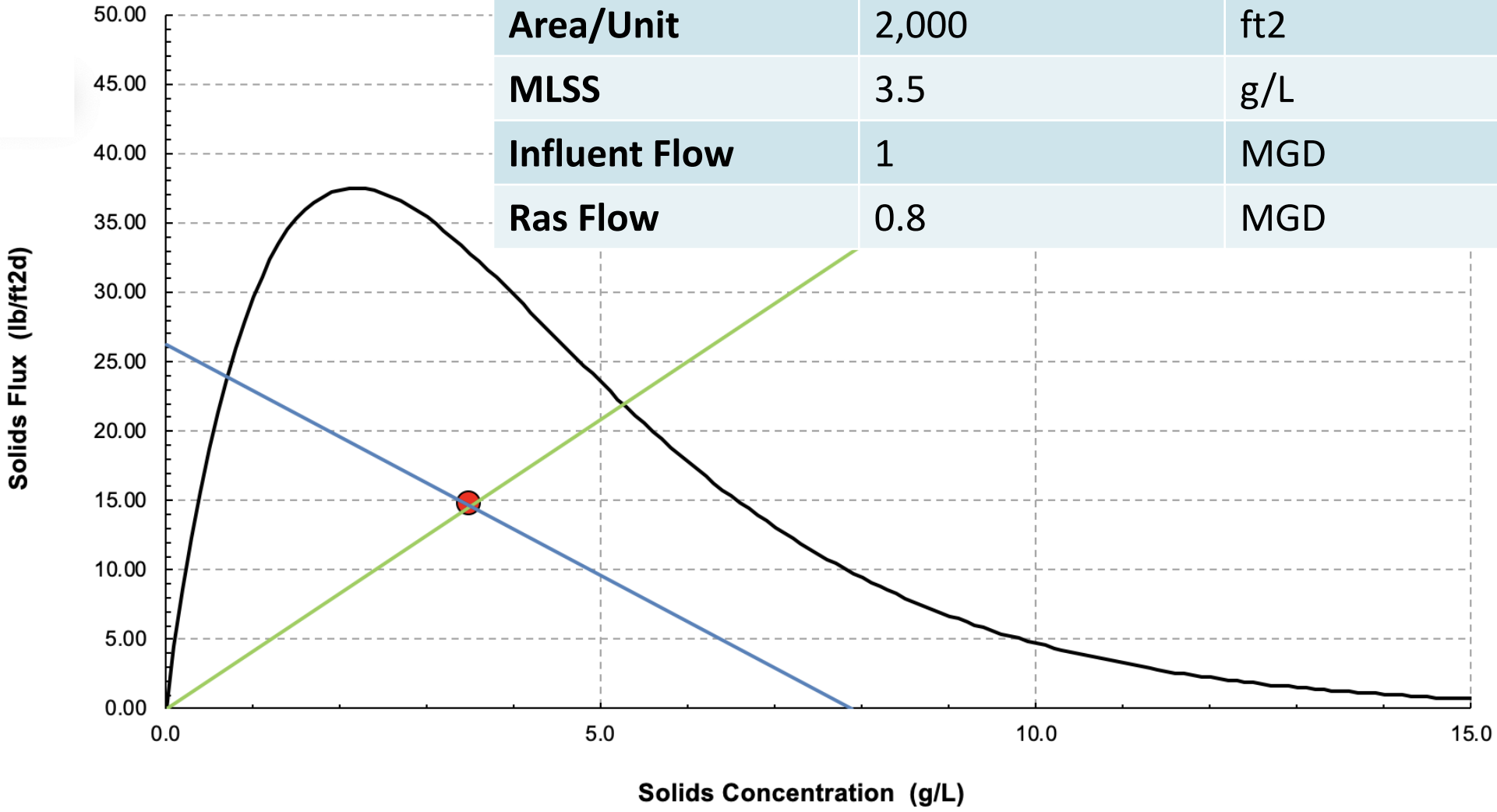
Settling Behavior

FEED FLOW OVERFLOW UNDERFLOW

Purpose

Aerobic Granular Sludge (AGS)

SVI	120	mL/g
# of Clarifiers	1	Units
Area/Unit	2,000	ft2
MLSS	3.5	g/L
Influent Flow	1	MGD
Ras Flow	0.8	MGD



Purpose

Aerobic Granular Sludge (AGS)

SVI	120	mL/g
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Area/Unit	2,000	ft2
MLSS	5.5	g/L
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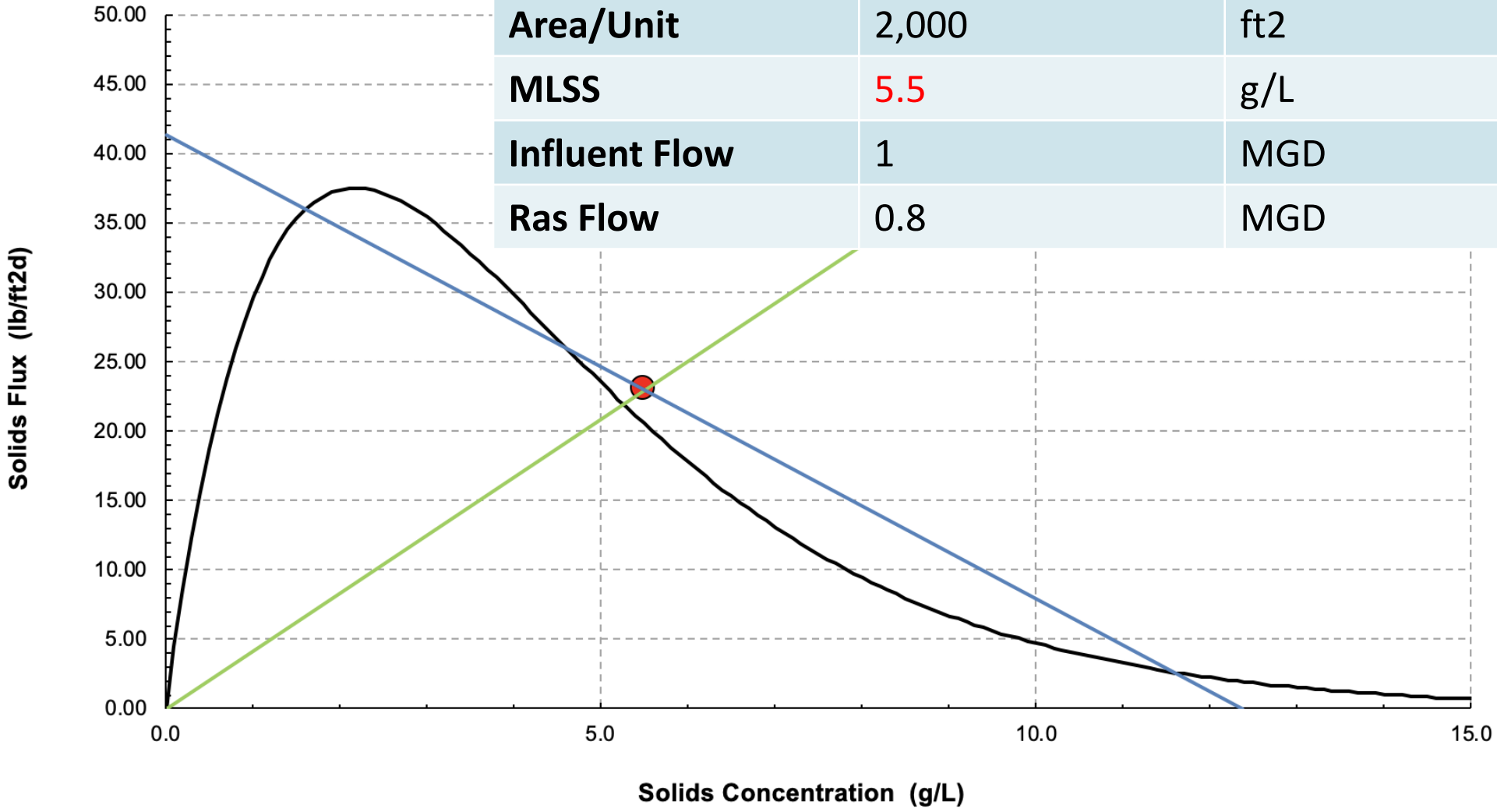
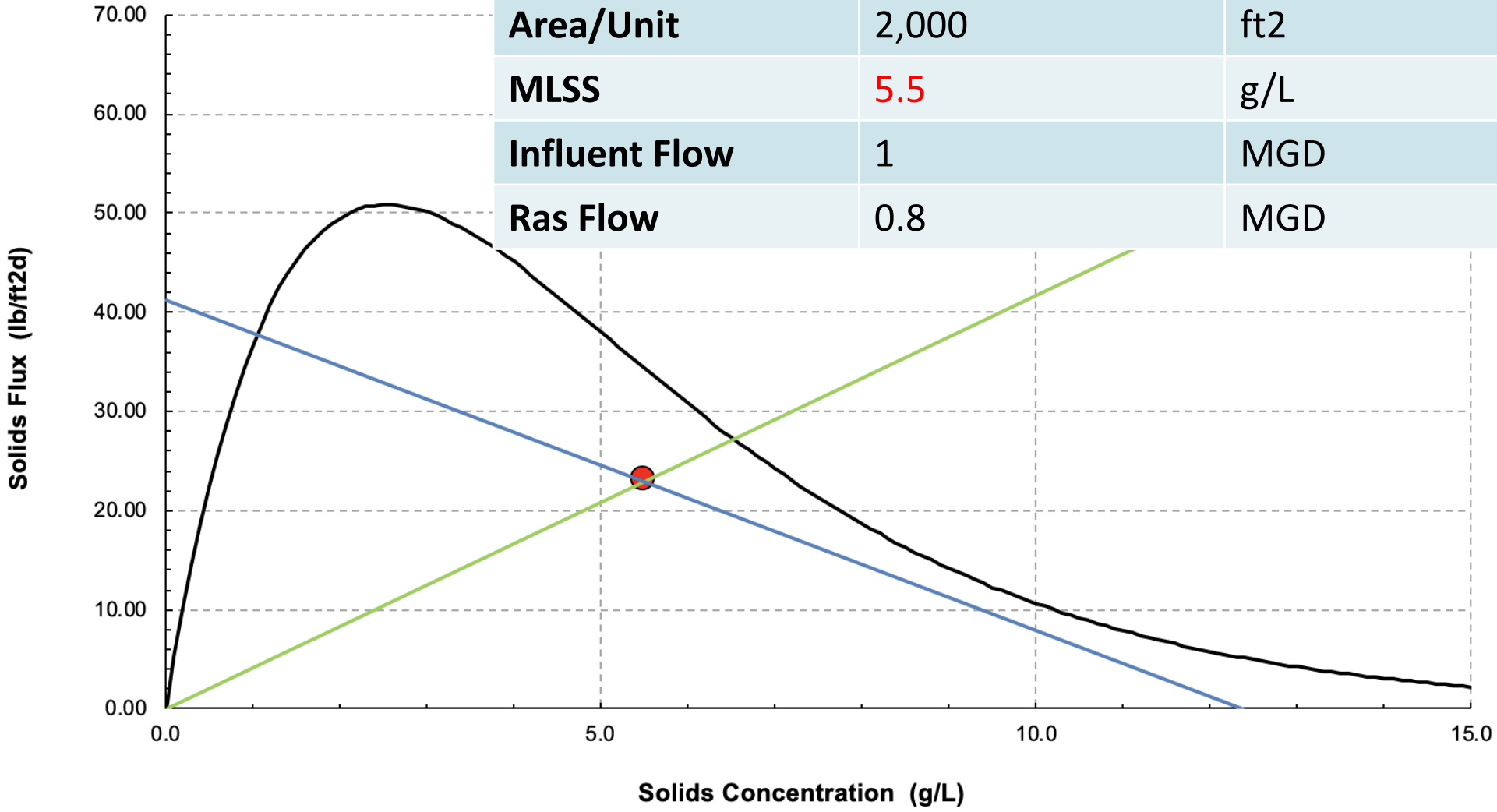


Purpose

Aerobic Granular Sludge (AGS)

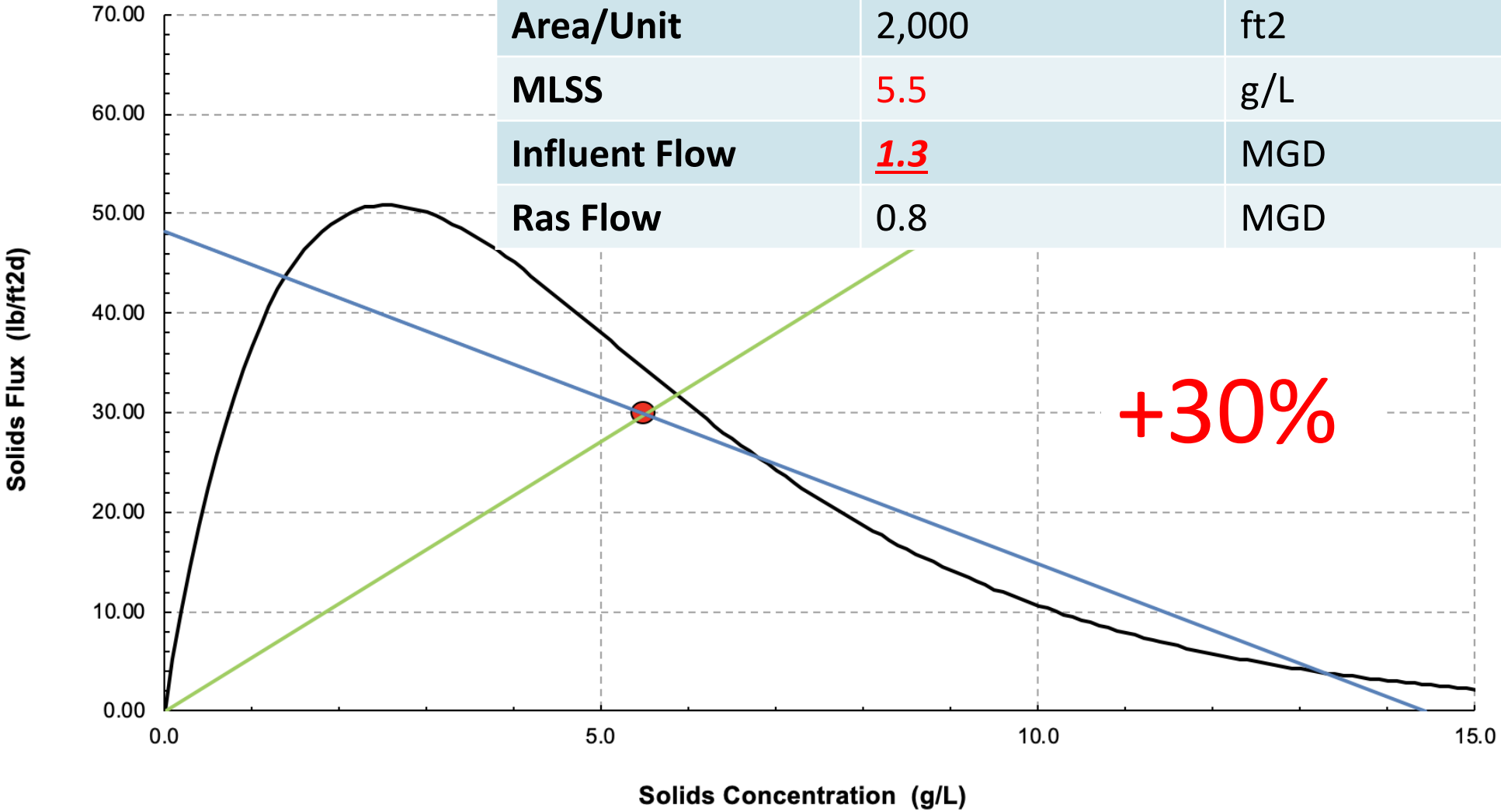
SVI	80	mL/g
# of Clarifiers	1	Units
Area/Unit	2,000	ft2
MLSS	5.5	g/L
Influent Flow	1	MGD
Ras Flow	0.8	MGD



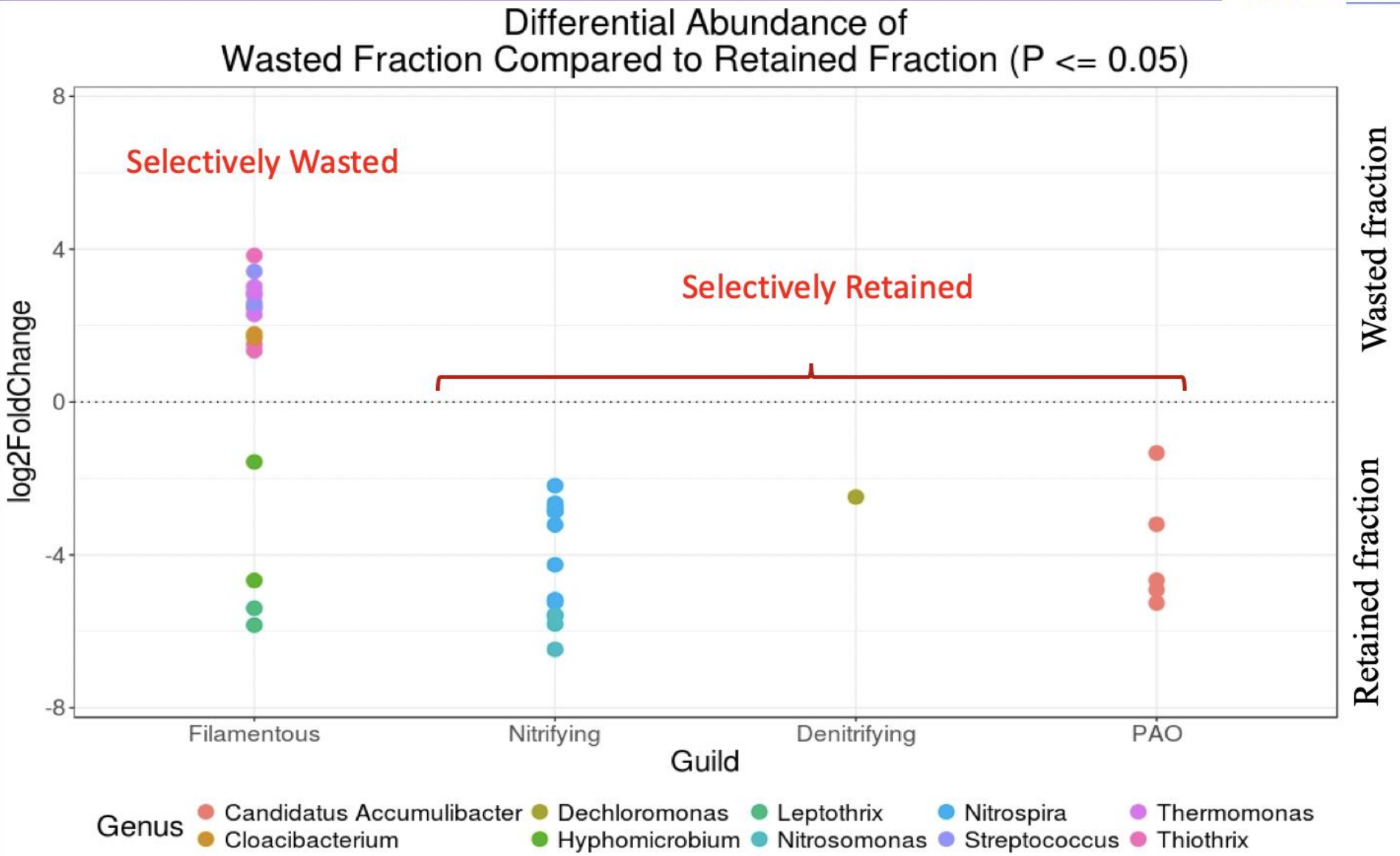
Purpose

Aerobic Granular Sludge (AGS)

SVI	80	mL/g
# of Clarifiers	1	Units
Area/Unit	2,000	ft2
MLSS	5.5	g/L
Influent Flow	***1.3***	MGD
Ras Flow	0.8	MGD



Microbial communities enrichment in the granule fraction



Sturm, et al

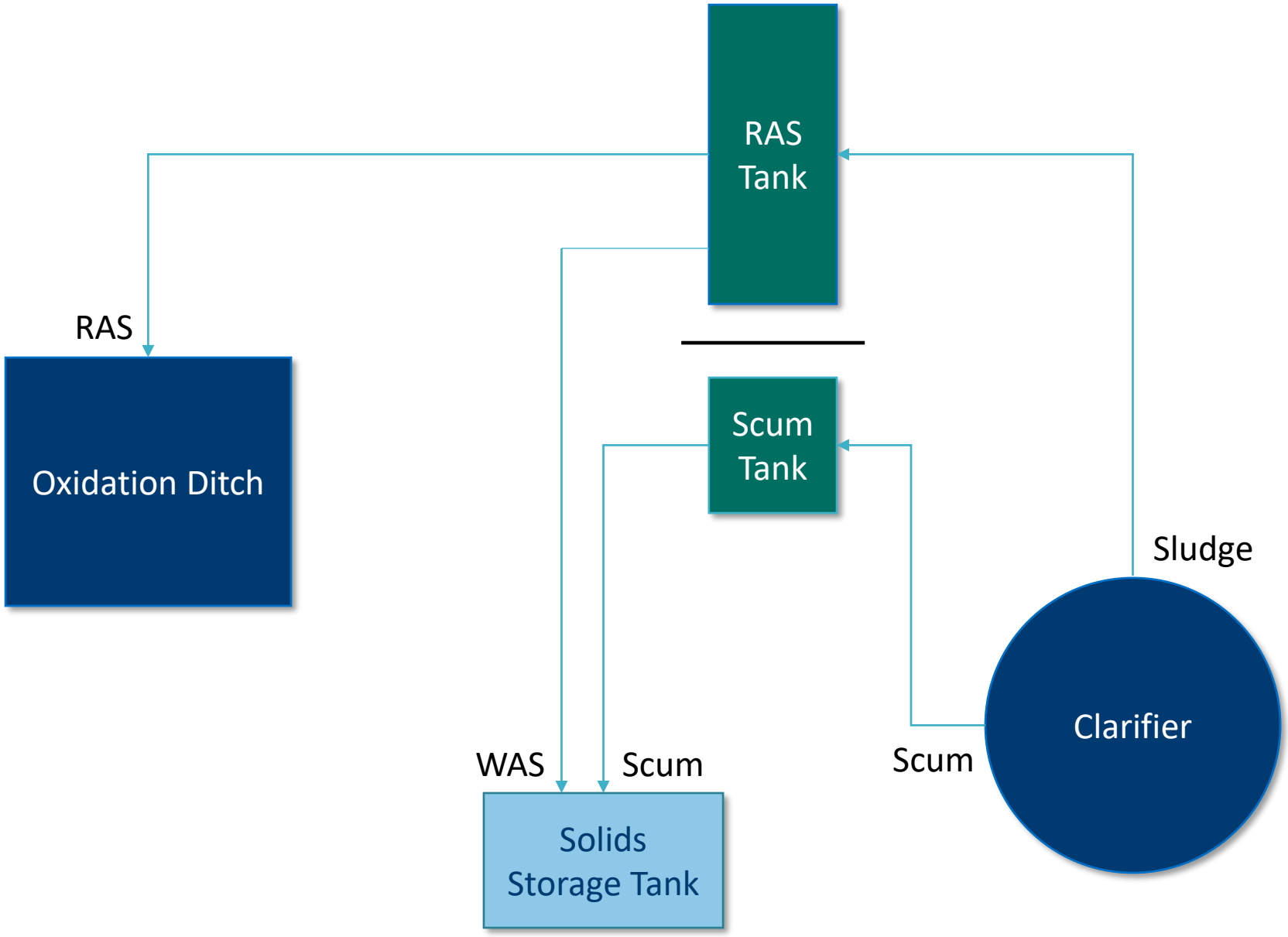
Case Study #1

Installation: 2019

3.8 MGD – A2O Oxidation Ditch

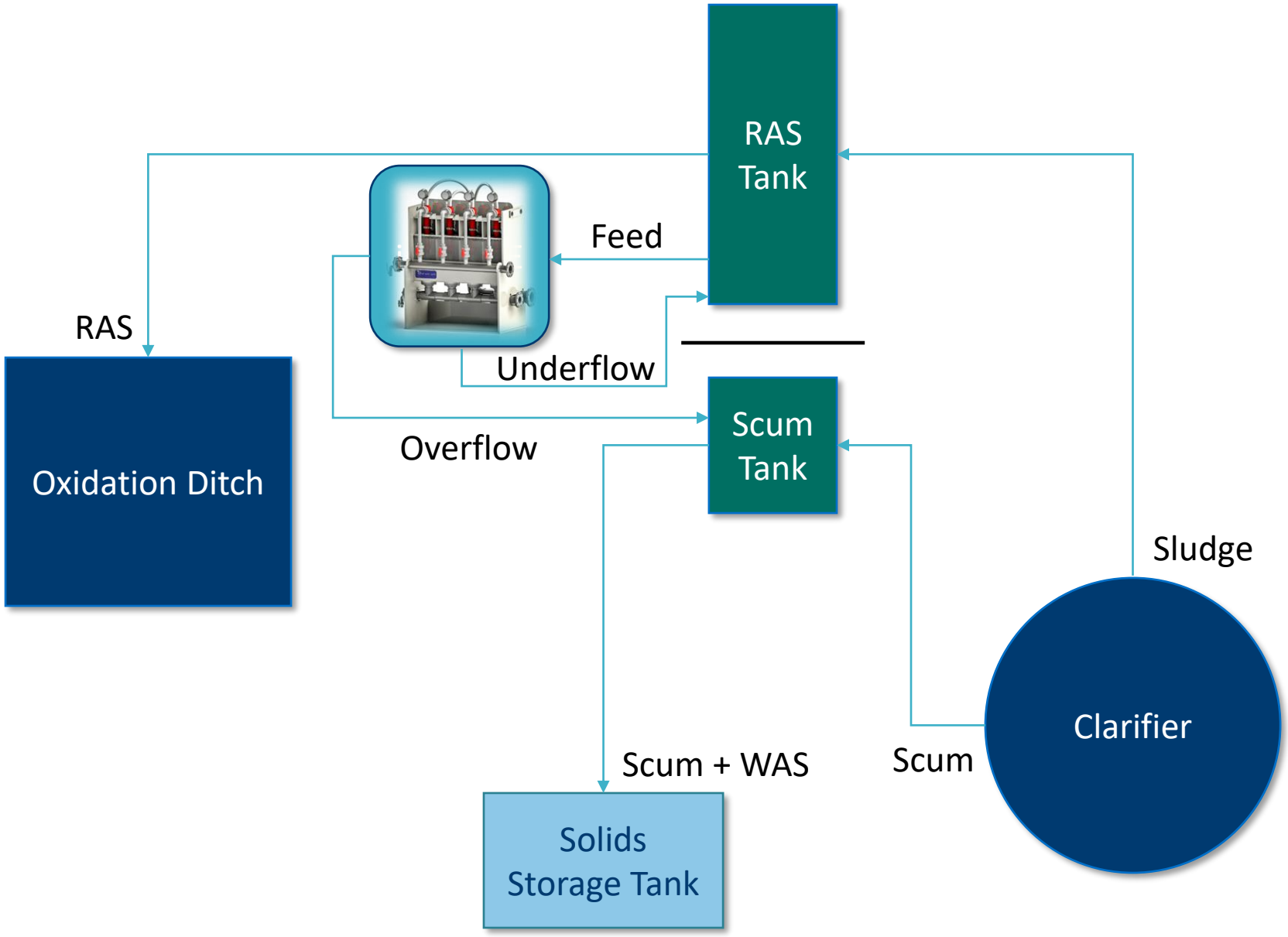
inDENSE Case Studies

Pennsylvania - Oxidation Ditch



inDENSE Case Studies

Pennsylvania - Oxidation Ditch

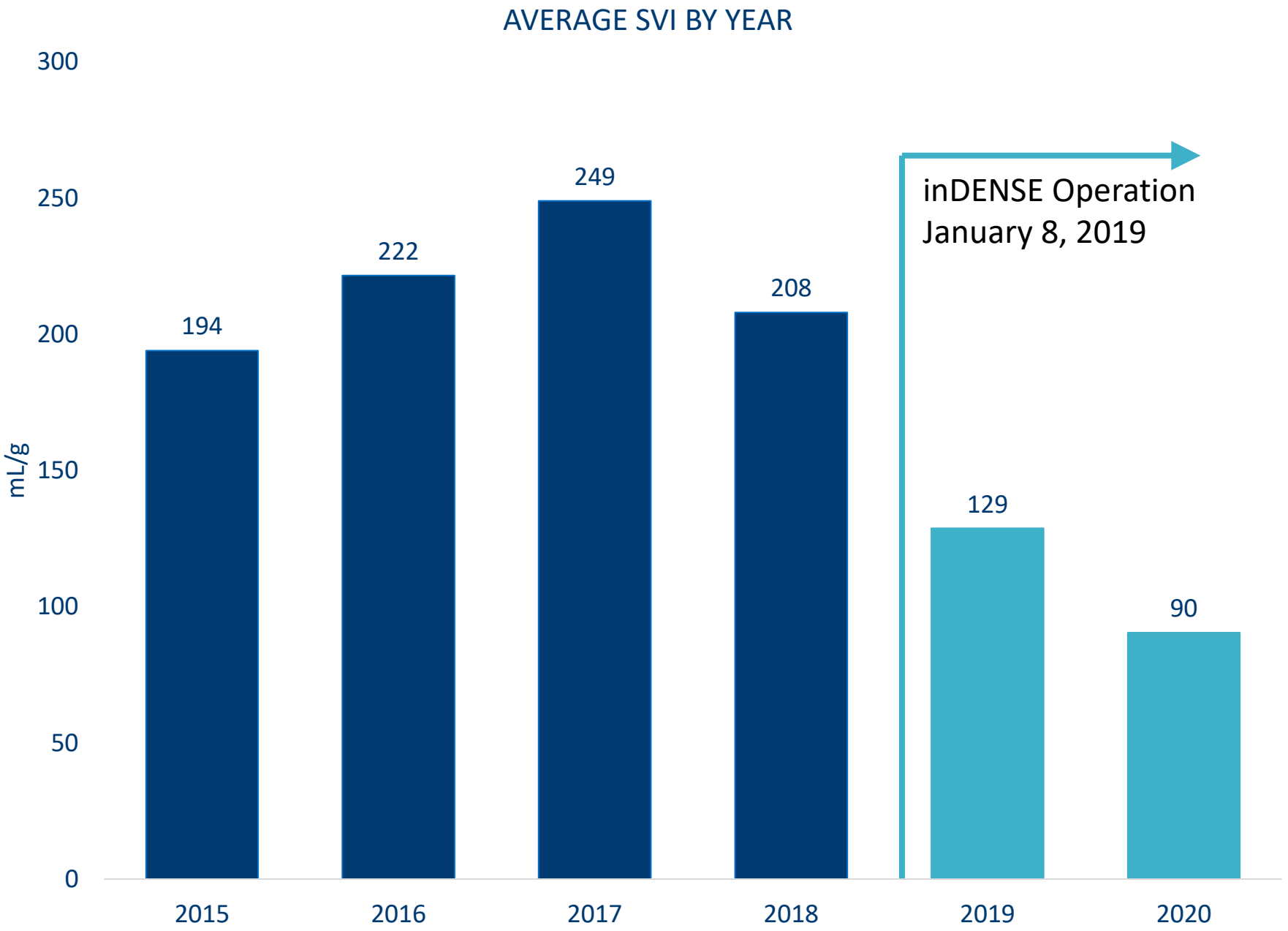


inDENSE Case Studies

Pennsylvania - Oxidation Ditch

Case Studies

Pennsylvania - Oxidation Ditch



Case Studies

Pennsylvania - Oxidation Ditch

Results:

- Improved plant performance and operation during winter
  - 38% improvement from 2018 to 2019
  - 58% improvement from 2018 to 2020 (current)
    - 2019 to 2020: 33% improvement (current)
  - Nitrification improvements
  - Easier plant operation
- Improvement to sludge dewaterability
  - Disposal volume decreased

Floc Size (μm):	< 150	150 – 500	> 500
(% in range)	20%	60%	20%

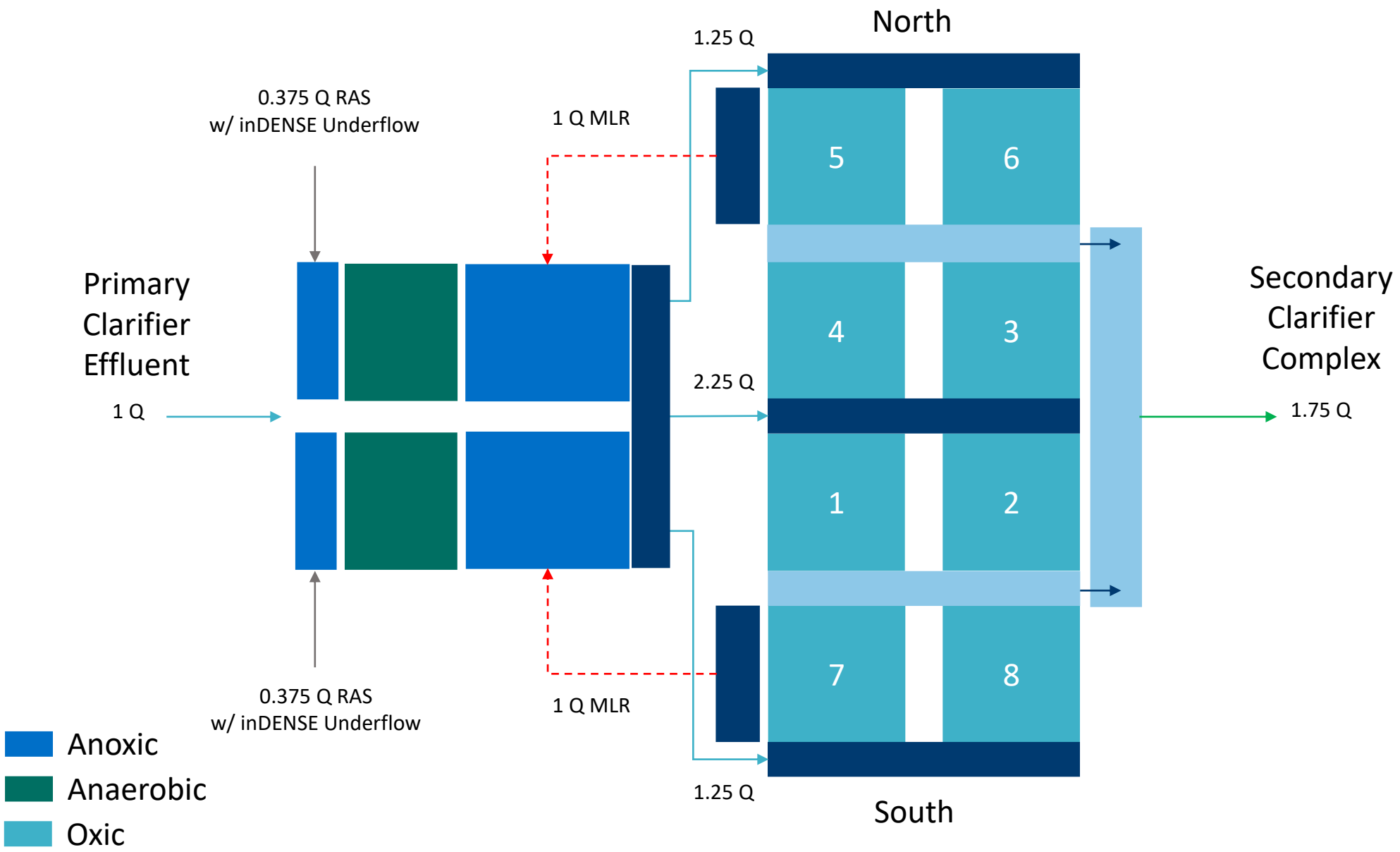
Case Study #2

Installation: 2019

15 MGD – A2O

Case Studies

Colorado - Johannesburg

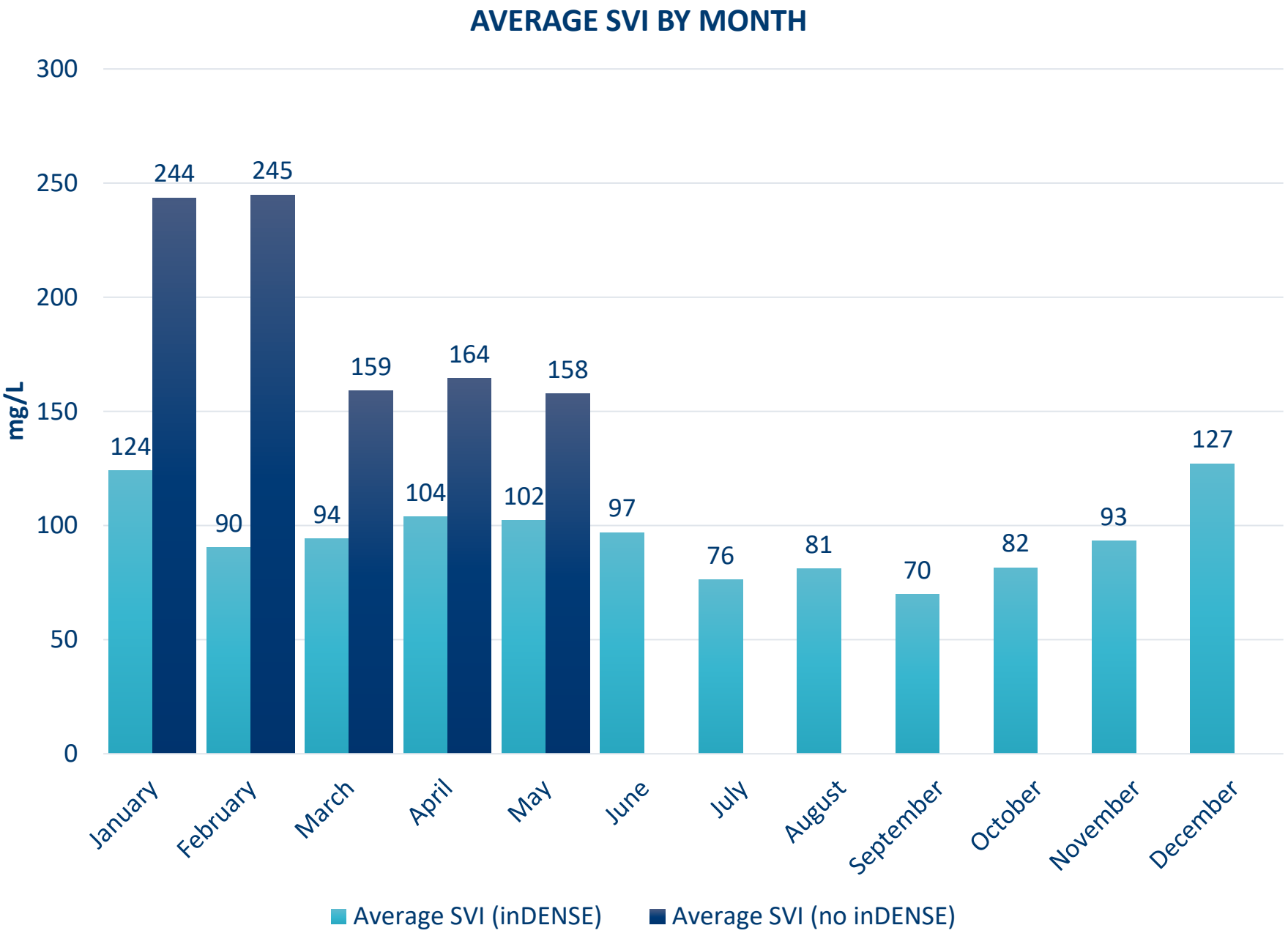


Case Studies

Colorado - Johannesburg

Case Studies

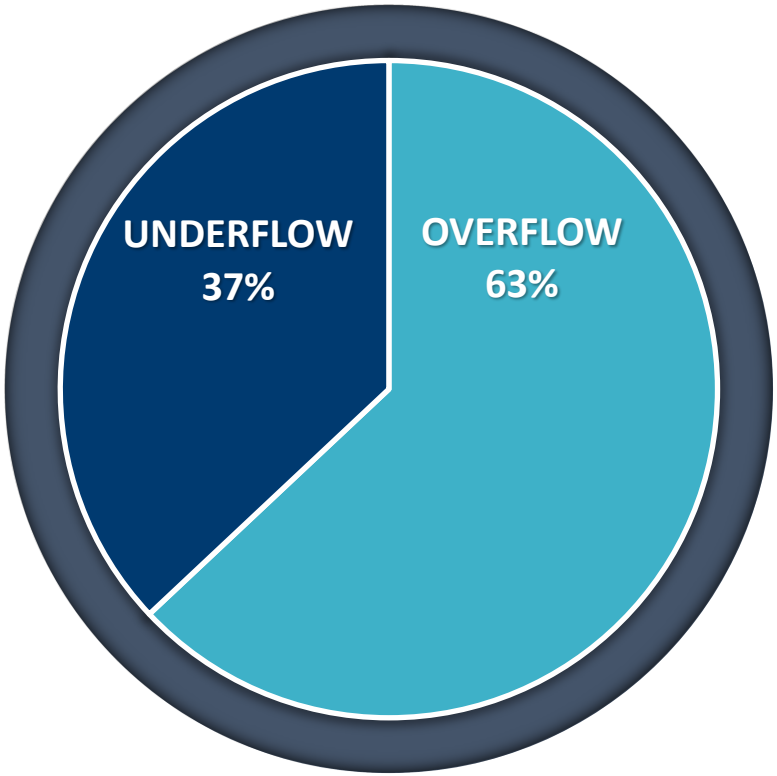
Colorado - Johannesburg



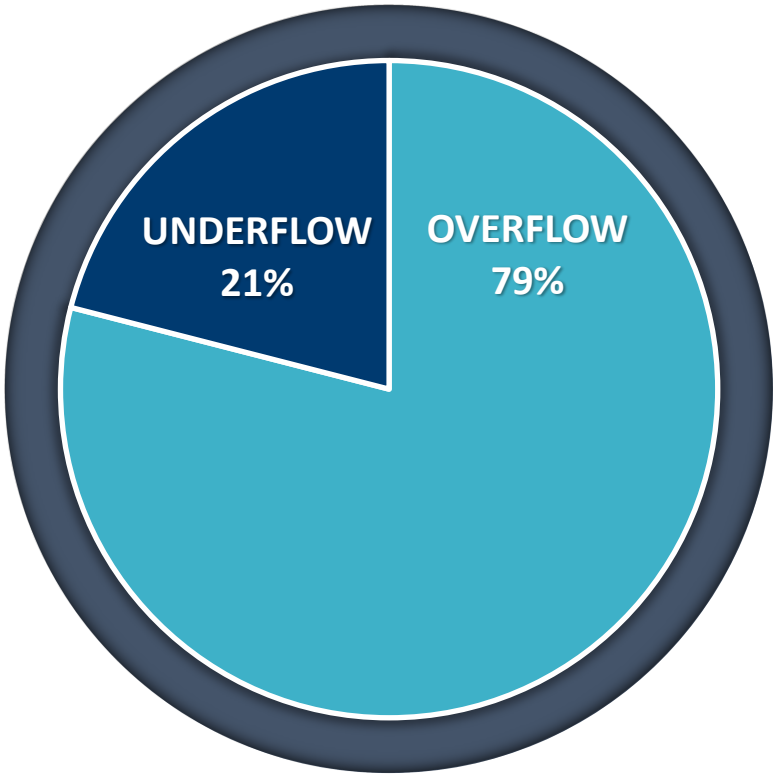
Case Studies

Colorado - Johannesburg

Mass Split



Flow Split



Case Studies

Colorado - Johannesburg

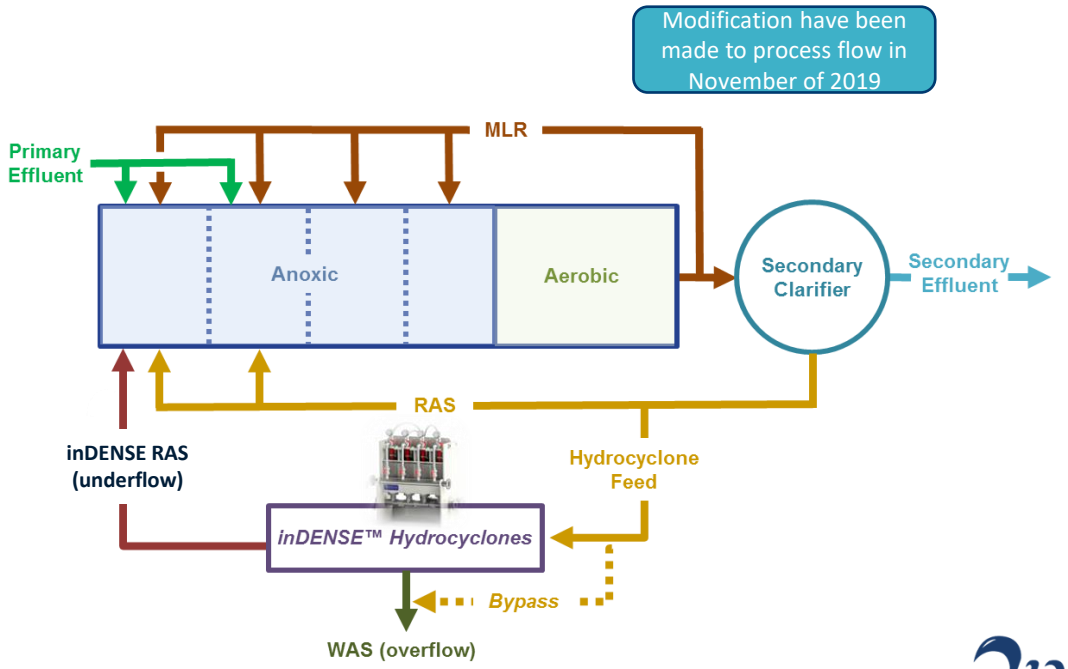
Results:

- Improved Settleability lead to:
  - Ease of operation
  - Consistent effluent quality
  - 49% improvement compared to January 2019 to 2020
  - 63% improvement compared to February 2019 to 2020
  - 35% improvement compared to March 2019 to 2020

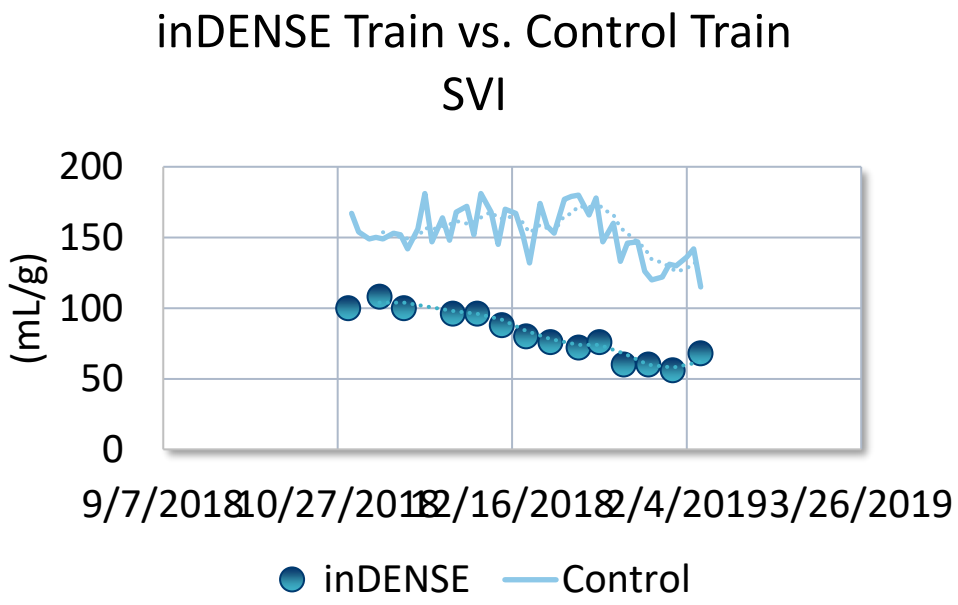
Case Study #3

Installation: 2018

8.8 MGD - AO


Modification have been made to process flow in November of 2019
MLR
Primary Effluent
Anoxic
Aerobic
Secondary Clarifier
Secondary Effluent
RAS
inDENSE RAS (underflow)
Hydrocyclone Feed
inDENSE™ Hydrocyclones
Bypass
WAS (overflow)

Avila


inDENSE Train vs. Control Train
SVI
200
150
100
50
0
(mL/g)
9/7/2018
10/27/2018
12/16/2018
2/4/2019
3/26/2019
inDENSE
Control

Avila

Results:

- Improved Settleability lead to:
  - 35% improvement compared to Control – November
  - 47% improvement compared to Control – December
  - 56% improvement compared to Control January
  - Increase PAO population
  - Increased SRT from 5 days to 7 days
  - Increased clarifier loading from 30 lb/ft2/day to 52 lb/ft2/day
  - 10-15% of particles >500 um where control was ~2% > 500 um
- Piloting still ongoing

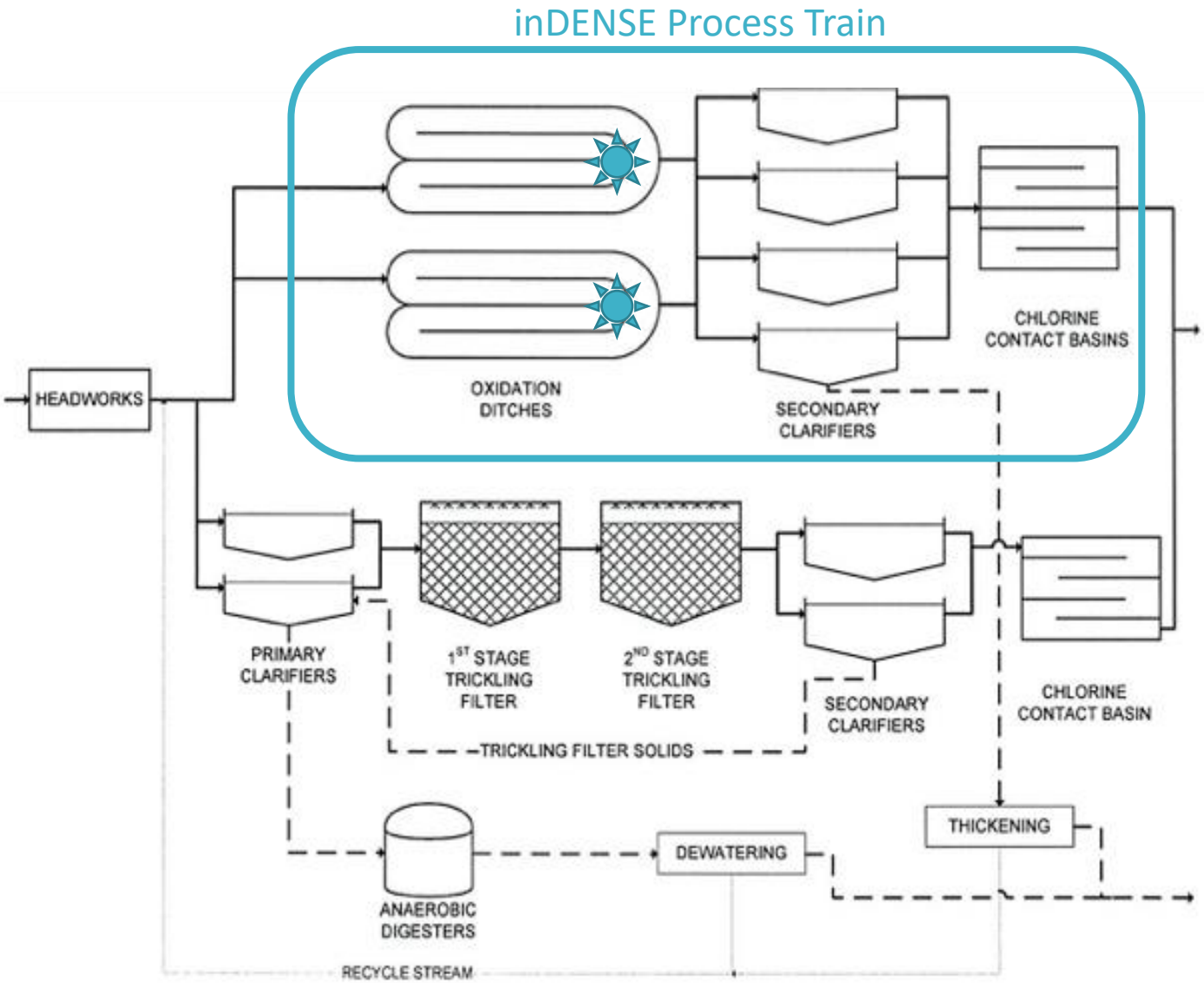
Case Study #4

Installation: 2019

10 MGD – Oxidation Ditch

Case Studies

Utah - Oxidation Ditch

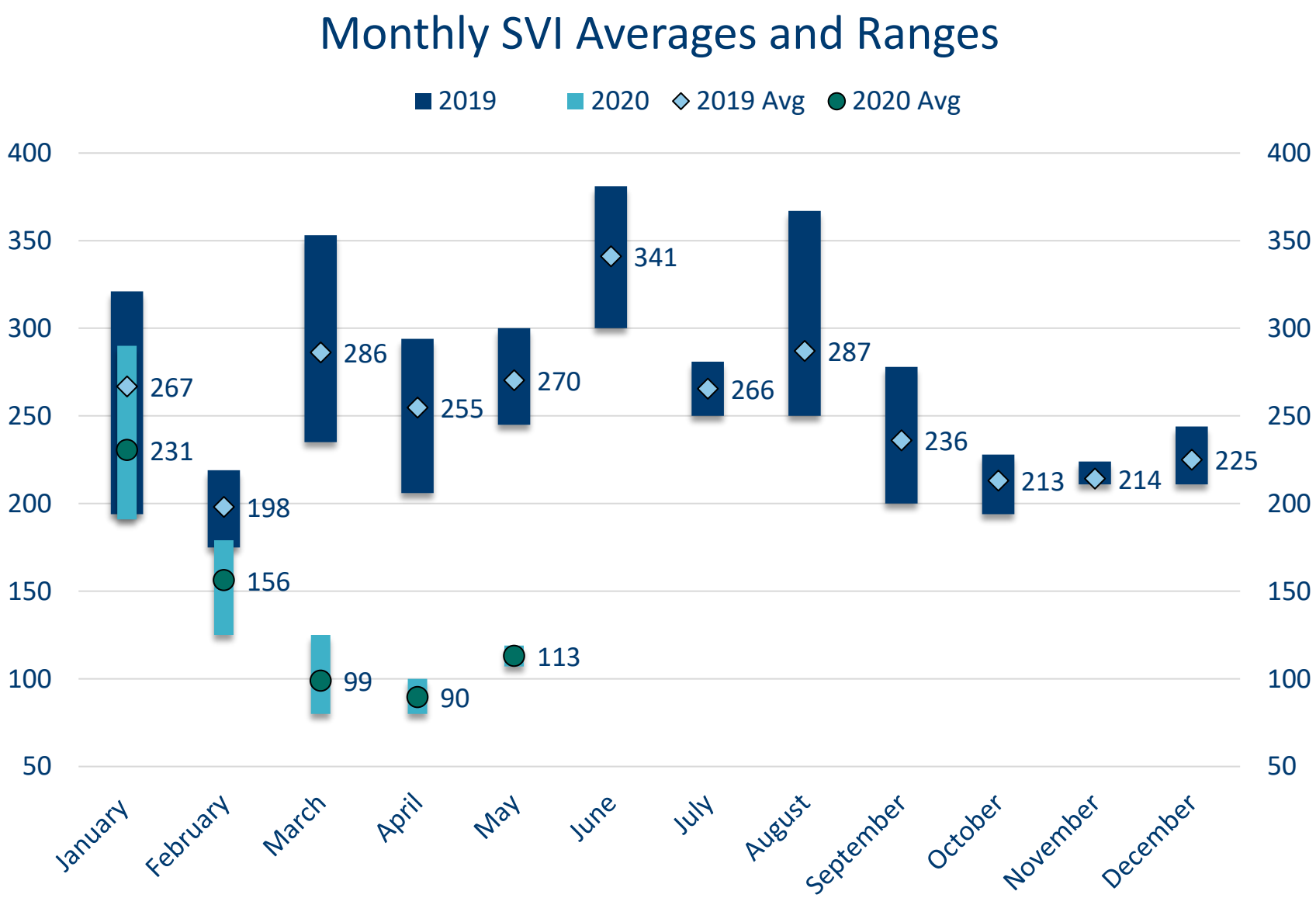


Case Studies

Utah - Oxidation Ditch

Case Studies

Utah - Oxidation Ditch



Case Studies

Utah - Oxidation Ditch

Results:

- Improved Settleability lead to:
  - 62% improvement compared to March of 2019 to 2020
- Still looking to validate:
  - Improved capacity
  - Increased clarifier loading

Denver Metro –Pilot Study

•The reduction in dSVI in the Test basin allowed operation at a solids loading rate to the Test clarifier that was 32% greater than the Control while maintaining equivalent effluent TSS.

•Under the conditions tested in the study, granulation was observed to occur in a full-scale continuous flow system. The total fraction of biomass larger than 250 µm began to increase after one month of operation, and within three months peaked at 56%. The fraction of biomass within the range of 250 to 500 µm fluctuated over time, while the fraction ≥500 µm continually increased, peaking at 20% before piloting ceased.

Acknowledgments

- ARA Consult - Dr. Bernhard Wett
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- HRSD – Dr. Charles Bott
- DC Water – Chris deBarbadillo
- Belinda Strum – University of Kansas

THANK YOU

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