Flexible Design Modifications: Cheap and Easy Ideas to Make Wastewater Treatment Better

Operator Training Committee of Ohio

Presented by

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Ohio EPA

Compliance Assistance Unit

April 25, 2023

What goes wrong…

- Permit Limits change, and the WWPT doesn't
  - Land Application of Treated Wastewater Rules
  - Effluent limits tighten statewide
- Disconnect between design and operation
  - Designers (engineers) put the pieces together
  - But have no idea how to operate
- Garbage IN, garbage OUT
  - Design assumptions by the book
  - Bacteria haven't read the book
- Flexibility must be designed in
  - Operators don't get to chose what to treat
  - They must treat whatever comes down the sewer
  - If no flexibility is designed in, the hands of the operator are tied.

Reasons Small Systems are More Difficult to Operate than Big Systems

- Small tanks are more subject to changes in influent flow volumes
- Small systems typically don’t have labs and send out sampling
- Small systems don’t have flexibility designed to respond changing influents
- Operators of small system don’t have good, effective process control tools
- Older small systems sometimes don’t have sludge tank to waste into
- Airlift RAS pumps are not controllable and often pump way too much
- Low flow systems in cold climates will lose temperature and nitrification
- New, modern low flow plumbing fixture will increase ammonia concentrations and decrease the alkalinity required for nitrification

Five Controls that an Operator of Small Systems Can Use

1. More aeration online, less aeration online
2. More clarifiers online, less clarifiers online
3. Ability to turn down RAS rates, or to turn up RAS rates
4. Waste more, waste less
5. Ability to change the mode of operation

What we will cover today

1. Remedies for Clarifier Issues and Total Suspended Solids Issues
2. Remedies for Treatment (BOD_5 and Ammonia) Issues
3. Remedies for RAS Issues
4. Sludge wasting issues
5. Mode of operation issues
6. Cheap, easy, and effective process control issues

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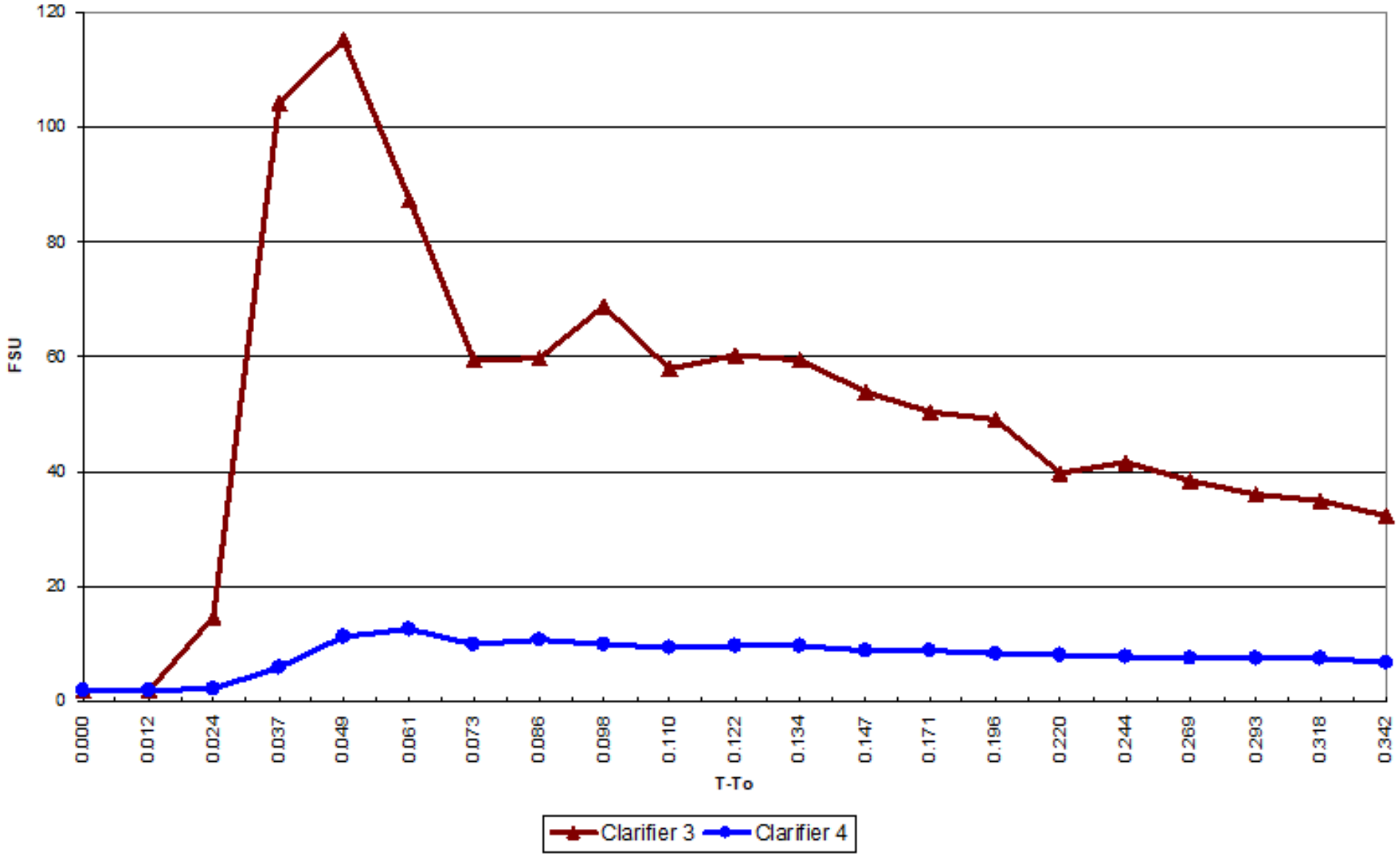
- Hydraulics by symmetry is rarely symmetrical
- Poor flow splitting results in unbalanced treatment
- Unbalanced treatment results in one treatment train being underloaded and the other train overloaded.
- With the higher flow, the overloaded train is noncompliant and the low flow underloaded train is compliant.
- And the combined flow will be noncompliant for TSS and others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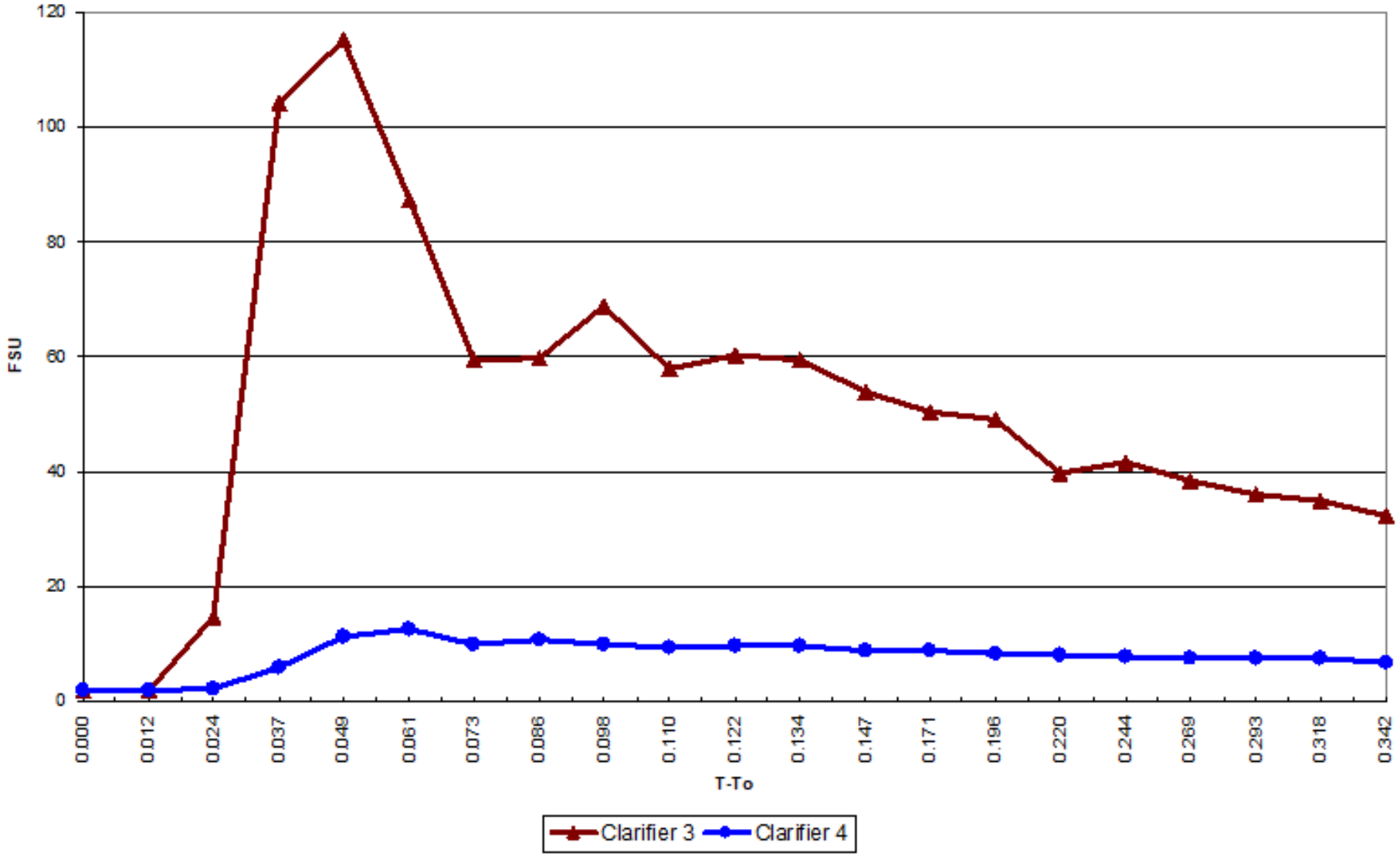
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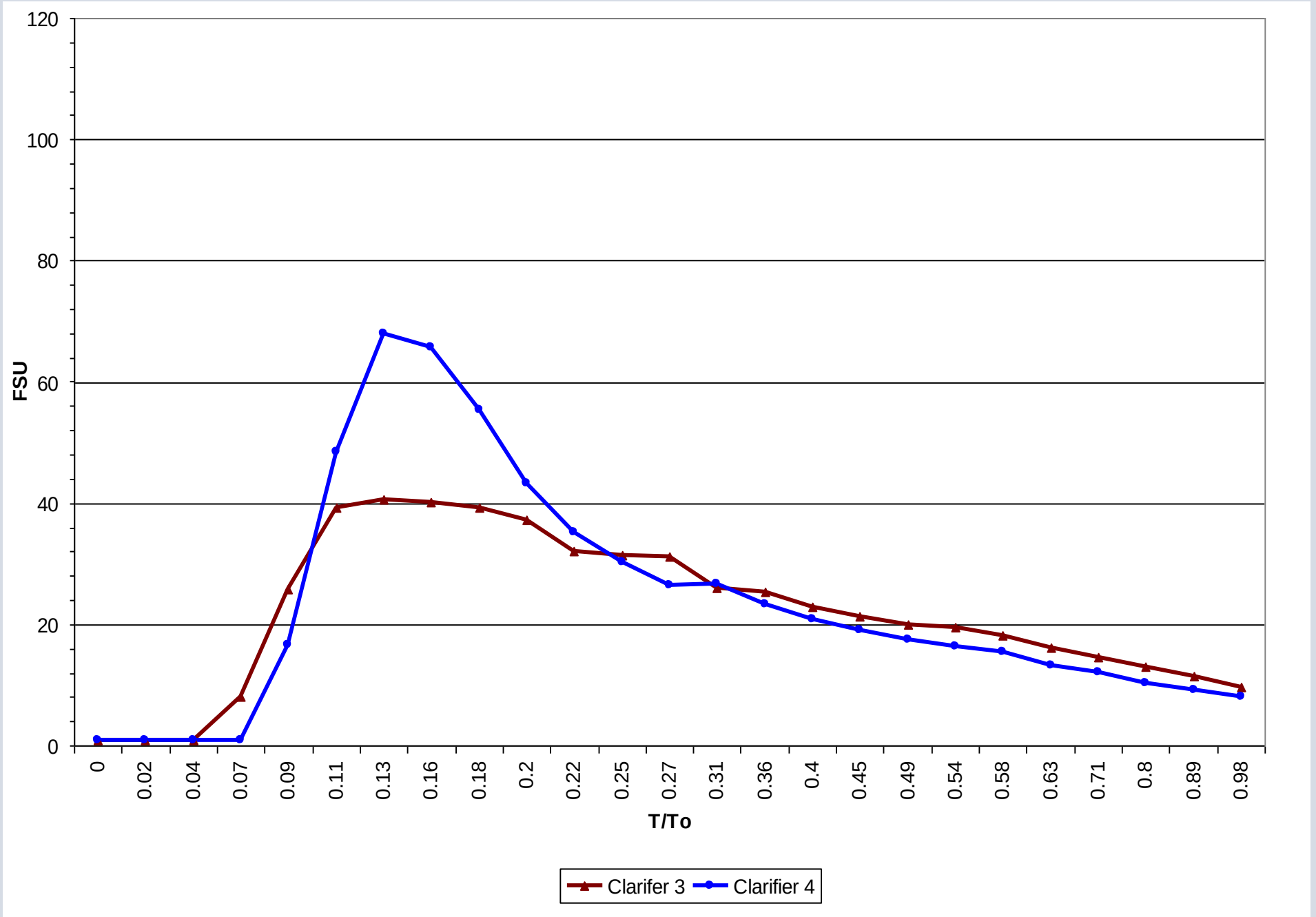
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0.2
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0.25
0.27
0.31
0.36
0.4
0.45
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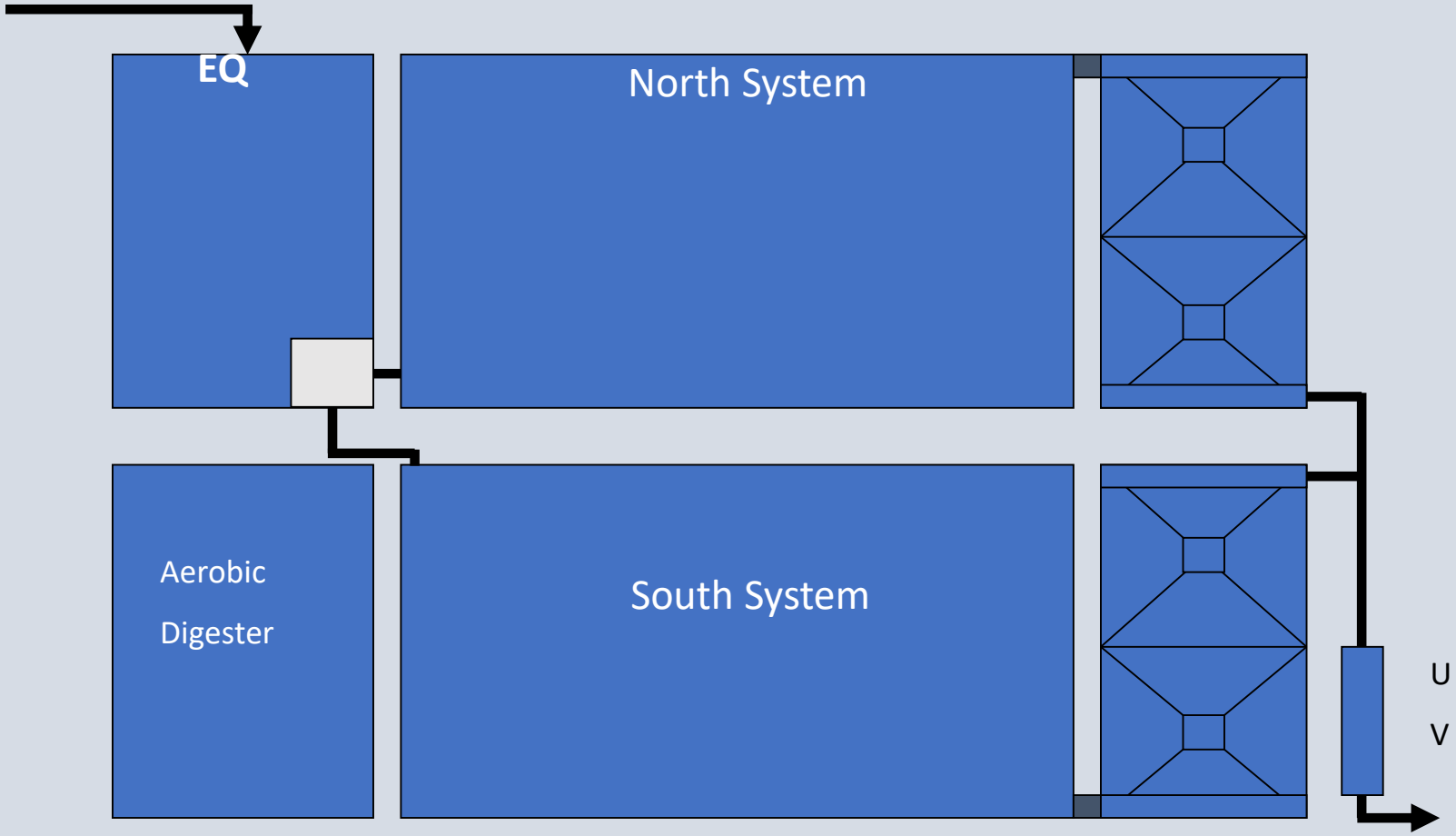
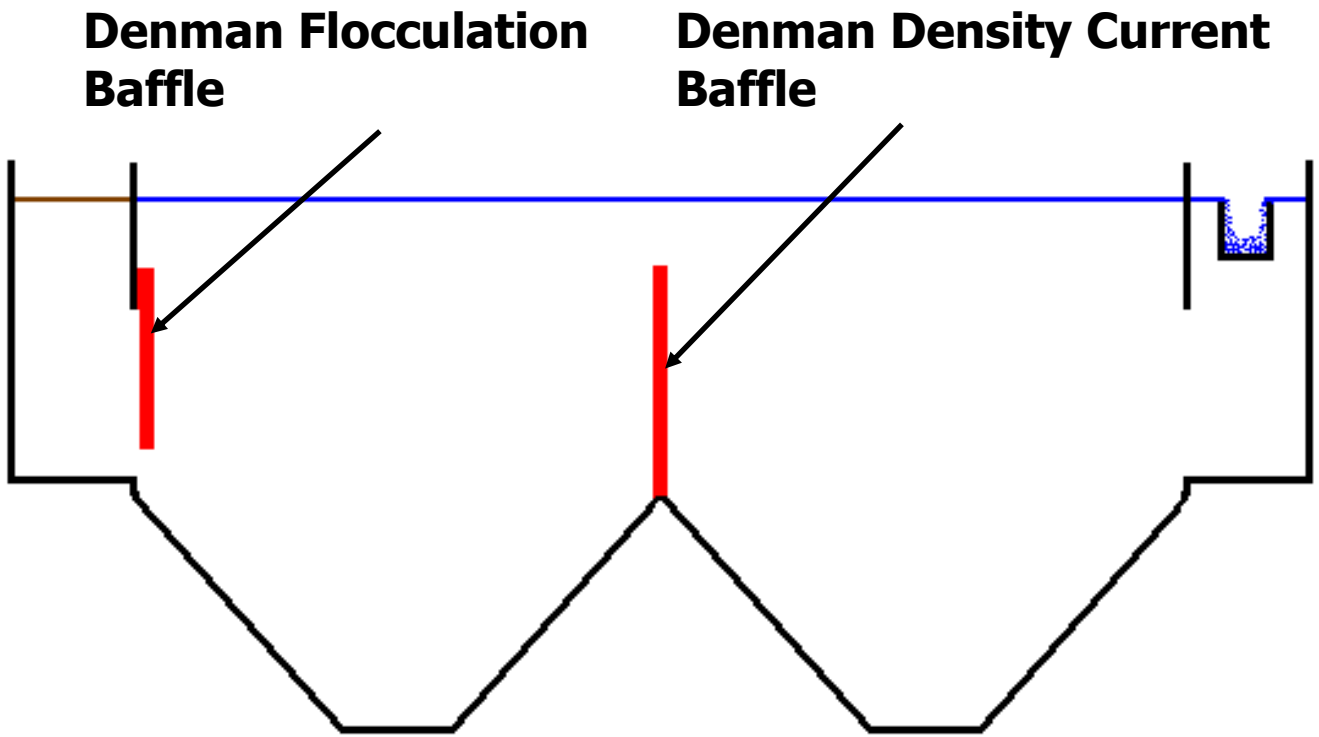
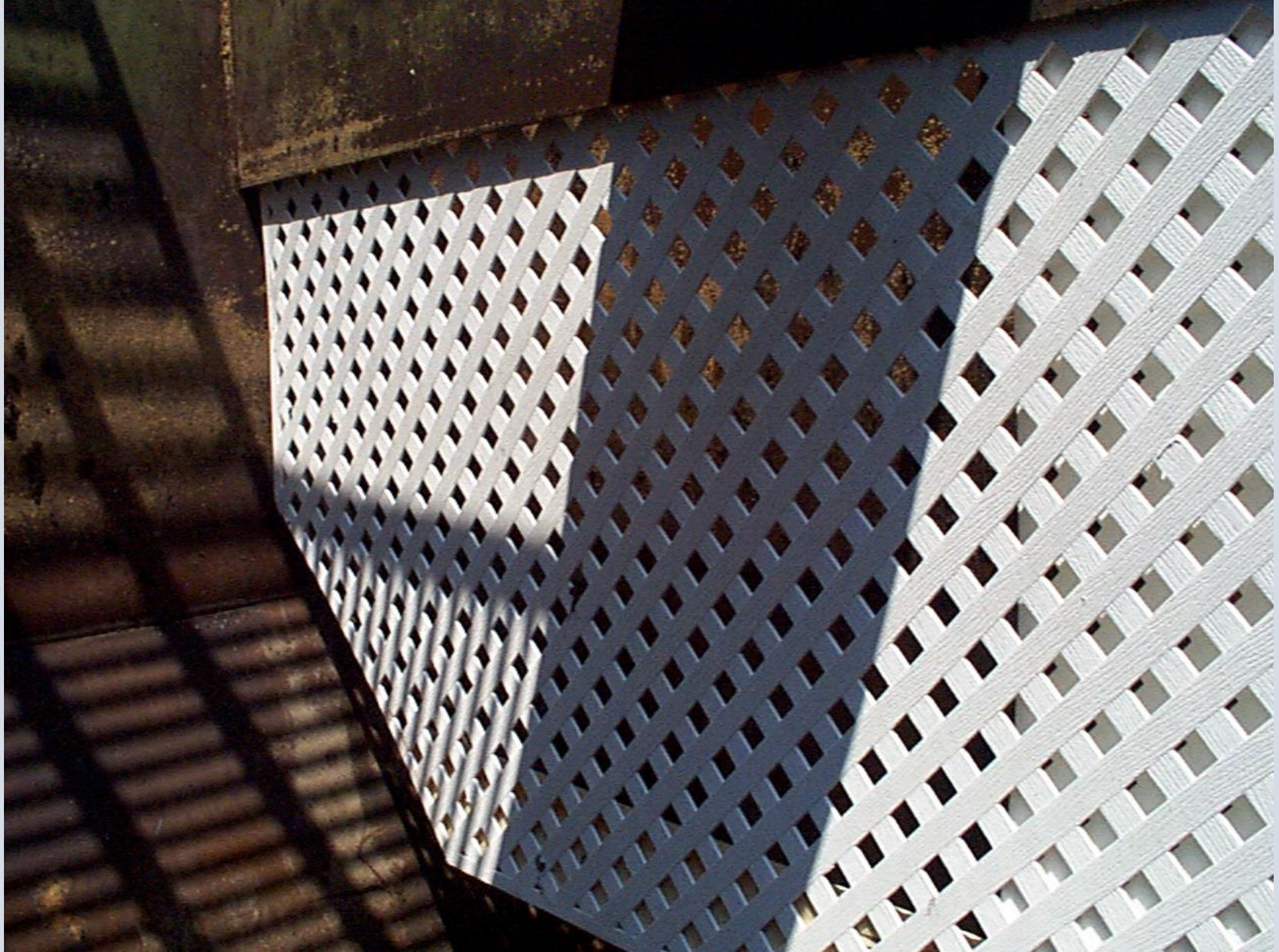
0.58
0.63
0.71
0.8
0.89
0.98
T/To
Clarifer 3
Clarifier 4

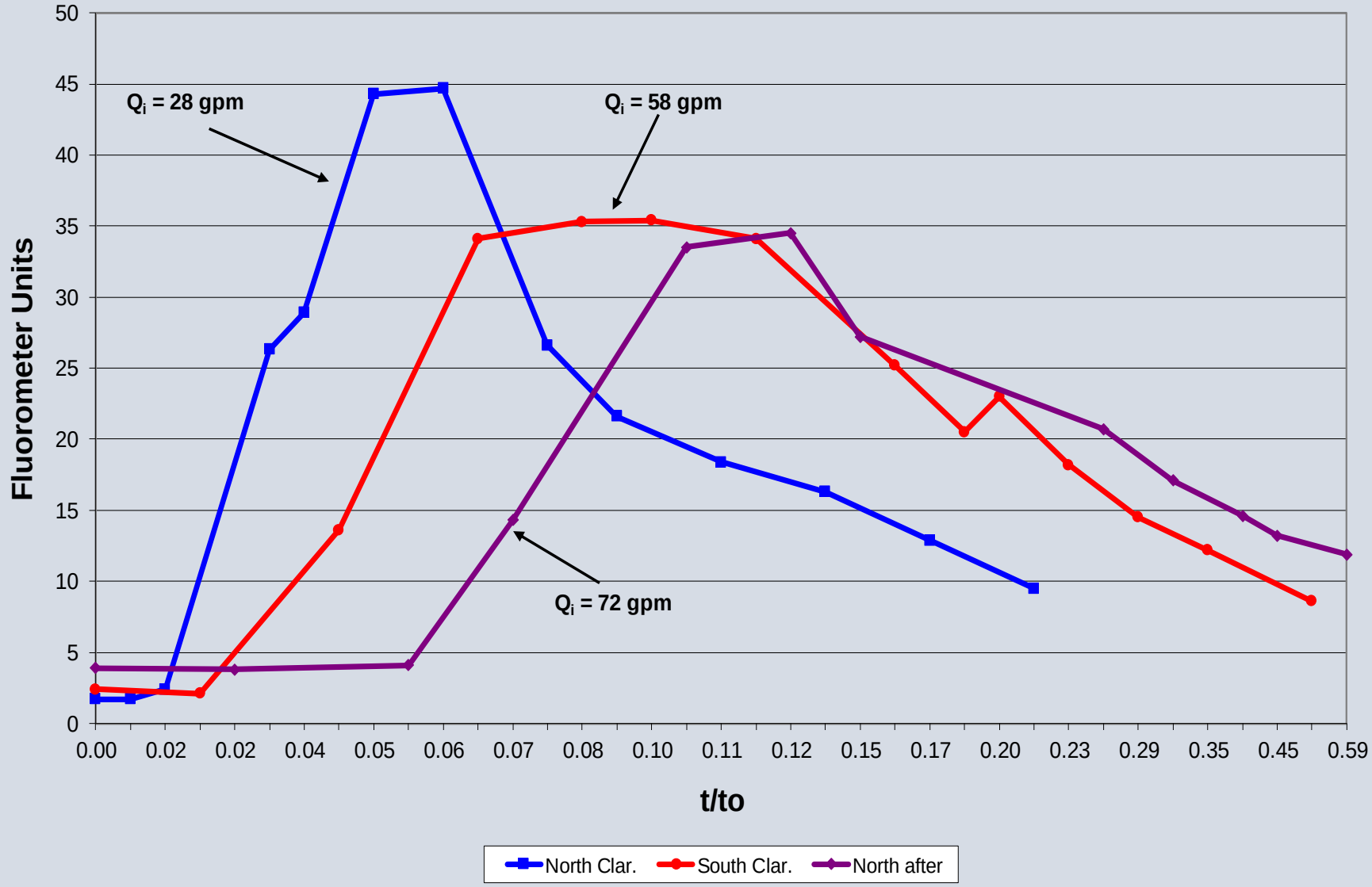

EQ
North System
Aerobic
Digester
South System
U
V

Denman Baffles

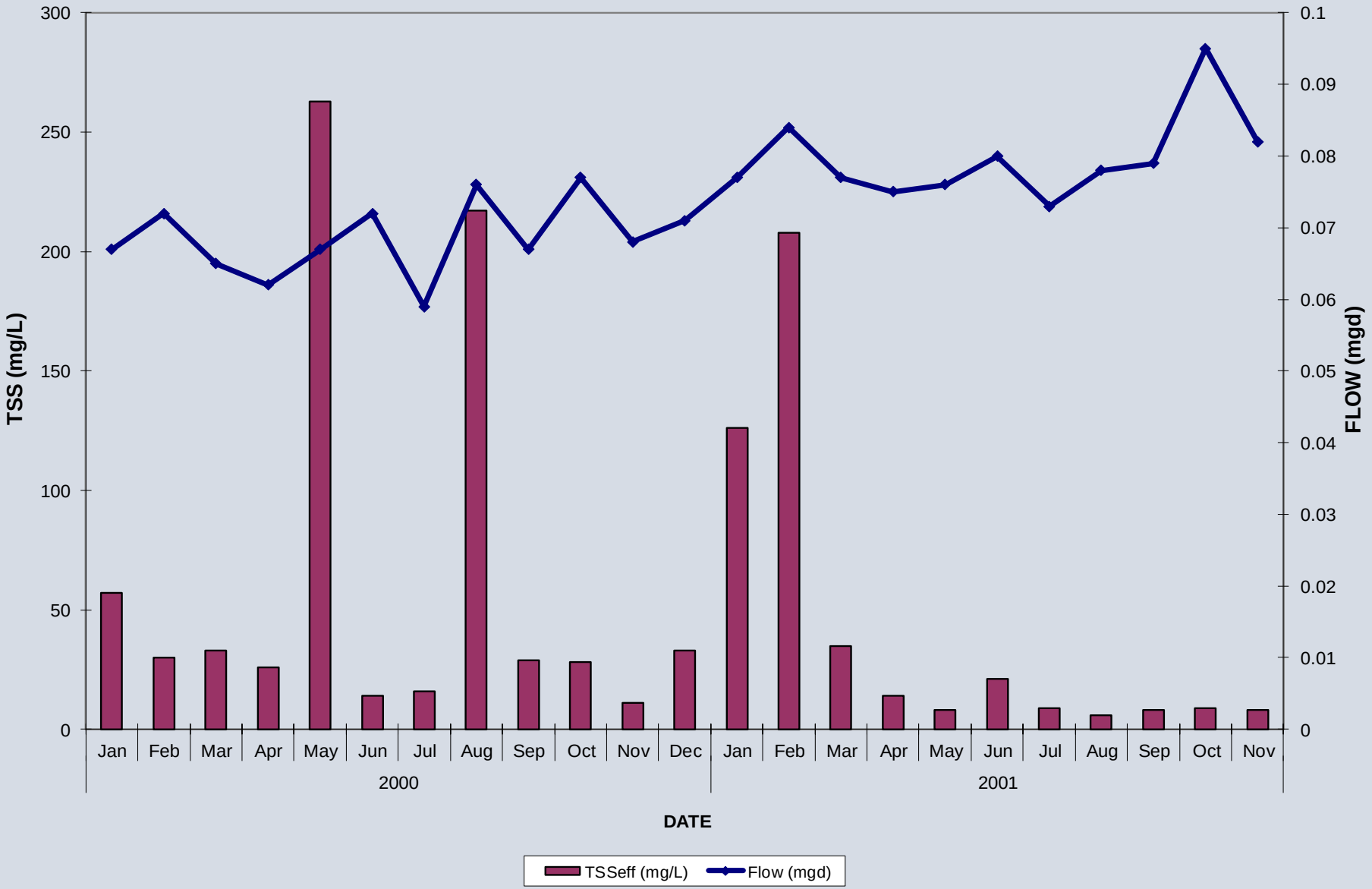


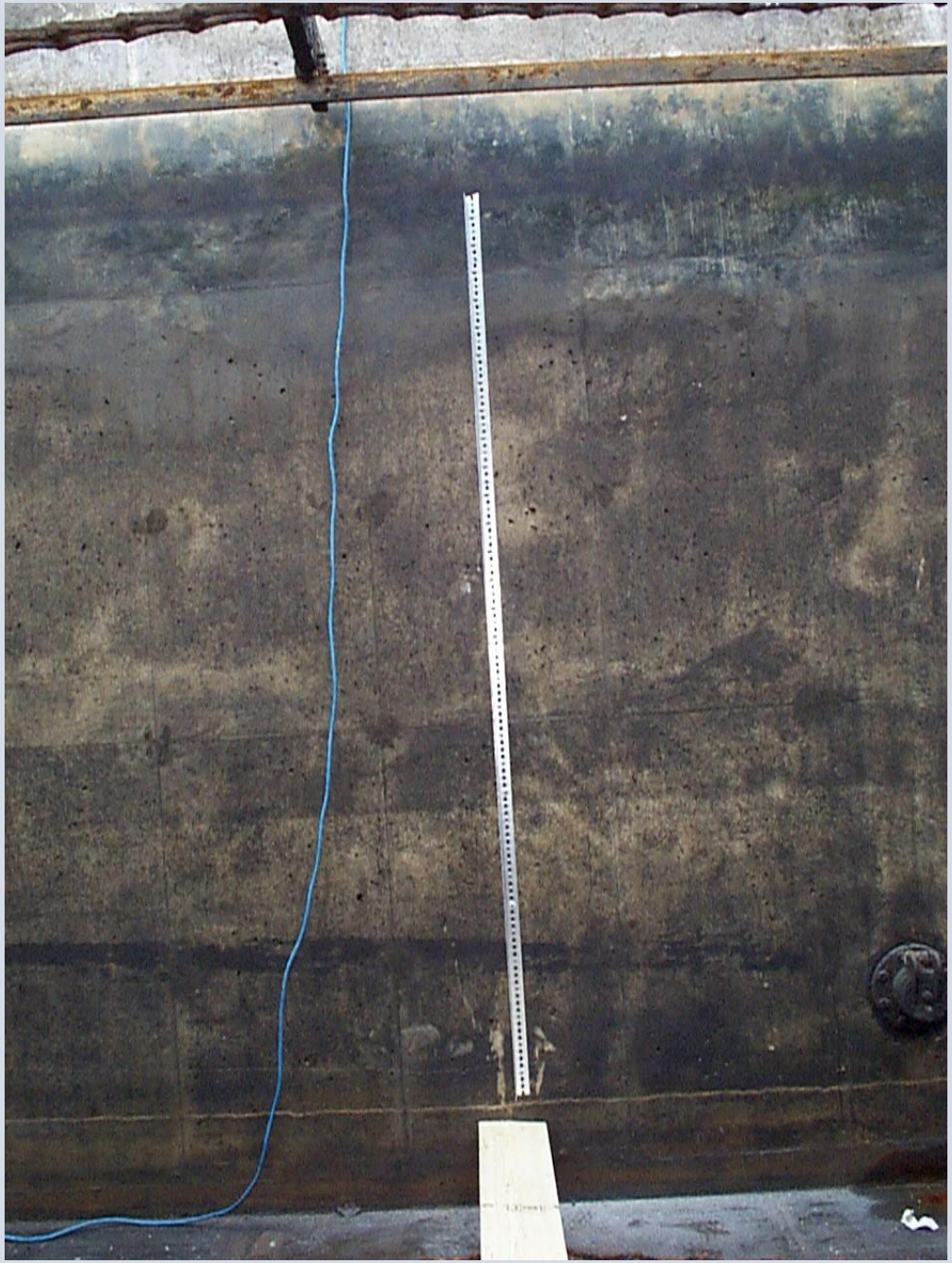


Regional Sewer District
Clarifier Dye Study - Standardized Flow Data
June 27-29, 2001



Monthly Average Effluent TSS





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3. Remedies for RAS Issues
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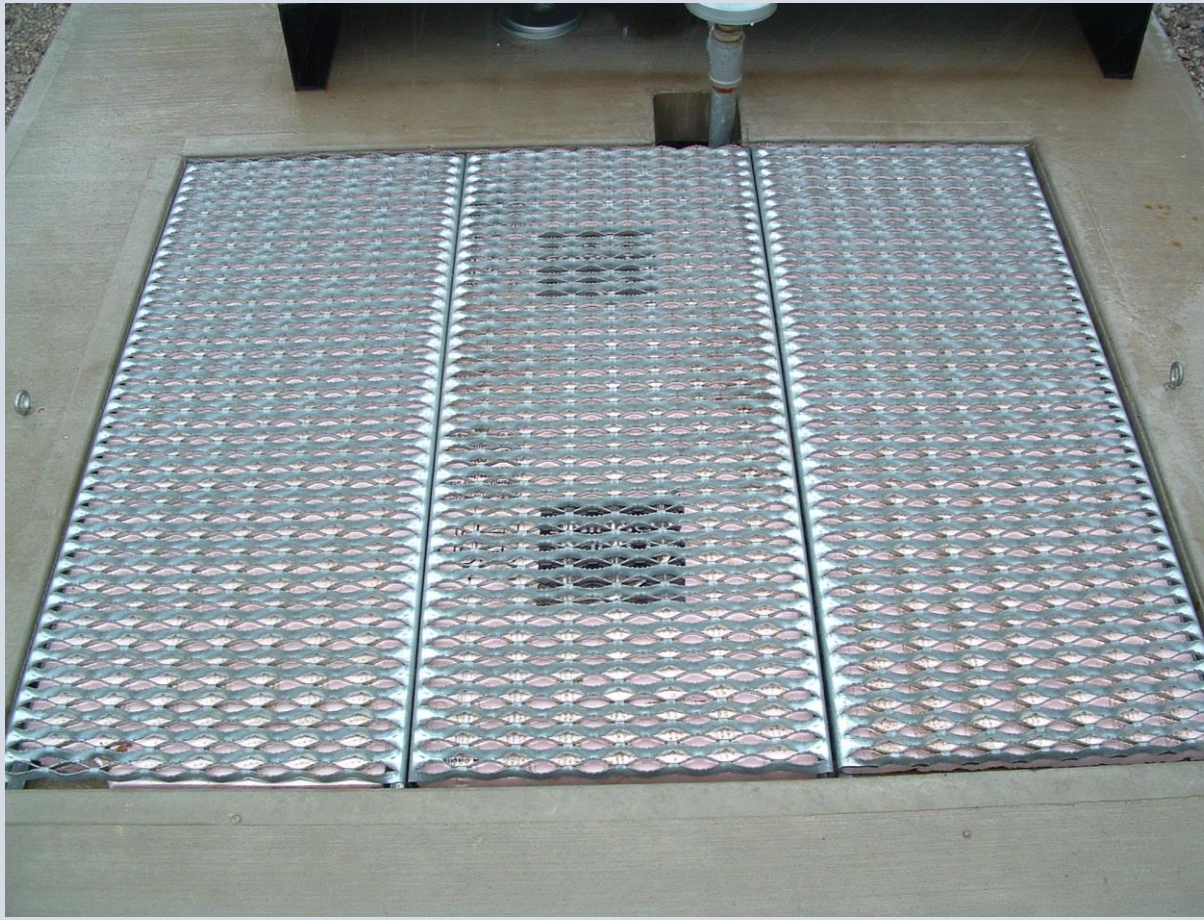
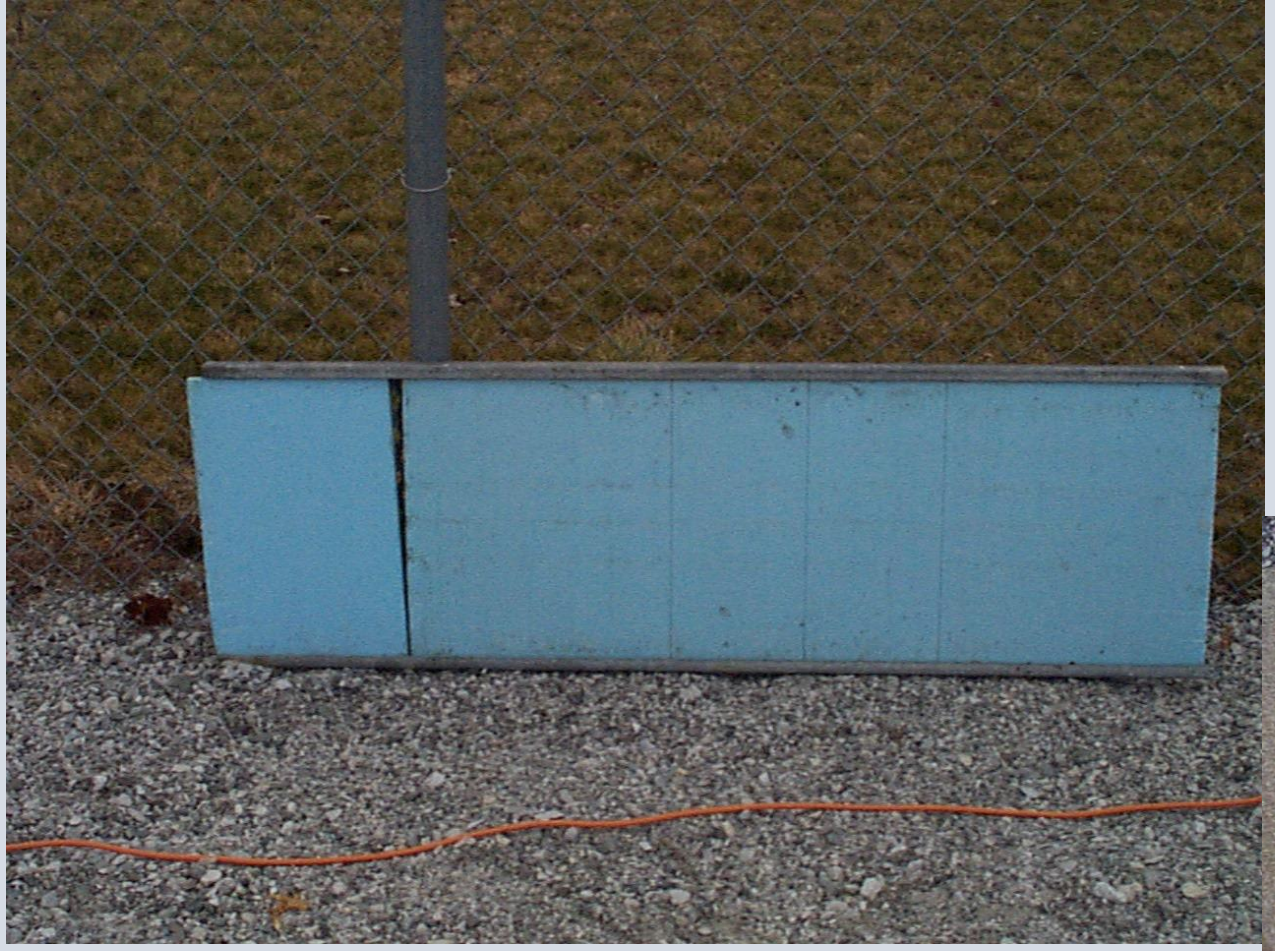
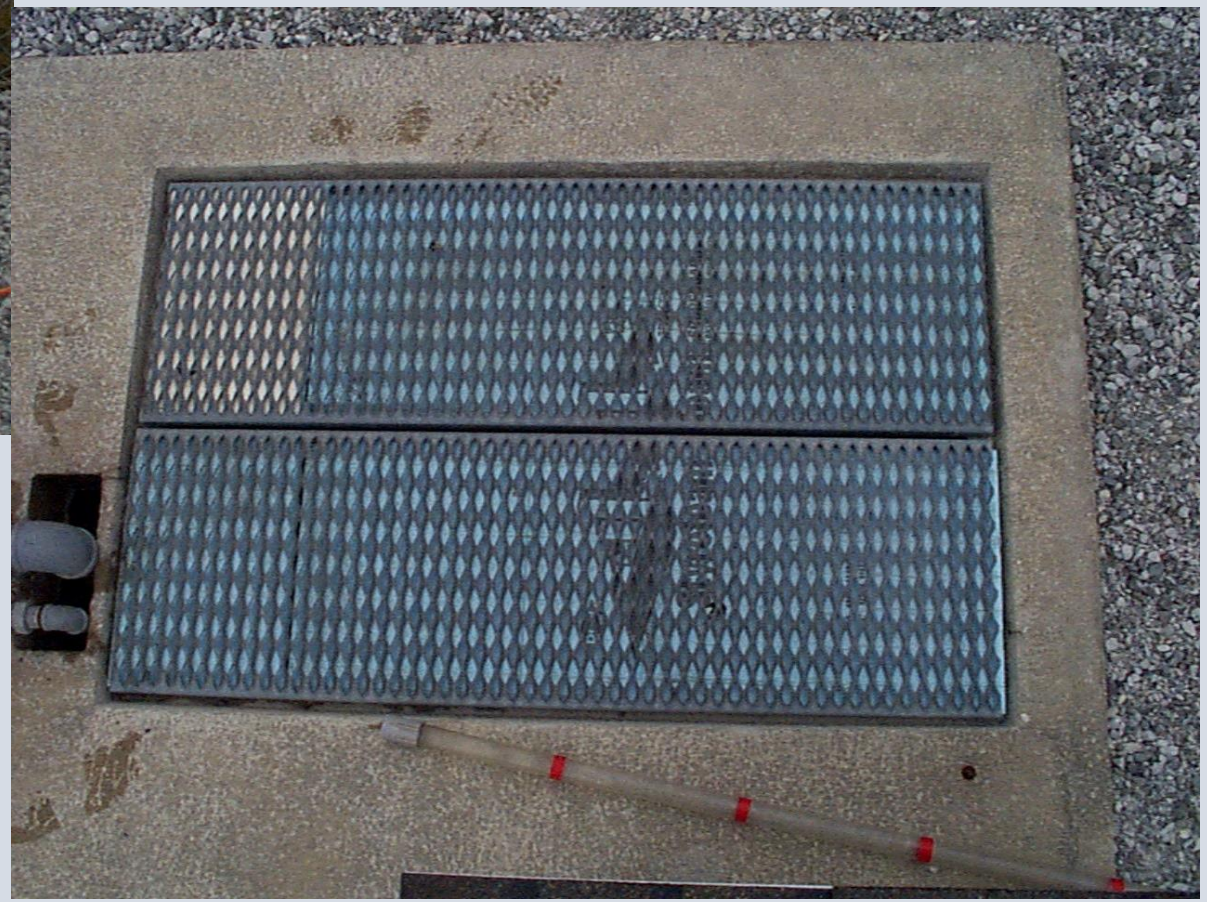
5. Mode of operation issues
6. Cheap, easy, and effective process control issues


B101D11B
R-5.0
FOAMULAR
OWENS CORNING



Cover’em up!





EQ basin
Aeration
Clarifiers

Other Cold Weather Fixes

1. Stall Mats

2. Concrete blankets (with weights so it won’t blow away)

3. Plywood?

(Wide open tanks are very difficult to cover)

Decrease aeration cycle time.

Over-aeration in winter lowers water temperature.

Don’t forget the EQ basin!

Flow Spitting…Again

This is an influent flow splitter box that does not evenly split the flow

Again:

To get an equal flow split,

equal length weirs at

equal heights will produce an

equal (as possible) flow split.

Alkalinity Test Kit

Cheap ($65)
Easy (1 minute)
Effective

Low flow plumbing will increase Ammonia concentrations

Carry water has the alkalinity that nitrifying bacteria need to nitrify (inorganic carbon)

When the alkalinity runs out, no ammonia oxidation will occur

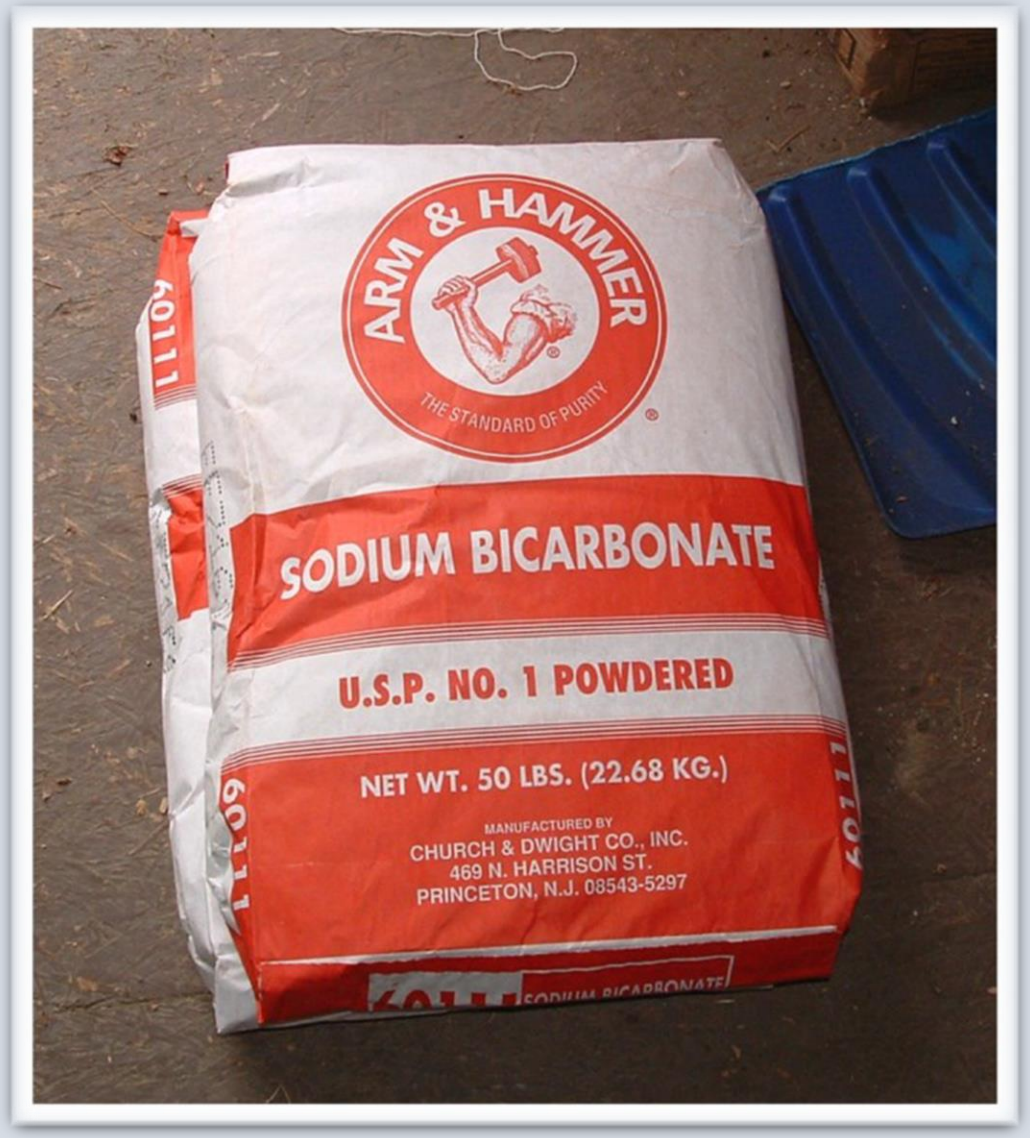

YSI
650 MDS
Run
650
Sonde
Log one sample
Start logging
Log one sample
Start logging
04/07/05 MDY
15:24:57
11.29 °C
737 µS/cm
67.7 DO %
7.39 DO mg/L
30.8 DO ch
5.37 pH
160.1 ORP
5.7 Volt
N 0° 0.000' E 0° 0.000'
04/07/2005 15:18:05
732.9mmHg
23
20
15
10

This is the way to improve and add alkalinity for small systems:
sodium bicarbonate.

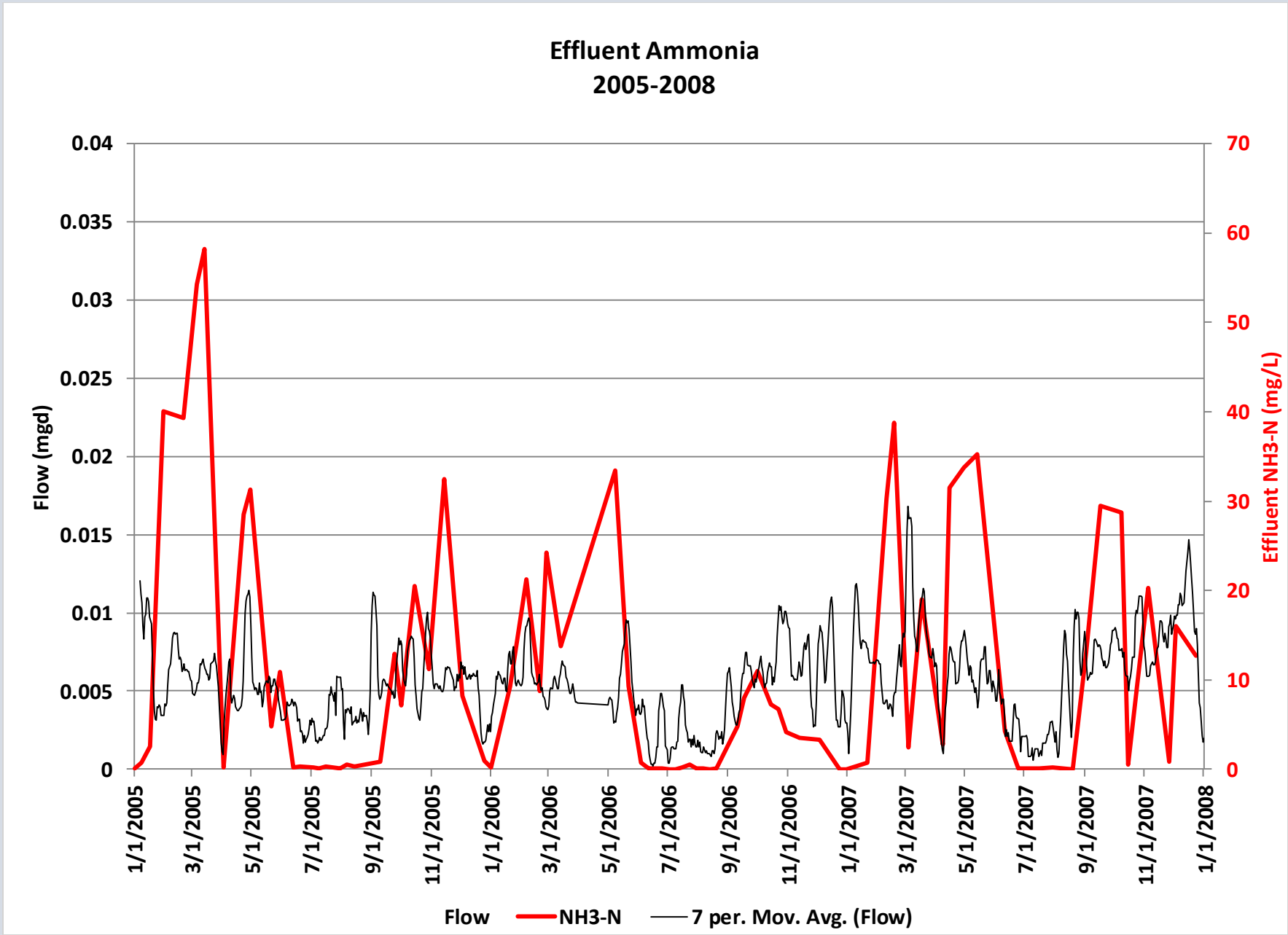
It is cheap (~$15 per 50 lb bag).

Depending on how much you need to get treatment, a couple of coffee cans wetted in 5-gallon bucket should work. (if the alkalinity isn't super low).

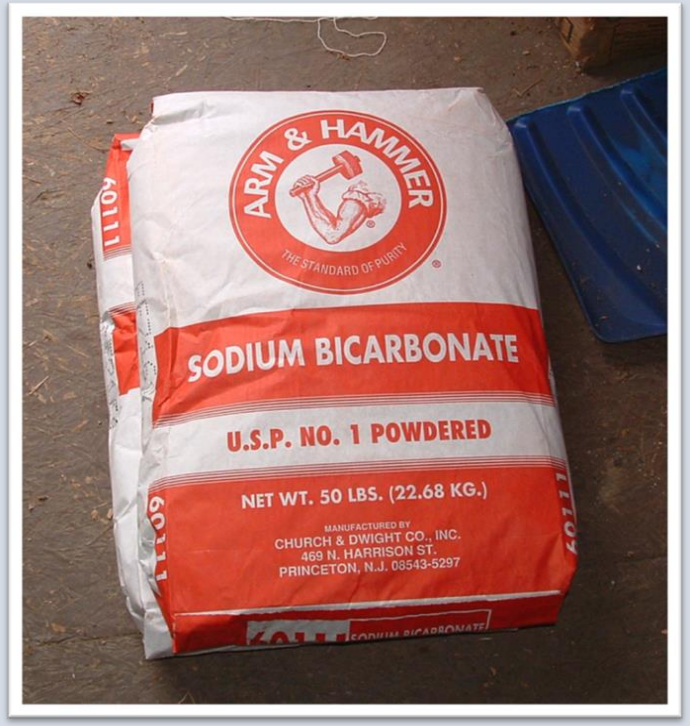
Available at Feed Stores (for cattle)



H Local School District


Effluent Ammonia
2005-2008
Flow (mgd)
Effluent NH3-N (mg/L)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
70
60
50
40
30
20
10
0
1/1/2005
3/1/2005
5/1/2005
7/1/2005
9/1/2005
11/1/2005
1/1/2006
3/1/2006
5/1/2006
7/1/2006
9/1/2006
11/1/2006
1/1/2007
3/1/2007
5/1/2007
7/1/2007
9/1/2007
11/1/2007
1/1/2008
Flow
NH3-N
7 per. Mov. Avg. (Flow)

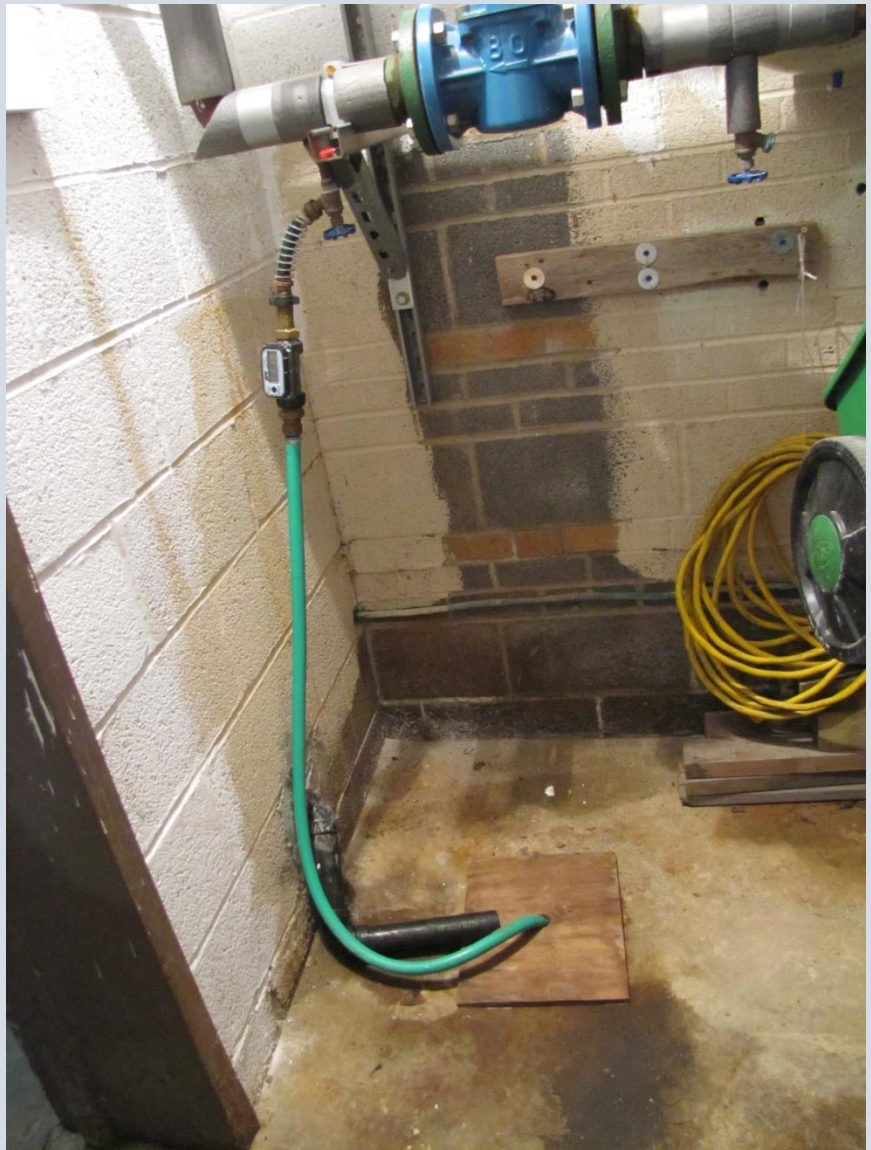
- WWTP Alkalinity Limited
- Drinking water was low in alkalinity (~80 mg/L)
- Considered Feeding $NaHCO_3$



The School District Uses Well Water to Irrigate Athletic Fields

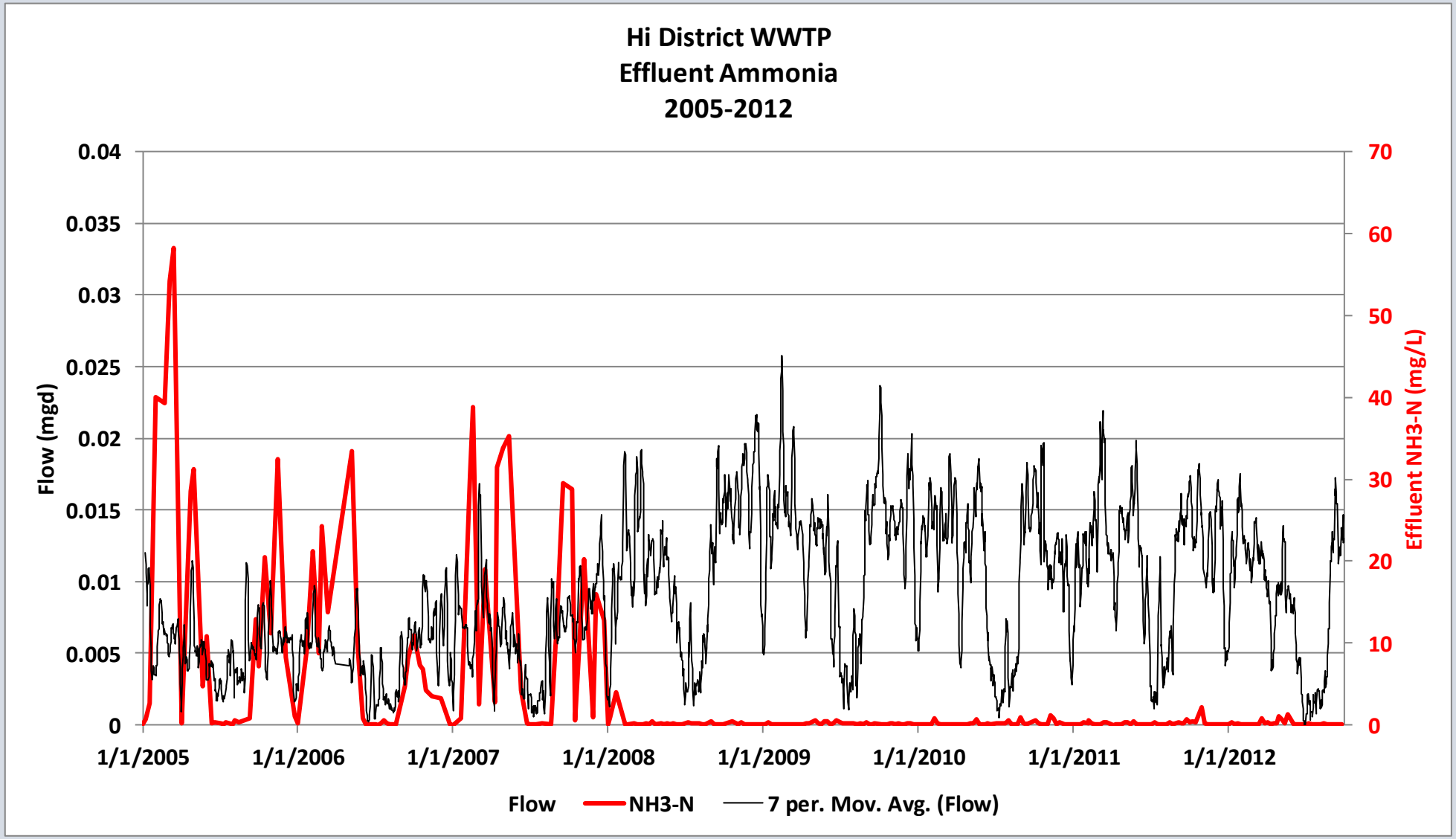
Well Alkalinity:
> 400 mg/L

Started Dripping In Well Water



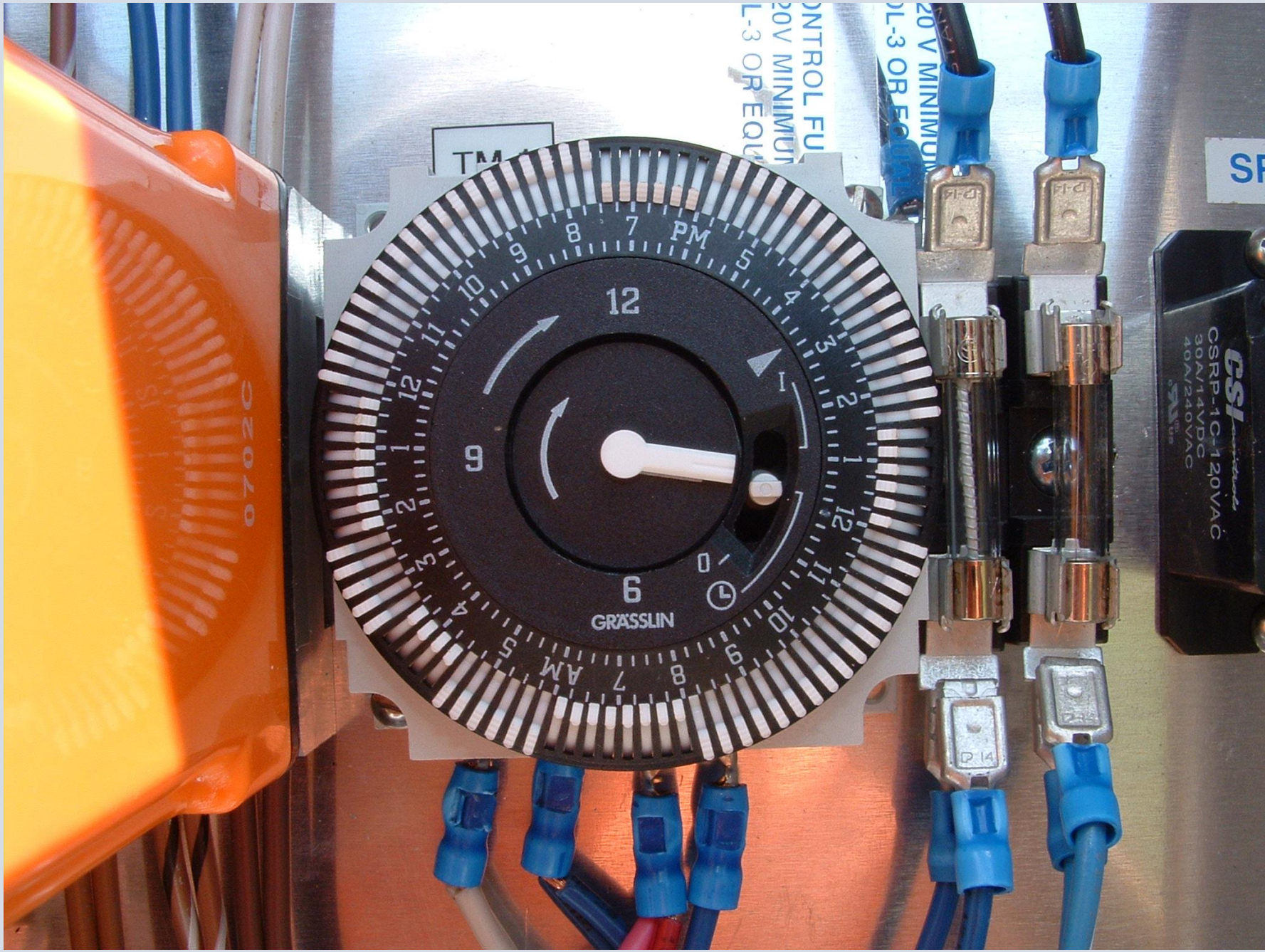
- Started with ~ 2000 gpd (about 1.5 gpm)

Date	Day	Alkalinity	pH	NH3N	Temp	Notes
2/4	Monday	300	7.2	27	7	Started Well Feed 2000 gpd
2/5	Tuesday	340	7.2	44	9	Things worse! More Air?
2/6	Wednesday	300	-	8	-	Full Aeration
2/7	Thursday	100	6.9	3	6.5	Increased Well Feed to 7000 gpd
2/8	Friday	40	6.5	0.1	7.5	Hit the Limit!
2/11	Monday	120	7.1	0.4	5.5	Adjust Feed Rate


Hi District WWTP
Effluent Ammonia
2005-2012
Flow (mgd)
Effluent NH3-N (mg/L)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
70
60
50
40
30
20
10
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
Flow
NH3-N
7 per. Mov. Avg. (Flow)

Cycle blower
ON and OFF
To Promote
Denitrification.

Denitrification
will recover
50% of the
alkalinity
consumed with
nitrification



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4. Sludge wasting issues
5. Mode of operation issues
6. Cheap, easy, and effective process control issues

RAS Pump Control Issues

Airlift pumps pump a lot of water

Turn the air down, and they quit pumping

For small WWTPs, the RAS pump rate exceeds what is necessary

Match the RAS pump rate to the settling rate

Eliminates excessive hydraulic loads to clarifiers

Ends “Clarifier mixing” due to high RAS rates

Allows solids to settle before pumping them back

A slow settling rate required a slower RAS pump rate
A fast settling rate requires a faster RAS rate


CRAFTSMAN

If you are running your blowers on a timer, usually the one blower will run the airlift pump as well as aeration;

But with a timer, the airlift pump will not be working, so it is like an extended slow pump rate when the blower is off.

(but you will have to watch out for denitrification in the clarifier)

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No digester, but there is an unused aeration tank due to low flow plumbing fixtures?

Repurpose the unneeded aeration tank as an aerobic digester

Just don’t overflow the aeration tank to the attached clarifier.

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Take a tank off-line.

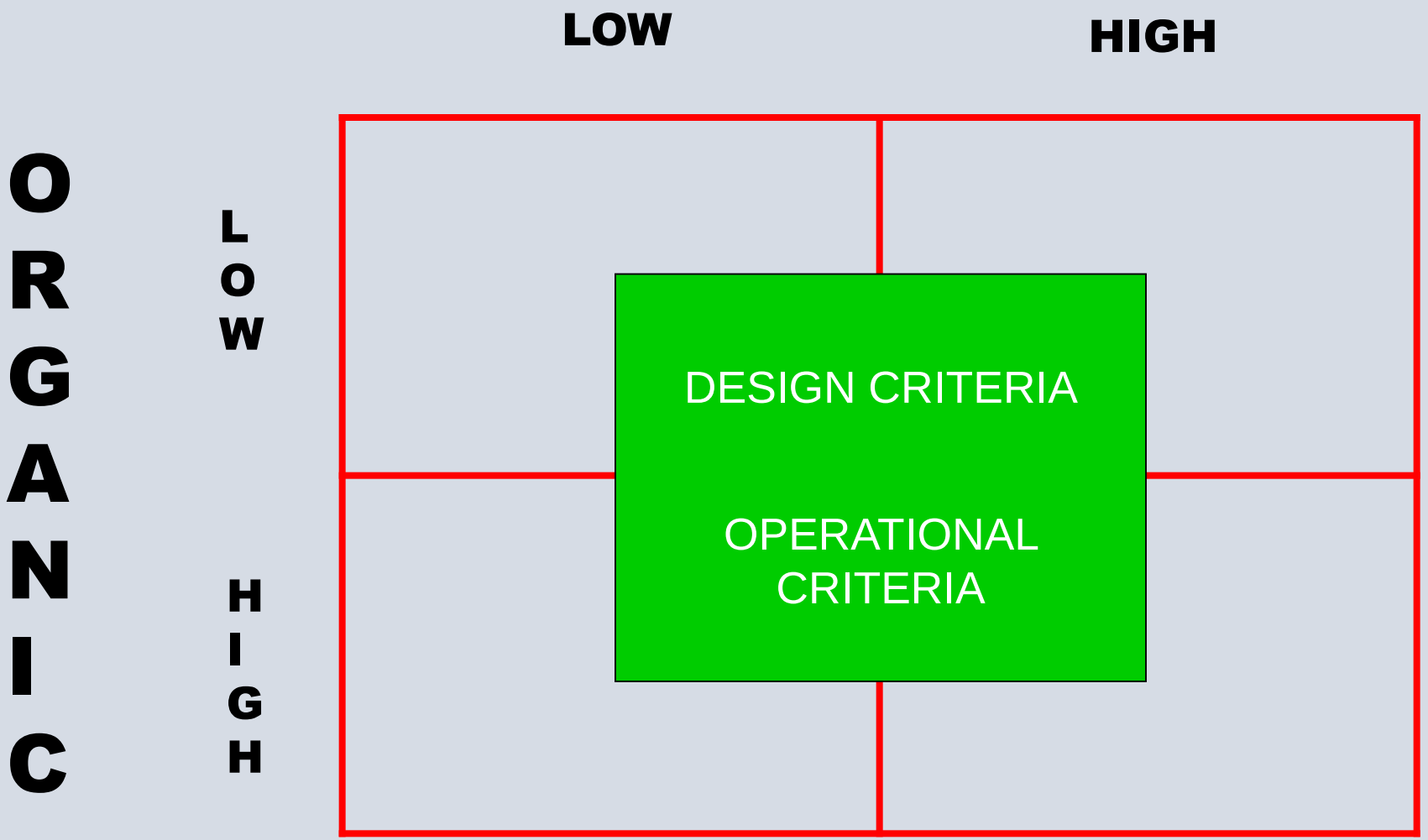
If you can meet permit with one less tank, why not?

Just put a stop plate in and check ammonia concentrations in the online tank.

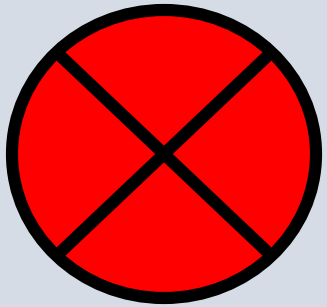
HYDRAULIC

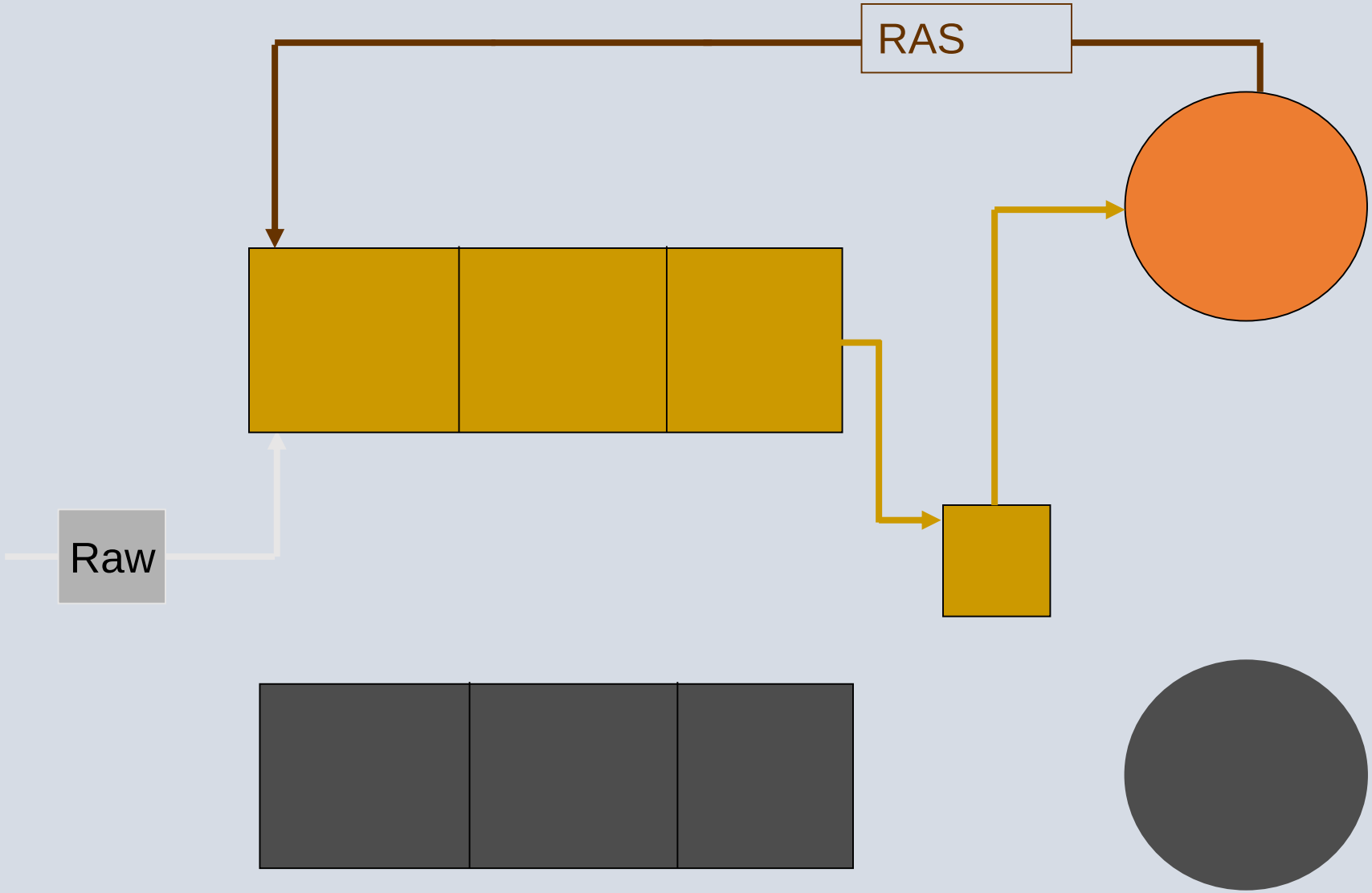
ORGANIC	LOW	HIGH
LOW		
HIGH		

HYDRAULIC


LOW
HIGH
ORGANIC
LOW
HIGH
DESIGN CRITERIA
OPERATIONAL CRITERIA

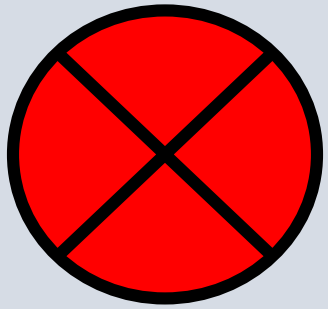
HYDRAULIC

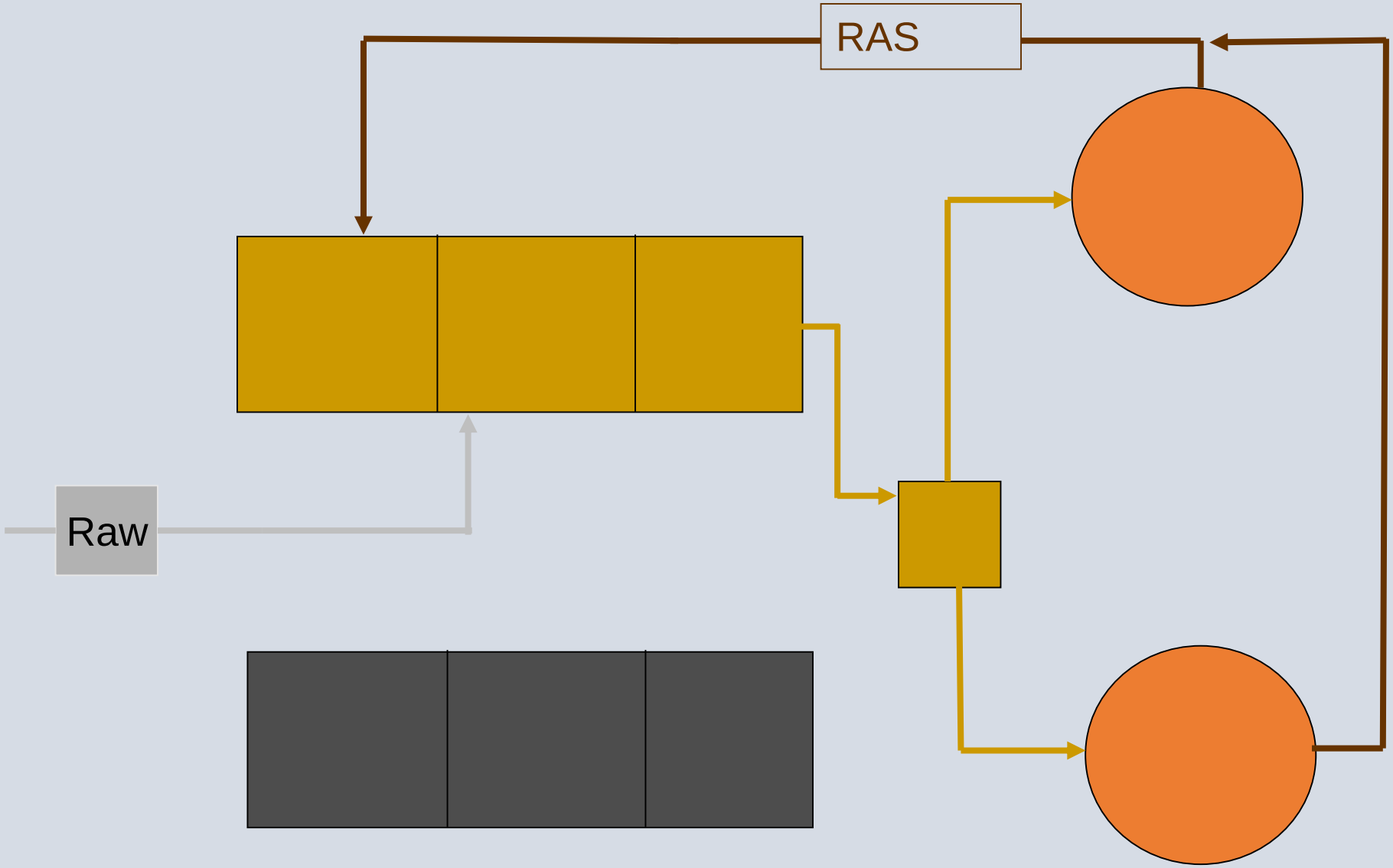
ORGANIC	LOW	HIGH
LOW		
HIGH		



Low Hydraulics, Low Organics

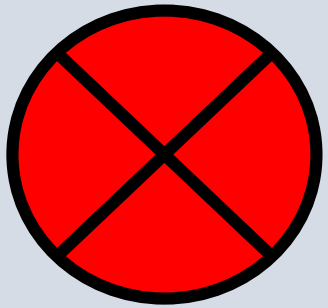
HYDRAULIC

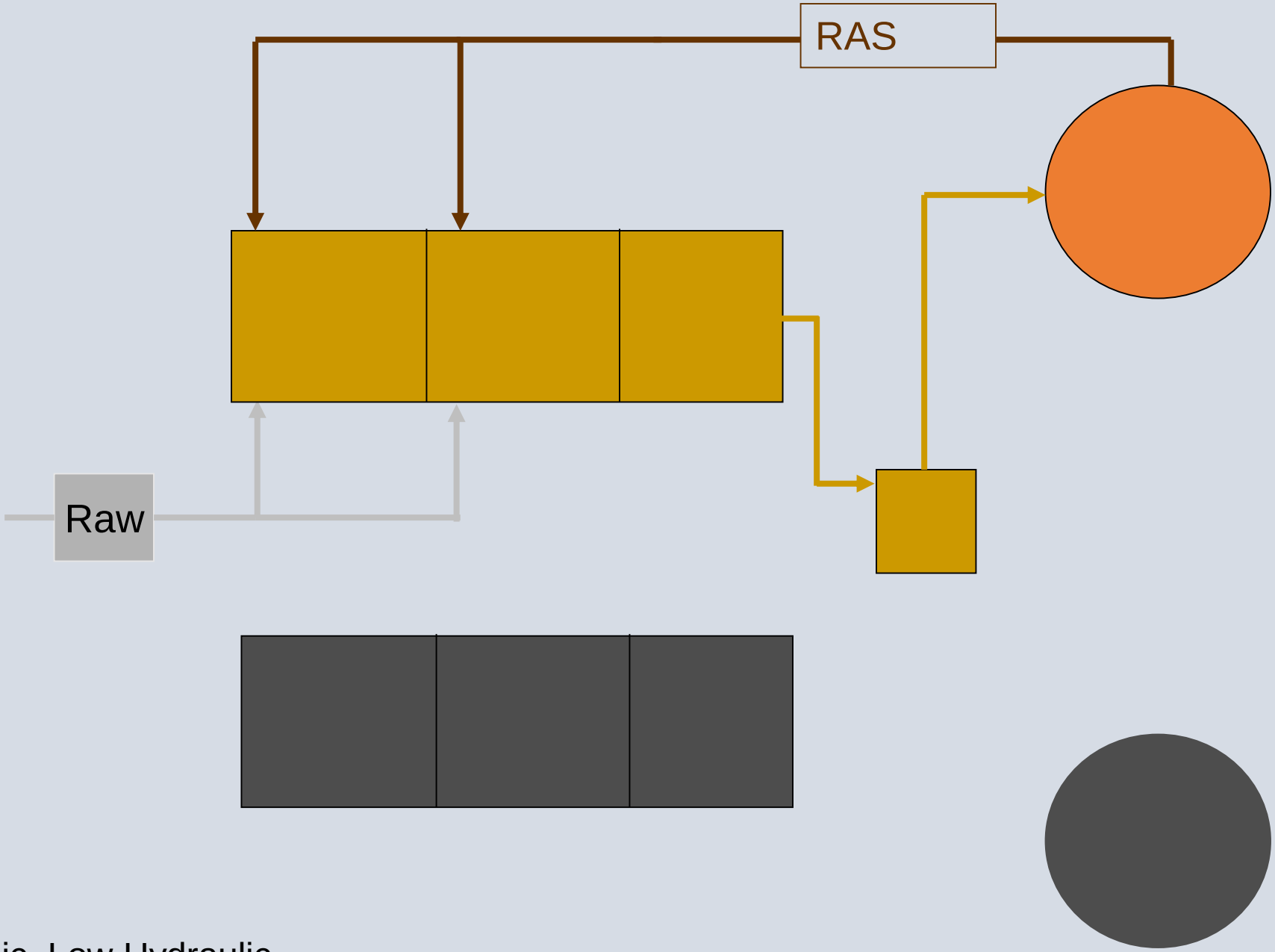
ORGANIC	LOW	HIGH
LOW		
HIGH		



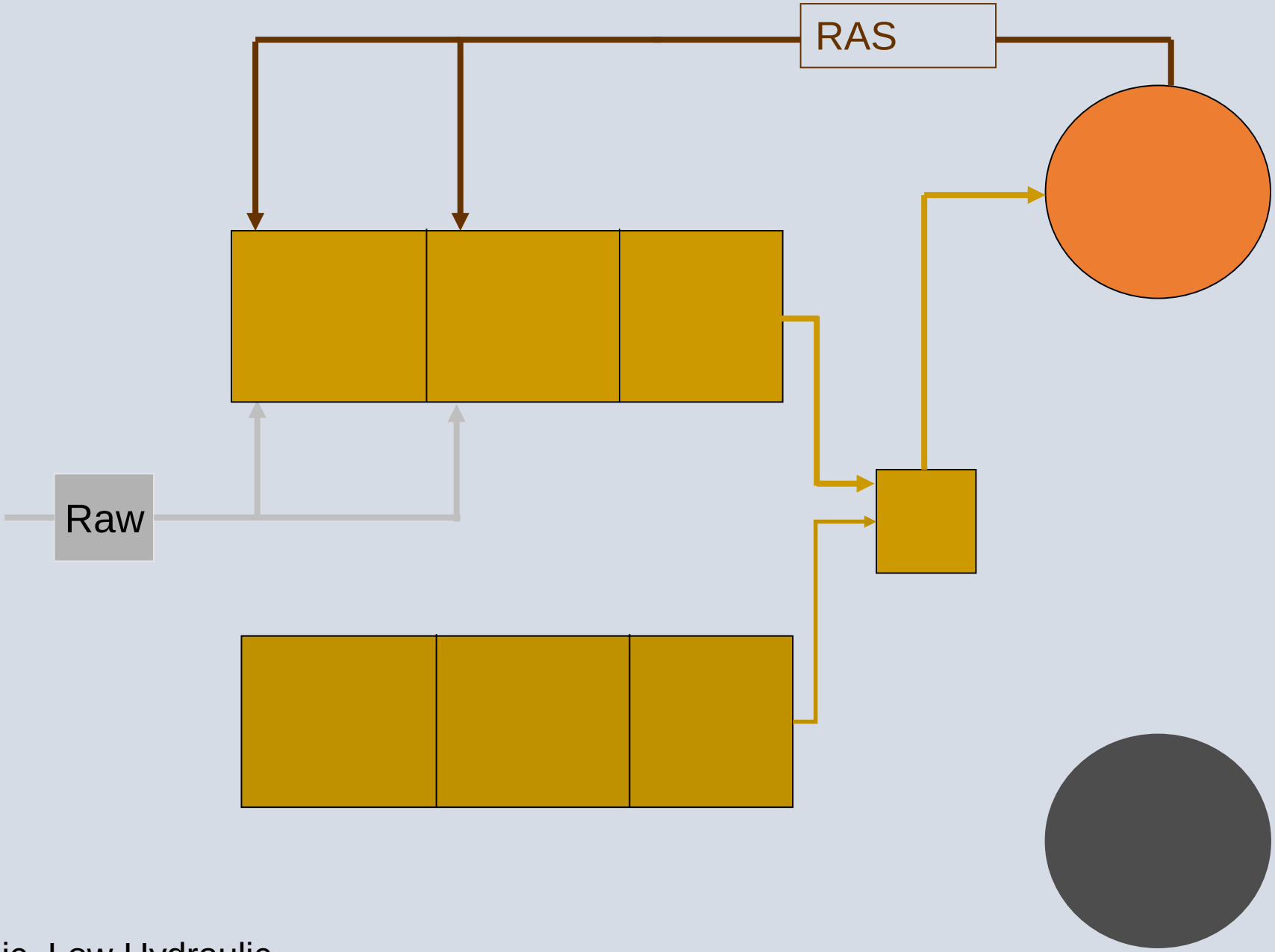
Low Organic, High Hydraulic

HYDRAULIC

ORGANIC	LOW	HIGH
LOW		
HIGH		

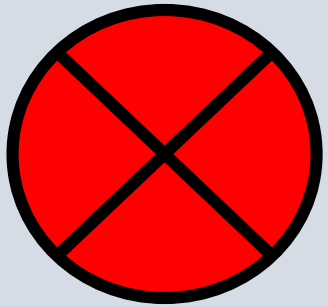


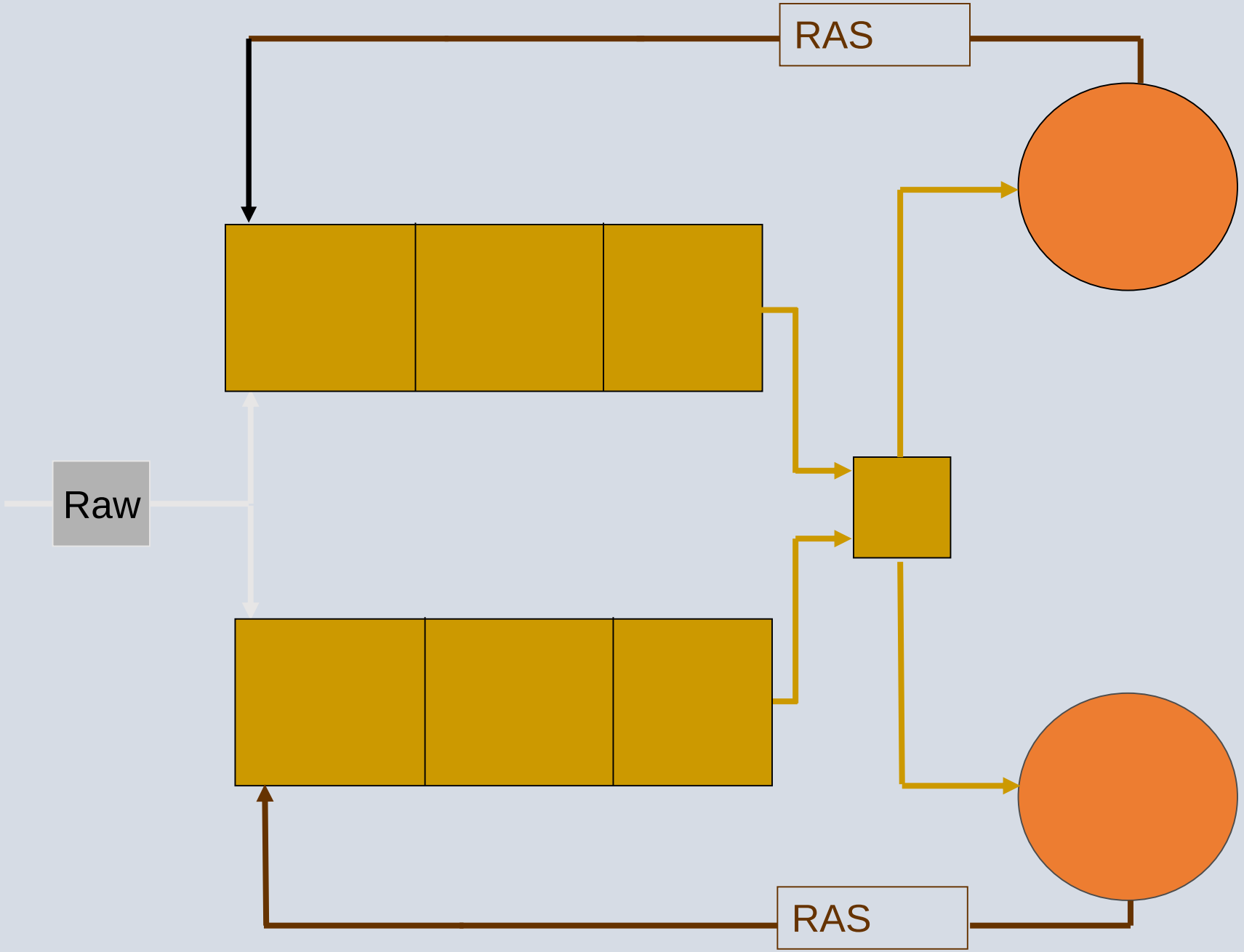
High Organic, Low Hydraulic



High Organic, Low Hydraulic

HYDRAULIC

ORGANIC	LOW	HIGH
LOW		
HIGH		



High Organic, High Hydraulics

HYDRAULIC

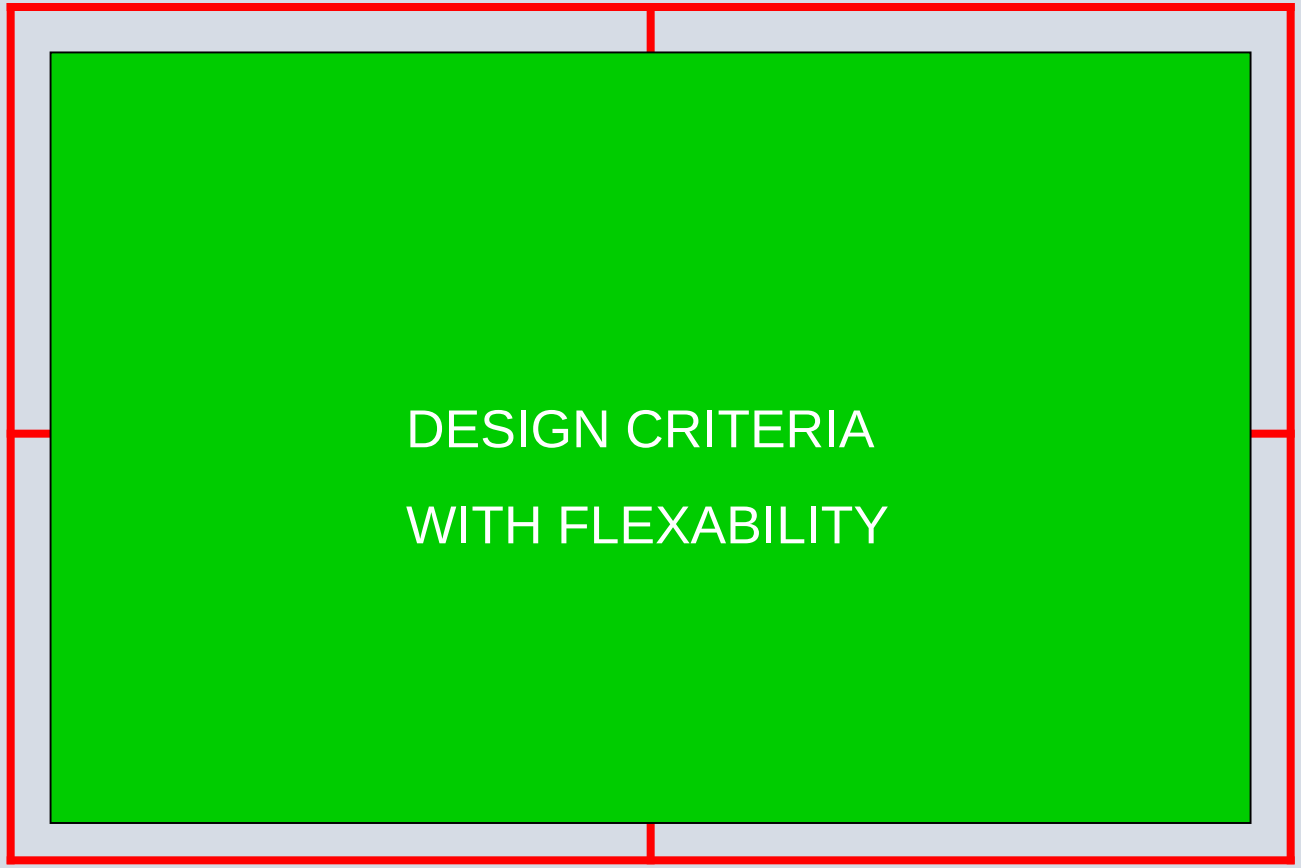
LOW

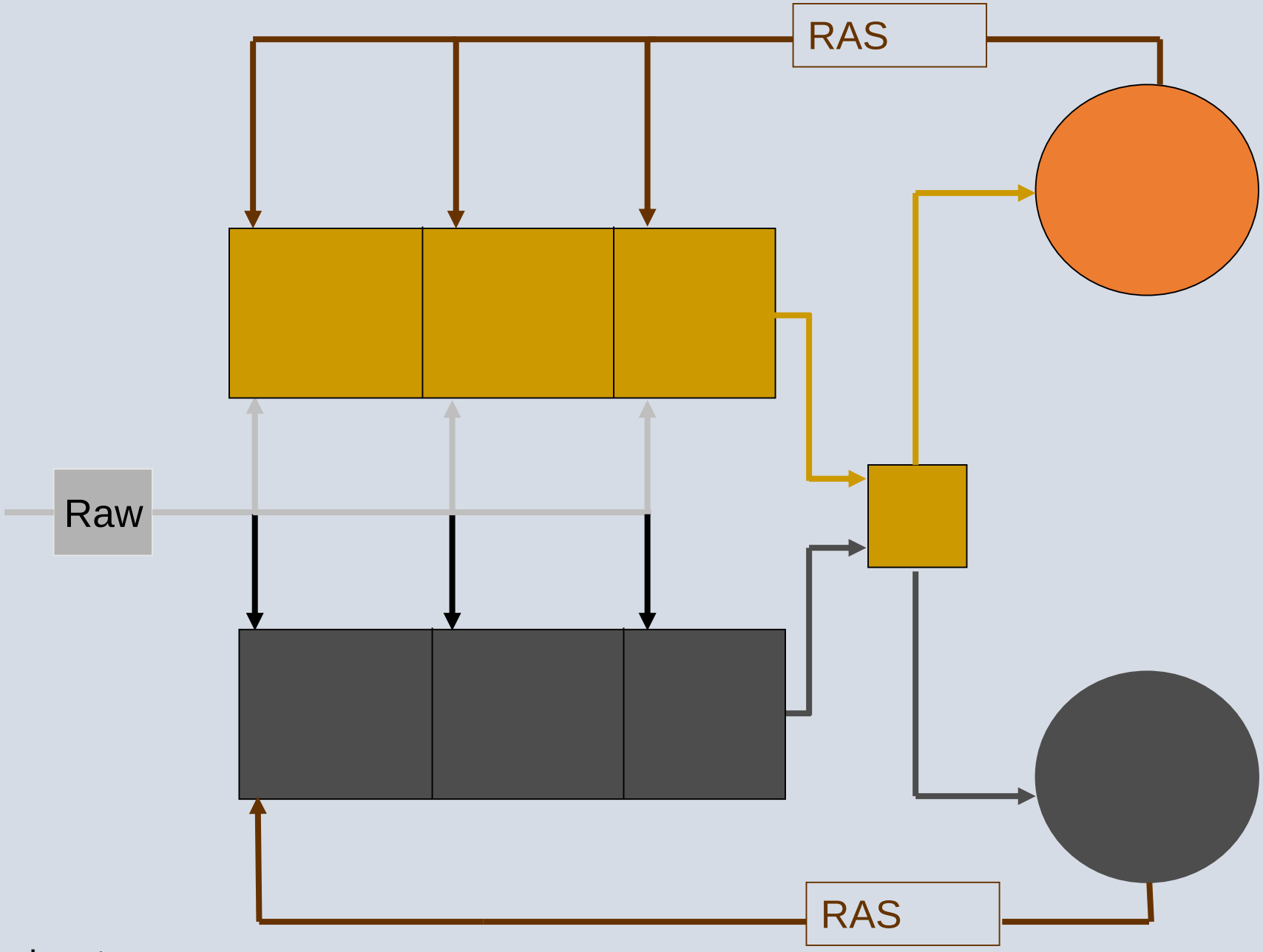
HIGH

ORGANIC

LOW

HIGH





Adjust to the inputs

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5. Mode of operation issues
6. **Cheap, easy, and effective process control issues**

Process Control:

Performing Process Control procedures will help to identify issues that can become violations BEFORE they actually do become violations.

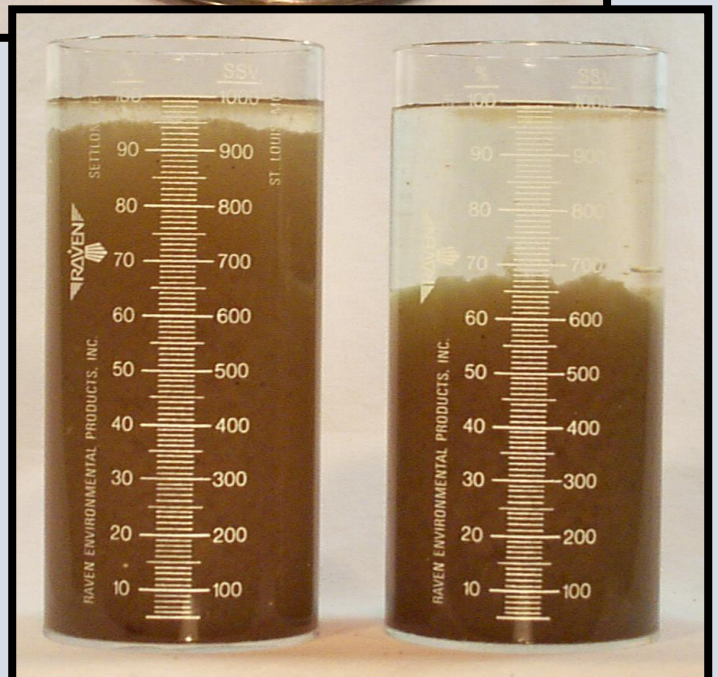

DR 900
535 P React. PV TNT
0.76
mg/L
P
Default 56
10 : 39 : 35
Default
02-26-2021
Options
Zero
Read


HACH


TWC #4


385 N Ammonia Salic.
0.59
mg/L
NH3-N
Default 54
10 : 36 : 55
Default
02-26-2021
Options
Zero


746.3
10.19
YSI


RAVEN ENVIRONMENTAL PRODUCTS, INC.
RAVEN ENVIRONMENTAL PRODUCTS, INC.

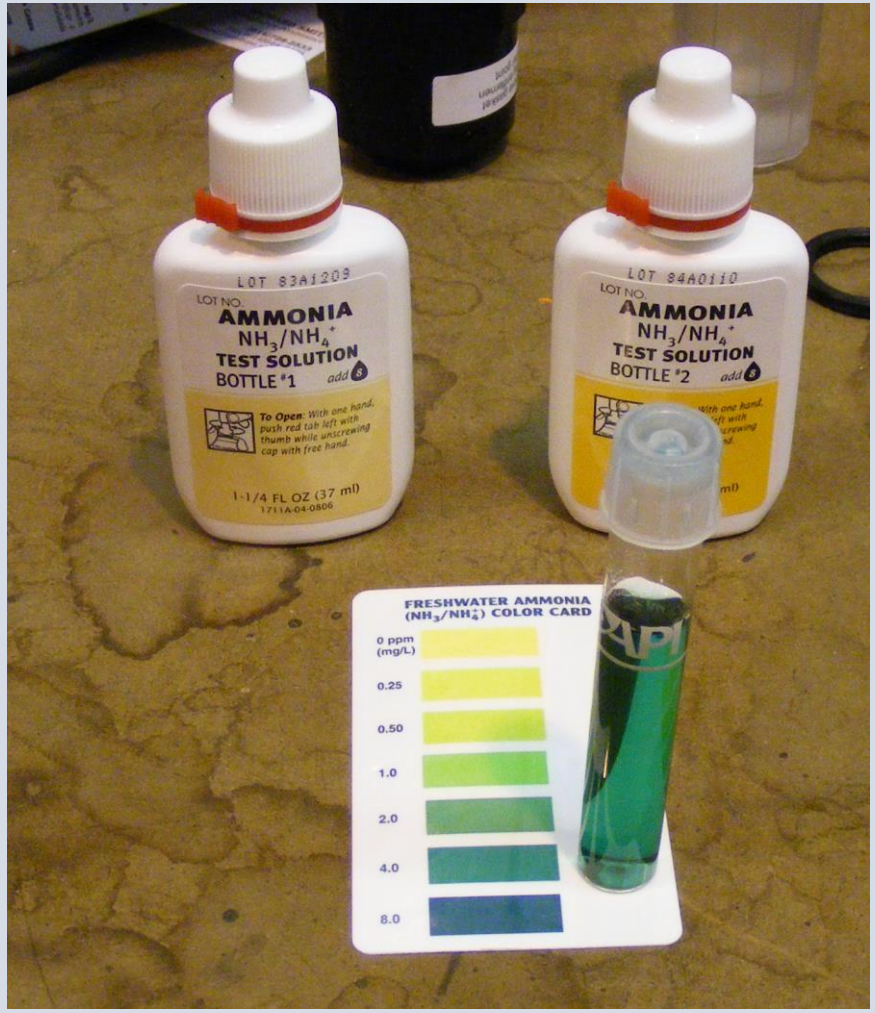
Conversion Tools

Ammonia Test Kit

If ammonia is low, cBOD5 will be low (likely)

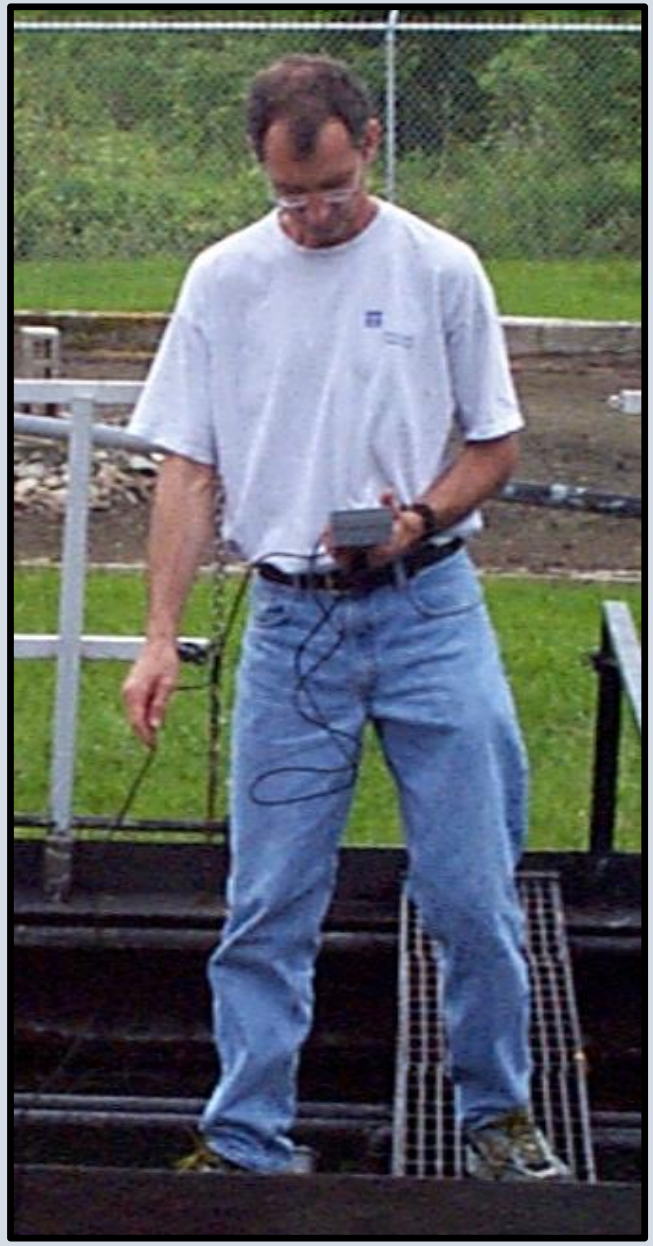
Testing onsite is crucial in order to know what process control is necessary

Checking ammonia in the aeration tank and the clarifier is important to diagnose treatment problems



Conversion Tools

Dissolved Oxygen Meter



Aeration tanks are an aerobic treatment system

You should be able to see how much DO is available <u>in the tank</u>

If ammonia is high, be sure that there is enough DO (summer)

If DO is very high, reduce aeration if possible (winter)

DO meters will also give you the water temperature

Conversion Tools

Alkalinity Test Kit

Enough to support nitrification

Especially with water saving

Plumbing fixtures

Conversion Tools

Centrifuge

How much mass do you have?

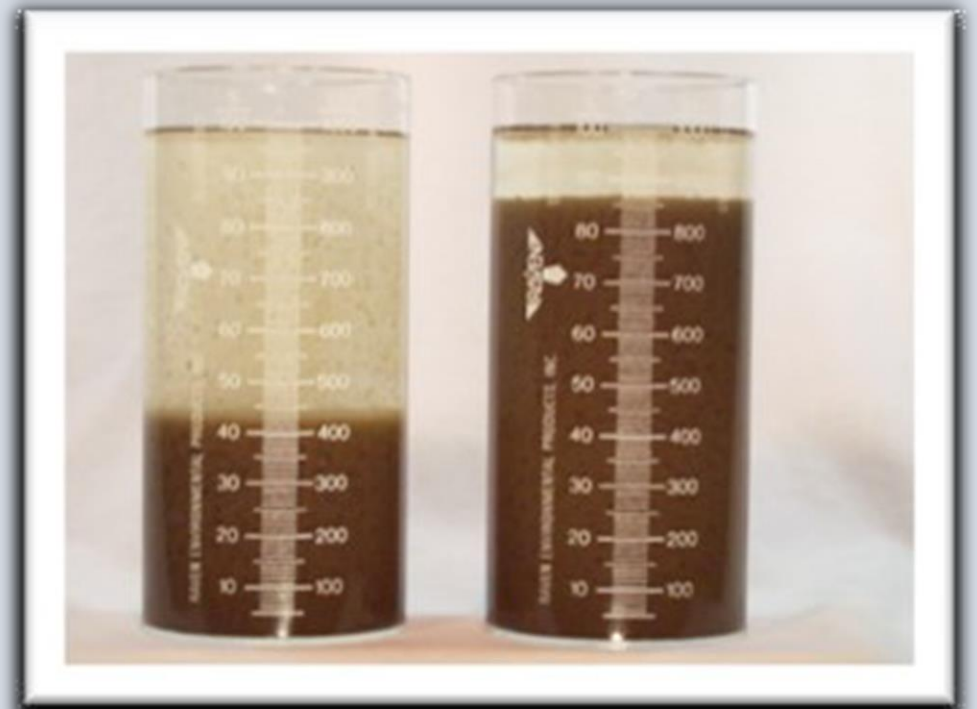
15 minutes you will know

Separation Tools

Settleometer

Poor settling?

Filaments or too much mass?




2 Minute Diluted
Settleometer Test
Concentration

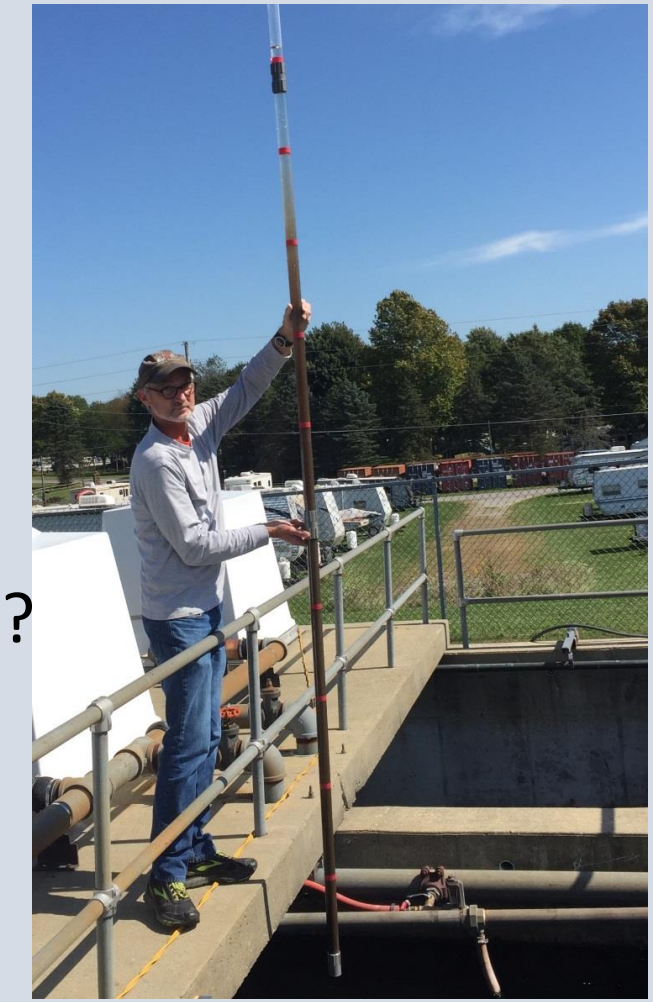

2 Minute Diluted
Settleometer Test
Density

Separation Tools

Core Sampler

What is in your clarifier?

How deep is the sludge blanket?



Separation Tools

Centrifuge

Wasting rate calculation

RAS rate calculation

Too much mass to settle

No Lab Building?

In Summary:

- There are usually some sort of design / construction errors in WWTPS
- Operators will find these errors
- They will live with them, or try to “fix” them
- Maybe some problems (and fixes) become more apparent after this Webinar
- A little bit of Process Control will go a long way toward Compliance
- Cheap, easy, and effective Process Control is the best Process Control

QUESTIONS?

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