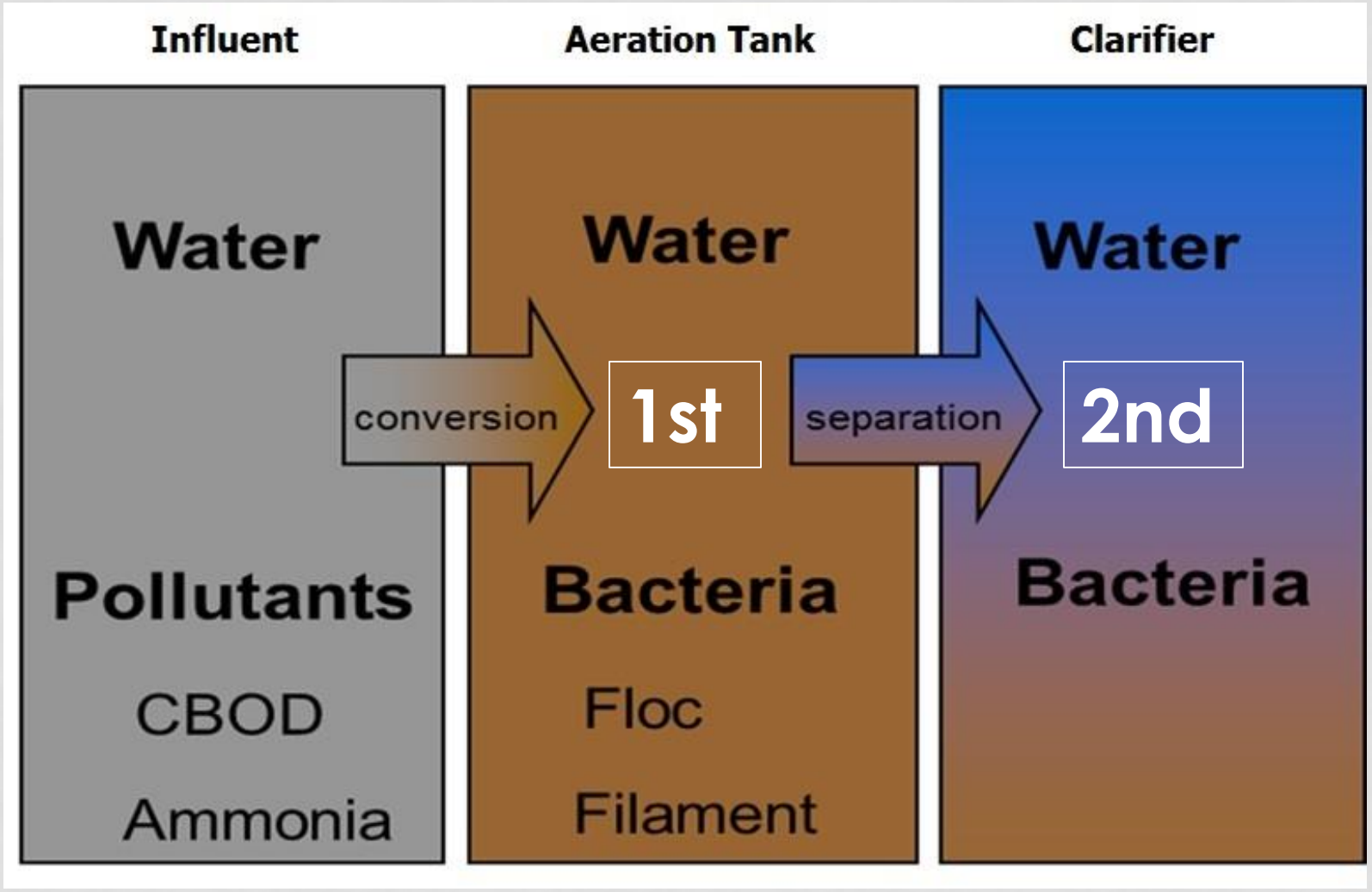
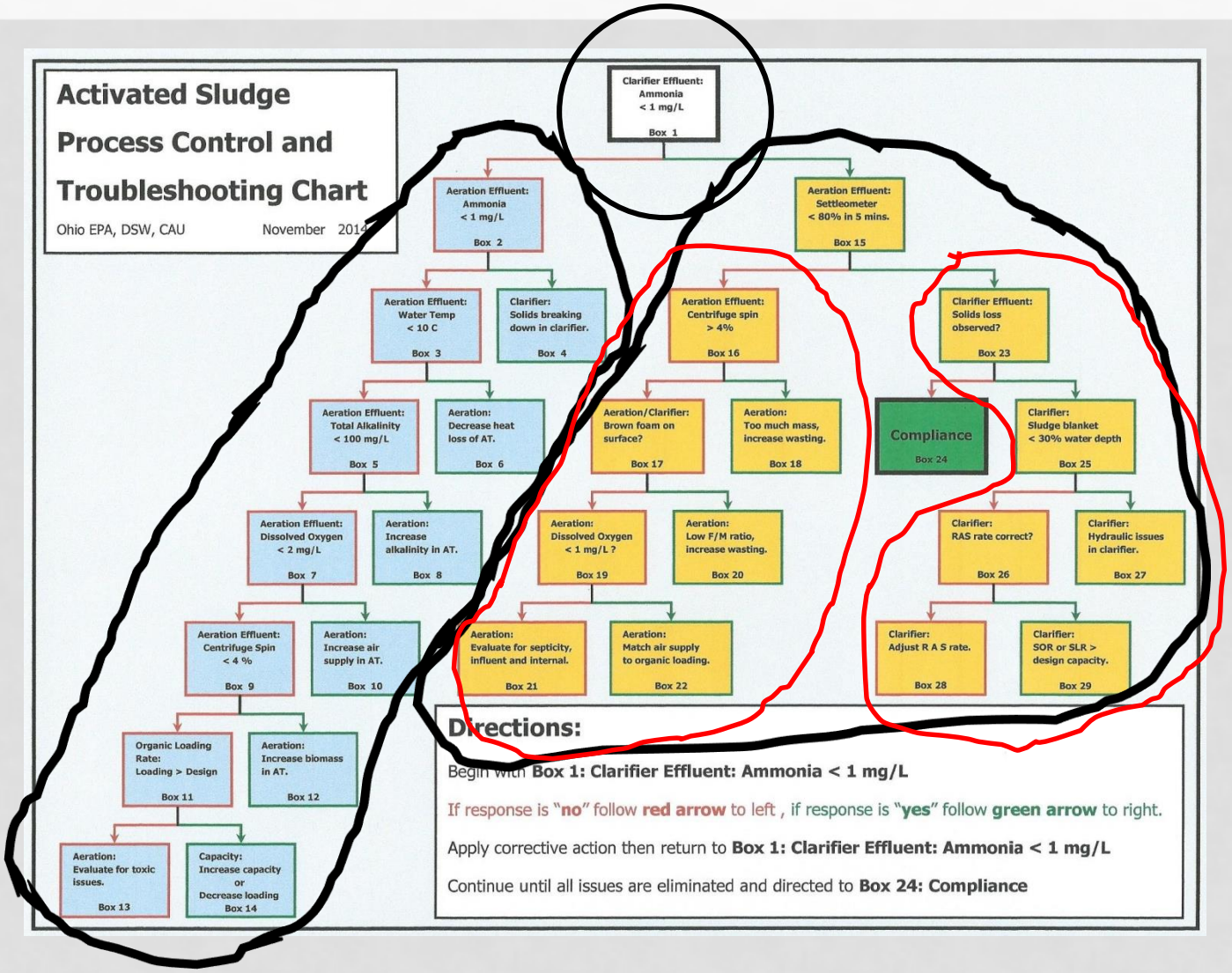
ACTIVATED SLUDGE PROCESS CONTROL

TROUBLESHOOTING CHART

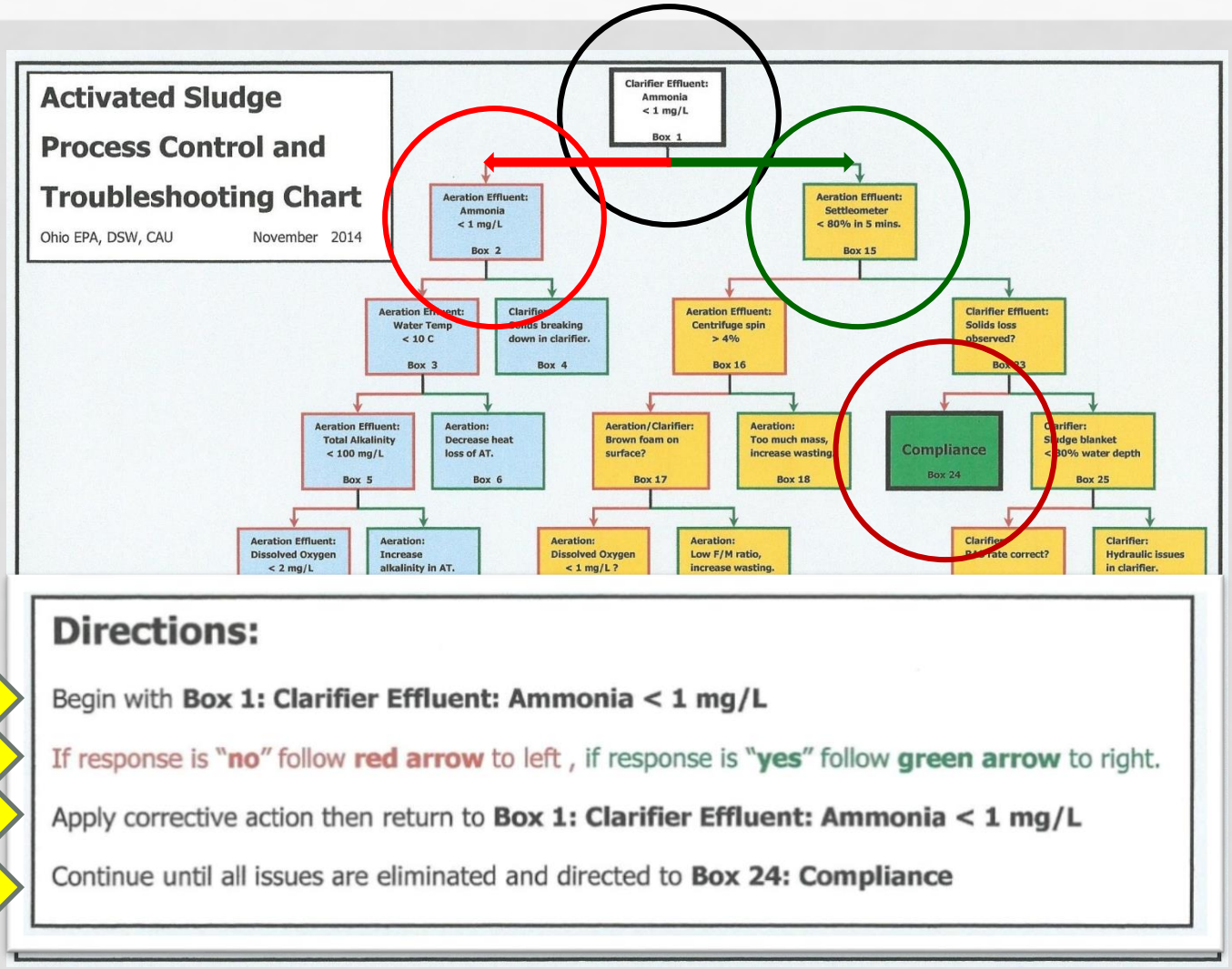
BASIC CONCEPTS



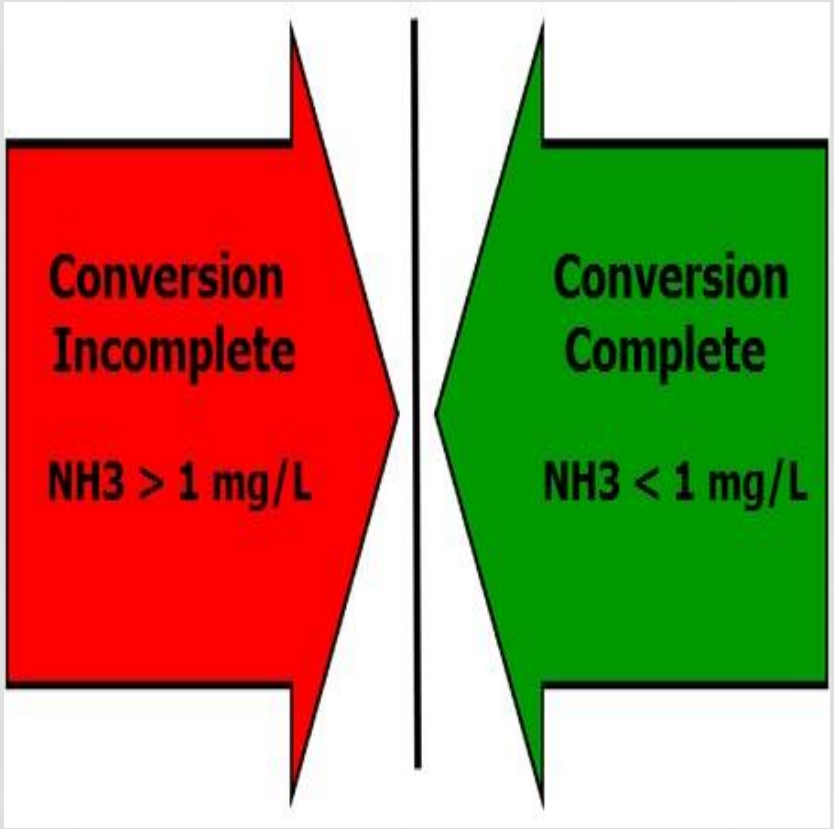
ACTIVATED SLUDGE PROCESS CONTROL



Each box will either request more data or identify the issue.

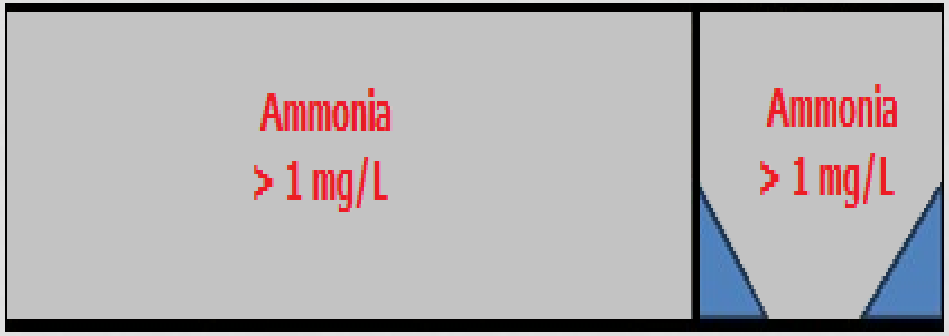


BOX # 1 CLARIFIER EFFLUENT: AMMONIA < 1 MG/L

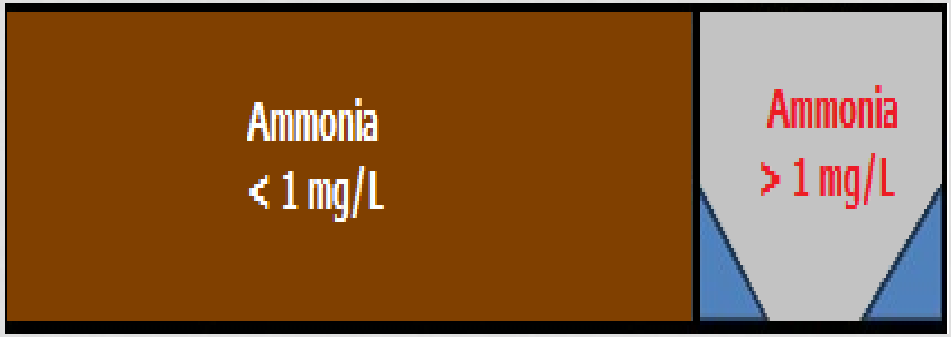


- Conversion Process
  - CBOD & NH3
- Ammonia Indicator
  - "sensitive"
    - Early warning
  - < 1 mg/L NH3
    - Conversion Complete
  - > 1 mg/L
    - Conversion problem

BOX # 2 **AERATION EFFLUENT: AMMONIA < 1 MG/L**



- Aeration Effluent
  - Problem: Conversion
  - Location: Aeration



- Clarifier Effluent
  - Problem: Re-release
  - Location: Clarifier

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

- Sources:
  - Scum Baffle
  - Clarifier Surface
  - Clarifier Sludge Blanket

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

Sources:

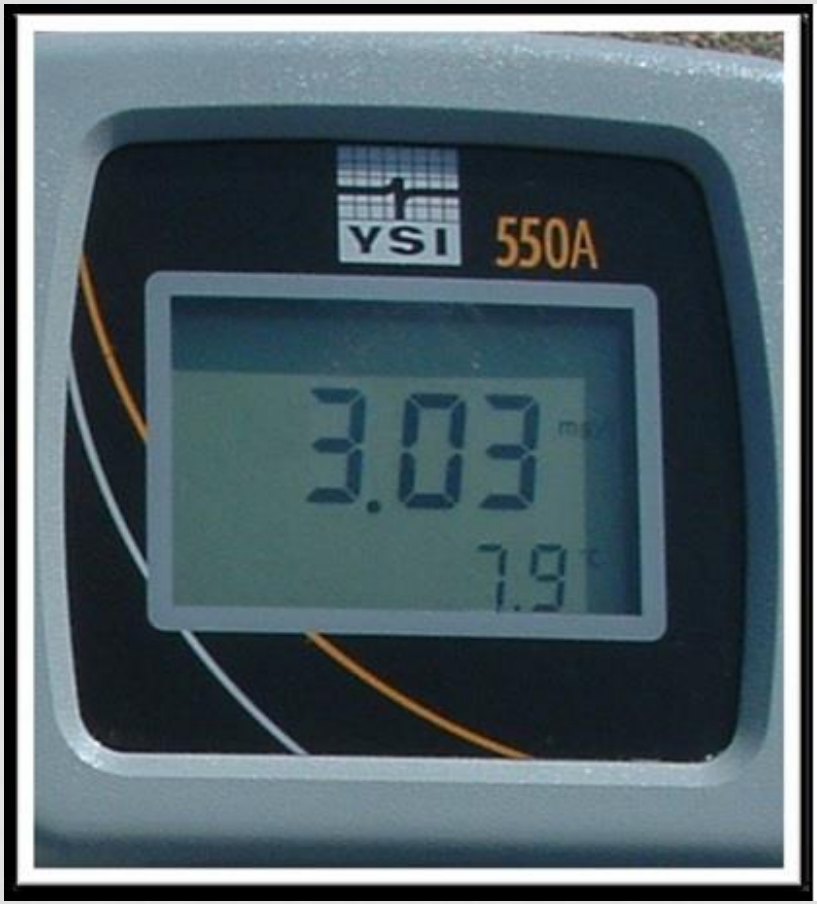
- Scum Baffle
- Clarifier Surface
- Clarifier Sludge Blanket

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

- Sources:
  - Scum Baffle
  - Clarifier Surface
  - Clarifier Sludge Blanket

BOX # 3 **AERATION EFFLUENT:**
WATER TEMPERATURE < 10 C



- WATER temperature impacts growth rate
  - slower growth = slower removal rates
- Measure AT effluent water temperature

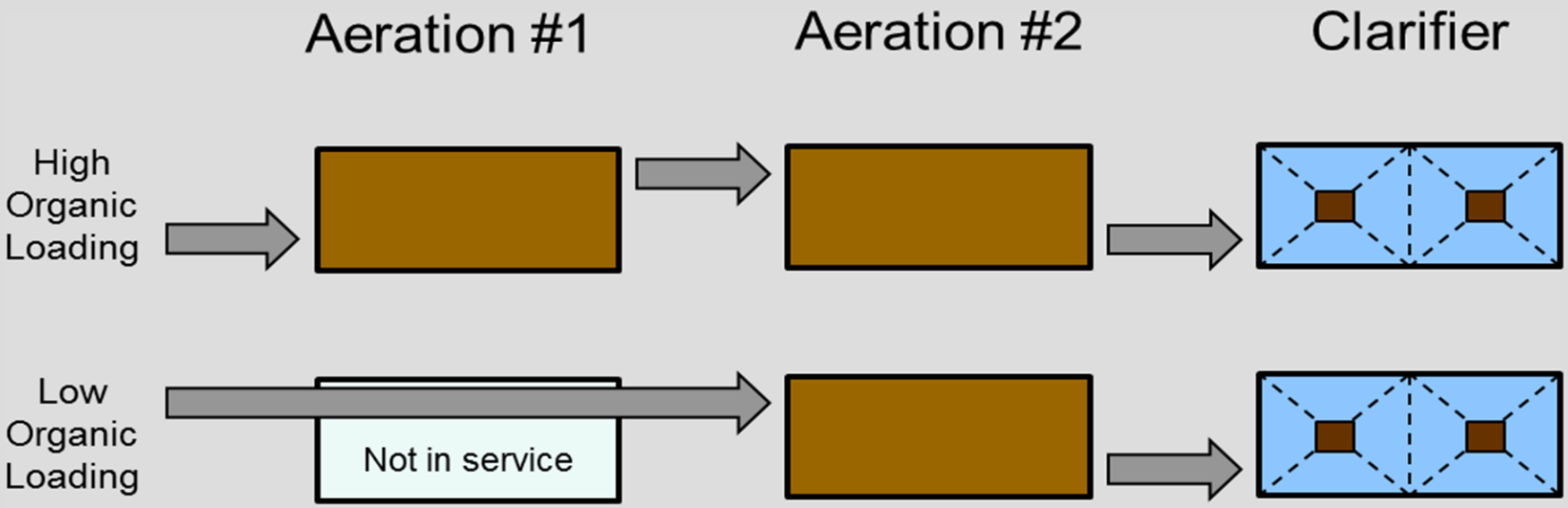
BOX # 3 **AERATION EFFLUENT:**
WATER TEMPERATURE < 10 C

- WATER temperature impacts growth rate
  - slower growth = slower removal rates
- Measure AT effluent water temperature

BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity



BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity
  - Reduce Blower Timers
    - Match supply to load
  - Reduce Loss
    - Cover AT, EQ, clarifiers

BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity
  - Reduce Blower Timers
    - Match supply to load
  - Reduce Loss
    - Cover AT, EQ, clarifiers

BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity
  - Reduce Blower Timers
    - Match supply to load
  - Reduce Loss
    - Cover AT, EQ, clarifiers

BOX # 5

AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L

- Nitrification
  - Consumes alkalinity
    - 7.14 mg/L alkalinity
  - No Alkalinity,
  - No Carbon,
    No Buffer
  - pH "post mortem"
    - Drops like a rock

BOX # 5

AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L

- Nitrification

- Consumes alkalinity
  - 7.14 mg/L alkalinity
- No Alkalinity,
- No Carbon,
  No Buffer
- pH "post mortem"
  - Drops like a rock

BOX # 5

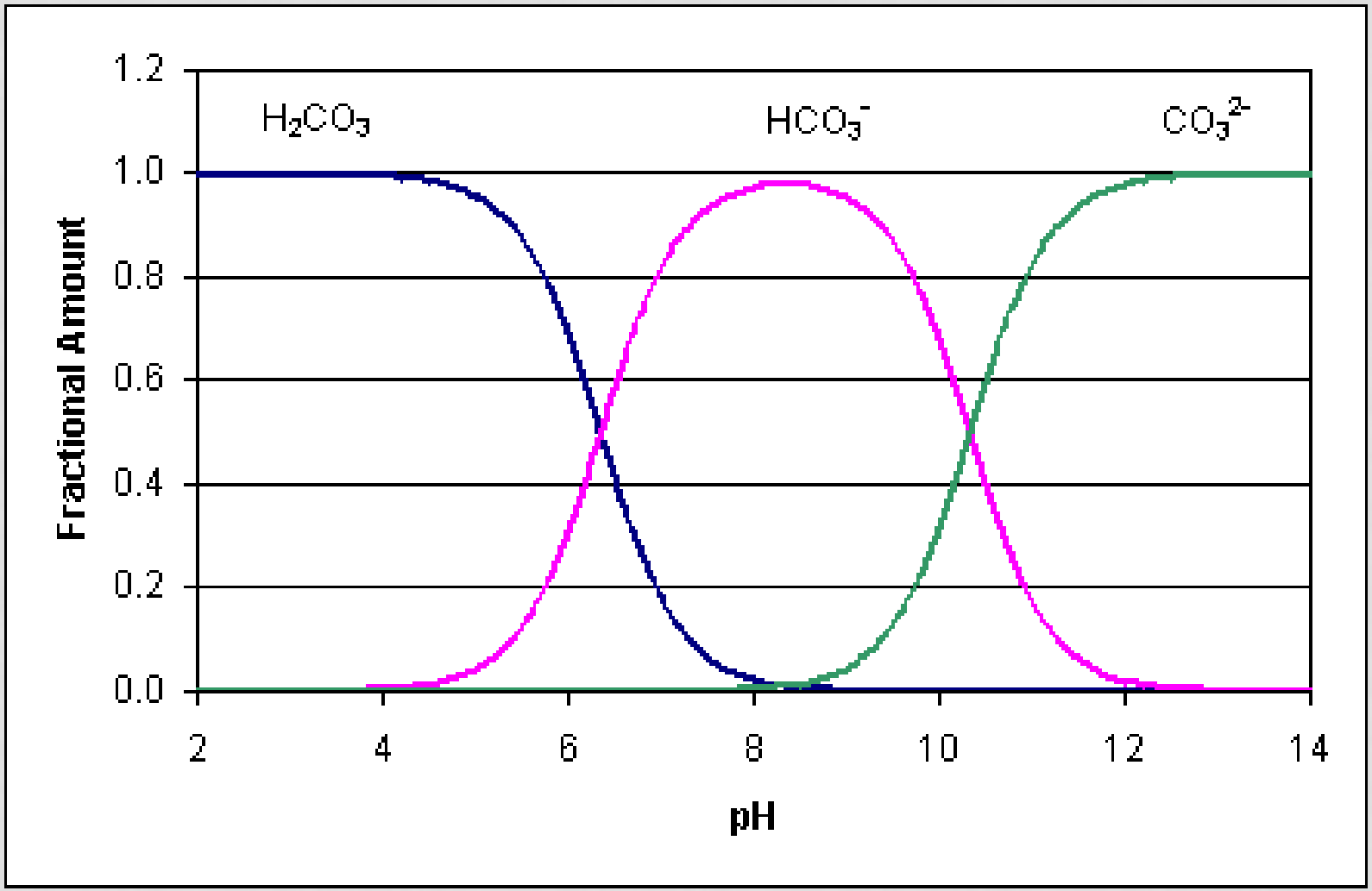
AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L

- Nitrification

- Consumes alkalinity
  - 7.14 mg/L alkalinity
- No Alkalinity,
- No Carbon
  No Buffer
- pH "post mortem"
  - Drops like a rock

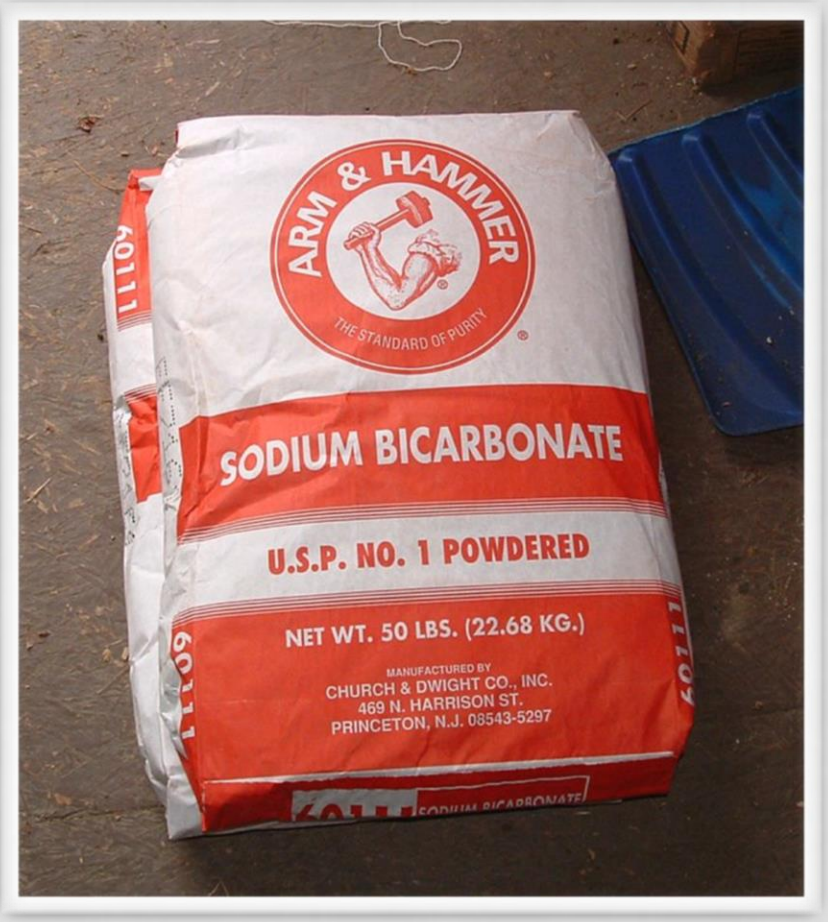
BOX # 5

AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L



BOX # 8

AERATION:
INCREASE ALKALINITY IN AERATION TANK

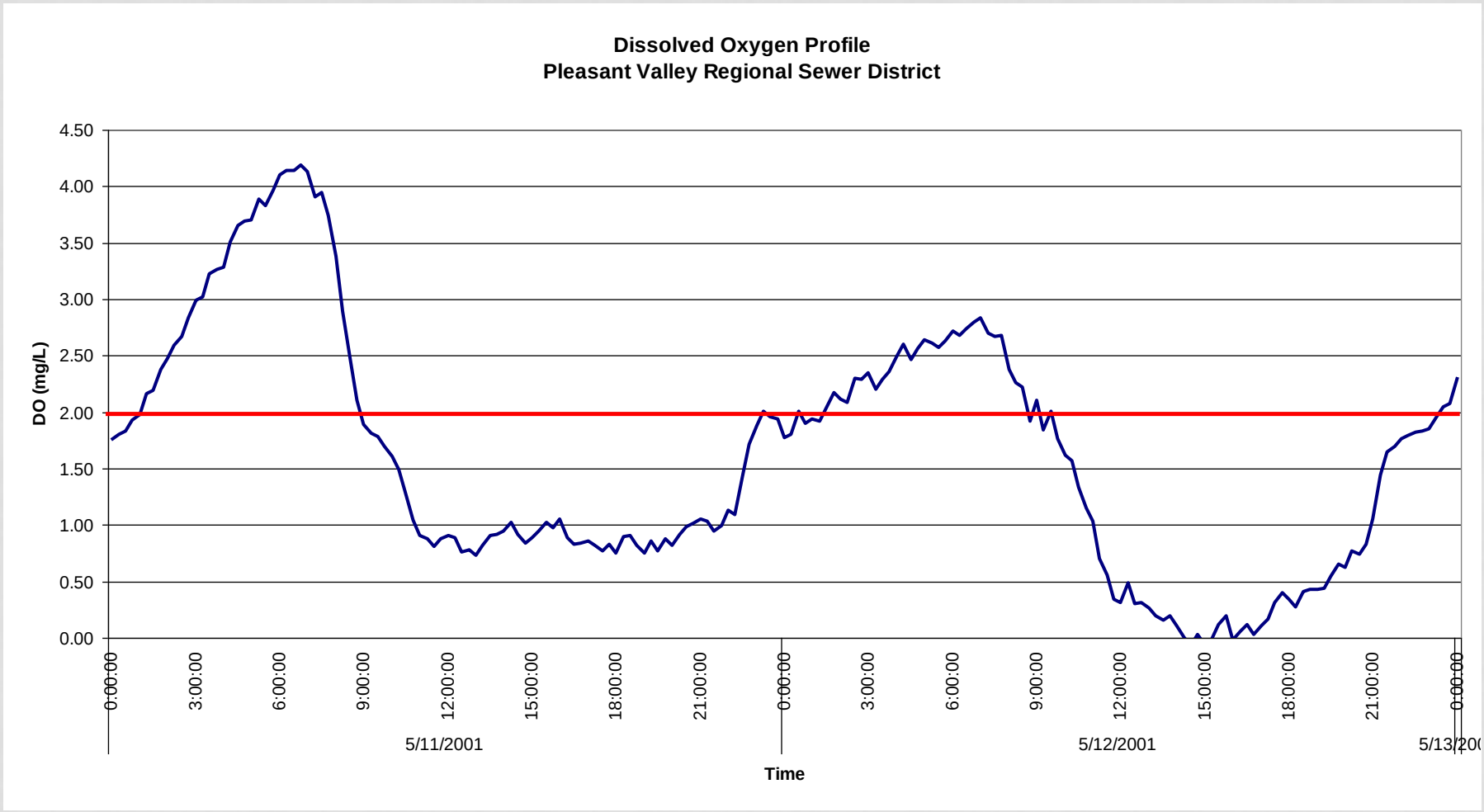


- Bicarb is best for an upset reactor
  - Safer to use in AT
  - Safer to use by operator
- Measure and know
  - Need 100 mg/L residual AND NH3 < 1 mg/L in AT

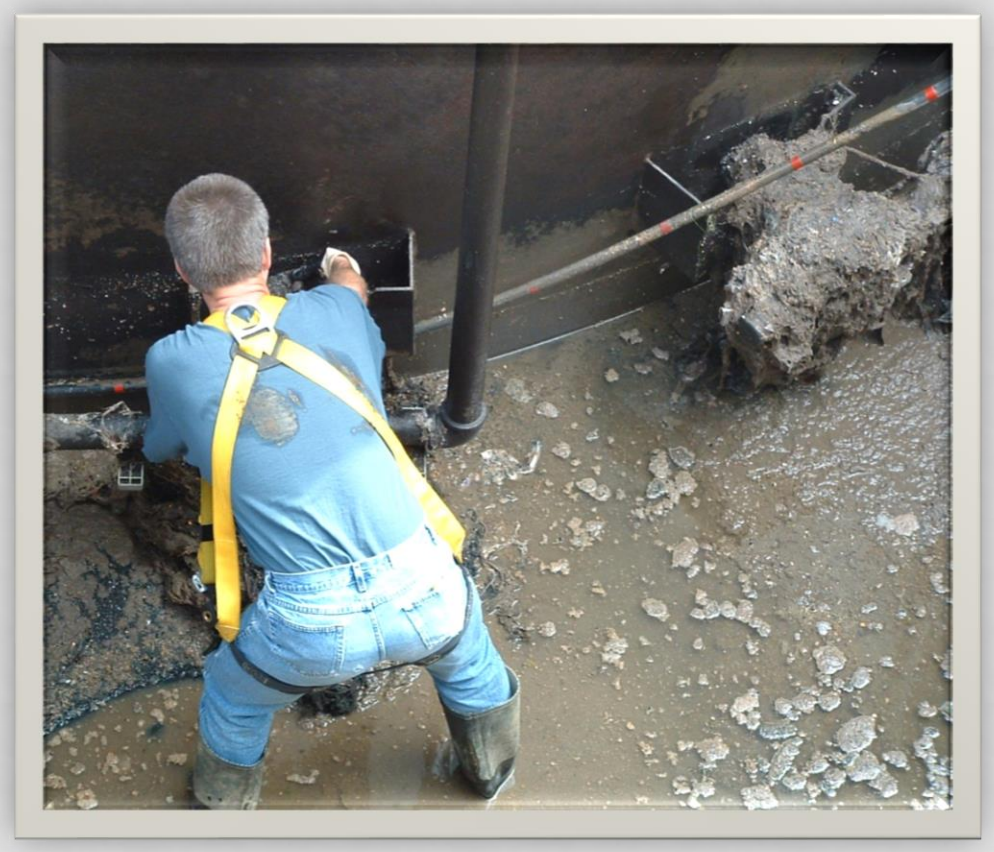
BOX # 7

AERATION EFFLUENT:
DISSOLVED OXYGEN < 2 MG/L

- DO Concentration
  - Aeration Tank Effluent
  - Photo vs Video
  - Multiple tanks
    - Parallel = equal value
    - Series = increasing value

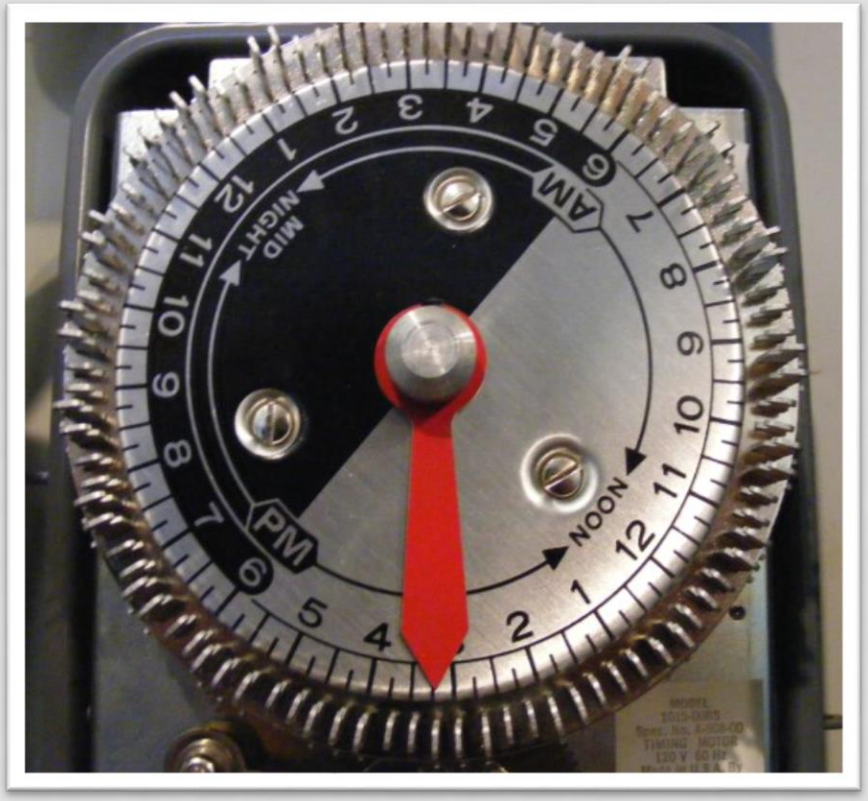

Dissolved Oxygen Profile
Pleasant Valley Regional Sewer District
DO (mg/L)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
5/11/2001
5/12/2001
Time

BOX # 10 **AERATION: INCREASE AIR SUPPLY IN AERATION TANK**



- Operational Issue
  - Blower run time
  - System Loading
- Mechanical Issue
  - Blower
  - Motor
  - Air Distribution

BOX # 10 **AERATION: INCREASE AIR SUPPLY IN AERATION TANK**



- Operational Issue
  - Blower run time
  - System Loading
- Mechanical Issue
  - Blower
  - Motor
  - Air Distribution

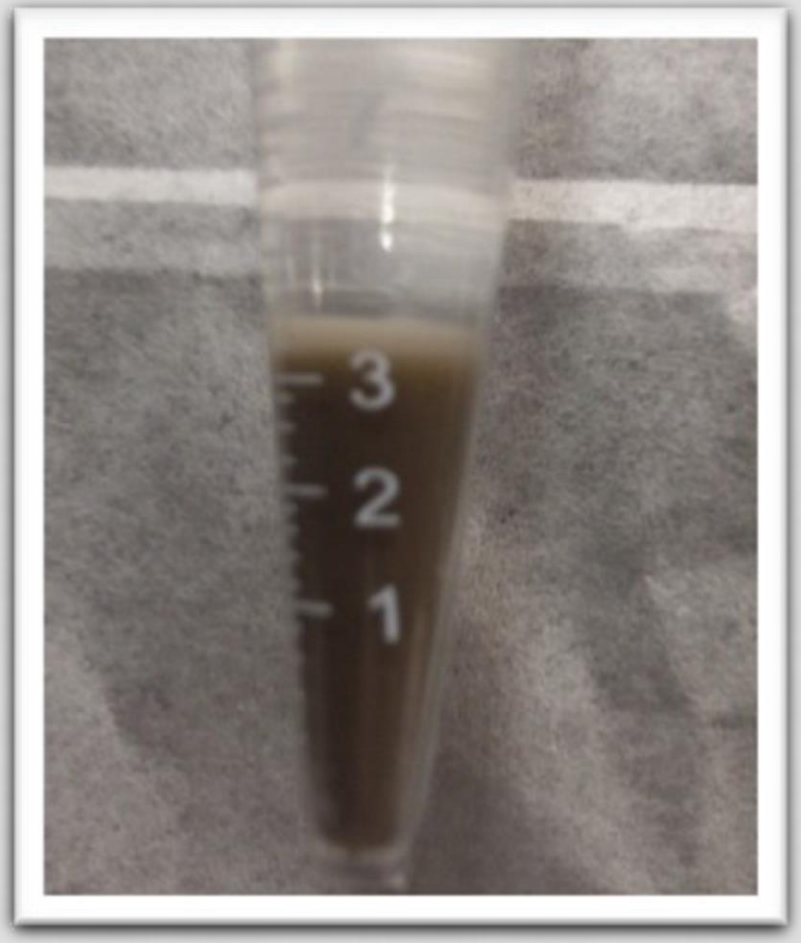
BOX # 9 **AERATION EFFLUENT: CENTRIFUGE SPIN < 4%**

- Need bacteria in AT to convert NH3
  - Hiding in clarifier?
- Estimate amount in 15 minutes
- Typical range 2-4% by volume

BOX # 9 **AERATION EFFLUENT: CENTRIFUGE SPIN < 4%**

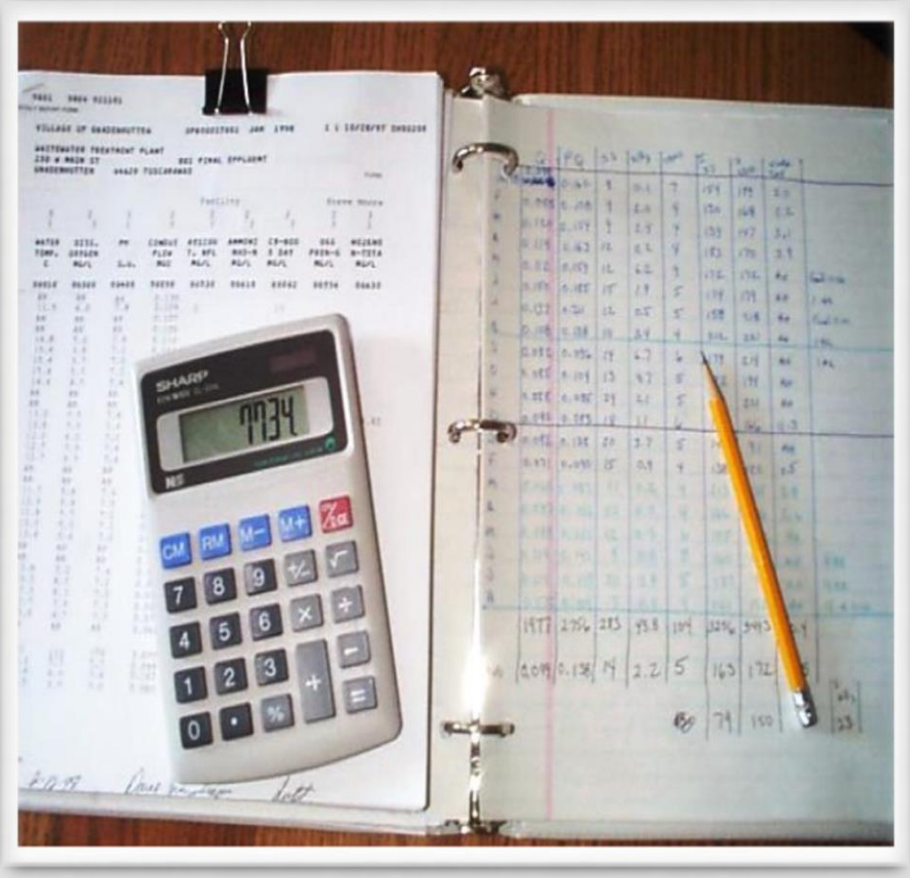
- Need bacteria in AT to convert NH3
  - Hiding in clarifier?
- Estimate amount in 15 minutes
- Typical range 2-4% by volume

BOX # 12 **AERATION: INCREASE BIOMASS IN AERATION TANK**



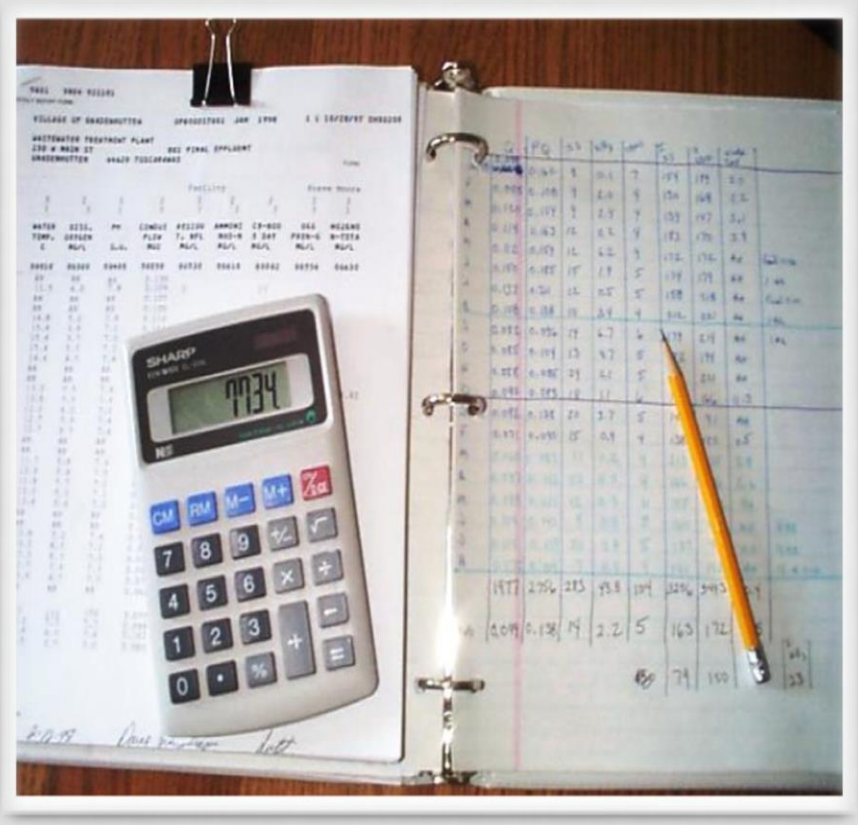
- Aeration Tank
  - 2% to 4% concentration
  - Decrease wasting to increase biomass
  - Colder temps require more biomass
  - Increased loadings require more mass

BOX # 11 **ORGANIC LOADING RATE: LOADING > DESIGN**



- **lbs./day/1,000 ft^3**
- (BOD)(MGD)(8.34)
- $\frac{\text{(length x width x wd)}}{1{,}000\ ft^3}$
- <25 lbs./d/1,000 ft^3

BOX # 11 **ORGANIC LOADING RATE: LOADING > DESIGN**



Typical Design
15 - 40 lbs./d/1,000 ft^3

- lbs./day/1,000 ft^3

AT Dimensions
=4[96'x 24'x 15' w.d.}

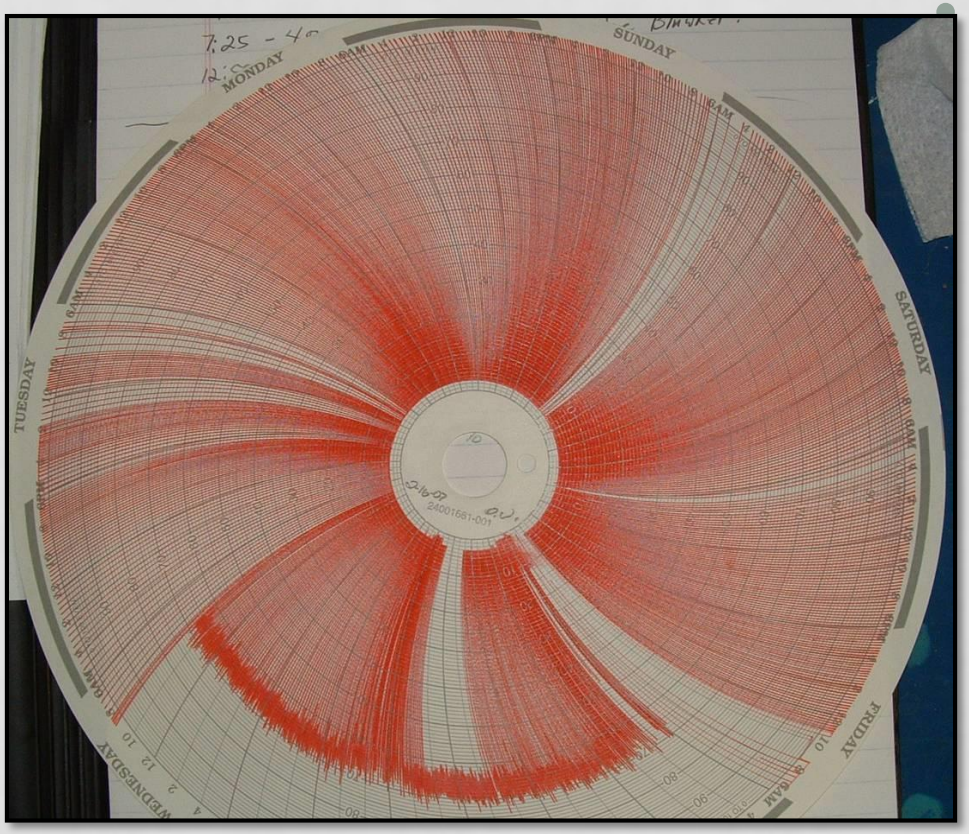
AT Environment
= 1.67 mgd
= 190 mg/L BOD

lbs./day/BOD
= 8.34 x 1.67 MGD x 190 mg/L
= 2646 lbs./d/BOD

1,000ft3
= (4x96x24x15)/1,000
= 138 AT capacity in 1,000 ft^3

lbs./d/1,000 ft^3
= 2646/138
= 20.7 lbs./d/1,000 ft^3

BOX # 14 **CAPACITY: INCREASE CAPACITY OR DECREASE LOADING**



- Equalize Flows
  - Avg. Daily Flow vs. Pumping Rate
  - Flow EQ Design
  - Evidence of Problem
    - "the block"
- Add more capacity

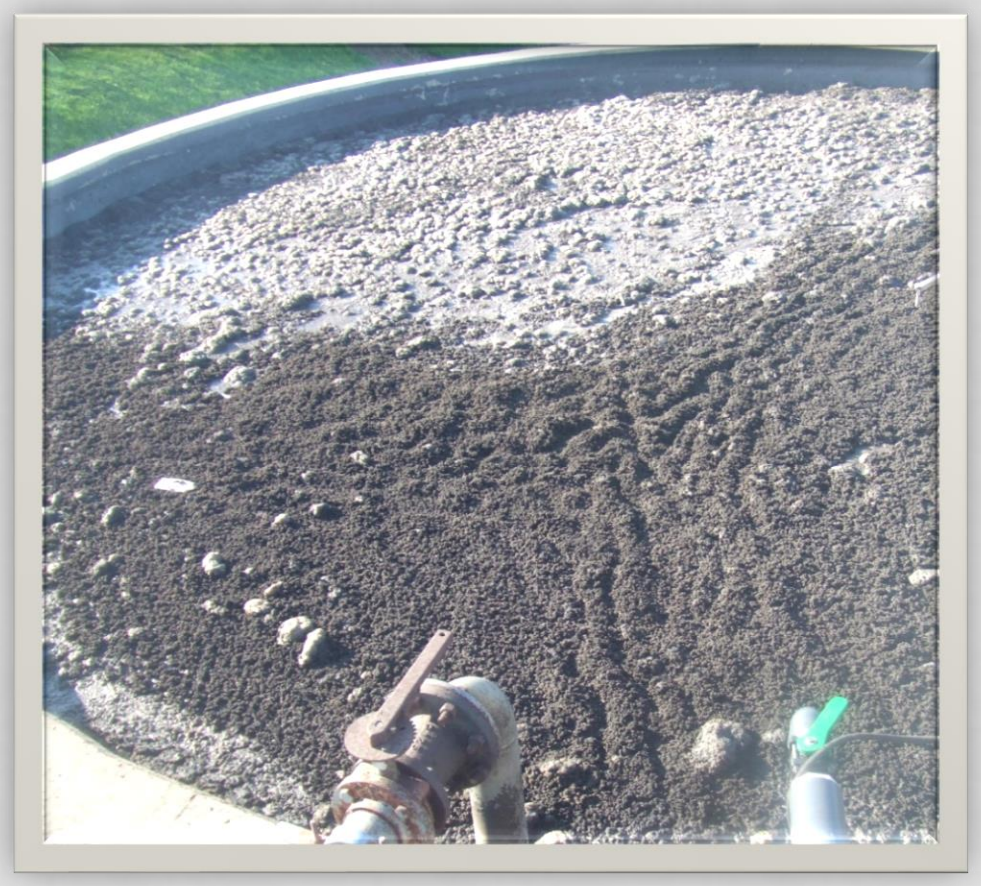
BOX # 14 **CAPACITY: INCREASE CAPACITY OR DECREASE LOADING**

- Equalize Flows
  - Avg. Daily Flow vs. Pumping Rate
  - Flow EQ Design
  - Evidence of Problem
    - "the block"
- Add more capacity

BOX # 14 **CAPACITY: INCREASE CAPACITY OR DECREASE LOADING**

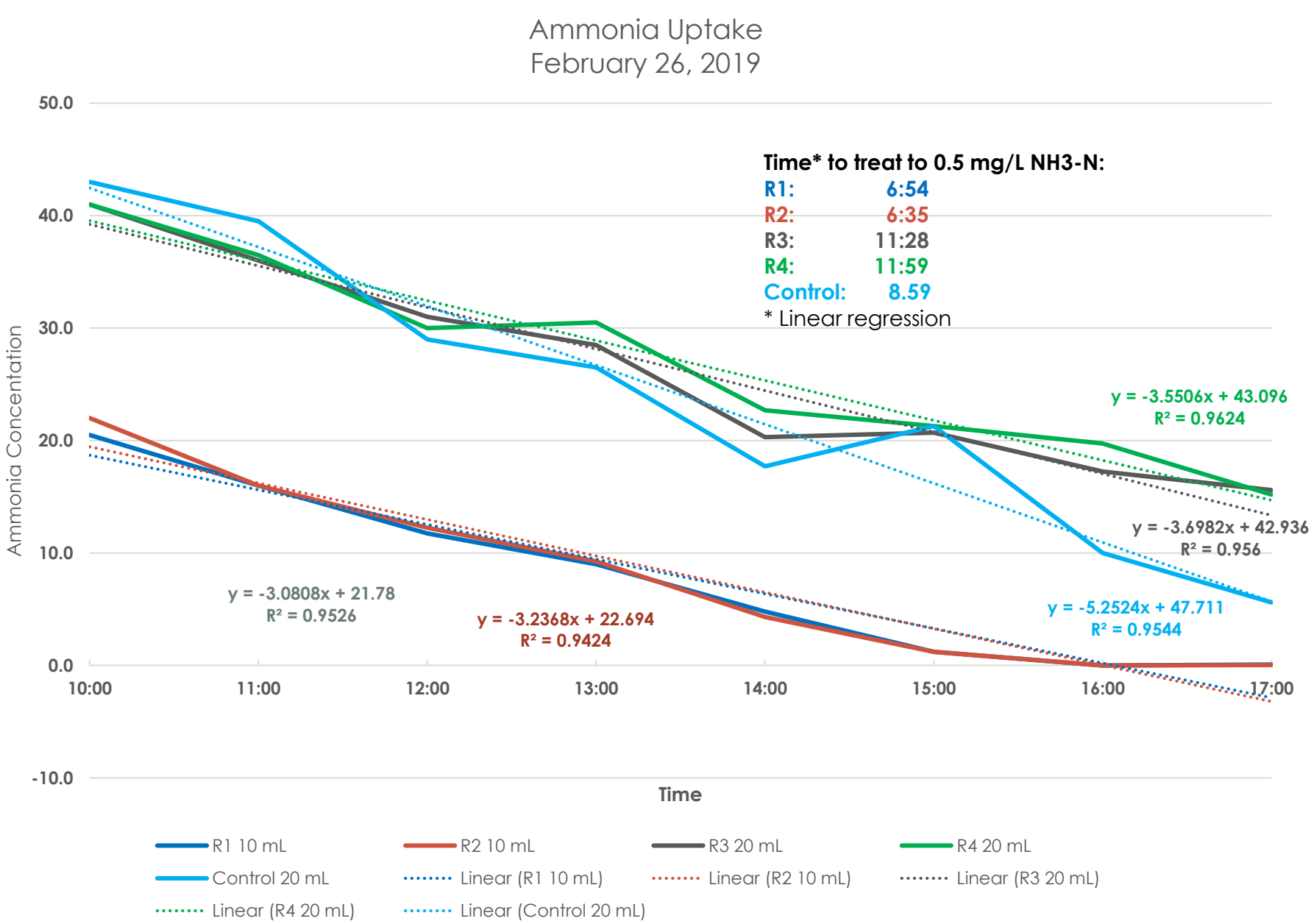
- Equalize Flows
  - Avg. Daily Flow vs. Pumping Rate
  - Flow EQ Design
  - Evidence of Problem
    - "the block"
- Add more capacity

BOX # 13 **AERATION: EVALUATE FOR TOXIC ISSUES.**



- Common sources
  - Internal
  - Digester Supernatant
  - Other side streams
- Other sources
  - External
  - Force Mains
  - Septage Receiving
  - Color, corrosion, odor

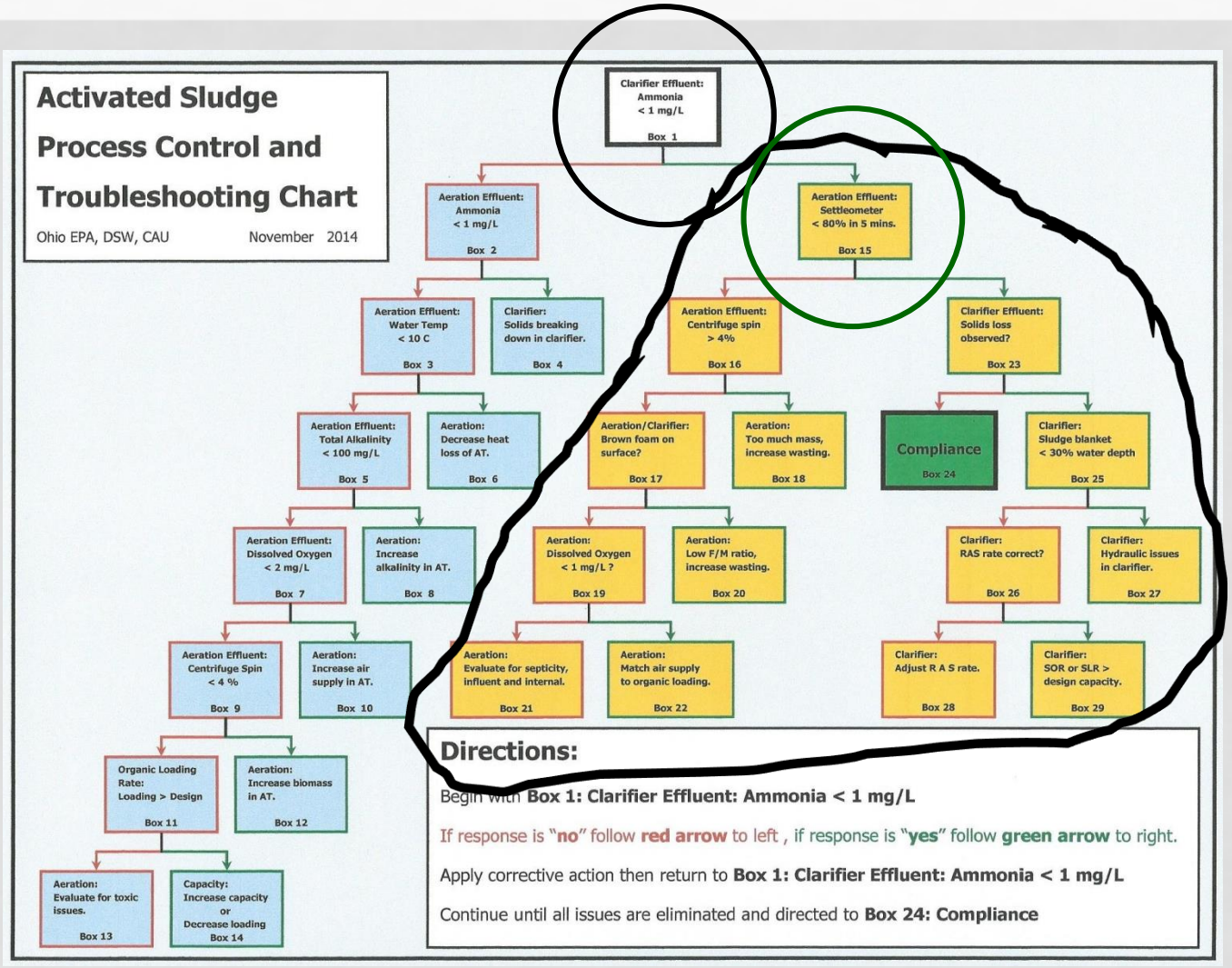

8.2
26.4
2
3
4
control


Ammonia Uptake
February 26, 2019
Time* to treat to 0.5 mg/L NH3-N:
R1: 6:54
R2: 6:35
R3: 11:28
R4: 11:59
Control: 8.59
* Linear regression
y = -3.5506x + 43.096
R² = 0.9624
y = -3.6982x + 42.936
R² = 0.956
y = -3.0808x + 21.78
R² = 0.9526
y = -3.2368x + 22.694
R² = 0.9424
y = -5.2524x + 47.711
R² = 0.9544
Ammonia Concentration
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
Time
R1 10 mL
R2 10 mL
R3 20 mL
R4 20 mL
Control 20 mL
Linear (R1 10 mL)
Linear (R2 10 mL)
Linear (R3 20 mL)
Linear (R4 20 mL)
Linear (Control 20 mL)

BOX # 13 **AERATION: EVALUATE FOR TOXIC ISSUES.**

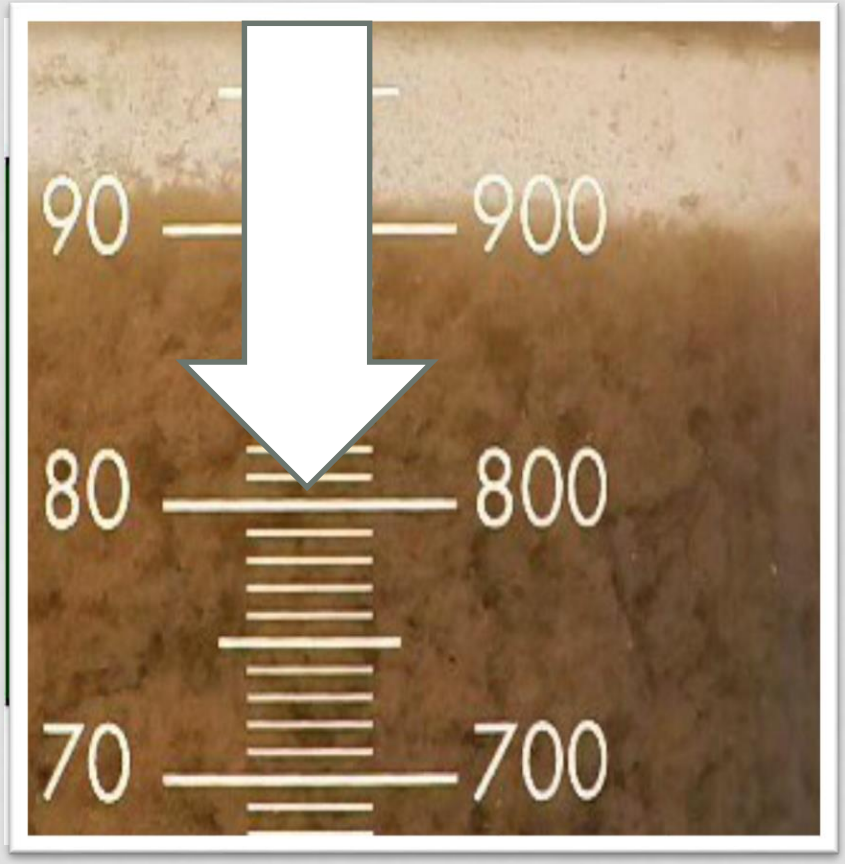
- Common sources
  - Internal
  - Digester Supernatant
  - Other side streams
- Other sources
  - External
  - Force Mains
  - Septage Receiving
  - Color, corrosion, odor

A. S. PROCESS CONTROL



BOX # 15

AERATION EFFLUENT: SETTLEOMETER < 80% IN 5 MINUTES



- Conversion Complete
- Separation Analysis
  - "Perfect Clarifier"
  - < 80 % in 5 minutes
- Inhibited Settling
  - High concentration mass (too crowded)
  - Low density mass (too buoyant)

BOX # 16 **AERATION EFFLUENT: CENTRIFUGE SPIN > 4%**

- Centrifuge Spin
  - Aeration Effluent
  - > 4% inhibits settling
  - Measure and know
- 2 Minute Diluted Settleometer
  - 100% vs 50%

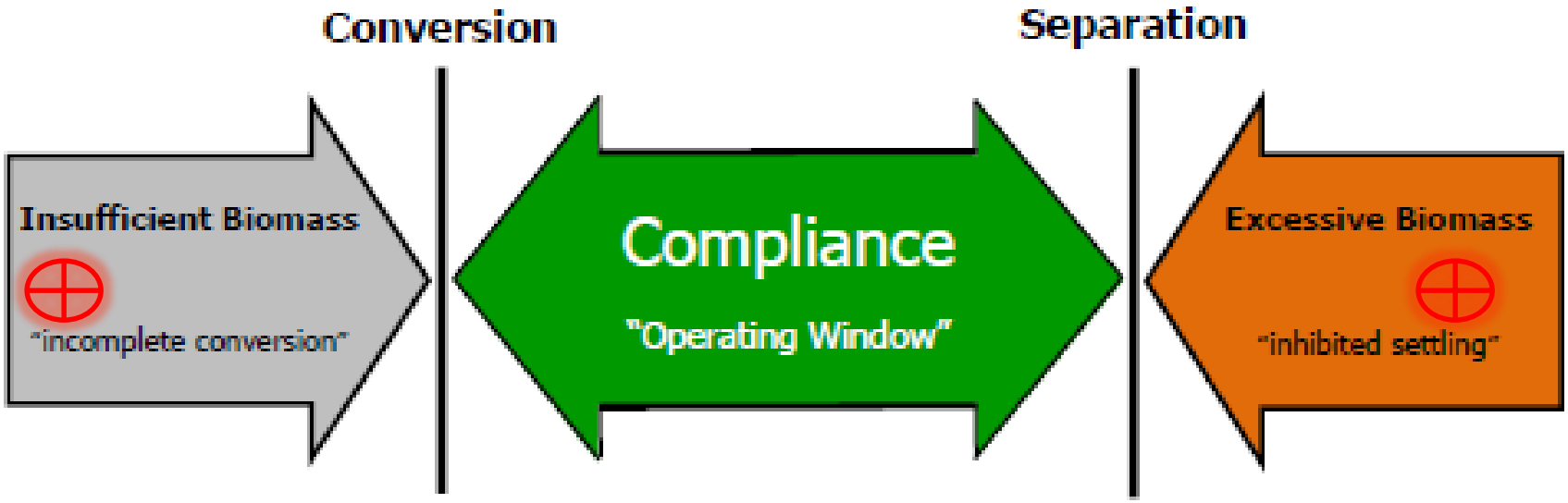
BOX # 16 **AERATION EFFLUENT: CENTRIFUGE SPIN > 4%**

- Centrifuge Spin
  - Aeration Effluent
  - > 4% inhibits settling
  - Measure and know
- 2 Minute Diluted Settleometer
  - 100% vs 50%


2 Minute Diluted
Settleometer Test
Concentration


2 Minute Diluted
Settleometer Test
Density

BOX # 18 **AERATION:**
TOO MUCH BIOMASS, INCREASE WASTING



Establishing a wasting rate is simply a process of maintaining sufficient biomass to achieve complete conversion in the aeration tank (ammonia < 1 mg/L), while not maintaining an excessive amount of biomass to inhibit the settling rate in the clarifier (< 80% in 5 minutes).

BOX # 17 **AERATION / CLARIFIER: BROWN FOAM ON SURFACE**

- Filaments
  - >80% in 5 mins.
  - AT spin < 4%
  - 2 min. diluted Settleometer analysis
  - Coning/Jagged
  - Supernatant Clarity
  - Low AT effluent NH3
  - **Brown Foam**
- Low F/M Environment

BOX # 17 **AERATION / CLARIFIER: BROWN FOAM ON SURFACE**

- Filaments
  - >80% in 5 mins.
  - AT spin < 4%
  - 2 min. diluted Settleometer analysis
  - Coning/Jagged
  - Supernatant Clarity
  - Low AT effluent NH3
  - **Brown Foam**
- Low F/M Environment

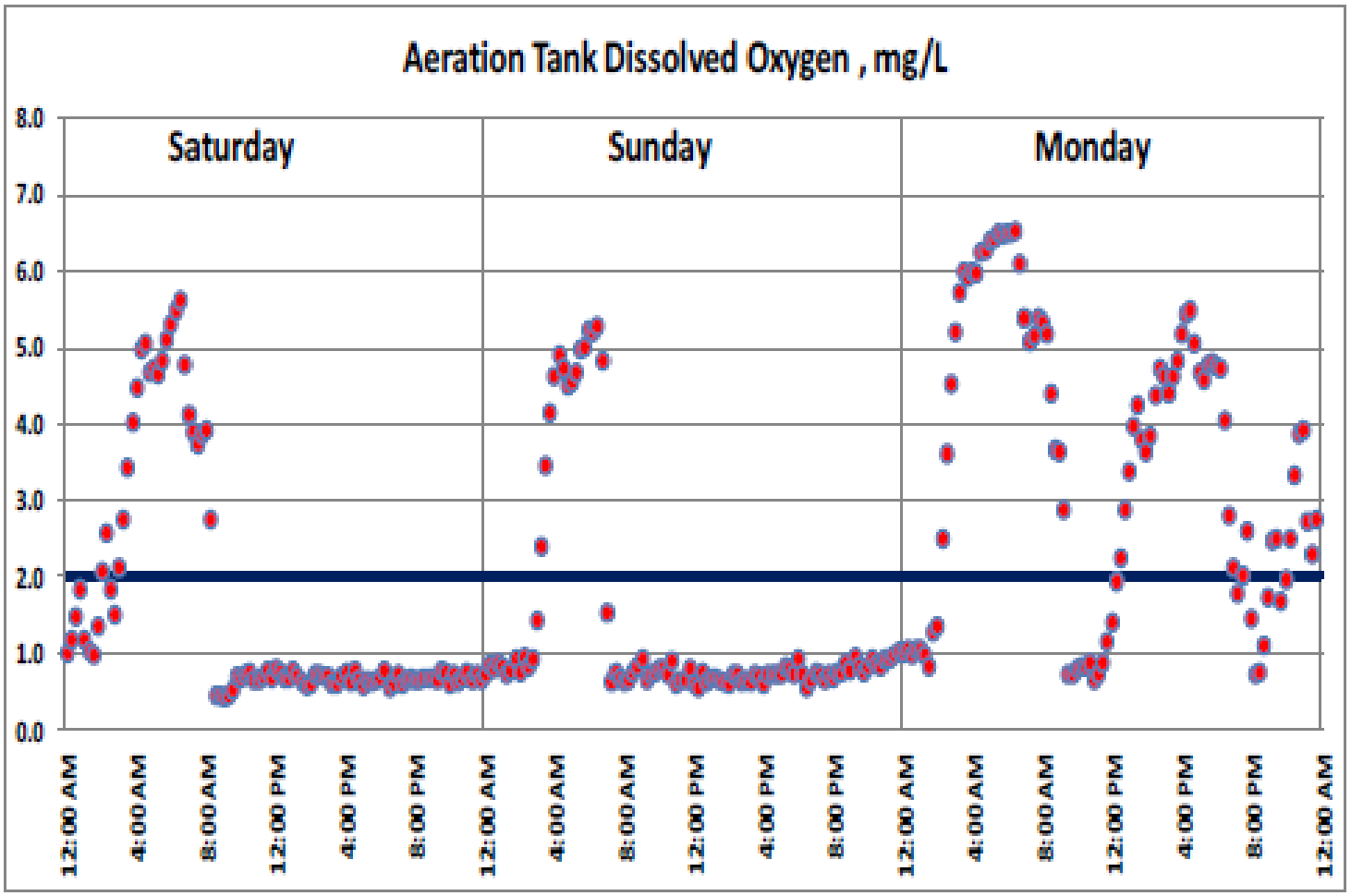
BOX # 20 **AERATION: LOW F/M RATIO, INCREASE WASTING**

- Low F/M Filaments
- Waste
  - Stop the madness
  - Clean up the mess

BOX # 19 **AERATION: DISSOLVED OXYGEN < 1 MG/L**

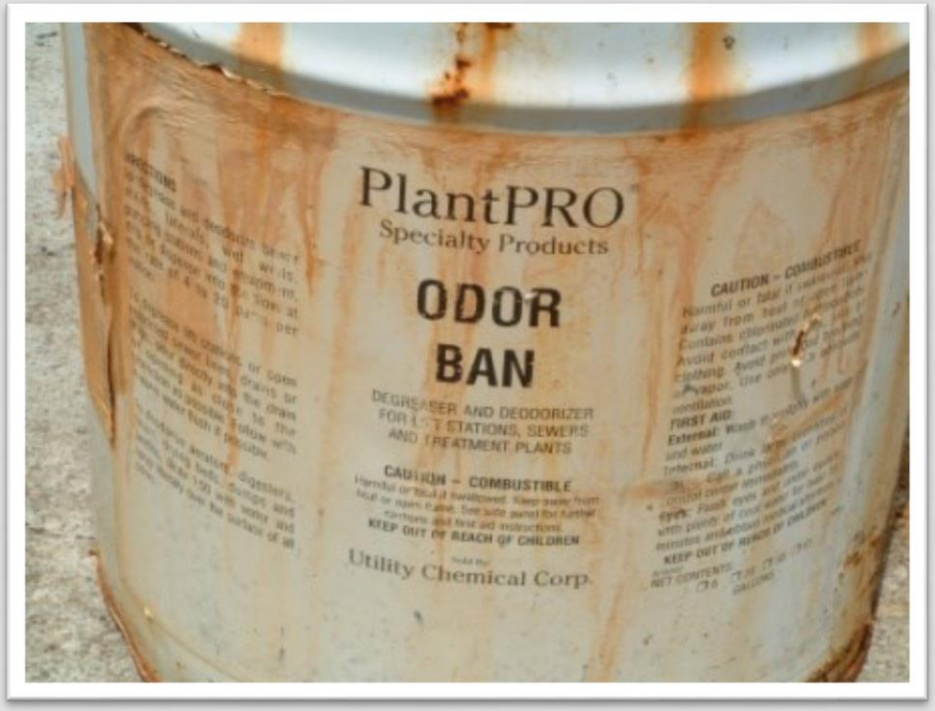
- Filaments
  - >80% in 5 mins.
  - AT spin < 4%
  - 2 min. diluted Settleometer analysis
- Low DO
  - Long, low levels
    - 1 mg/L DO
  - Short, deep levels
    - < 1 mg/L DO
  - Measure and know

BOX # 22 **AERATION: MATCH AIR SUPPLY TO ORGANIC LOADING**



BOX # 21

AERATION: EVALUATE FOR SEPTICITY, INFLUENT AND INTERNAL

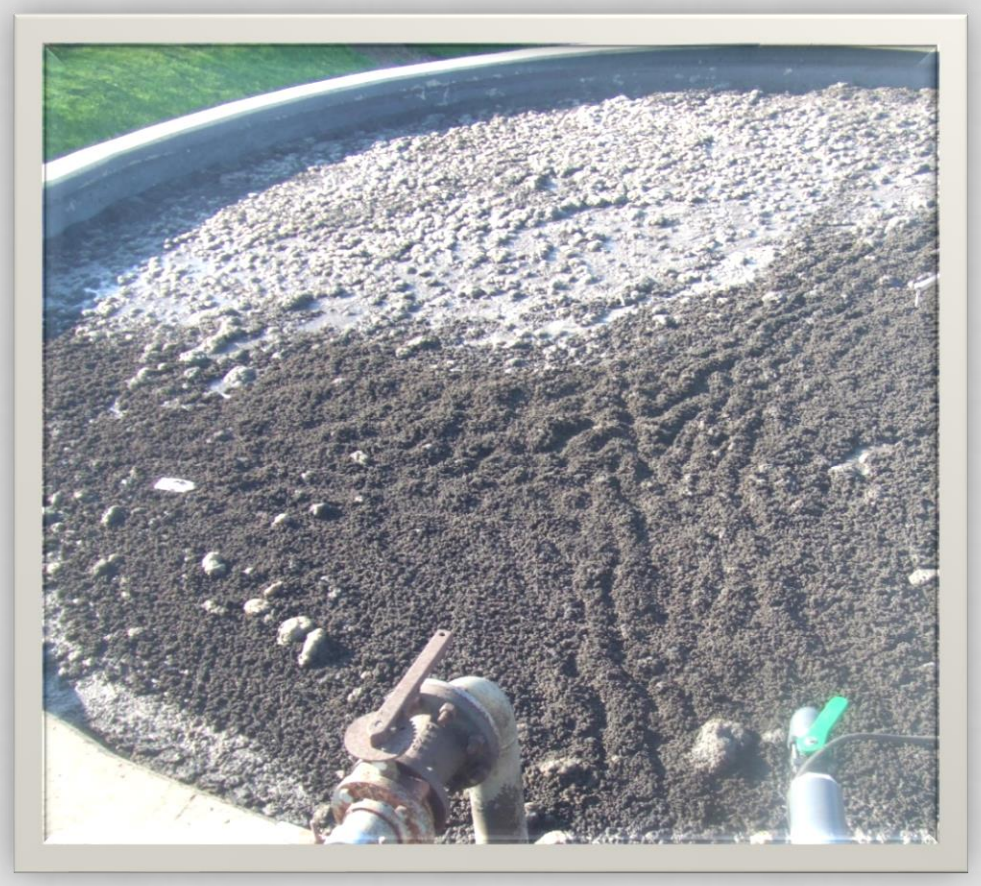


- Filaments
  - >80% in 5 mins.
  - AT spin < 4%
- Septic Sources
  - Influent
    - Odor
    - Corrosion
    - Color
  - Internal
    - "aerobic" digester
    - Solids breaking down in clarifier

BOX # 21 **AERATION: EVALUATE FOR SEPTICITY, INFLUENT AND INTERNAL**

- Filaments
  - >80% in 5 mins.
  - AT spin < 4%
- Septic Sources
  - Influent
    - Odor
    - Corrosion
    - Color
  - Internal
    - "aerobic" digester
    - Solids breaking down in clarifier

BOX # 21 **AERATION: EVALUATE FOR SEPTICITY, INFLUENT AND INTERNAL**



- Filaments
  - >80% in 5 mins.
  - AT spin < 4%

Septic Sources

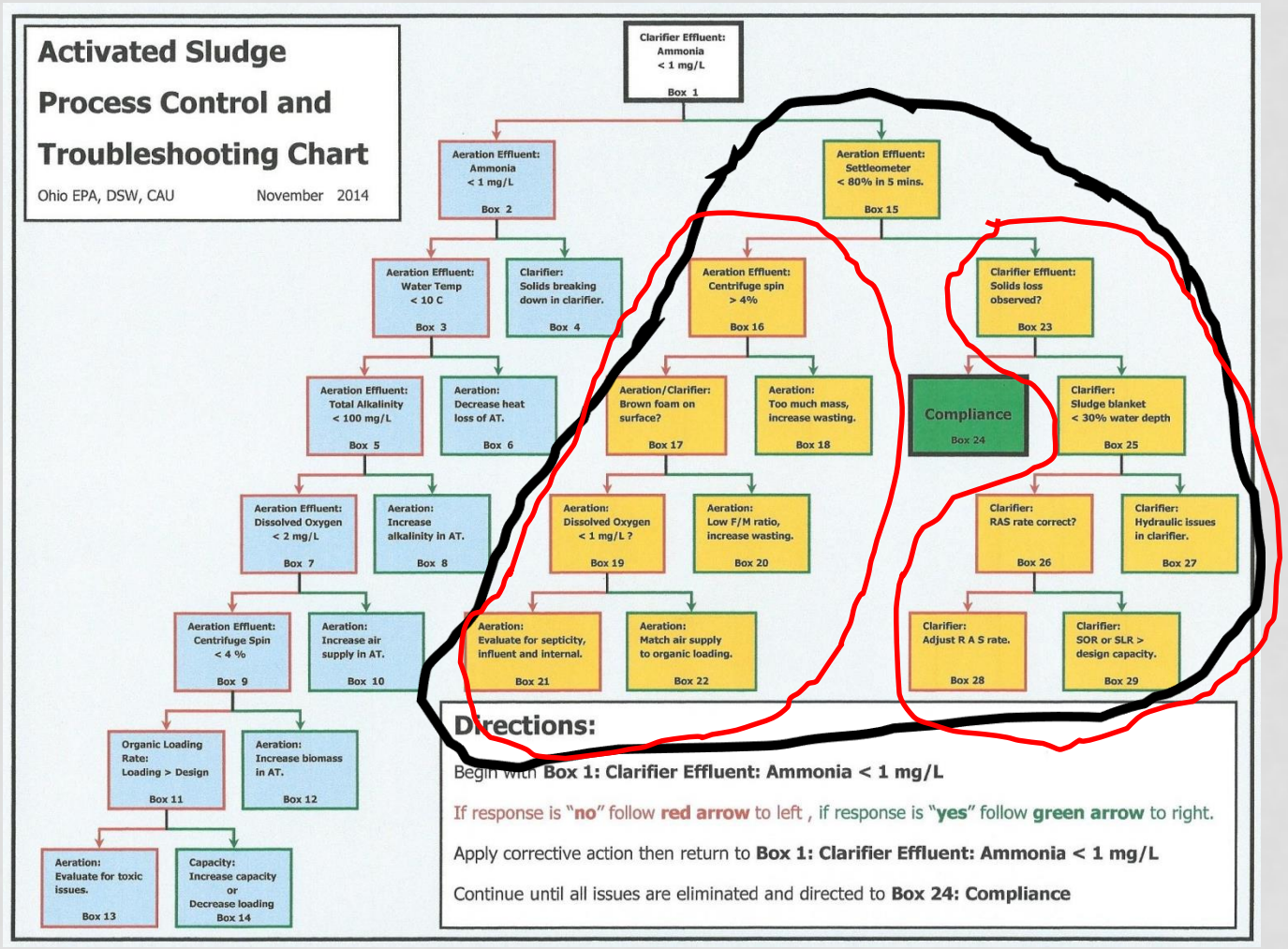
- Influent
  - Odor
  - Corrosion
  - Color
- Internal
  - "aerobic" digester
  - Solids breaking down in clarifier

BOX # 21

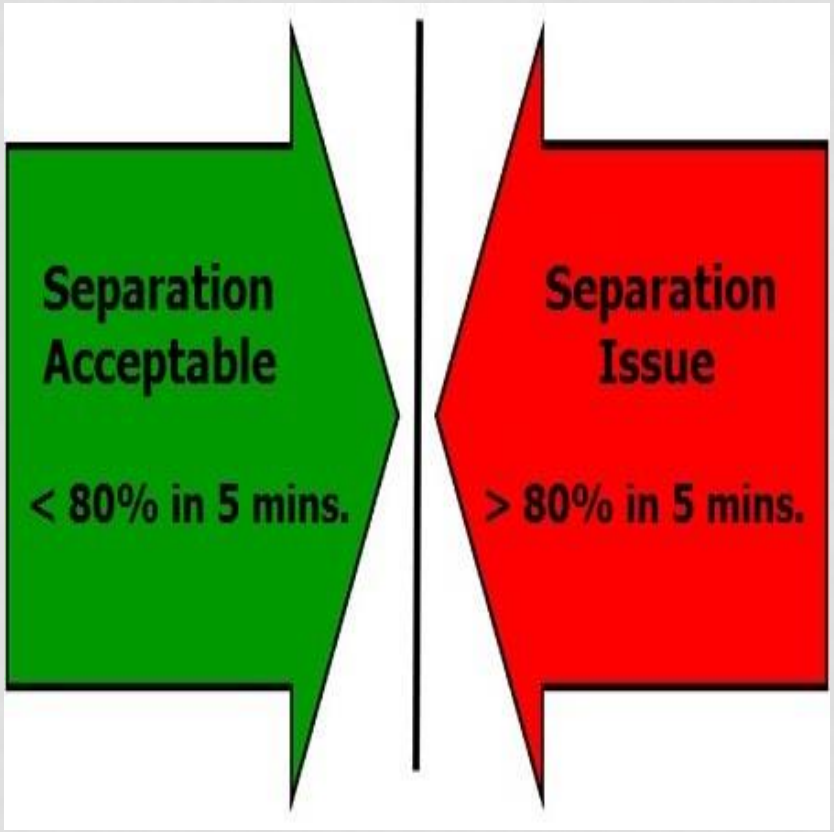
AERATION: EVALUATE FOR SEPTICITY, INFLUENT AND INTERNAL

- Filaments
  - >80% in 5 mins.
  - AT spin < 4%
- Septic Sources
  - Influent
    - Odor
    - Corrosion
    - Color
  - Internal
    - “aerobic” digester
    - Solids breaking down in clarifier

A. S. PROCESS CONTROL

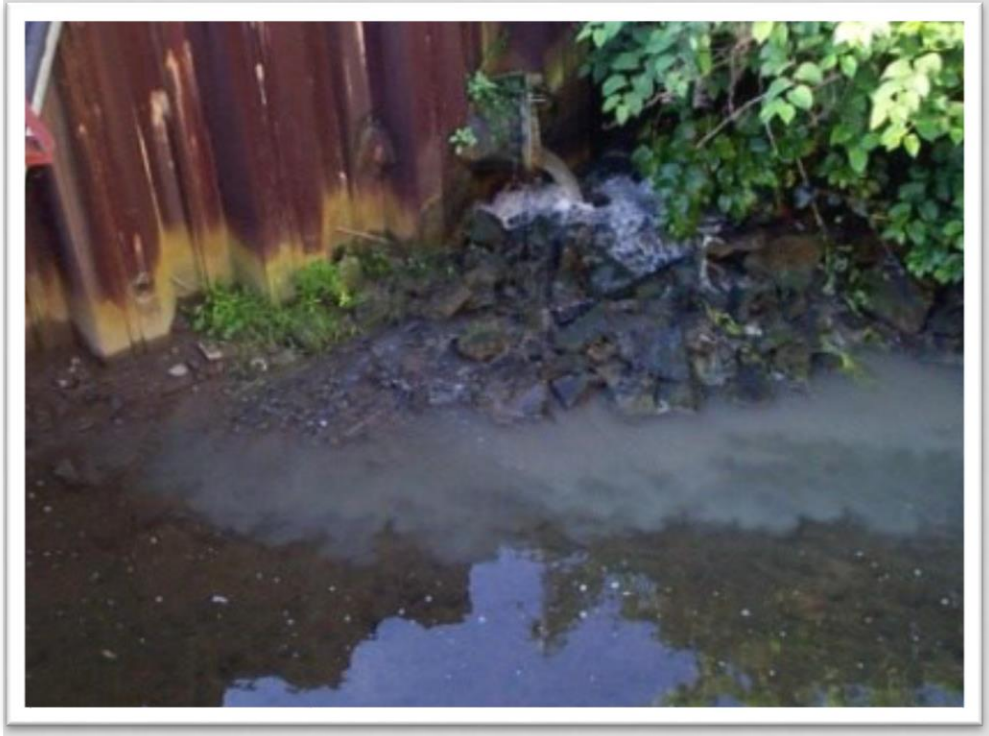


BOX # 15 **AERATION EFFLUENT:**
SETTLEOMETER < 80% IN 5 MINUTES



- Conversion Complete
- Separation Analysis
  - "Perfect Clarifier"
  - < 80 % in 5 minutes
- Inhibited Settling
  - High concentration mass (too crowded)
  - Low density mass (too buoyant)

BOX # 23 **CLARIFIER EFFLUENT: SOLIDS LOSS OBSERVED**



- Observed Loss
  - Clarifier Weir
  - Effluent
- Unobserved Loss
  - Life Expectancy
    - Birth
    - Aged
    - Deceased
  - 2-3 months?

BOX # 23 **CLARIFIER EFFLUENT: SOLIDS LOSS OBSERVED**

- Observed Loss
  - Clarifier Weir
  - Effluent
- Unobserved Loss
  - Life Expectancy
    - Birth
    - Aged
    - Deceased
  - 2-3 months?

BOX # 23 **CLARIFIER EFFLUENT: SOLIDS LOSS OBSERVED**

- Observed Loss
  - Clarifier Weir
  - Effluent
- Unobserved Loss
  - Life Expectancy
    - Birth
    - Aged
    - Deceased
  - 2-3 months?

BOX # 23 **CLARIFIER EFFLUENT: SOLIDS LOSS OBSERVED**

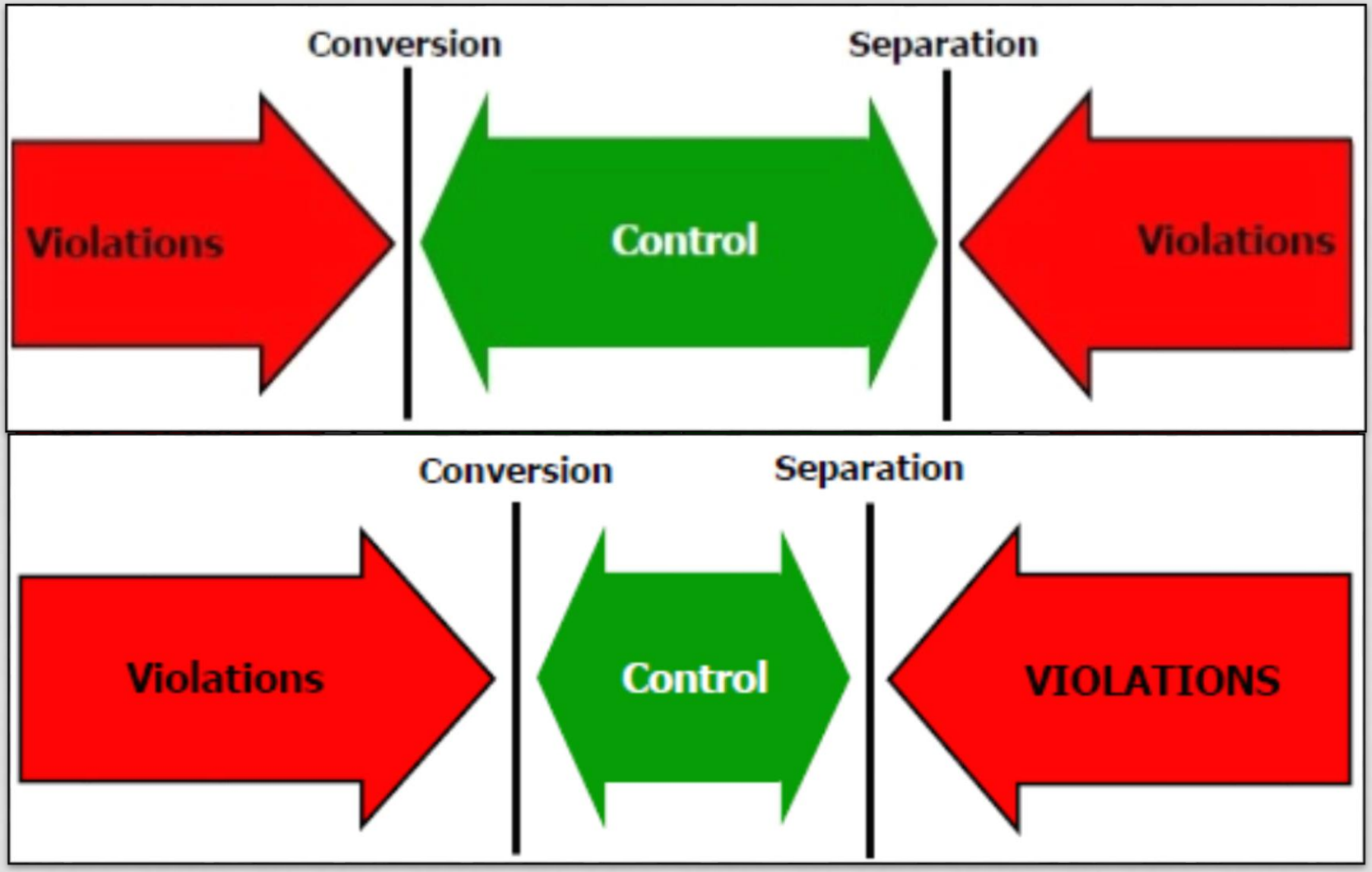
- Observed Loss
  - Clarifier Weir
  - Effluent
- Unobserved Loss
  - Life Expectancy
    - Birth
    - Aged
    - Deceased
  - 2-3 months?

BOX # 23 **CLARIFIER EFFLUENT: SOLIDS LOSS OBSERVED**

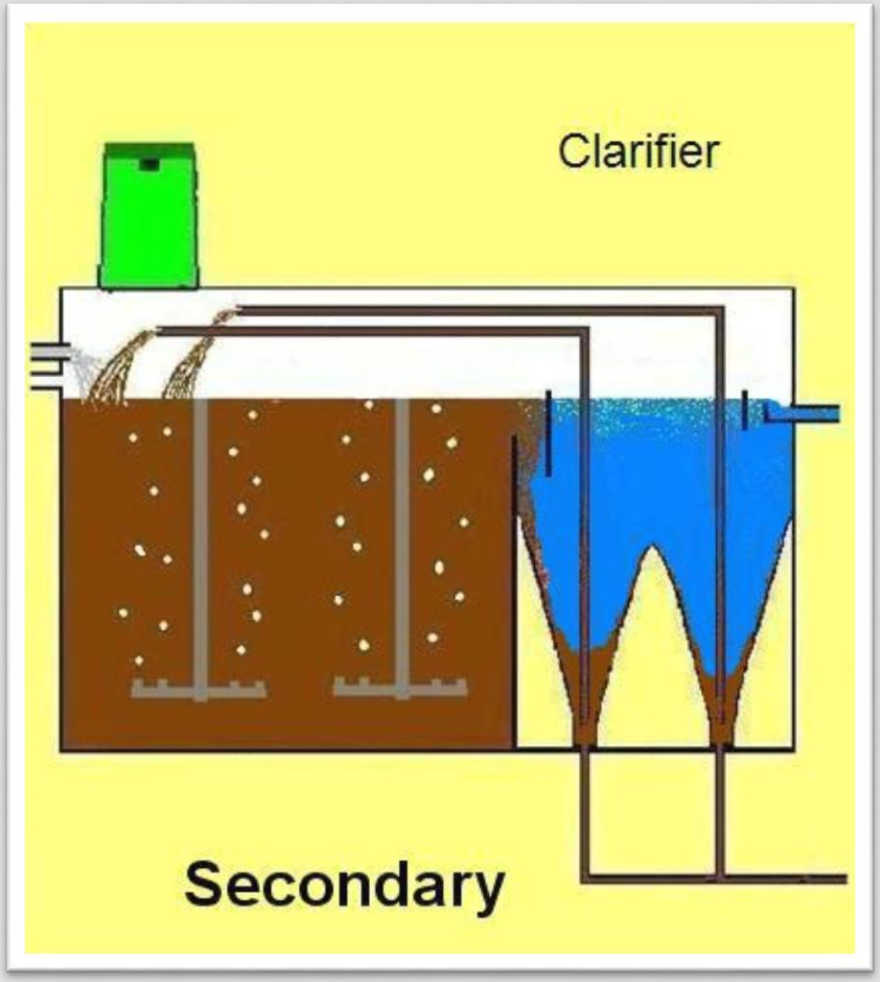
- Observed Loss
  - Clarifier Weir
  - Effluent
- Unobserved Loss
  - Life Expectancy
    - Birth
    - Aged
    - Deceased
  - 2-3 months?

BOX # 24

COMPLIANCE

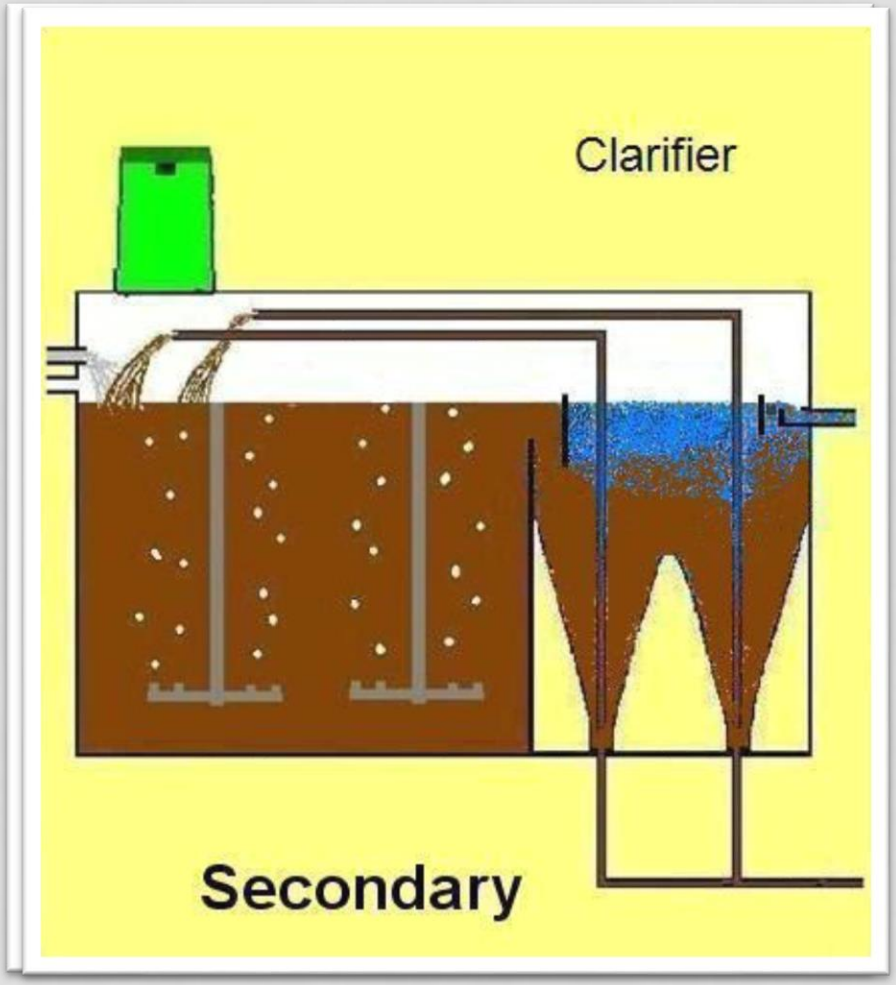


BOX # 25 **CLARIFIER:**
SLUDGE BLANKET < 30% WATER DEPTH

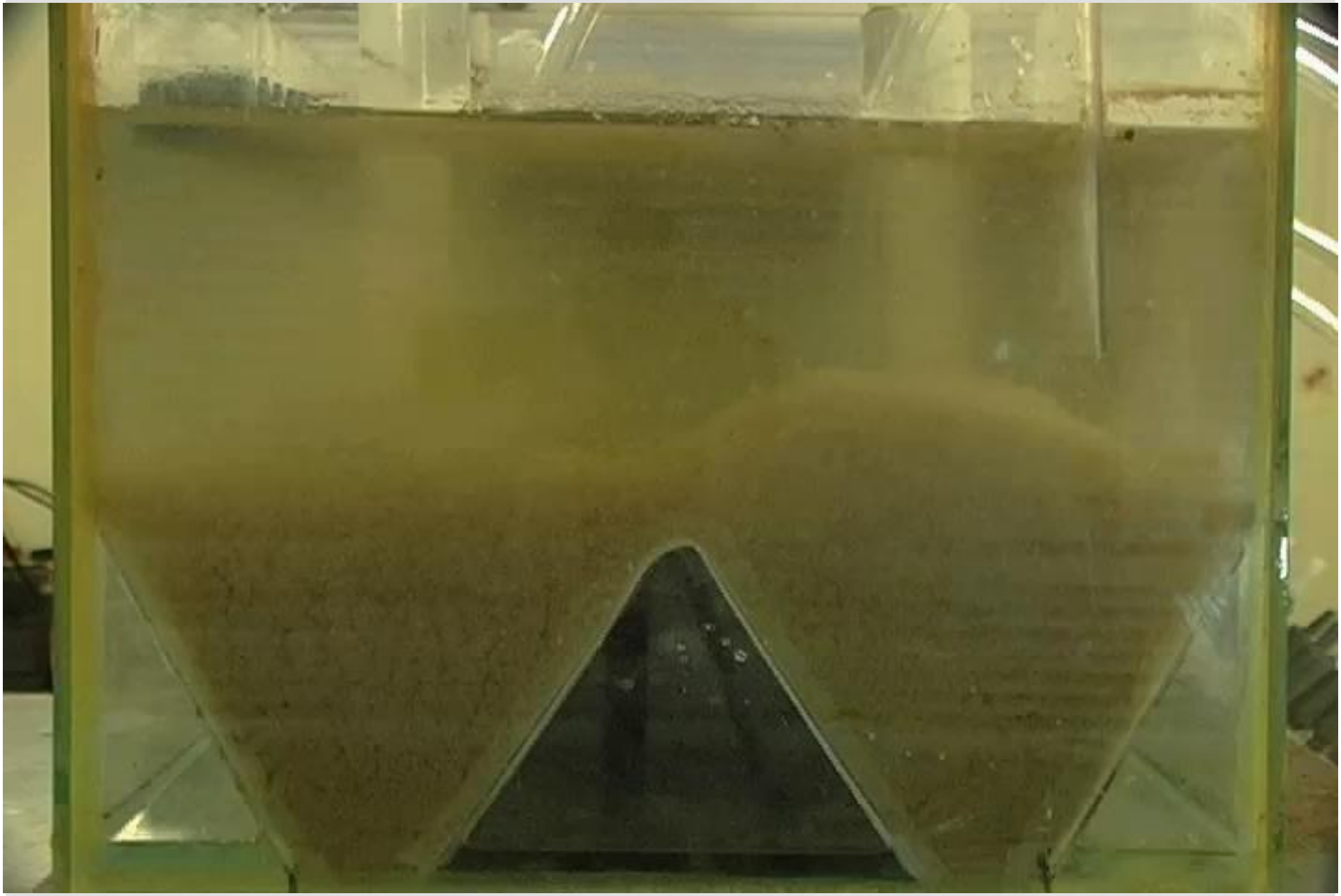


- Blanket Depth
- High blanket,
  less capacity
- Range: 20% to 30%
- Reduce blanket
  - RAS rate correct?
  - Too much biomass?

BOX # 25 **CLARIFIER:**
SLUDGE BLANKET < 30% WATER DEPTH



- Blanket Depth
- High blanket, less capacity
- Range: 20% to 30%
- Reduce blanket
  - RAS rate correct?
  - Too much biomass?

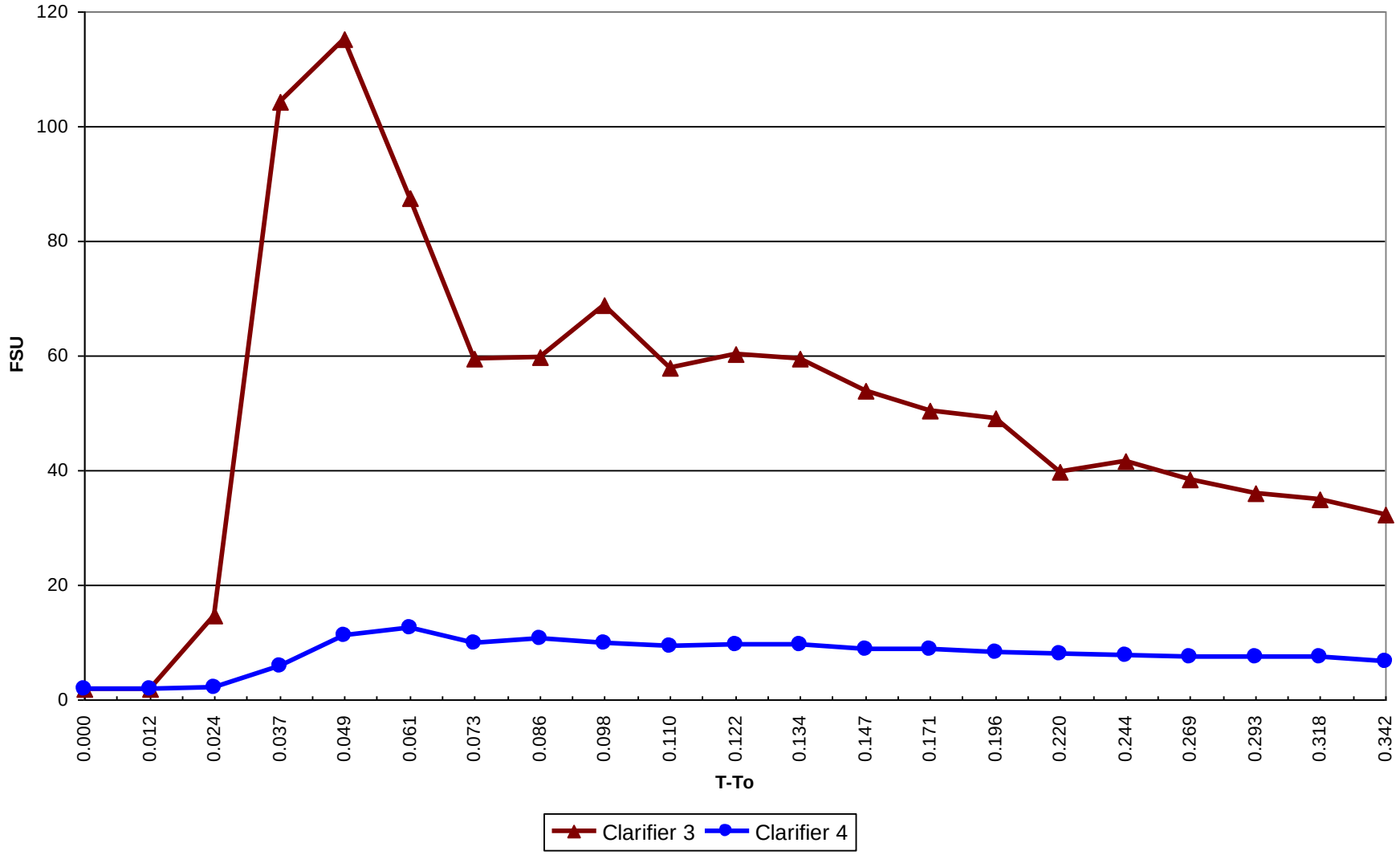


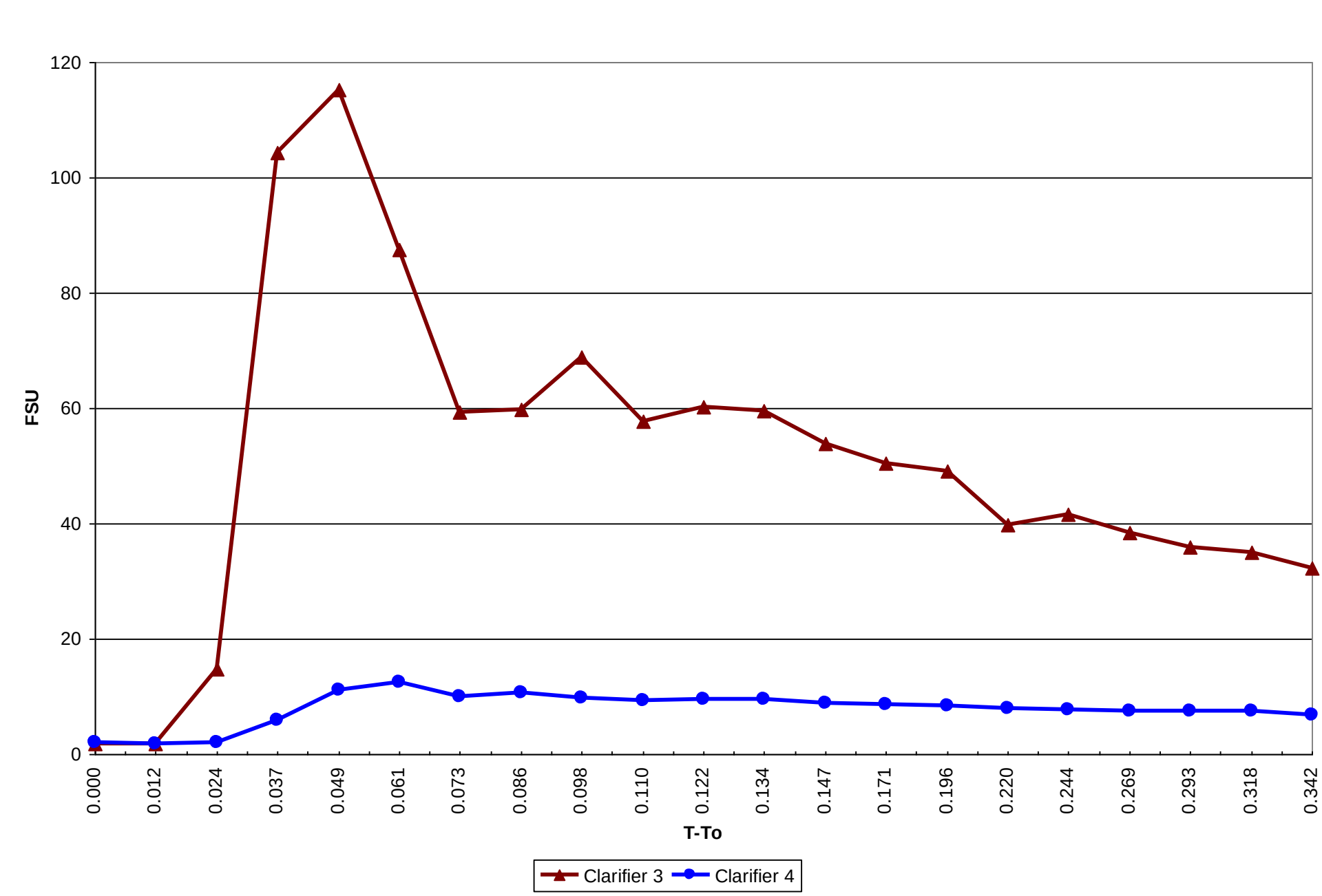
BOX # 25 **CLARIFIER:**
SLUDGE BLANKET < 30% WATER DEPTH

- Blanket Depth
- High blanket,
  less capacity
- Range: 20% to 30%
- Reduce blanket
  - RAS rate correct?
  - Too much biomass?

BOX # 27 **CLARIFIER: HYDRAULIC ISSUE IN CLARIFIER**

- Flow Splitting
- Density Currents
- Effluent Weir
  - Location
  - Elevation


120
100
80
60
40
20
0
FSU
0.000
0.012
0.024
0.037
0.049
0.061
0.073
0.086
0.098
0.110
0.122
0.134
0.147
0.171
0.196
0.220
0.244
0.269
0.293
0.318
0.342
T-To
Clarifier 3
Clarifier 4


120
100
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20
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FSU
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0.012
0.024
0.037
0.049
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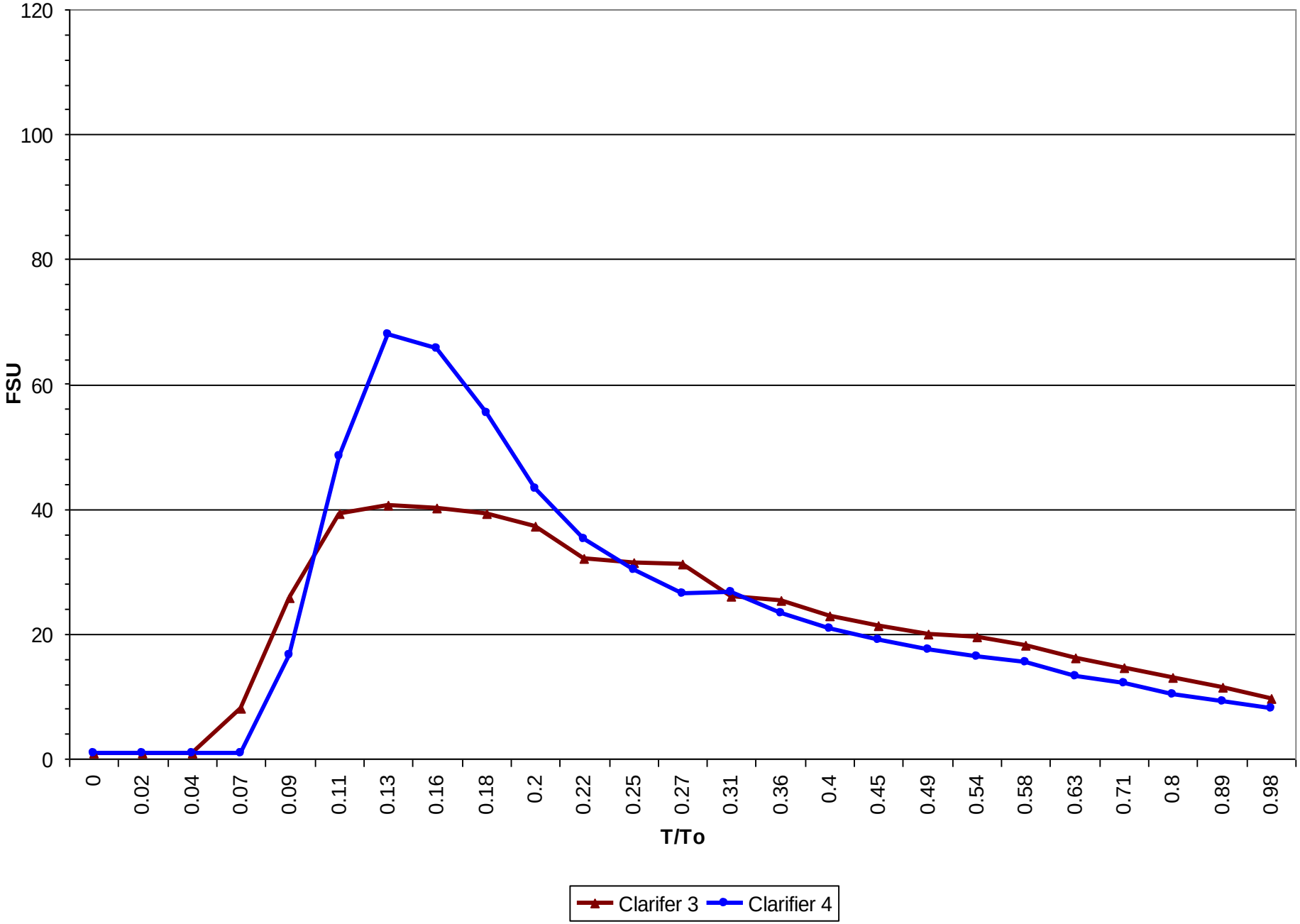
0.073
0.086
0.098
0.110
0.122
0.134
0.147
0.171
0.196
0.220
0.244
0.269
0.293
0.318
0.342
T-To
Clarifier 3
Clarifier 4


120
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0.09
0.11
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0.16
0.18
0.2
0.22
0.25
0.27
0.31
0.36
0.4
0.45
0.49
0.54
0.58
0.63
0.71
0.8
0.89
0.98
T/To
Clarifer 3
Clarifier 4

BOX # 27 **CLARIFIER: HYDRAULIC ISSUE IN CLARIFIER**

- Flow Splitting
- Density Currents
- Effluent Weir
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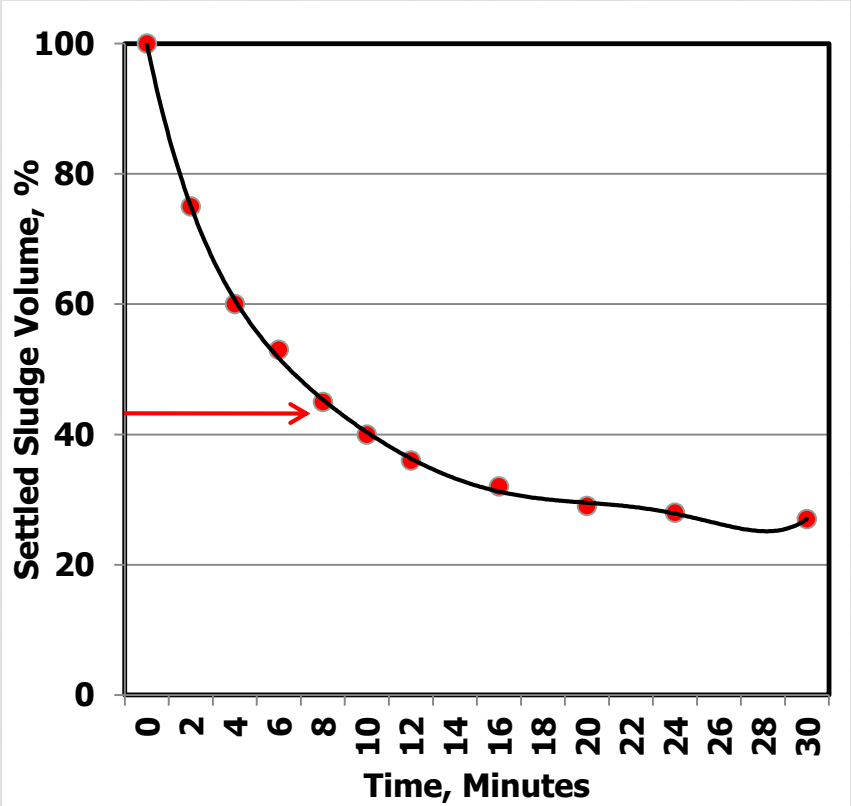
BOX # 27 **CLARIFIER: HYDRAULIC ISSUE IN CLARIFIER**

- Flow Splitting
- Density Currents
- Effluent Weir
  - Location
  - Elevation

BOX # 26 **CLARIFIER: RAS RATE CORRECT**



- RAS rate
  - Slow settling/slow rate
  - Fast settling/fast rate
- Chart settling rate
- Locate "knee"
- Spin Aeration & RAS
- Calculate
  - Increase/decrease
  - Adjust

CALCULATING CORRECT RAS RATE

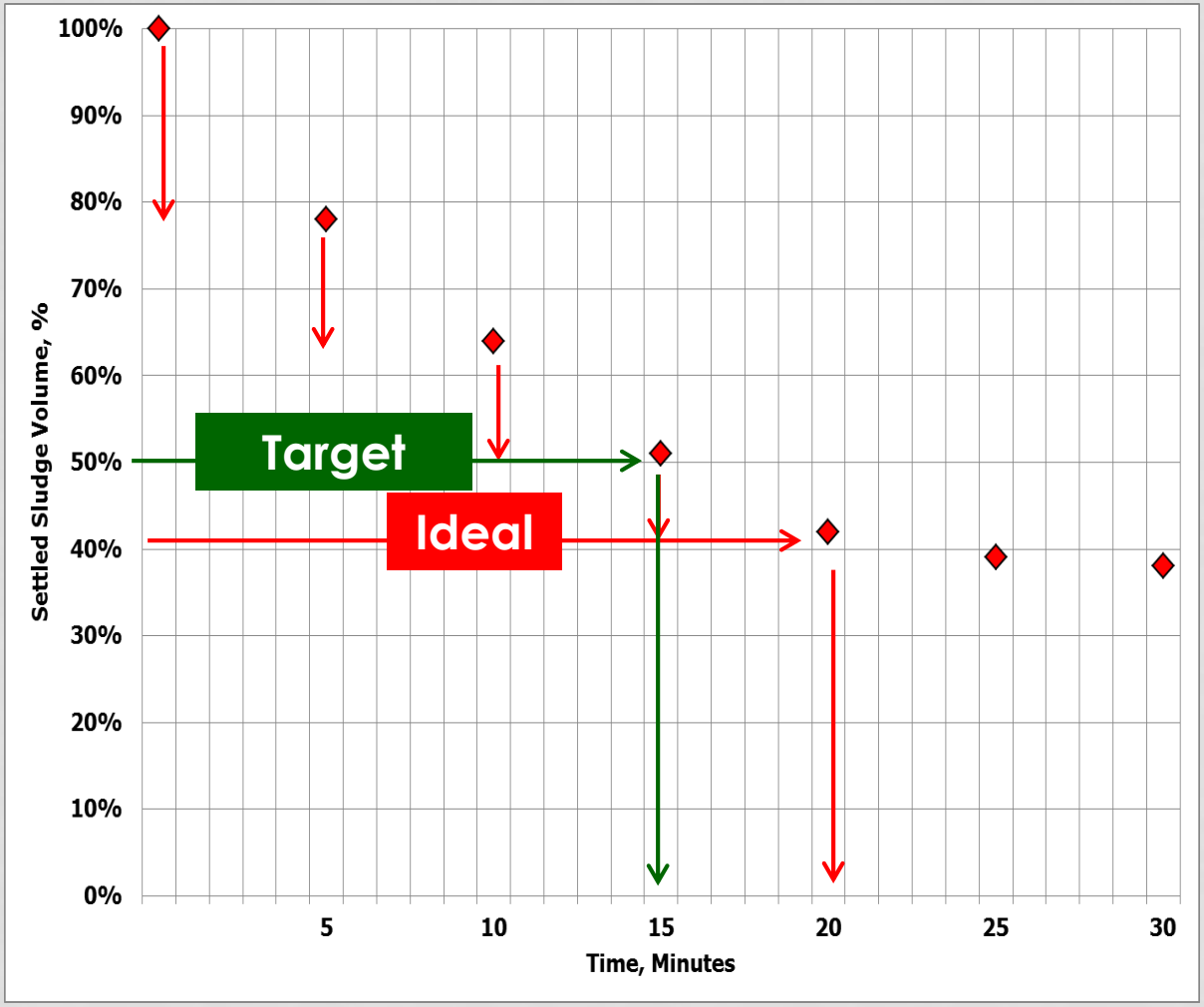
Spins:

AT = 3.2 %

Actual RAS = 8.8 %

Settleometer Results

Time,mins.	SS, %
0	100
5	78
10	64
15	51
20	42
25	39
30	38



CALCULATING CORRECT RAS RATE

Spins:

AT = 3.2 %

Actual RAS = 8.8 %

Target RAS = 6.3 %

Settleometer Results

Time,mins.	SS, %
0	100
5	78
10	64
15	**51**
20	42
25	39
30	38

Calculating Correct RAS Rate

1. Volume of Settleometer at start of analysis: 100

2. Aeration Tank Spin 3.2

3. Settled RAS volume (from Chart) 51

Target RAS Spin: 6.3%

$$\frac{100 \times 3.2}{51} =$$

What adjustment is required to the RAS?

BOX # 29 **CLARIFIER: SOR OR SLR > DESIGN CAPACITY**

- SOR
  - Surface overflow rate
- SLR
  - Solids loading rate

BOX # 29 **CLARIFIER: SOR OR SLR > DESIGN CAPACITY**

"Ten States Standards" Clarifiers
=1000 gpd/ft^2

- SOR
  - Surface overflow rate

Clarifier: 90 ft diameter
= 6361 ft^2

Flow Rate 4.6 mgd

$$\frac{4.6 \text{ mgd}}{6361 \text{ ft}^2} = 723 \text{ gpd/ft}^2$$

BOX # 29 **CLARIFIER: SOR OR SLR > DESIGN CAPACITY**

Ten States Standards Clarifiers
=35 lbs./d/ft^2

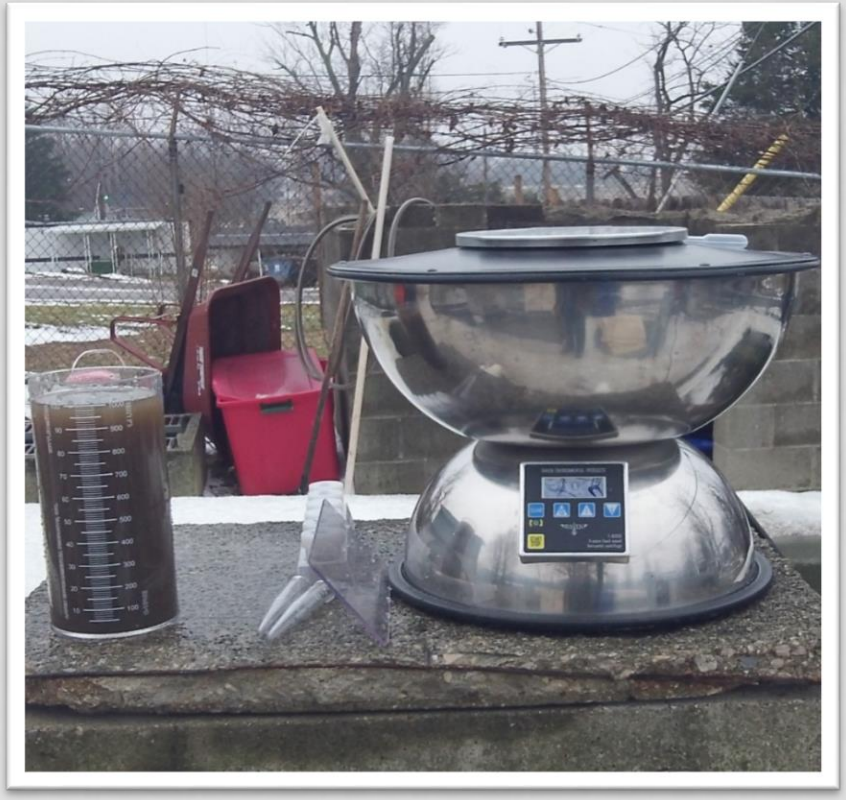
- SLR
  - Solids loading rate

Clarifier	6361 ft^2
MLSS	3,250 mg/L
Inf. Flow	4.6 MGD
RAS Flow	2.3 MGD

$$\frac{3{,}250 \times 6.9 \times 8.34}{6361\ ft^2} =$$

29.4 lbs./d/ft^2

BOX # 28 **CLARIFIER: ADJUST RAS RATE**



- Evaluate Rate
- RAS_{spin} 2 x to 3 x AT_{spin}
- RAS_{spin} 4 x AT_{spin}
  - Possible
  - Problems can occur
- Confirm with Core

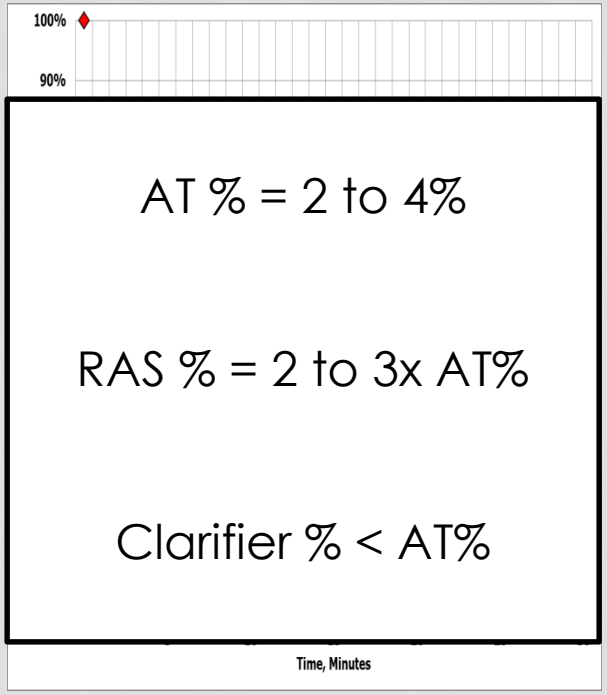
EVALUATE CORRECT RAS RATE

Spins:

AT = 3.2 %

Actual RAS = 8.8 %

Target RAS = 6.3 %



Evaluate Correct RAS Rate

Compare ratio of AT, RAS and Clarifier Spins

Typical Spin Ratios

RAS% 2 to 3 x greater than AT%

RAS > 2x could be RAS too slow

Clarifier % greater than AT % ?

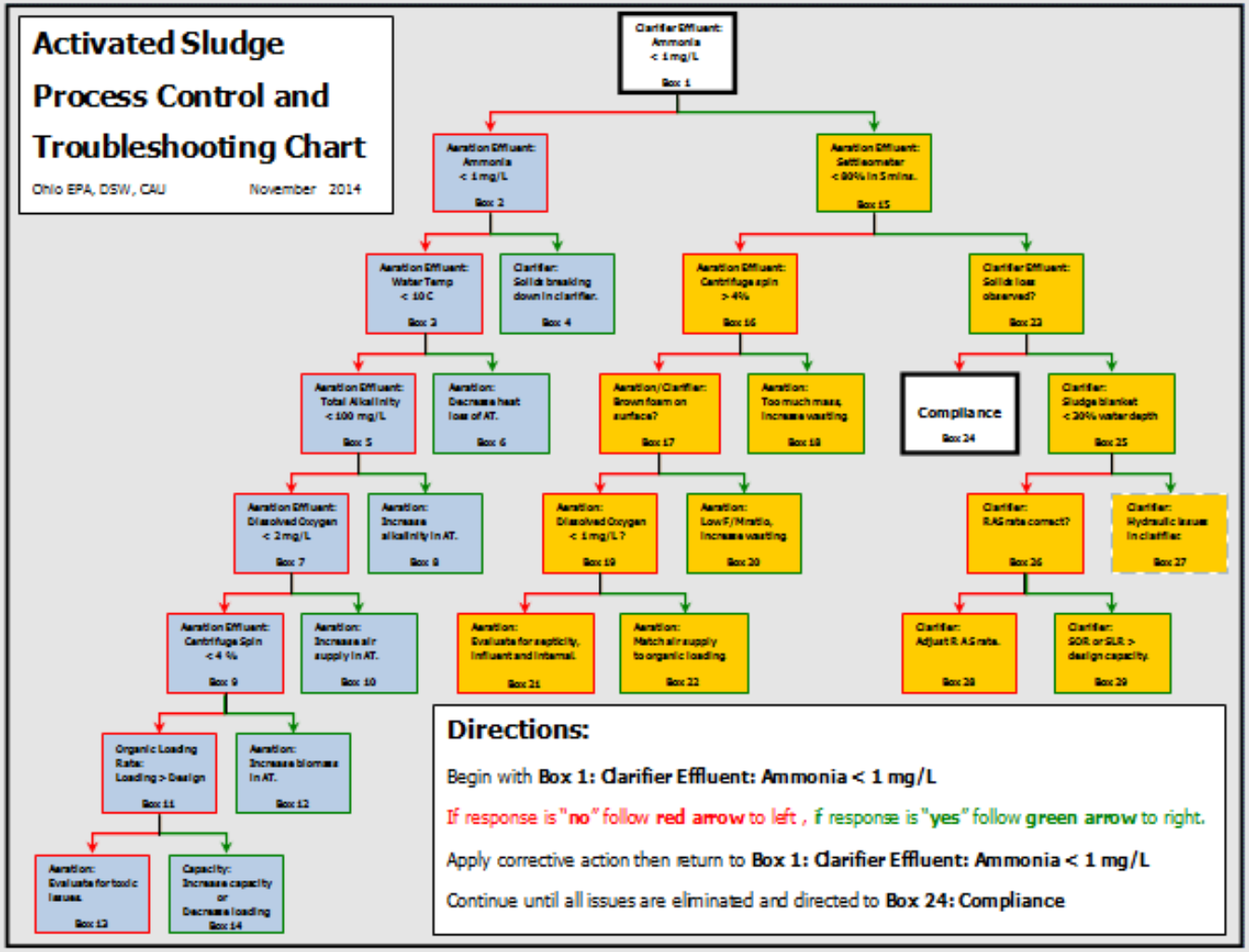
indicates solids stored in clarifier

RAS too slow

Too much mass in system

Develop a trend for "standard" operations, evaluate periodically, calculate if necessary

ACTIVATED SLUDGE PROCESS CONTROL



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Activated Sludge Process Control and Troubleshooting Chart

Or email me at: jon.vandommelen@epa.ohio.gov

ACTIVATED SLUDGE PROCESS CONTROL

TROUBLESHOOTING CHART