

SETTLEOMETER TEST

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RETURN SLUDGE CONTROL

Easy!

Quick results

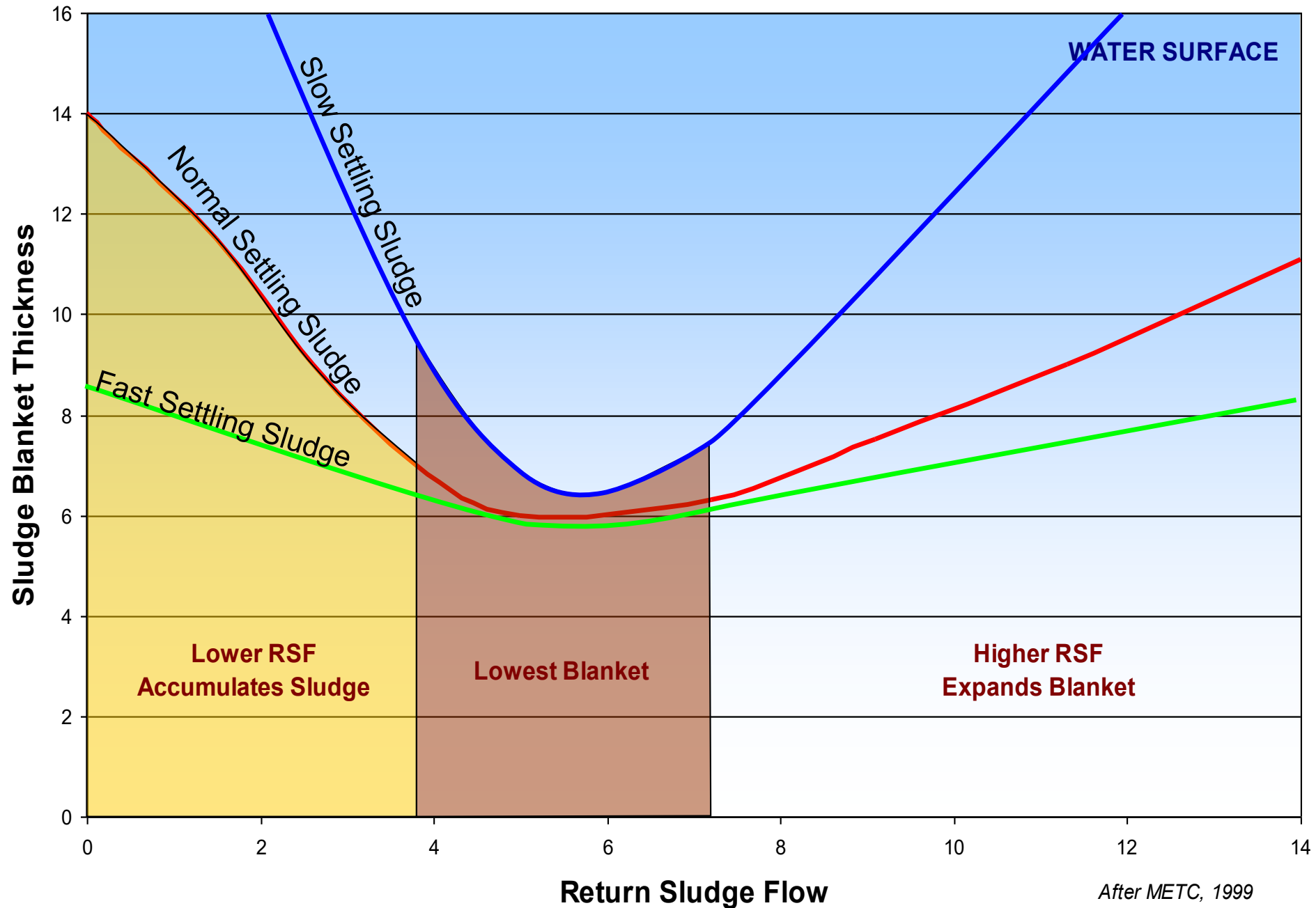
RAS Rates are usually too high –

Turning RAS down benefits:

- Reduced Clarifier Solids Load
- Increased Time for Microbes to Work
- Allows for Lower MCRT

How low should it go?

BLANKET THICKNESS VS RAS FLOW



SETTLEOMETER TEST

PURPOSE

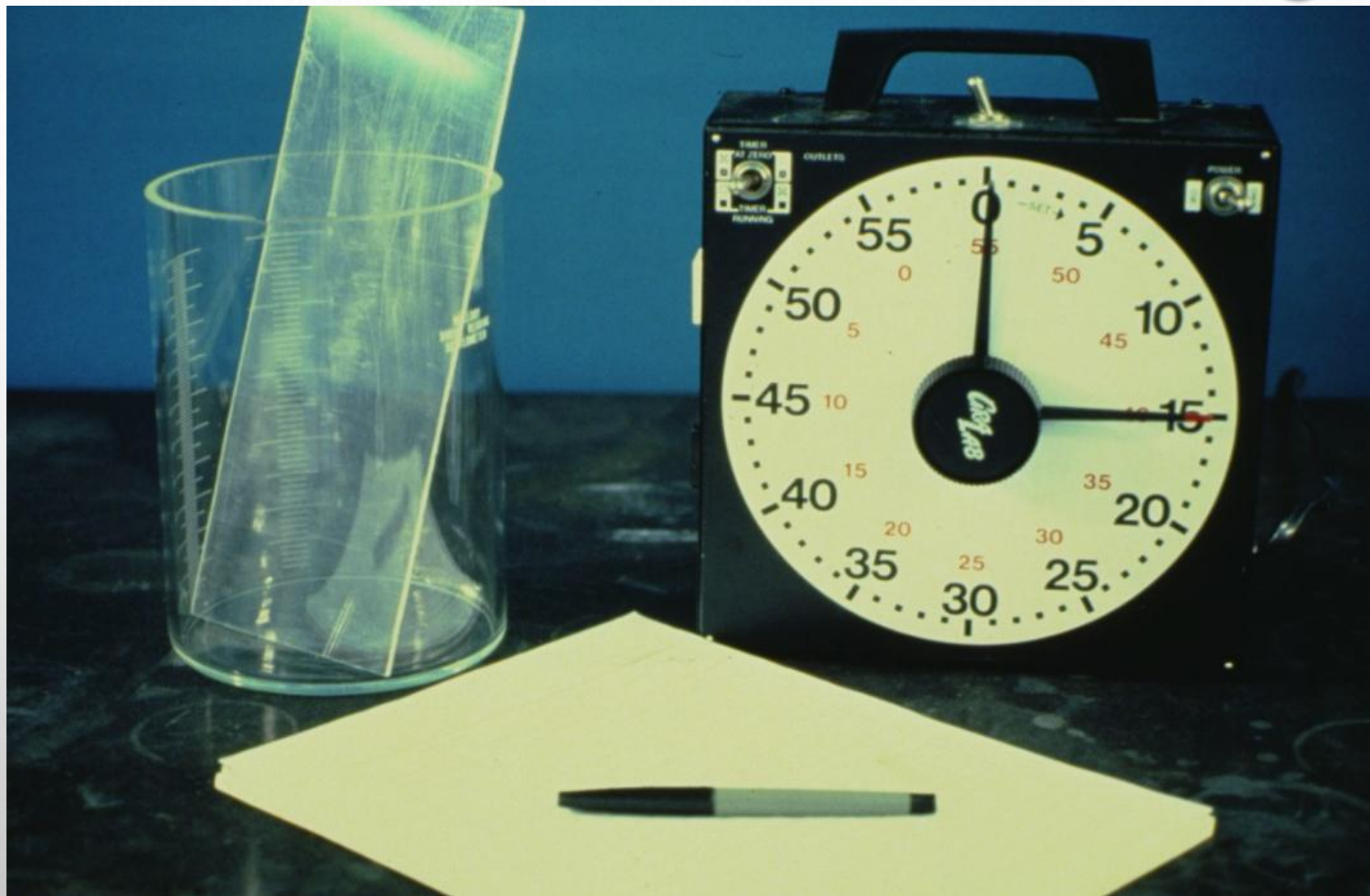
- Determine Mixed Liquor Settleability Under Optimum Settling Conditions
- Determine Settling Rate, Use to Set RAS Rate
- Observe Sludge Characteristics
- Observe Effluent Characteristics
- Estimate Denitrification Potential
- Compare Settleometer to Actual Clarifier Conditions

SIMULATE CLARIFIER CONDITIONS



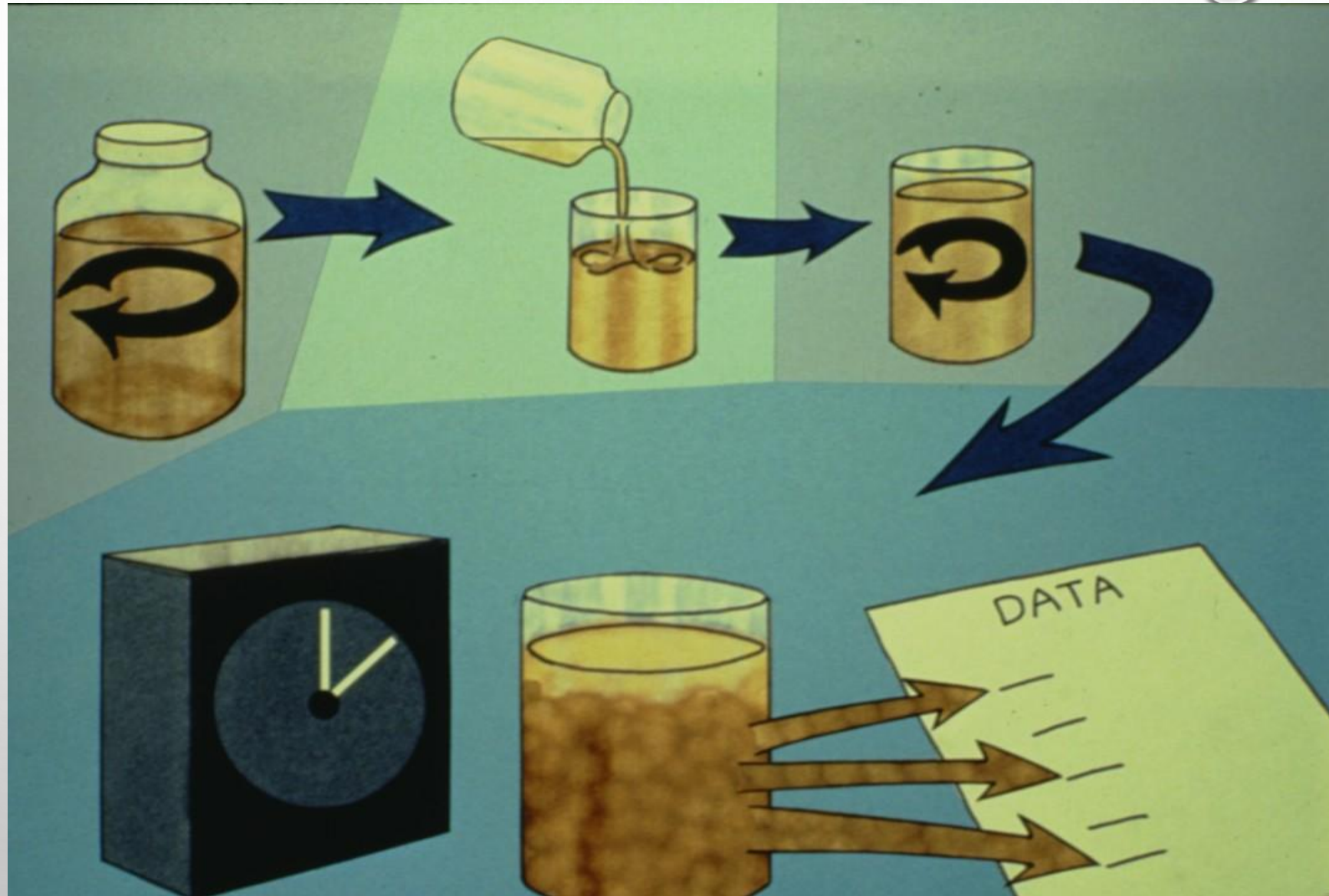
REQUIRED EQUIPMENT

- Mallory Settleometer with Paddle
- Timer
- Data Recording
- MLSS Sample



PROCEDURE

1. Collect MLSS Sample
2. Pour into Settleometer
3. Gently Mix
4. Stop All Motion
5. Observe & Record
 - Every 5 Min for first 30
 - Every 10 Min for next 30
 - Every 15 min Until POP



OBSERVATIONS

1. Settled Sludge Volume (SSV)
2. Settled Sludge Concentration (SSC)
 $SSC = (1000 * MLSS) / SSV$
3. Floc Characteristics
4. Supernate Quality
5. Blanket Character

PLOT

1. Settled Sludge Volume (SSV)
2. Settled Sludge Concentration (SSC)

Settleometer Bench Sheet

$$SSC = (1000 * MLSS) / SSV$$

$$SVI_{30} = SSV_{30} \times 1000 / MLSS$$

Time + Date: _____
Operator: _____

SVI ₃₀	RAS Tgt

TIME (MIN)	SSV	SSC (MG/L)
0	MLSS→	
5		
10		
15		
20		
25		
30		
40		
50		
60		
75		
90		
105		
120		

OBSERVATIONS

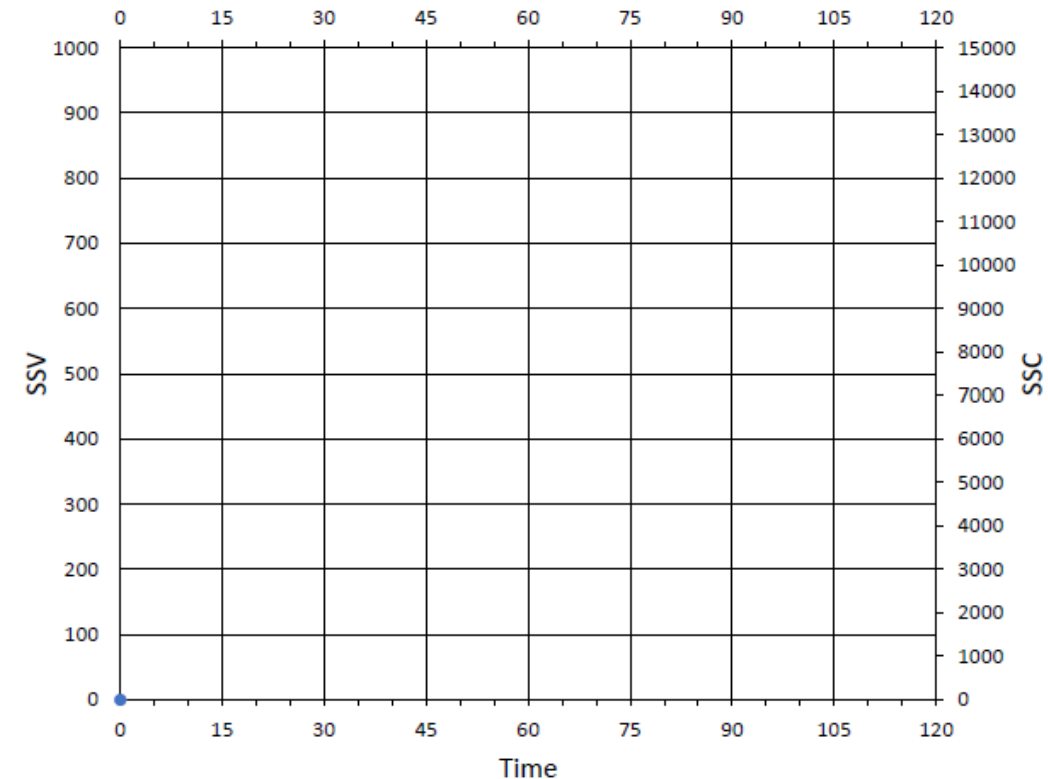
Floc: _____

Blanket: _____

Supernate: _____

Directions:

Record Settleometer Data every 5 minutes for the first 30 minutes, 10 minutes for the next 30 minutes, and 15 minutes for the next 60. Plot the data in the chart below, find the "knee" of the SSC curve. The "knee" is the RAS TSS Target Concentration



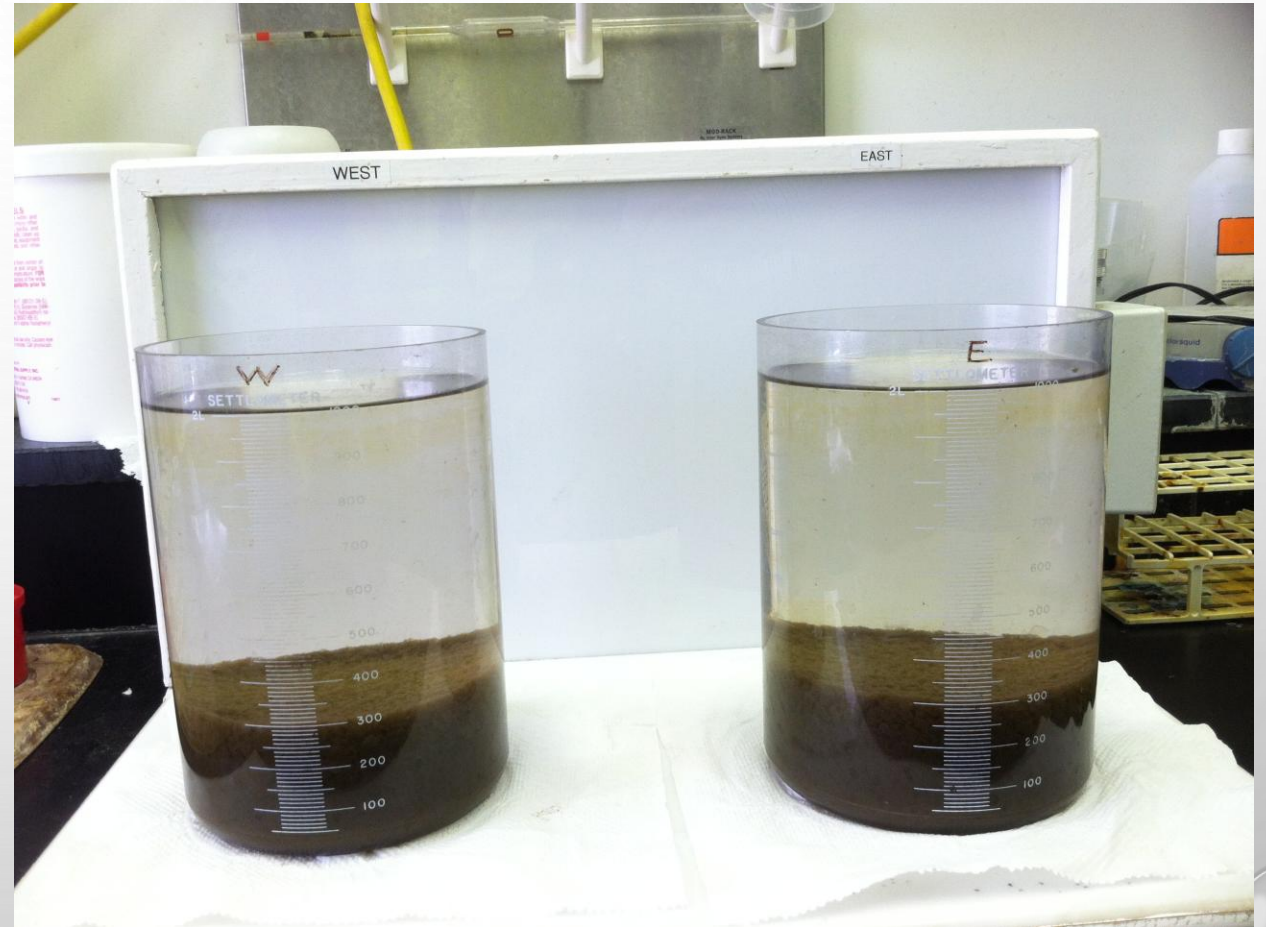
SAMPLING

- Most Representative Location
 - Between Aeration Tank and Clarifier
 - As Close to the Clarifier as Possible
- Do Not Let DO Go to Zero!
 - Do Not Denitrify Before the Settleometer Test
- Collect at Least 2 Liters



WHERE TO PERFORM THE TEST?

- Where Settleometer Values are Easily Observed
- Out of Direct Sunlight
- Away From Hot or Cold Air Flows
- On a Stable Surface That Will Not Vibrate
- Where Temperature Remains Relatively Stable
- White Background Helps with Supernate Visualization
- Easy Cleanup Area



GENTLY MIX SAMPLE



GENTLY FILL SETTLEOMETER

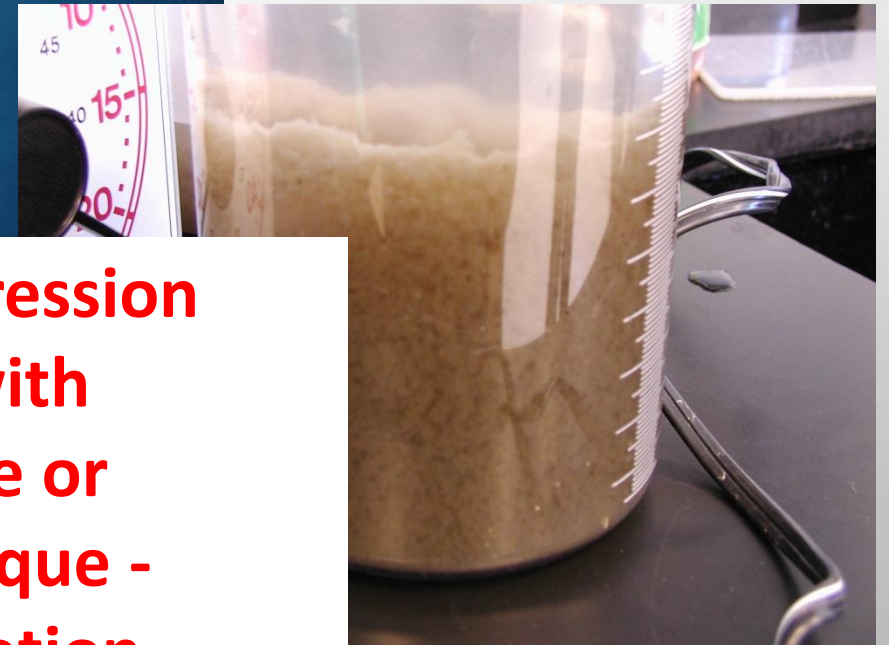


Gently Mix Back and Forth To Uniform Concentration



**NO TWISTING MOTION,
Back & Forth Only**

**Center depression
only seen with
bulky sludge or
poor technique -
Twisting Motion**



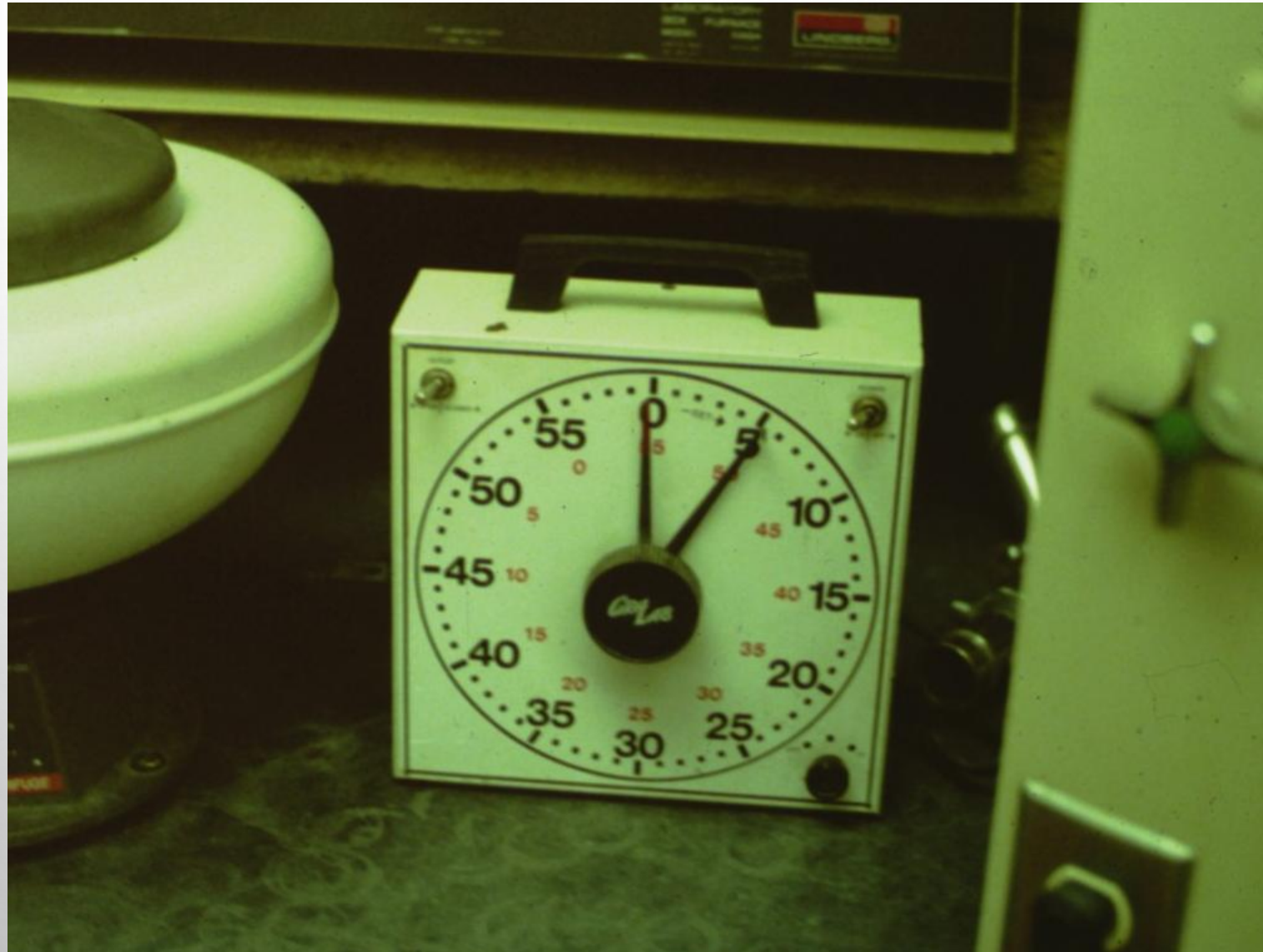
Stop All Liquid Motion



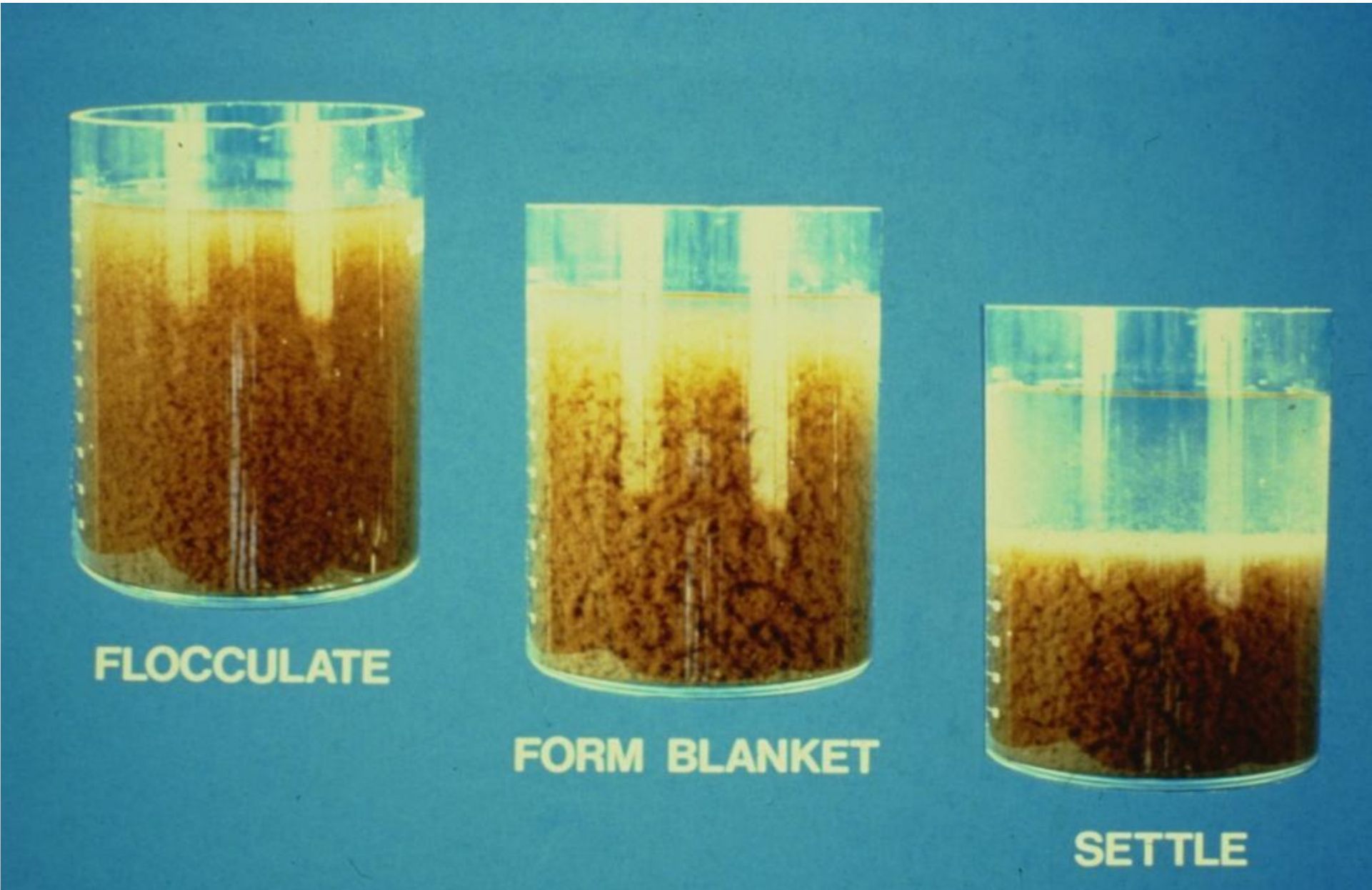
Remove Stirrer



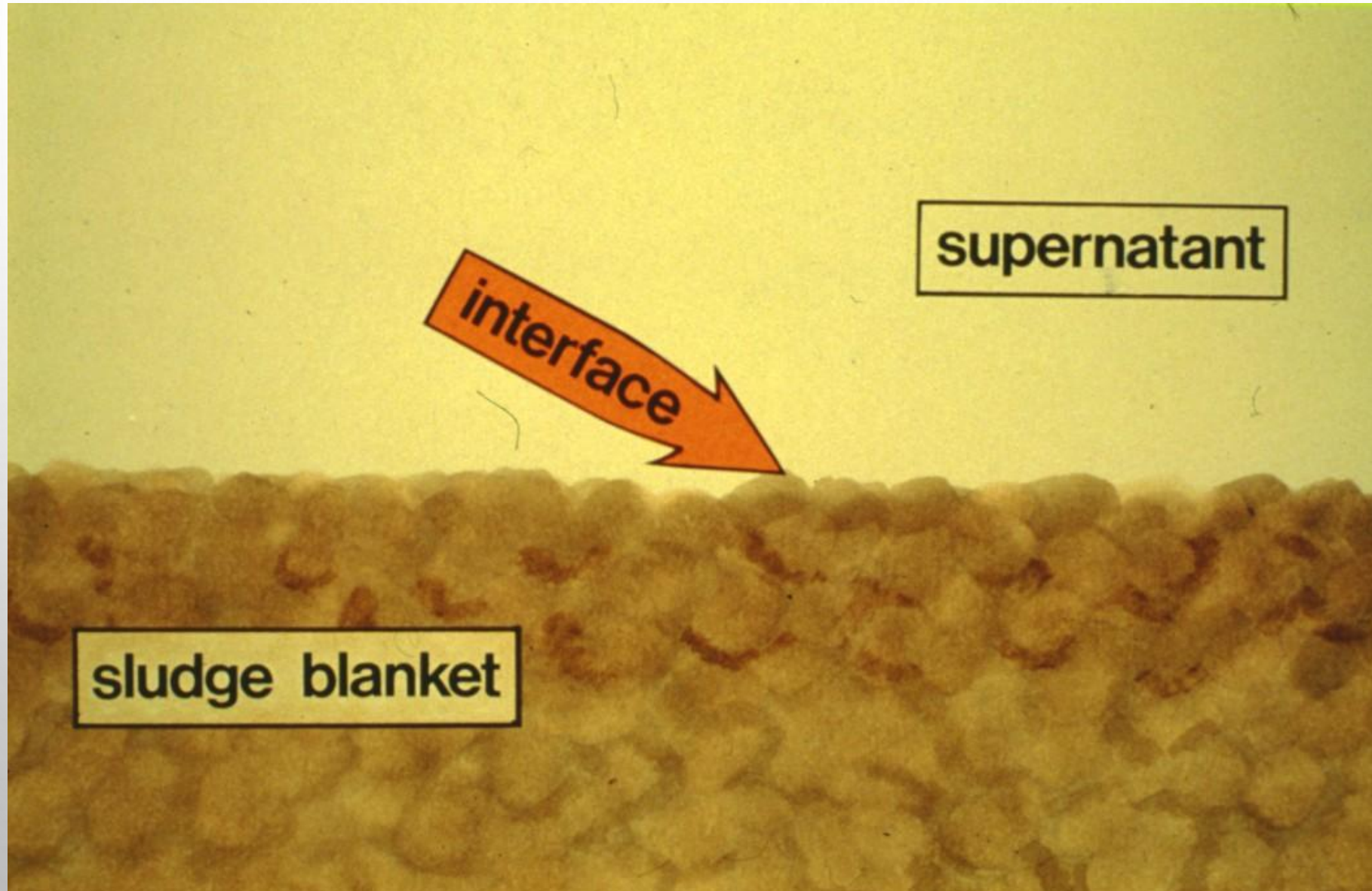
Set Timer & Go!



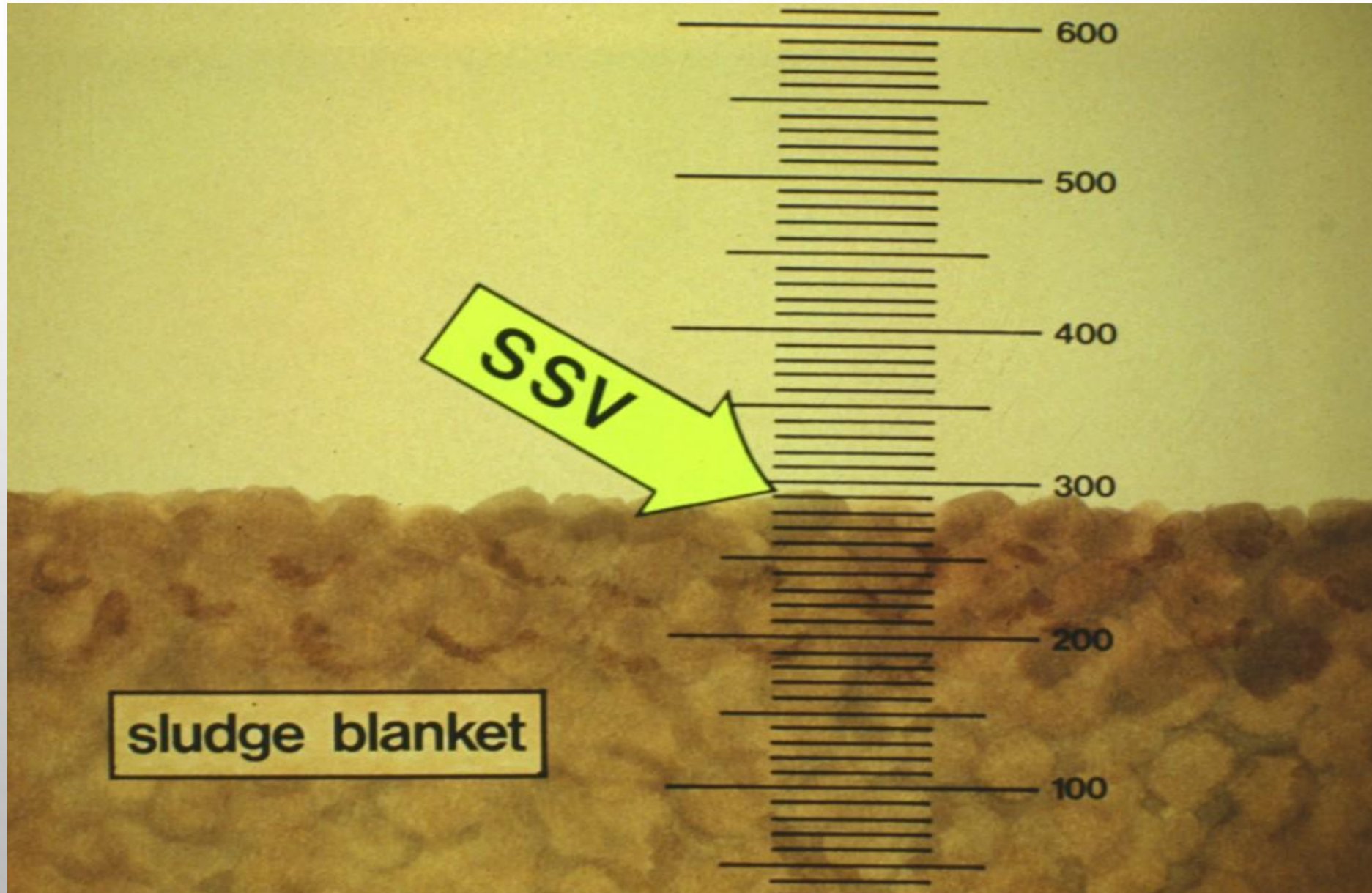
Settling Phases



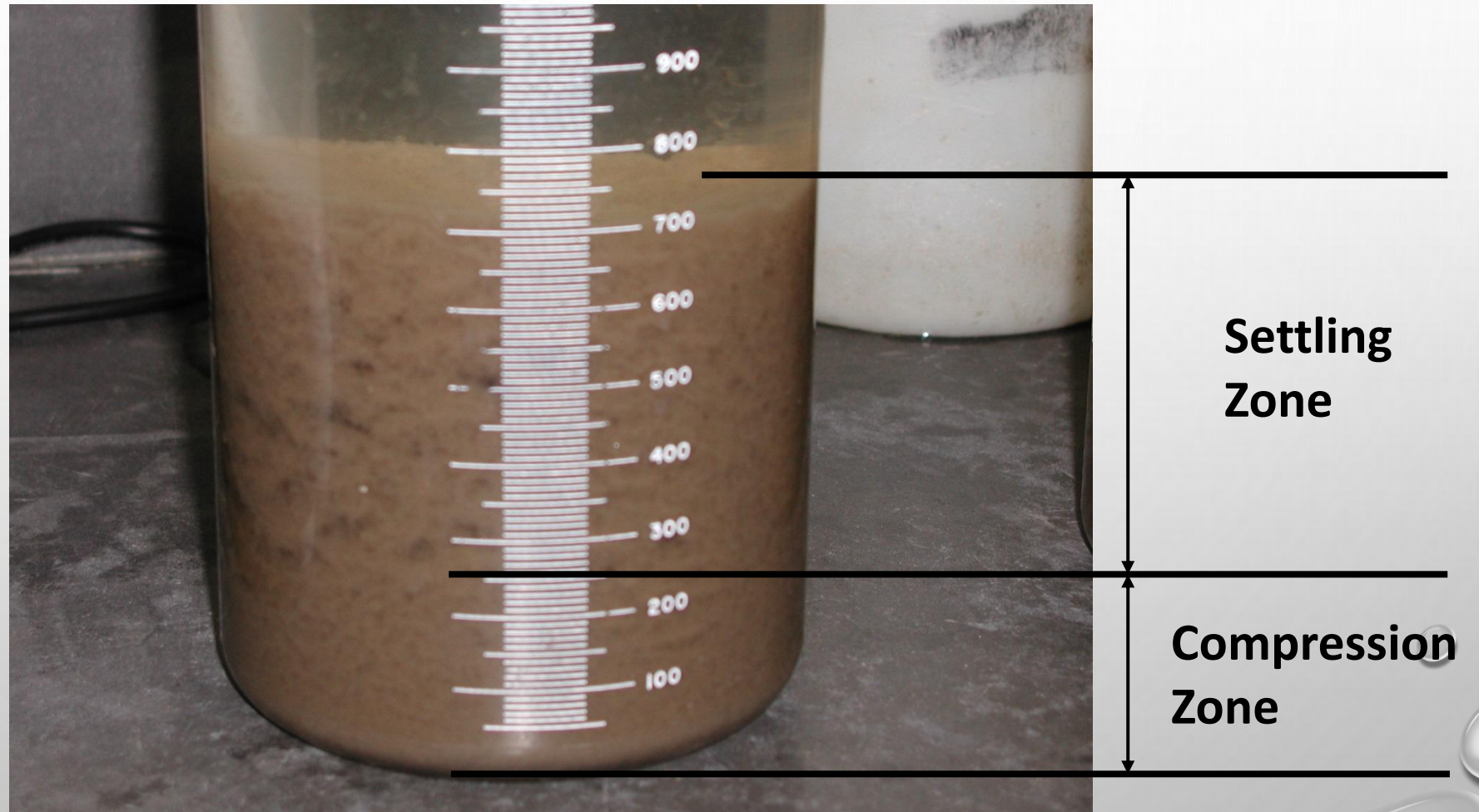
Blanket Formation



Sludge Blanket

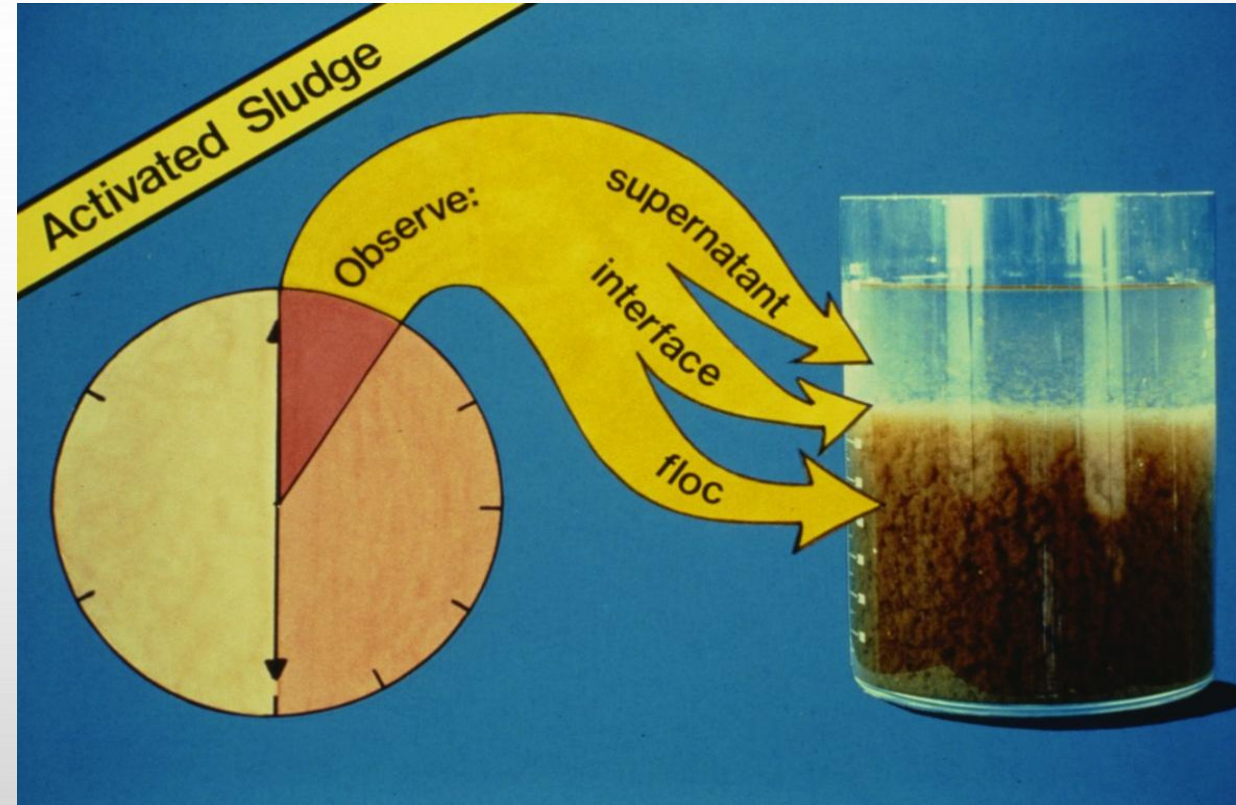


COMPRESSION ZONE FORMATION - BOTTOM OF BLANKET -

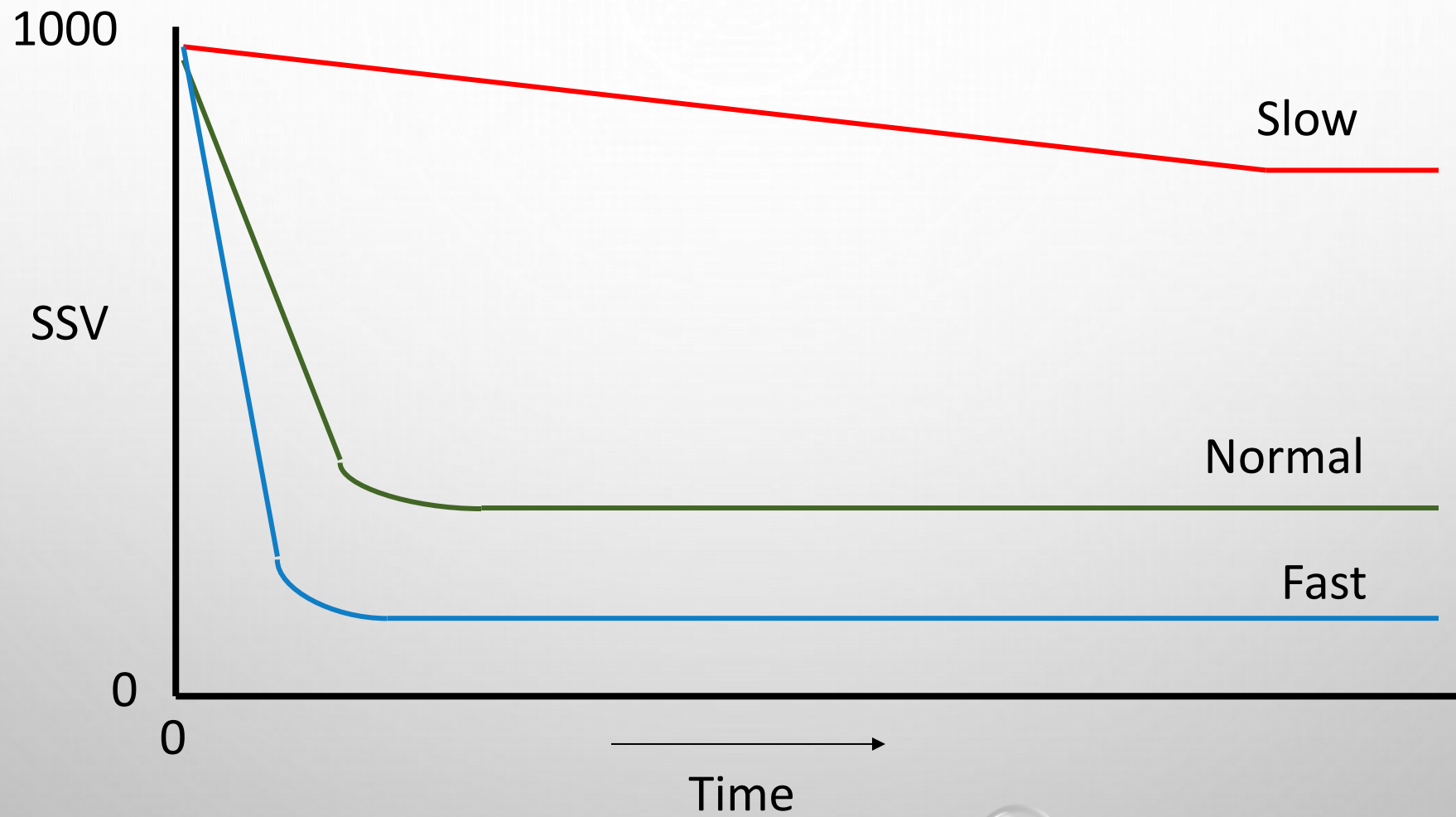


OBSERVATION TIMES

- Every 5 minutes for the first half-hour
- Every 10 minutes for the second half-hour
- Every 15 minutes after the first hour until settling and compaction is completed



SETTLING CURVE

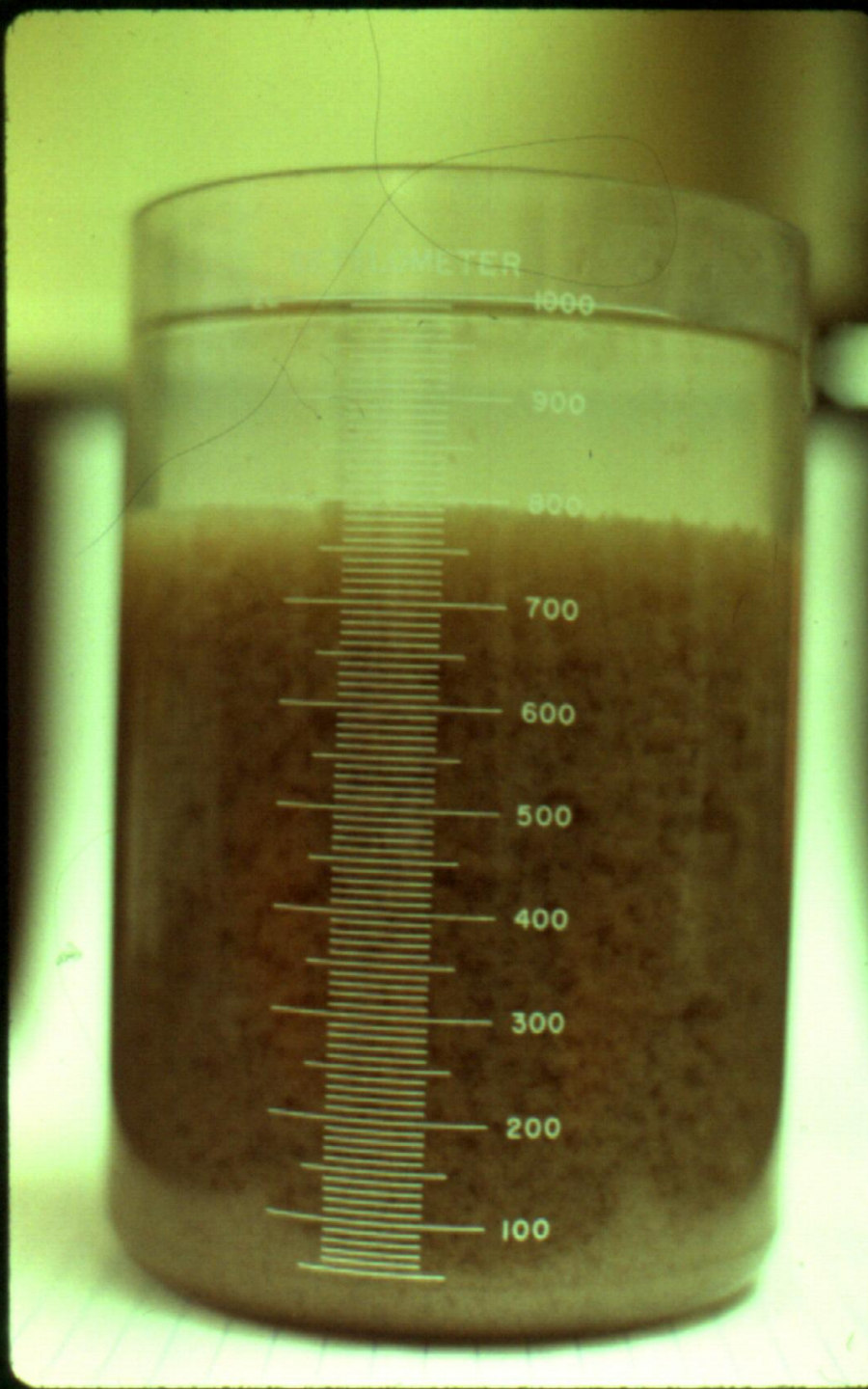




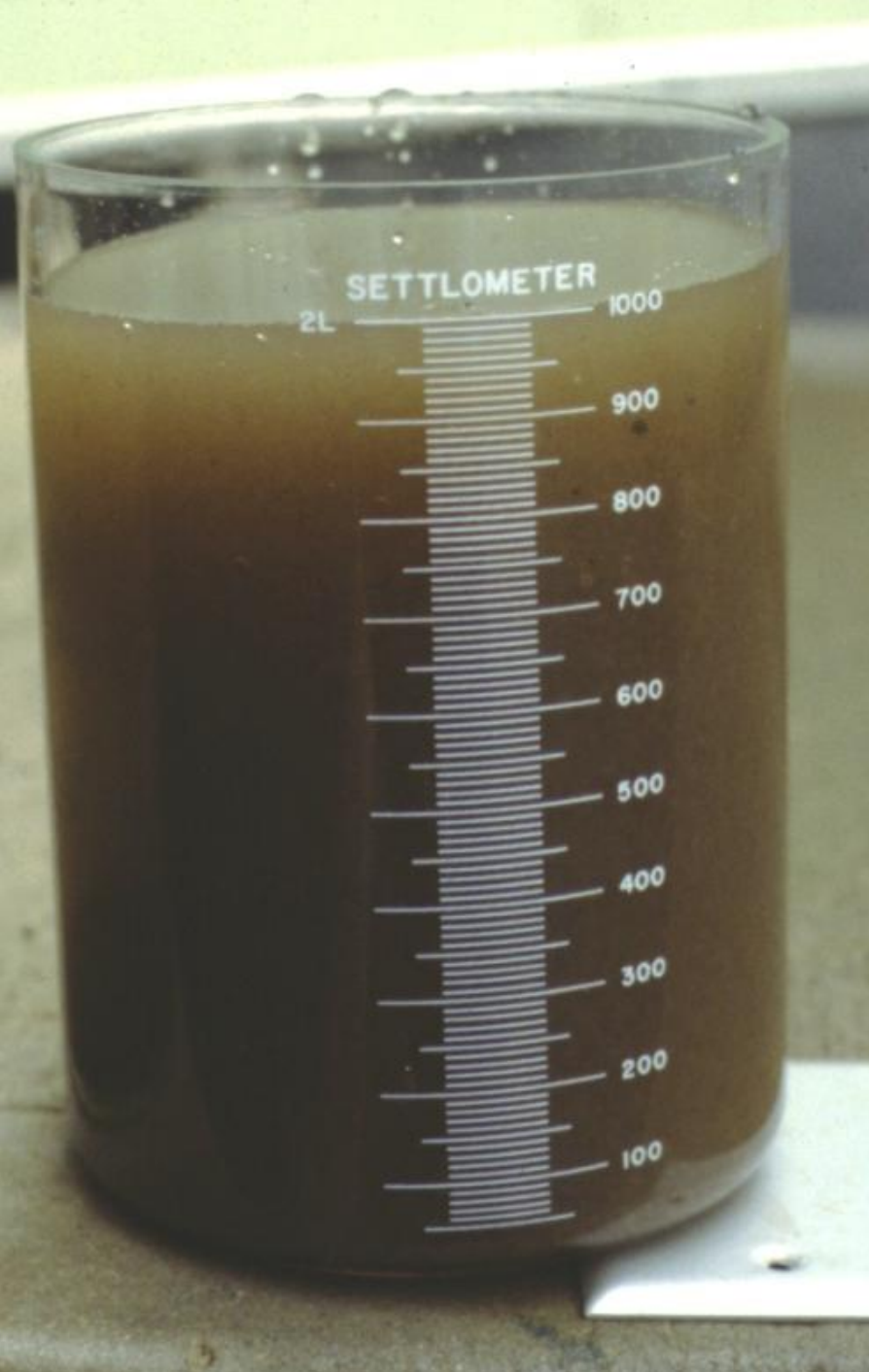
DIFFERENT TYPES OF FLOC

- Flocculant Biological Floc
- Nonflocculant Biological Floc
- Chemically Flocculated

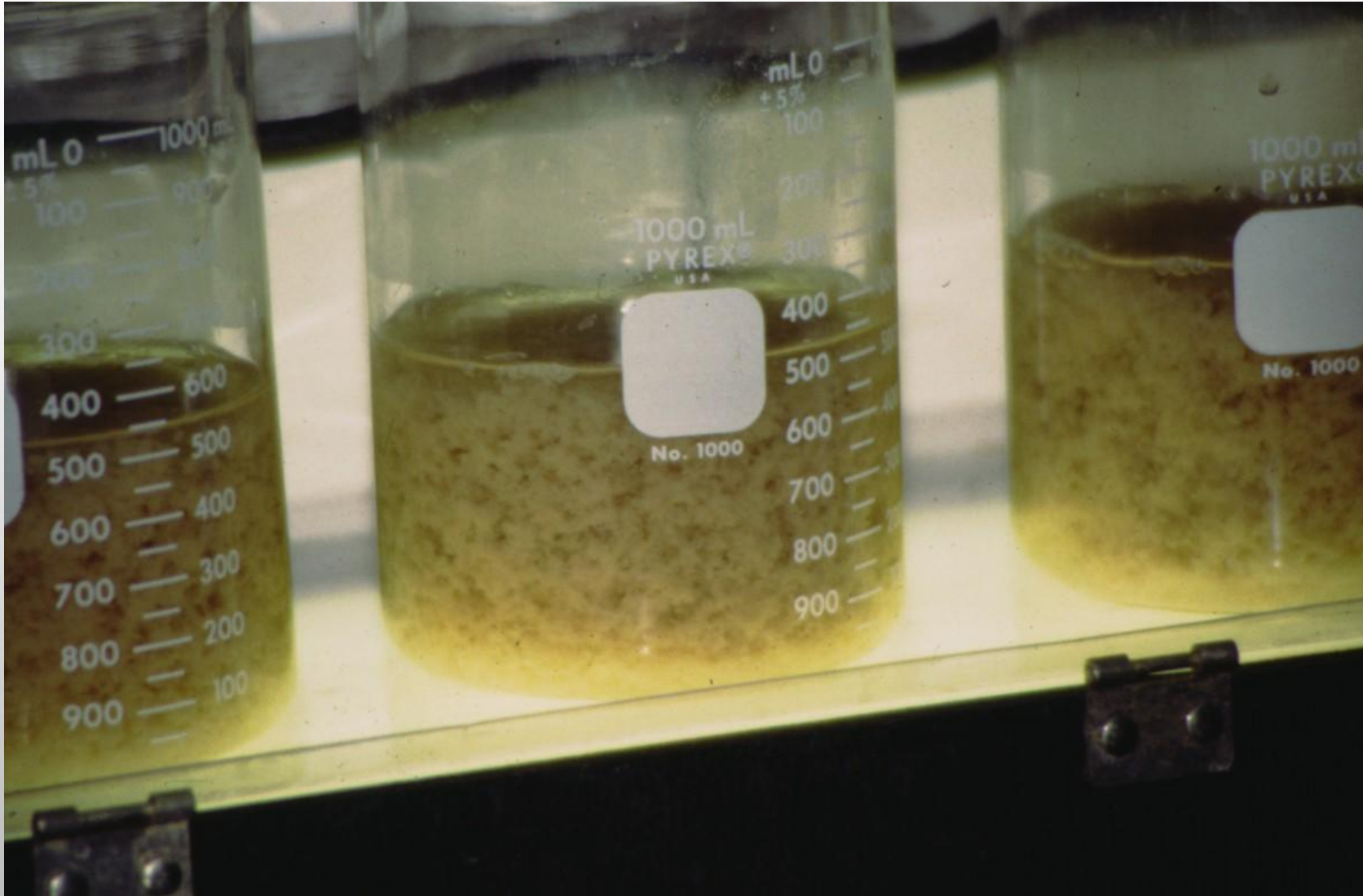
FLOCCULANT



BIOLOGICAL NONFLOCCULANT



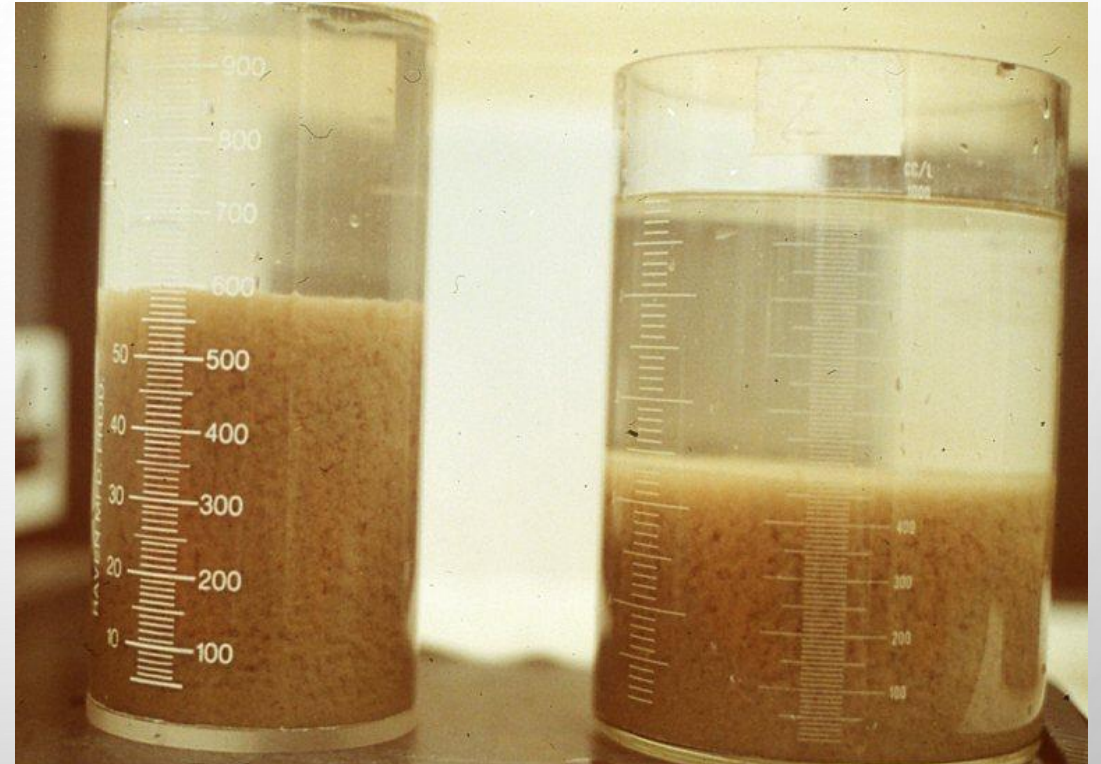
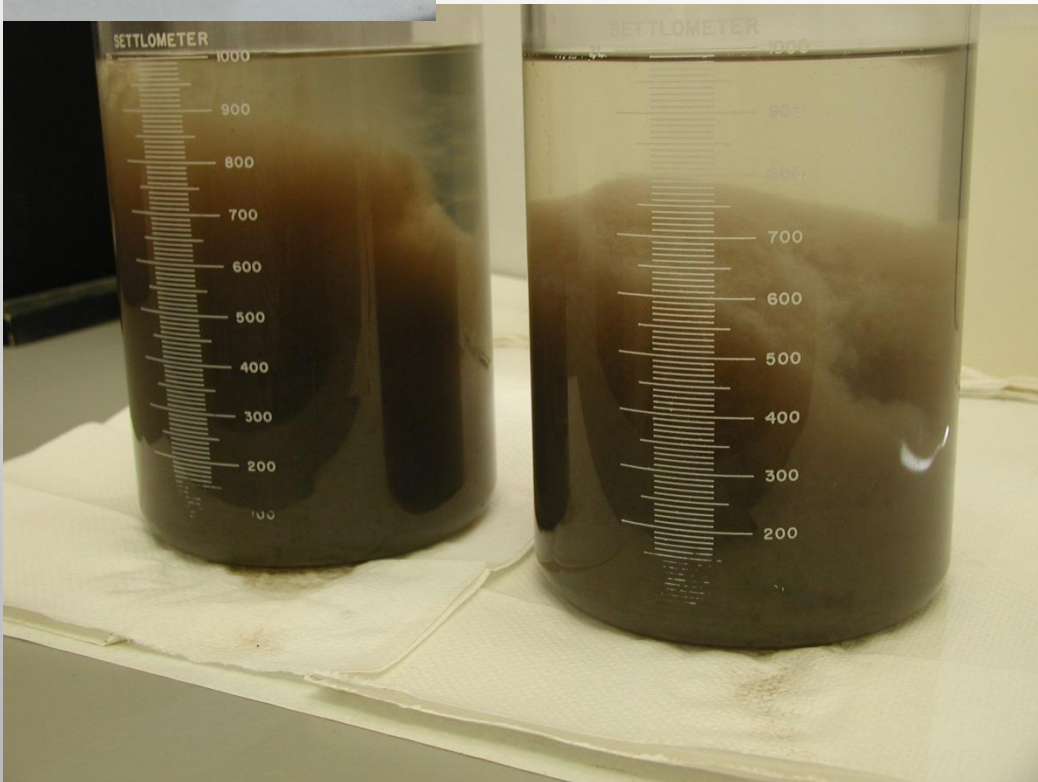
CHEMICALLY FLOCCULATED



INTERFACE

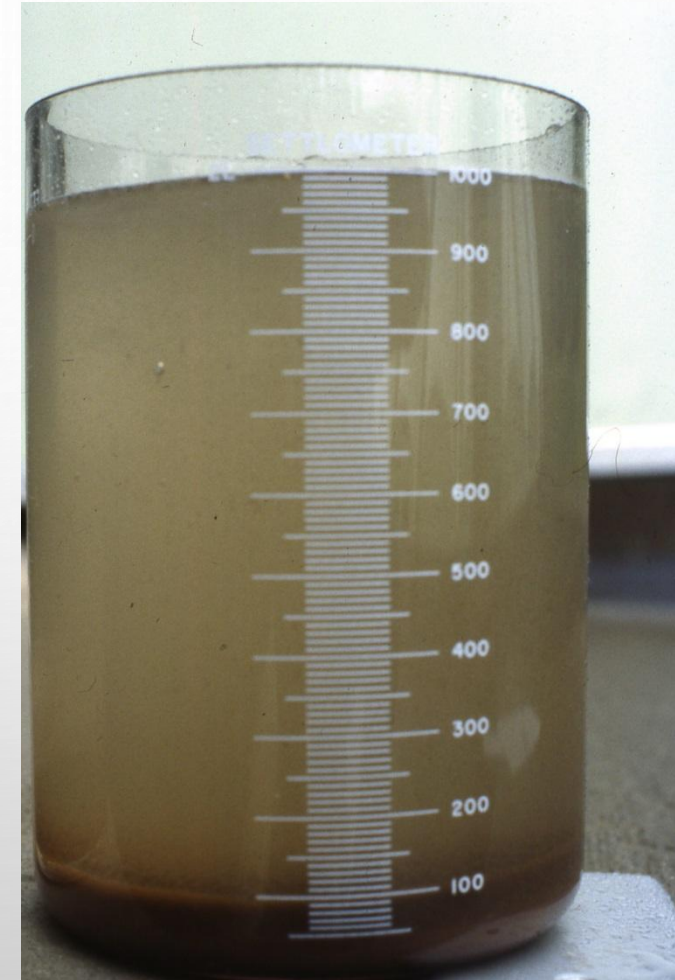
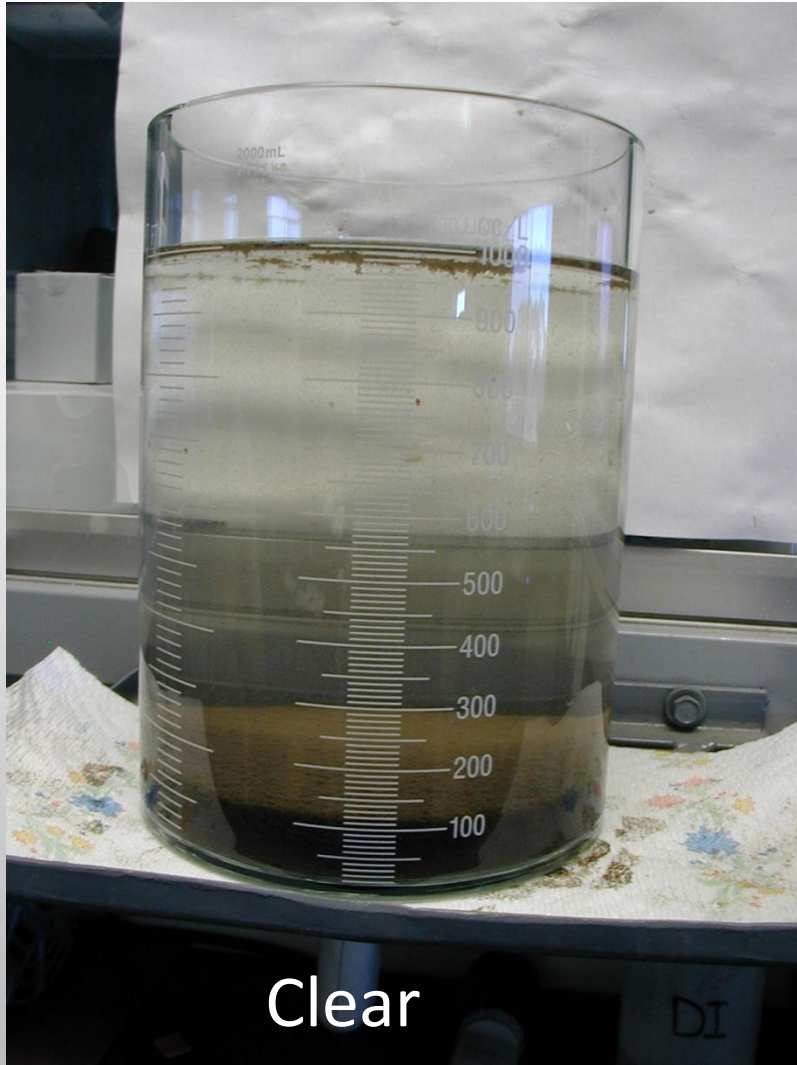


**Poorly
Defined**



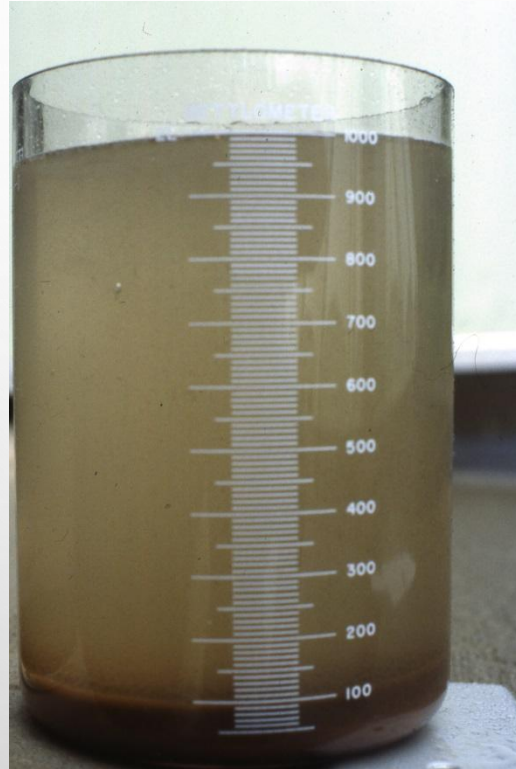
Well Defined

SUPERNATANT TURBIDITY

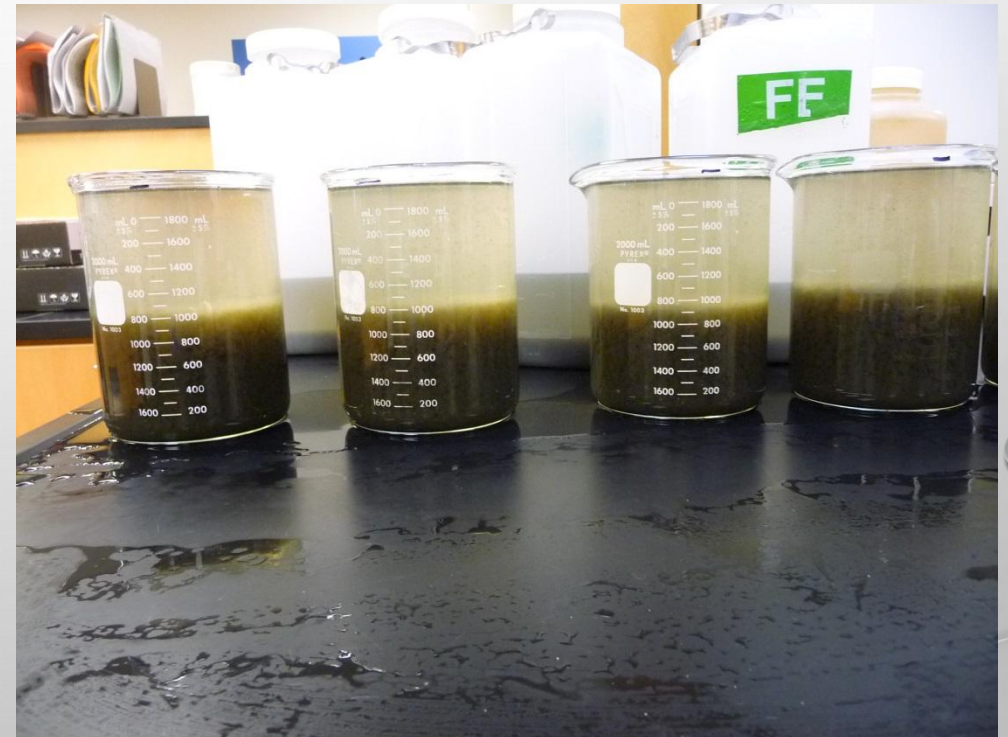


CAUSE OF TURBIDITY

Pin floc – very small, pin-point
Old, over-oxidized sludge,
worse with DN



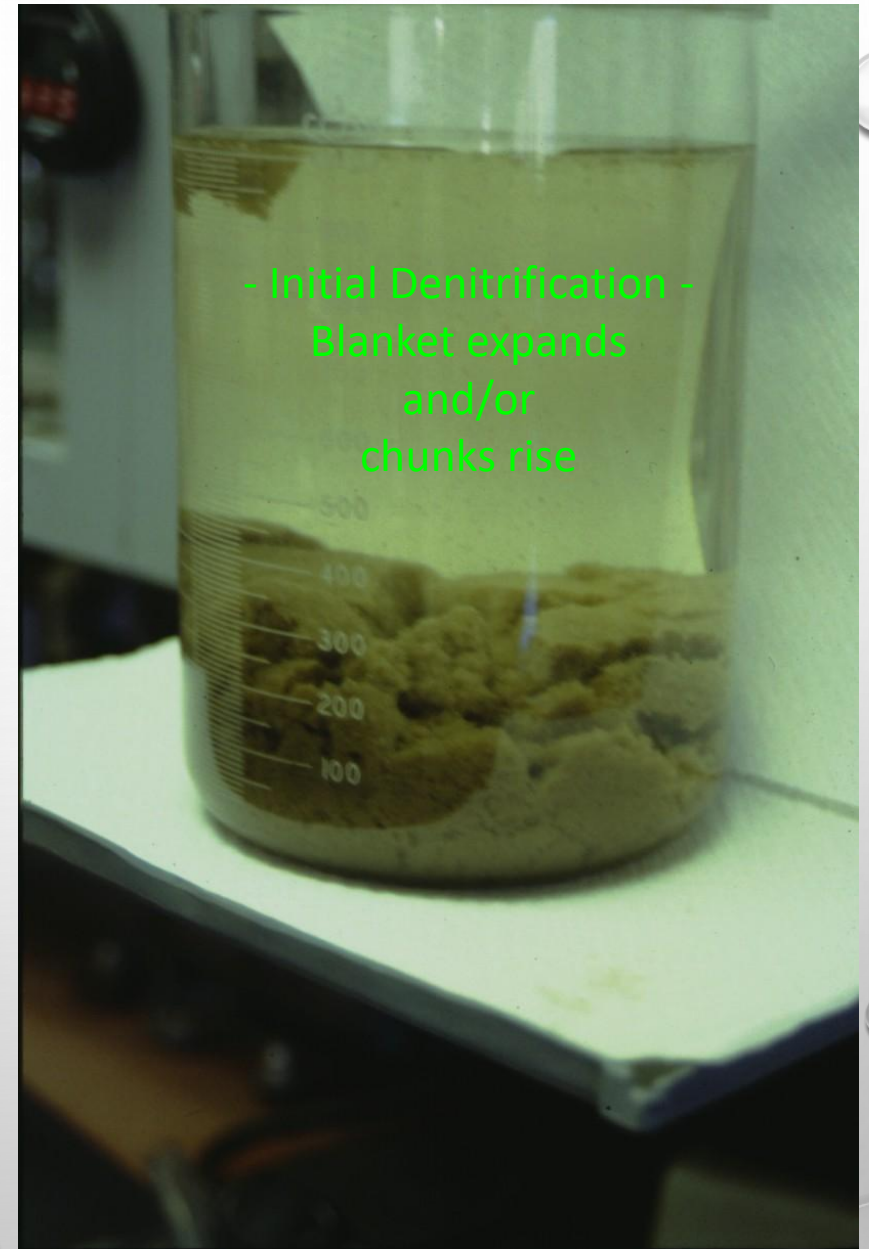
Individual cells –
Microscopic
Very fast growth,
toxicity,
heavy surfactant load



Straggler floc – large
Fast growth or
filamentous

TEST DURATION

- Leave settleometer until either the
 - Blanket expands/rises or
 - 4 hours time reached



QUICK TEST: TURBIDITY IN SETTLEOMETER VS CLARIFIER

- Run settleometer and final clarifier turbidities
- If not equal:
 - Denitrification?
 - Sludge quality change between aeration tank and clarifier?
 - Hydraulic conditions within the clarifier?
 - Density currents
 - Directional currents
 - Poor flocculation

QUICK TEST: TURBIDITY IN SETTLEOMETER VS CLARIFIER

- Run turbidity on clarifier effluent sample
- Let the sample sit for 30 minutes
- Run the turbidity on the settled sample
 - Poor off any scum and do not mix any settled material
- Settled = Unsettled
 - Turbidity is due to a sludge quality problem
- Settled < Unsettled
 - Clarifier problem is adding to the initial turbidity

DILUTED SETTLEOMETER TEST

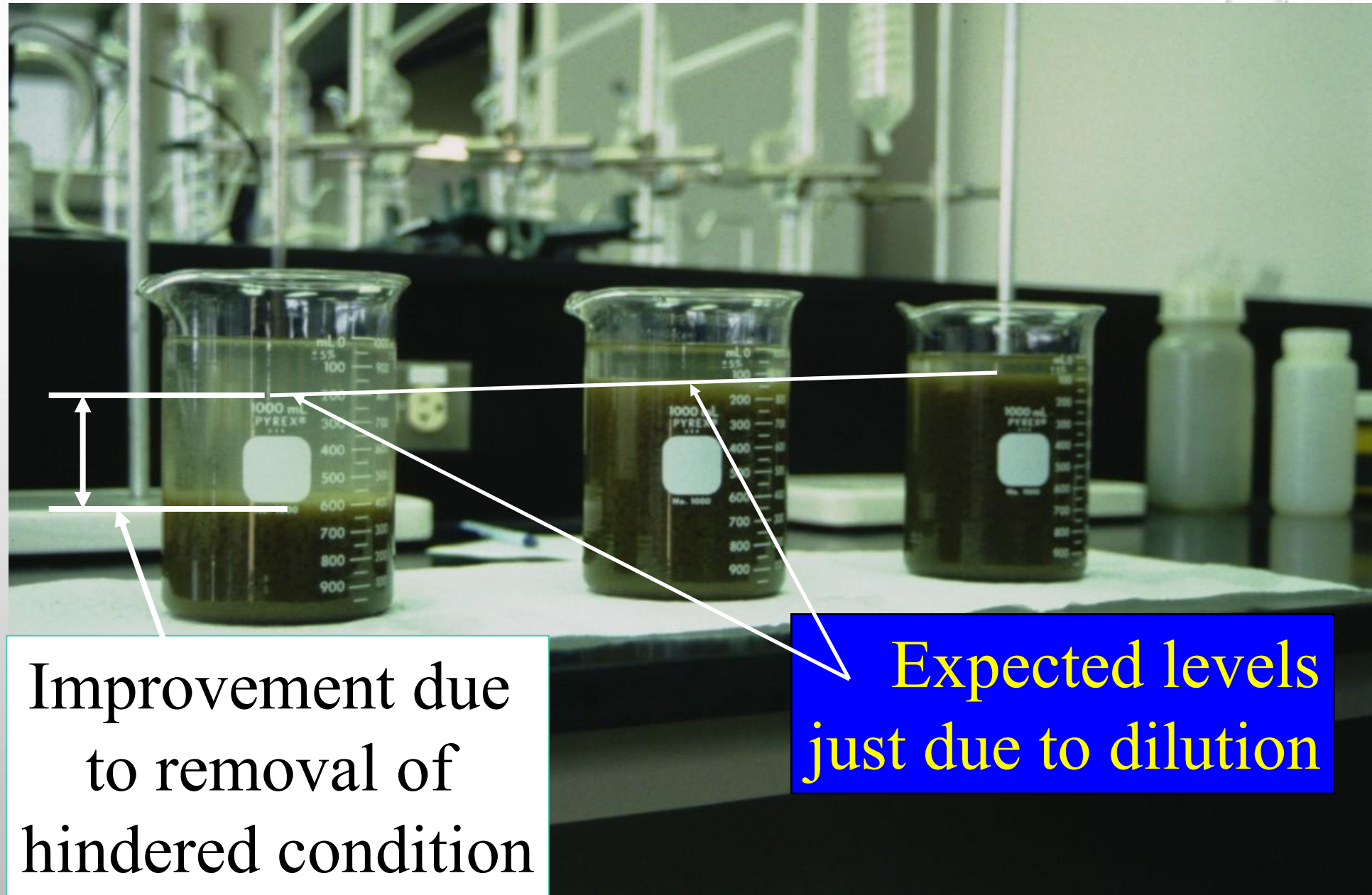
Determination:

- Bulking
- Too much 'old' sludge
- Three containers (beakers OK)
 - #1 – 100% mixed liquor
 - #2 – 75% mixed liquor, 25% final effluent
 - #3 – 50% mixed liquor, 50% final effluent

ANALYSIS OF DILUTED TEST

- Little or no improved settling observed
 - Sludge is bulky
 - Requires control of specific filaments or slime
- Significantly improved settling in #3 or #2 and #3
 - Too much over oxidized (old) sludge
 - Significantly increase wasting within process limits
 - Improvement has to be more than that just expected from dilution

EXAMPLE DILUTED SETTLEOMETER TEST



Improvement due
to removal of
hindered condition

Expected levels
just due to dilution

POTENTIAL INCREASED TURBIDITY IN DILUTED TEST



SETTLEABILITY INDEX

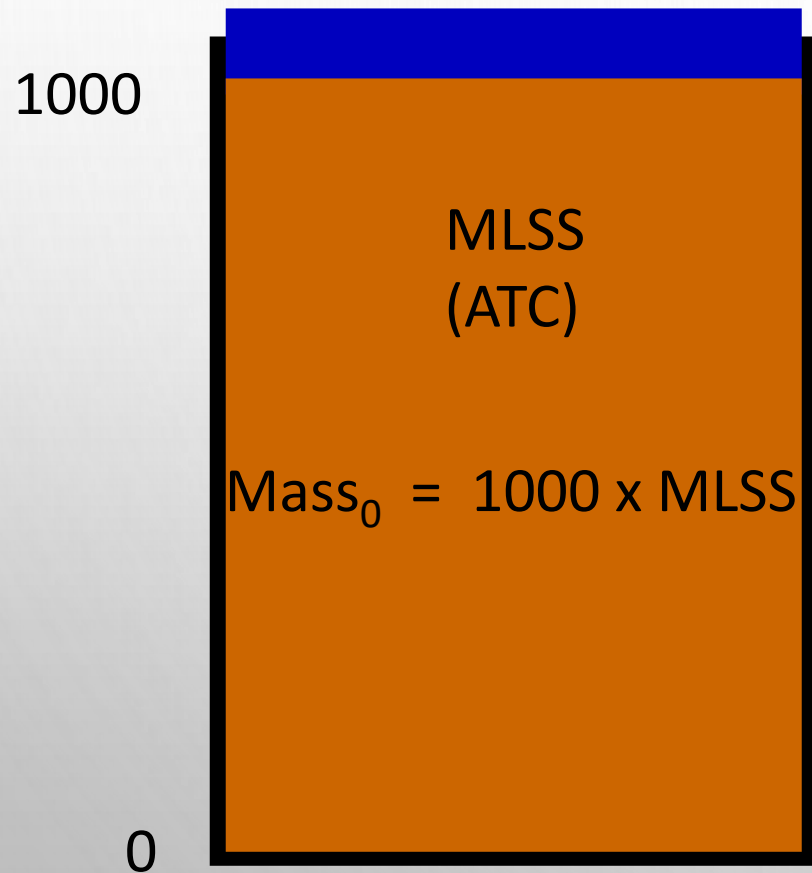
$$\text{Sludge Volume Index} - SVI = \frac{SSV_{30} * 1000}{MLSS}$$

Developed in 1938 so folks could compare settleabilities
30-minute point only
Graduated cylinder – stirred?

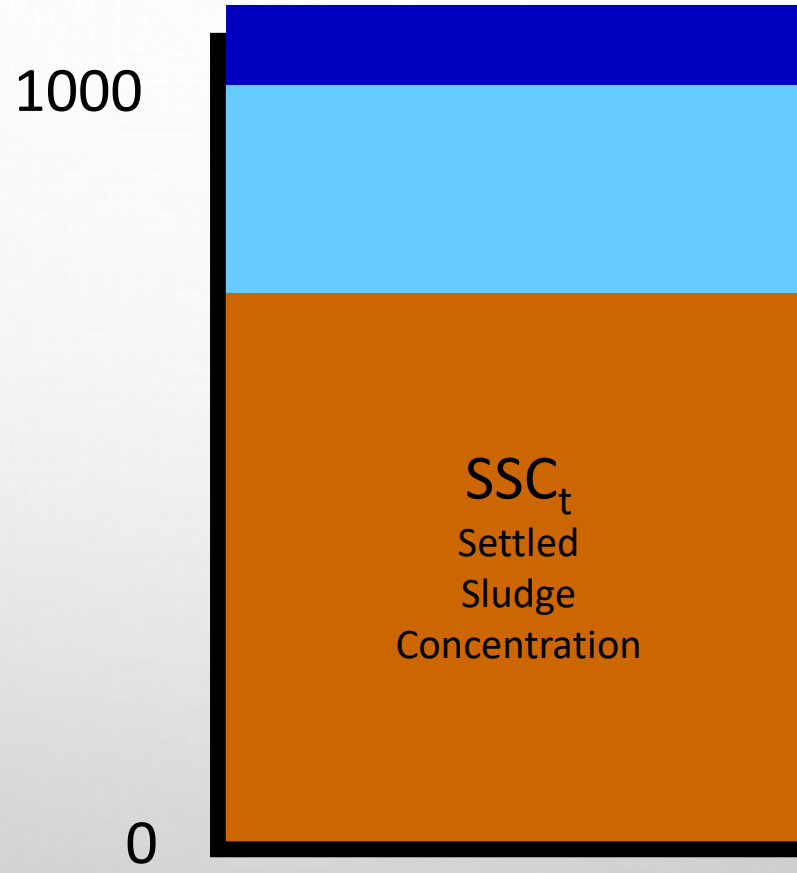
$$\text{Settled Sludge Concentration} - SSC_t = \frac{MLSS * 1000}{SSV_t}$$

Developed in the 1930s by E. B. Mallory using centrifuge
and wide-mouthed settleometer
SSC calculated at each time SSV read

SSC – MASS IN SETTLEOMETER



ATC – Aeration Tank Concentration



$SSV_t = \text{Settled Sludge Volume}$

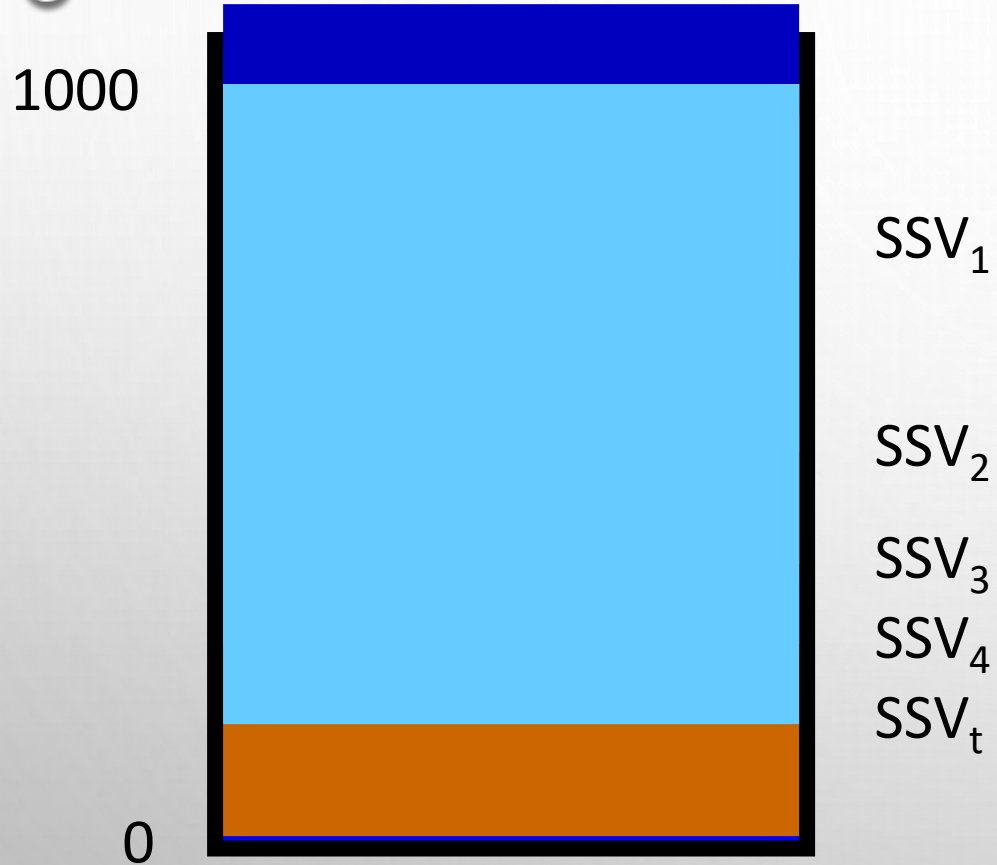
$Mass_{set} = SSV \times SSC$

$t = \text{any time}$

SSV_T AND SSC_T RELATIONSHIP

- SSV_t represents the settled sludge volume expected after letting the sludge settle for the amount of time t
- SSC_t represents the return sludge concentration expected after letting the sludge settle for the amount of time t

SETTLING AT VARIOUS TIMES



MASS = MASS

$$\text{Mass}_0 = \text{Mass}_1 = \text{Mass}_2 = \text{Mass}_t$$

$$\text{SSC}_t \times \text{SSV}_t = 1000 \times \text{MLSS}$$

$$\text{SSC}_t = (1000 \times \text{MLSS}) / \text{SSV}_t$$



BENCH SHEET

Settleometer Bench Sheet

$SSC = (1000 \times MLSS) / SSV$

$SVI_{30} = SSV_{30} \times 1000 / MLSS$

Time + Date: _____
Operator: _____

SVI ₃₀	RAS Tgt

TIME (MIN)	SSV	SSC (MG/L)
0	MLSS→	
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OBSERVATIONS

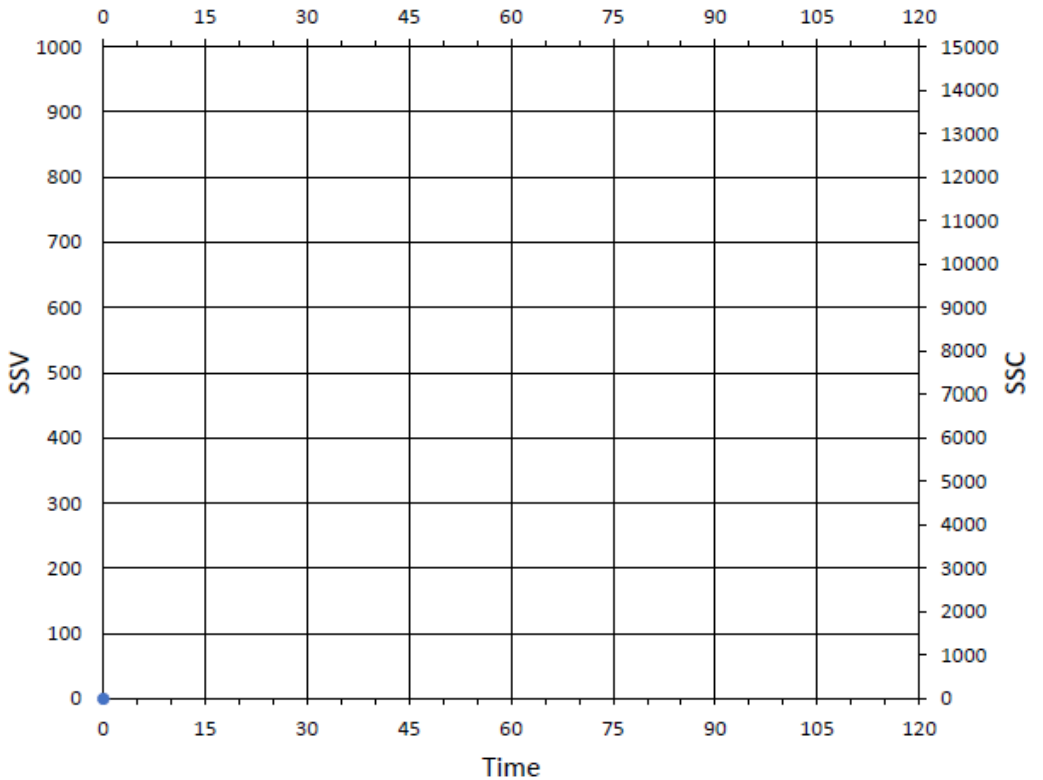
Floc: _____

Blanket: _____

Supernatant: _____

Directions:

Record Settleometer Data every 5 minutes for the first 30 minutes, 10 minutes for the next 30 minutes, and 15 minutes for the next 60. Plot the data in the chart below, find the "knee" of the SSC curve. The "knee" is the RAS TSS Target Concentration



SUMMARY

- Define SSC curve for return sludge flow rate (RSF) calculation
- Estimate final clarifier effluent quality
- Quantify turbidity and pin/straggler floc issues
- Determine if poor effluent quality due to clarifier or aeration tank issues
- Does not tell you what to do with wasting
 - Except with excess over-oxidized sludge shown by diluted settleometer test