

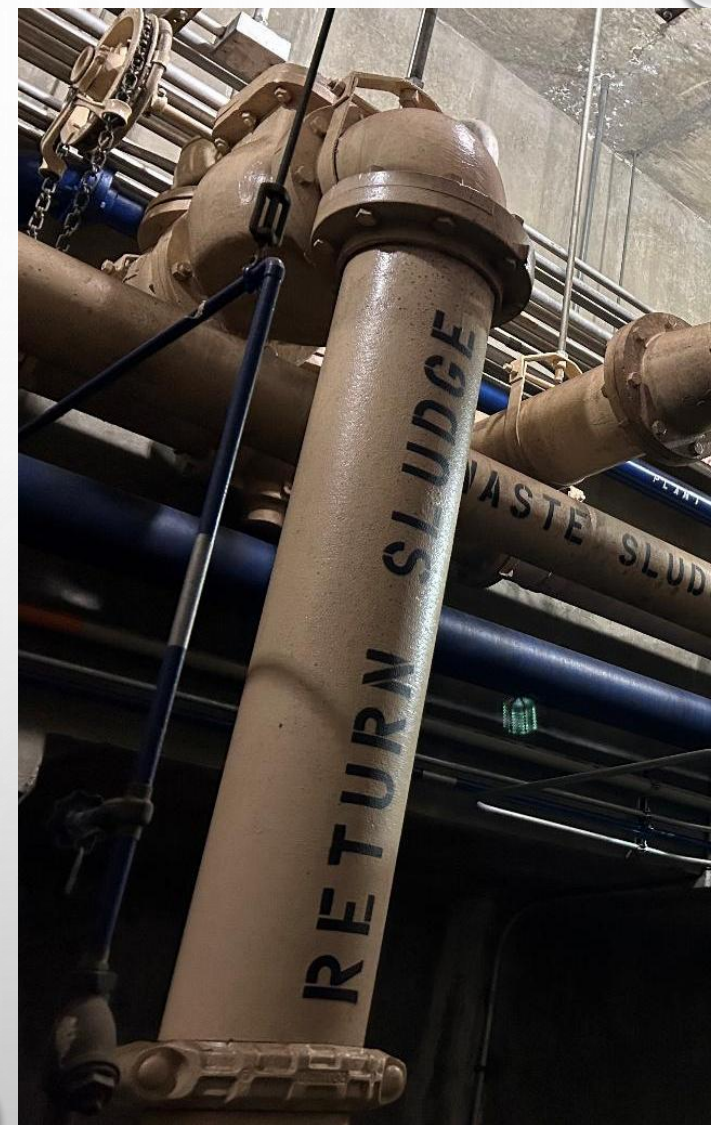
RAS FLOW CONTROL

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WHY IS RSF IMPORTANT TO YOU?

- Easiest process control decision to make
- Your quickest process change to get results
- RSF usually found to be too high
 - Reduced clarifier solids load
 - Increased time for microorganisms to do their work
 - Allows lower MCRT



RAS FLOW CONTROL PHILOSOPHIES

- Constant Rate – “always 100 gpm”
- % of Influent Flow Rate – “50% of Influent Flow”
- State Point Analysis – Not For This Class!
- Variable Rate According to Settling and Flow



CONSTANT RETURN RATE

- Influent Flow Not Usually Constant
- Sludge Quality Not Constant
 - Often Changes Throughout the Day
- Does Not Optimize the Process
- Better For Very Large Plants



% OF INFLUENT

- Good When Settling is Fast
- Not Good When Settling is Slow
- Not Good With Variable Settling
- What Happens When Inflow Drops Below the Min RAS Pump Speed?
- Better, But Not Great



VARIABLE ACCORDING TO SETTLING & FLOW

- Responds to Fast Settling
- Responds to Slow Settling
- Responds to Variable Settling Rates
- Responds to Variable Flow



SETTLING CURVES

- Represent timed settling in the settleometer
- Do not indicate age of sludge
- Tell nothing about what to do to maintain good conditions or to solve a problem
- Tell nothing about required wasting rate
- Can be used to define required return rate

SSC CURVE

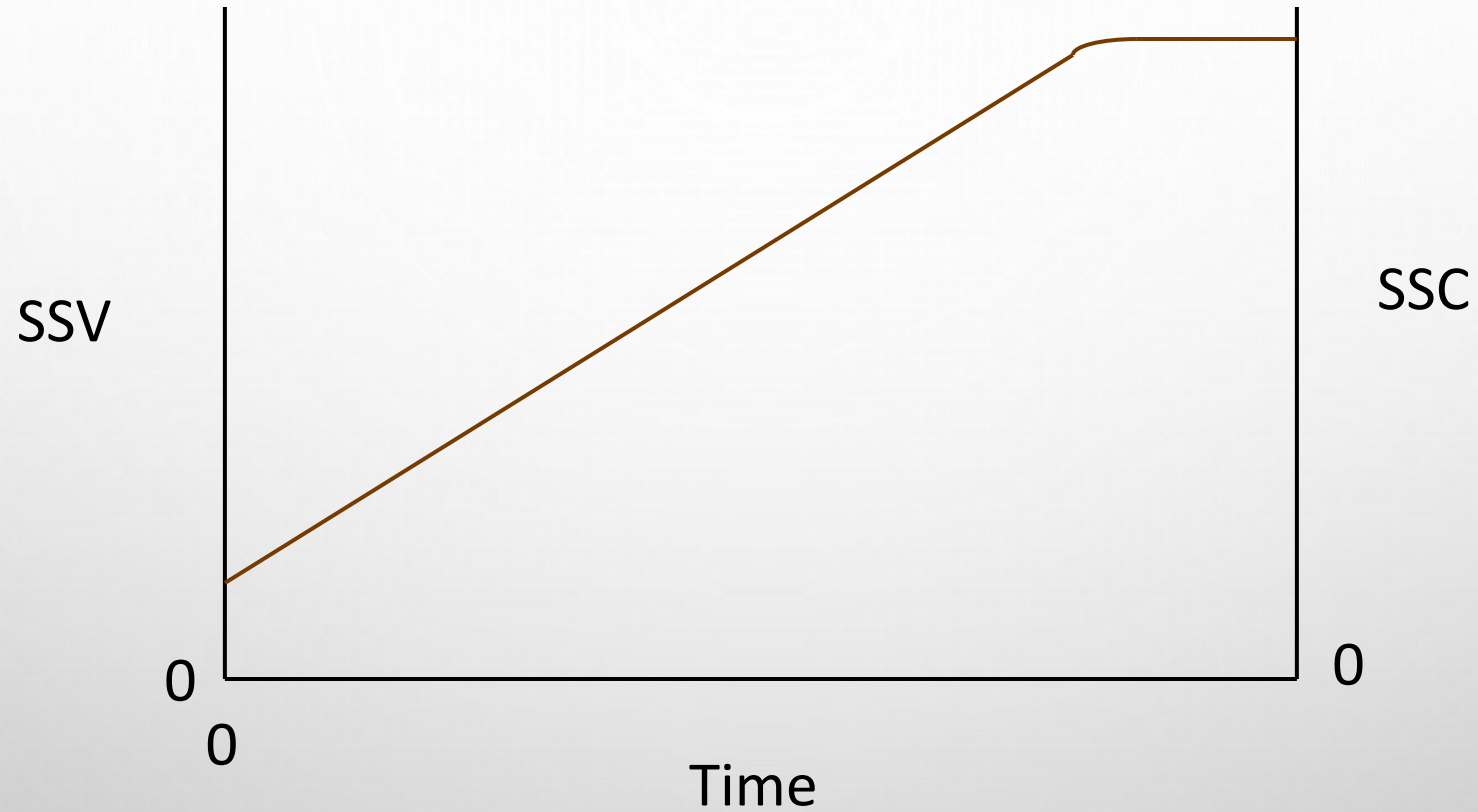
- Shows how long the sludge will continue to compact
- When compared to return sludge concentration (RSC), will suggest whether to increase or decrease return sludge flow rate (RSF) and how much to change

RAS FLOW PROCEDURE

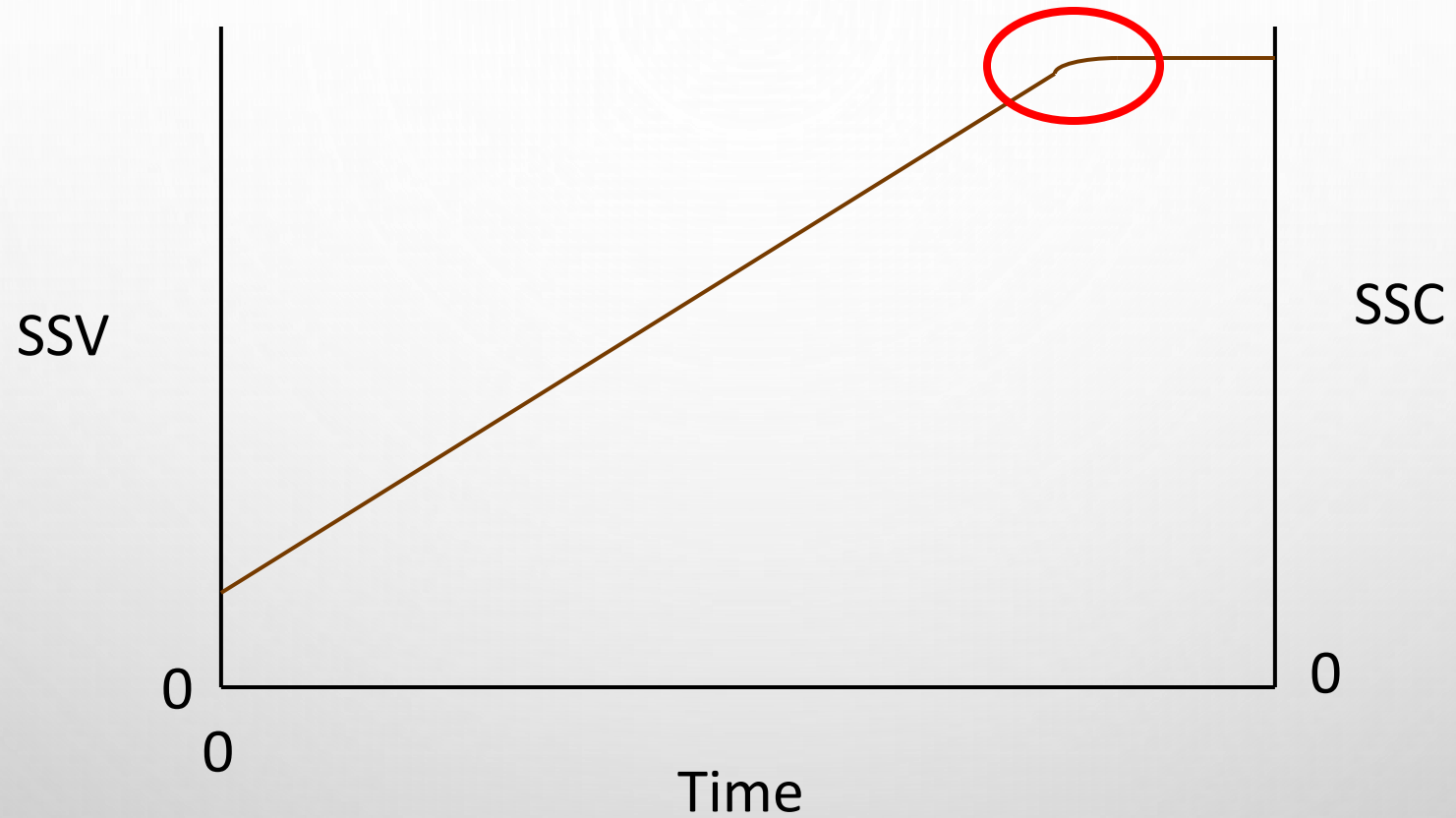
- Perform Settleometer Test
- Calculate Concentrations With Time →
- Plot Concentration Curve
- Find “Knee of Curve”
- Determine Allowable Concentration Range
 - Target SSC
- Compare with RAS Concentration
- Vary Return Rate to Get RAS Conc $\approx$ Target SSC

$$SSC = \frac{1000 \times MLSS}{SSV}$$

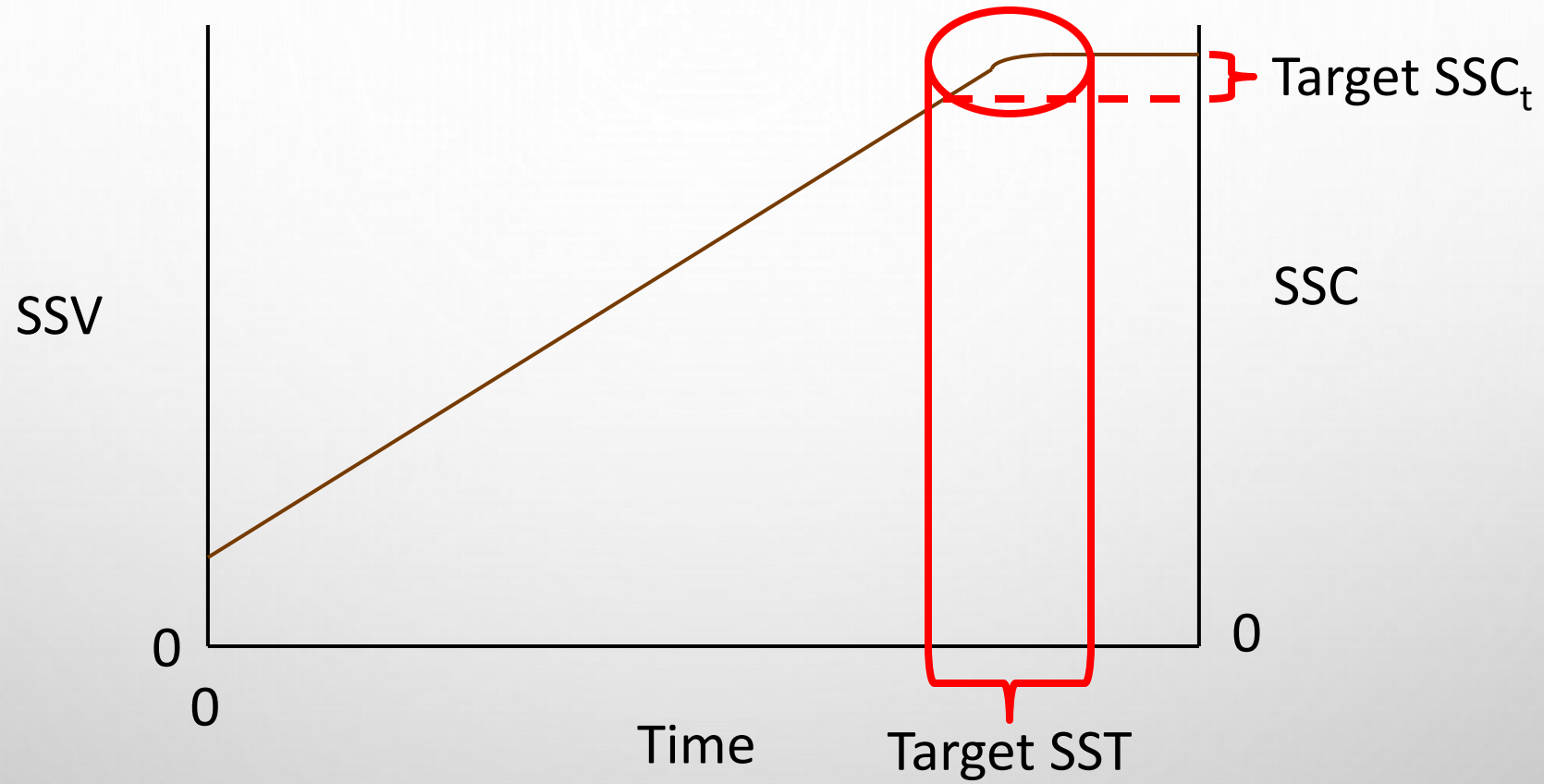
DRAW SSC CURVE



DETERMINE "KNEE"



DETERMINE TARGET SSC_T



ADJUST RAS FLOW

- Compare RAS Concentration to SSC_t
- If RAS Conc Less Than SSC_t – DECREASE RAS FLOW
- If RAS Conc More Than SSC_t – INCREASE RAS FLOW

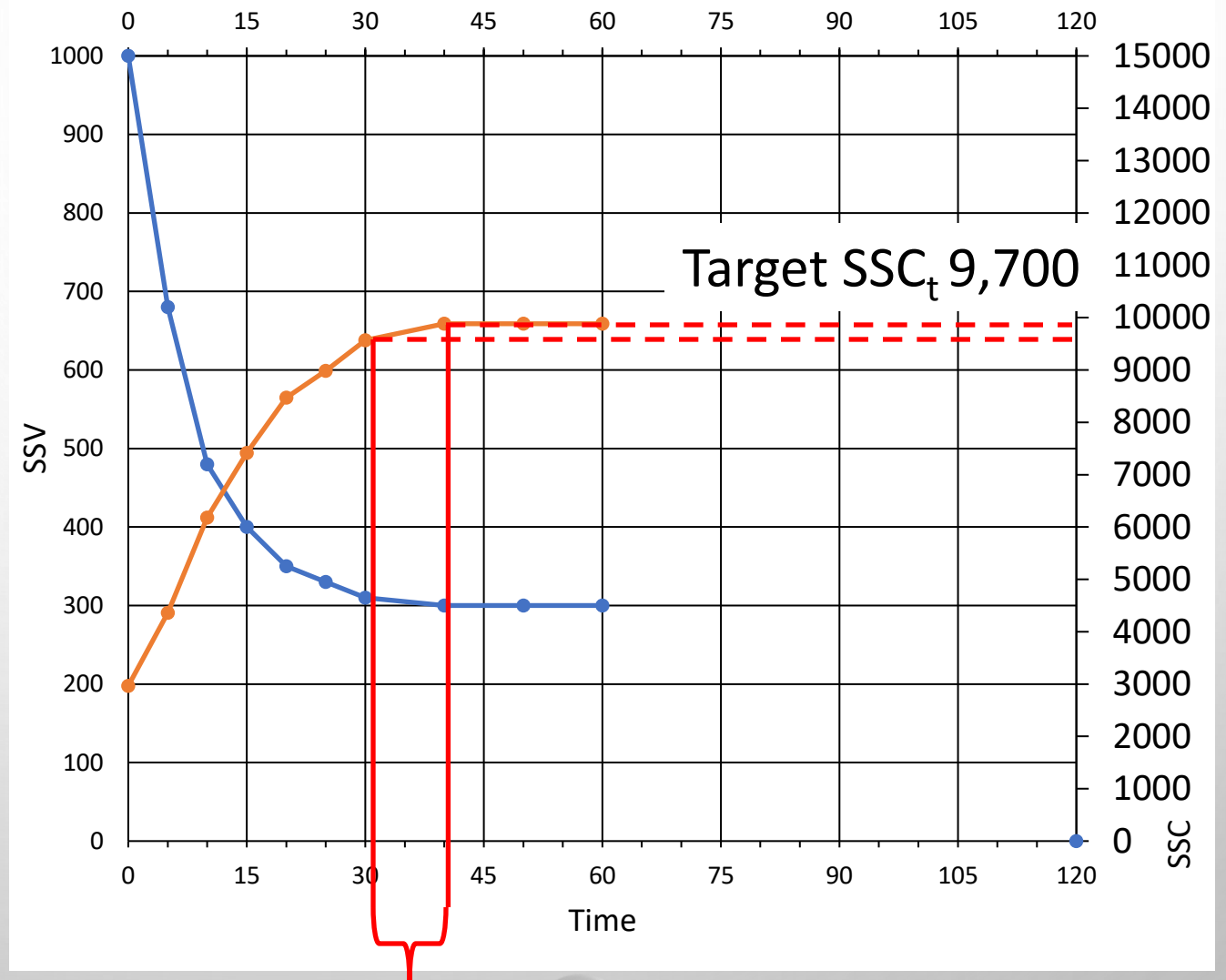
$$\text{New RSF} = \frac{Q * MLSS}{SSC_t - MLSS} ??$$

- Let system equalize
- Repeat procedure

?? Based on steady
state – watch it!!

EXAMPLE

TIME (MIN)	SSV	SSC (MG/L)
0	1000	2965
5	680	4360
10	480	6177
15	400	7413
20	350	8471
25	330	8985
30	310	9565
40	300	9883
50	300	9883
60	300	9883
75		
90		
105		
120	POP	



Target SST

EXAMPLE

- Actual RAS Conc = 8,833 mg/L, MLSS = 2,965 mg/L
- Target $SSC_t = 9,700$ mg/L
- Actual RAS Flow = 15.75 MGD
- $Q = 34.79$ MGD
- **Required Action: Reduce RAS Flow Slightly**

$$\text{New RSF} = \frac{34.79 * 2965}{9700 - 2965} = 15.3 \text{MGD}$$

RULES OF THUMB

- RAS Concentration Should Be At Least 3 x MLSS
- RAS Flow Rate Usually Found To Be Too High
- Raise RAS Flow Rate if Excessive Clarifier Denitrification
 - Temporary
 - Denitrify Elsewhere!
- Let Sludge Settle As Long As It Will Continue To Settle, Then Remove It!
- “10% Change Rule”
 - OK On Daily Averages, Not Applicable to RAS Flow Rate
- # Of Settleometer Tests/Day and RAS Flow Changes
 - Minimum of 2, Small Plant Without Shifts
 - Preferably 3-4 Larger Plants With Shifts

Use RAS Flow Equation
With CAUTION!!

EXAMPLE

- Activated sludge plant with day and swing shift settleometer tests
- Two separate sides of the plant using different activated sludge processes
- Same wastewater to both sides
- Same sludge all day?
- Return rates set properly?

DAY SHIFT DATA

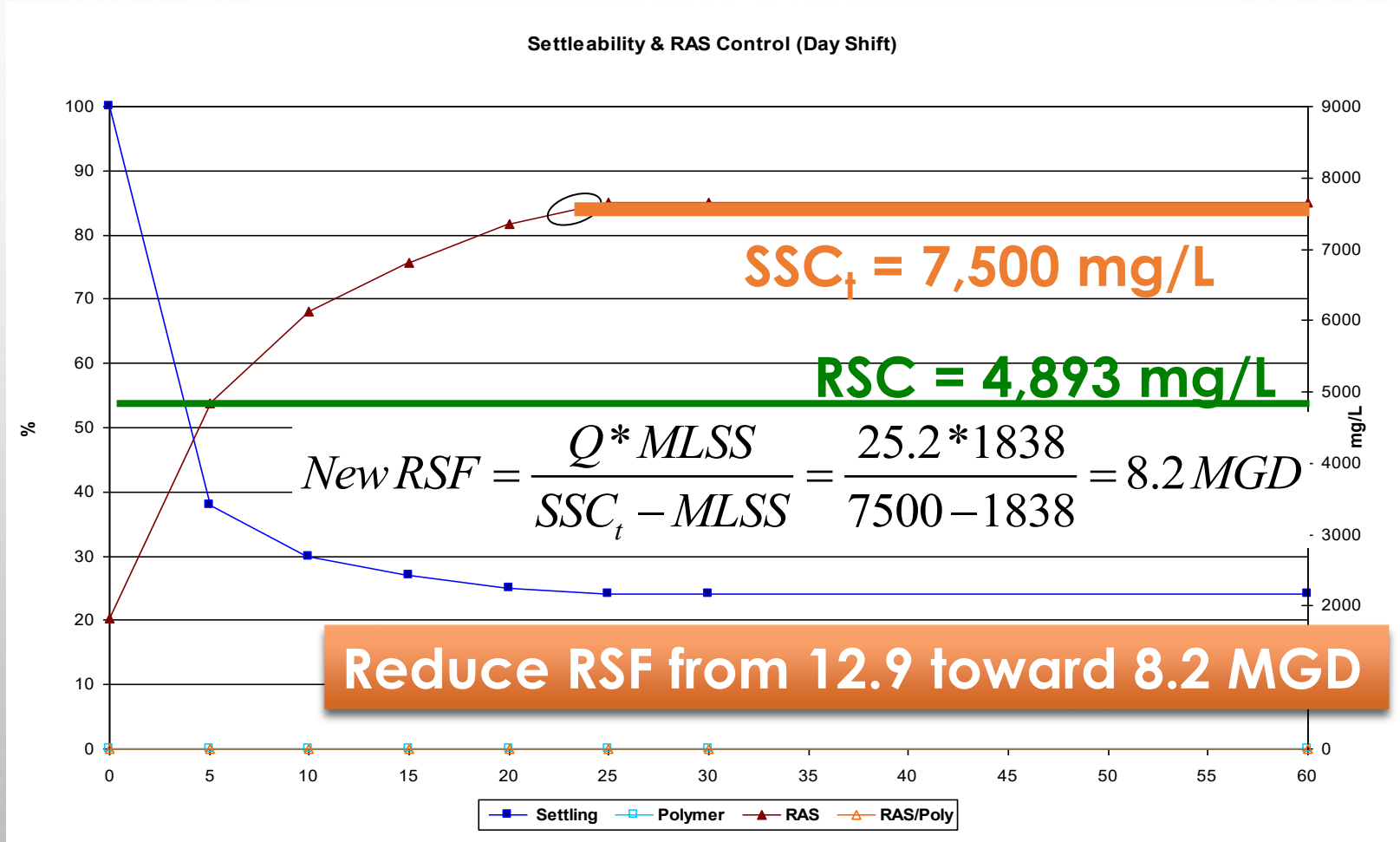
Process Data

MLSS = 1838

Q = 25.2 MGD

RSF = 12.9 MGD

RSC = 4,893 mg/L



SWING SHIFT DATA

Process Data

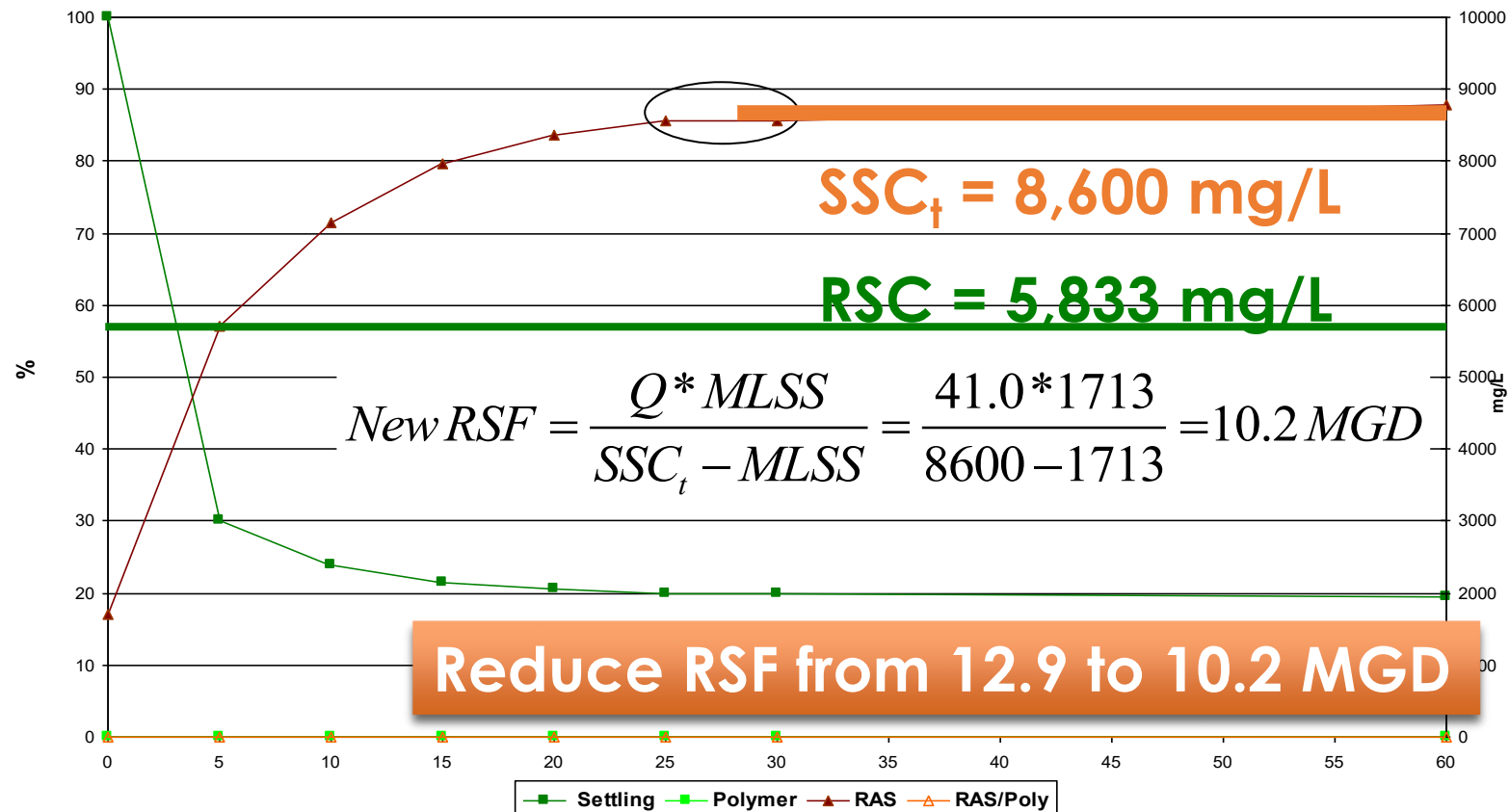
MLSS = 1,713

Q = 41.0 MGD

RSF = 12.9 MGD

RSC = 5,833 mg/L

Settleability & RAS Control (Swing Shift)



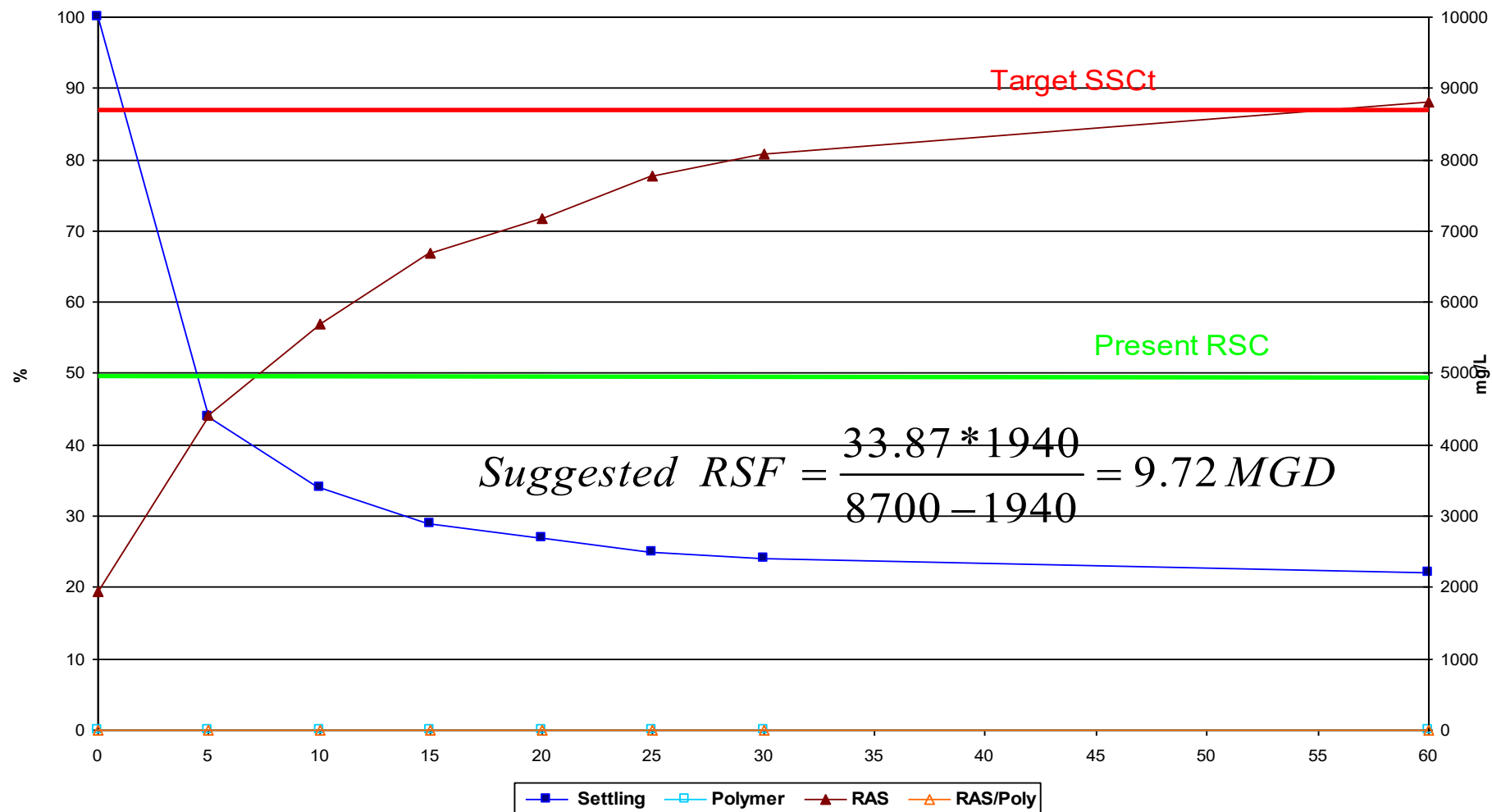
PLANT SUMMARY

- Initial RSF reduction from 12.9 MGD toward 8.2 necessitated primarily by settling conditions
- RSF increase from 8.2 on day to 10.2 on swing necessitated primarily by flow variation as swing settleometer compacted better than day settleometer

EXAMPLE 2

Q = 33.87 MGD RSF = 15.53 MGD MLSS = 1,940 mg/L RSC = 4,990 mg/L

Settleability & RAS Control (Day Shift)



EXAMPLE 2

Initial SLR = 33,303 lb/hr

Revised SLR = 29,373 lb/hr

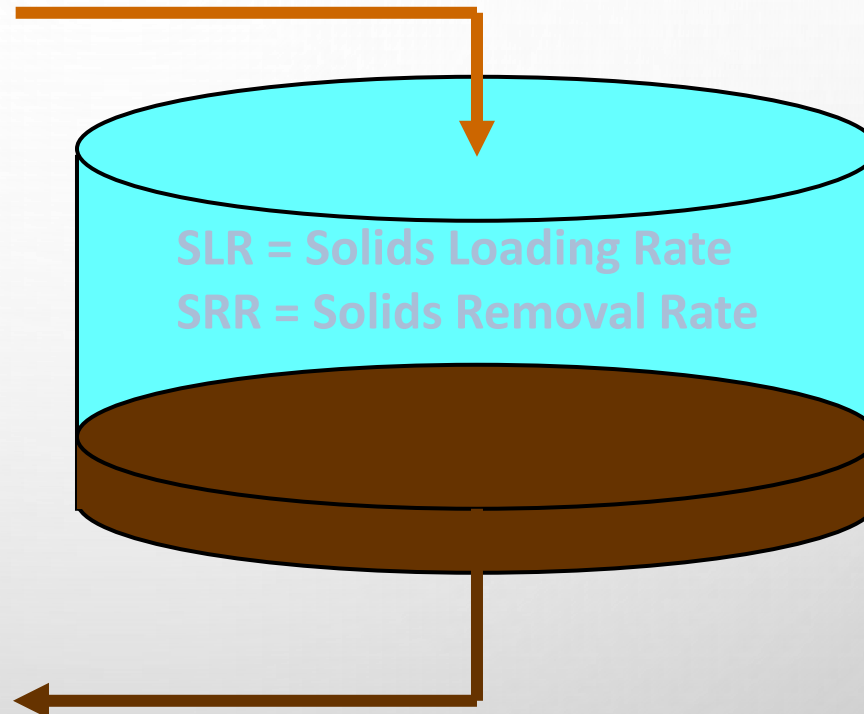
Reduction in SLR = 11.8%

Reduce RSF to 9.7 MGD

Increase in SRR = 8.9%

Revised SRR = 29,326 lb/hr

Initial SRR = 26,929 lb/hr



Blanket falling with RSF = 9.7 MGD!

RAS CONTROL SUMMARY

- Setting RAS Flow Based on Settleability is the Best Practice
- Reducing RAS Flow:
 - Increases the TIME microorganisms have to digest food
 - Reduces denitrification potential in the clarifier
 - Reduces the Solids Loading to the Clarifier – Increasing TIME for Settling
 - Can also increase system capacity
- “10% Change Rule” does not apply to RAS flow