KWWOA
Kentucky Water & Wastewater Operators Association

How to Manage Secondary Clarification During Wet Weather

Annual Fall Conference – North Central & Eastern Chapters

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How to Manage Secondary Clarification During Wet Weather

Agenda

Wet Weather

- Court ruling regarding blending

Optimize Biological Treatment

- Contact Stabilization / Step Feed
- RAS Flow Equalization

Other Considerations

- Ballast the on-line process
  - Improve settleability rather than sludge quality if less than optimum
- Sludge juggling

Questions

Concepts for Improved Wet Weather Performance at the Plant

- Evaluate options for reduced solids loading to the clarifiers.
- Evaluate options for improving settleability of biological solids.
- Temporary “sludge juggling” techniques
- Other “Low Cost Options” such as baffling secondary clarifiers to improve hydraulic performance are not covered due to available time.

The Reality of Wet Weather Operations….

Large Plants

Most time and attention typically focused on first flush and hydraulics. Headworks typically needs a lot of attention and operator time.

Smaller plants

Typically not staffed at the start of wet weather event

By the time staff arrive, clarifiers already in stressed condition

Impact to the Biological system

First flush hydraulics

Shift of solids to clarifiers affects performance if not managed properly

Short detention times contribute to less effective solids settling

Some of our client's "First Flush Concerns"

Strategies for Wet Weather Treatment

Utilize existing facilities to maximum capacity and minimize expensive high rate treatment investments

- Dynamics of solids movement in the biological treatment system is key to effective treatment

- Two (2) examples of controlling solids movement to the clarifiers:

  1. Step Feed/Contact Stabilization

  2. RAS Flow Equalization

- Maintain biological solids in the system for a quick return to dry weather compliance

- These examples have been effectively applied at other facilities…..

Wet Weather Treatment

- Elimination of effluent blending rules by regulators
- Focus on in-plant optimization 1st
- Midwest Projects Wet Weather Projects Utilizing main stream facilities

  BCWS - LeSourdsville WRF, OH (3x)

  Sidney, OH – WW PER (7x)

  North Olmsted, OH (4.5x)

  Dry Creek WWTP, KY (5x)

  Greencastle, IN (10x)

  Peru, IN (7x)

  Glendale, OH (8x)

  Summersville, WV (10x)

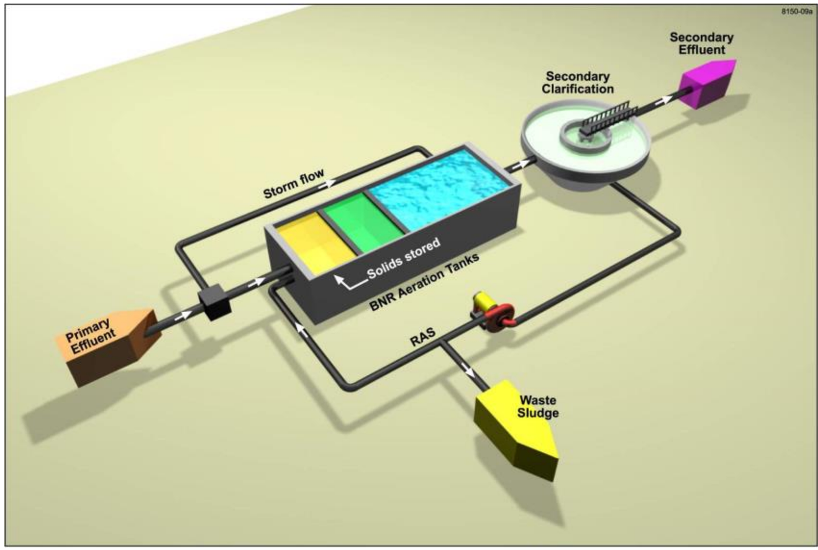
  Hamilton, OH (5x – peer review)

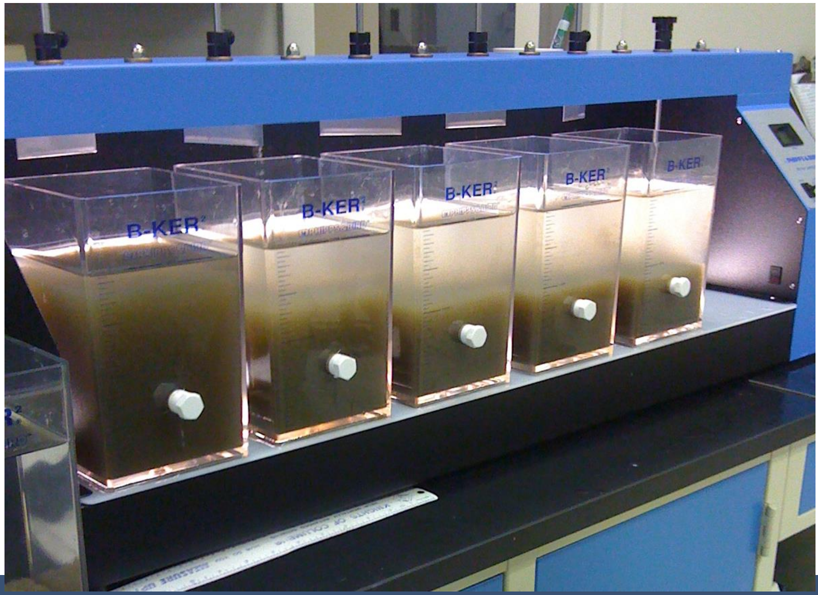
  Wellston, OH (5x)

  Hurricane, WV (4x)

  DC Water Blue Plains

  NYCDEP (all NYC plants)





Blending: US Court of Appeals Eighth Circuit

- If a POTW designs a secondary treatment process that routes a portion of the incoming flow through a unit that uses non-biological technology, this will be viewed as a prohibited bypass by USEPA, regardless of whether the end of pipe output ultimately meets the secondary treatment regulations.
- The Iowa League of Cities stated, the EPA not only lacks the statutory authority to impose these regulations, but it violated the Administrative Procedures Act (“APA”), 5 U.S.C. § 500 et seq., by implementing them without first proceeding through the notice and comment procedures for agency rulemaking.

Blending: US Court of Appeals Eighth Circuit

- The court vacated both the mixing zone rule in the June 2011 letter and the blending rule in the September 2011 letter as procedurally invalid.
  - We vacate the blending rule as in excess of statutory authority insofar as it would impose the effluent limitations of the secondary treatment regulations internally, rather than at the point of discharge into navigable waters. We remand to the EPA for further consideration.
  - EPA appeal was denied on July 10, 2013.

Contact Stabilization

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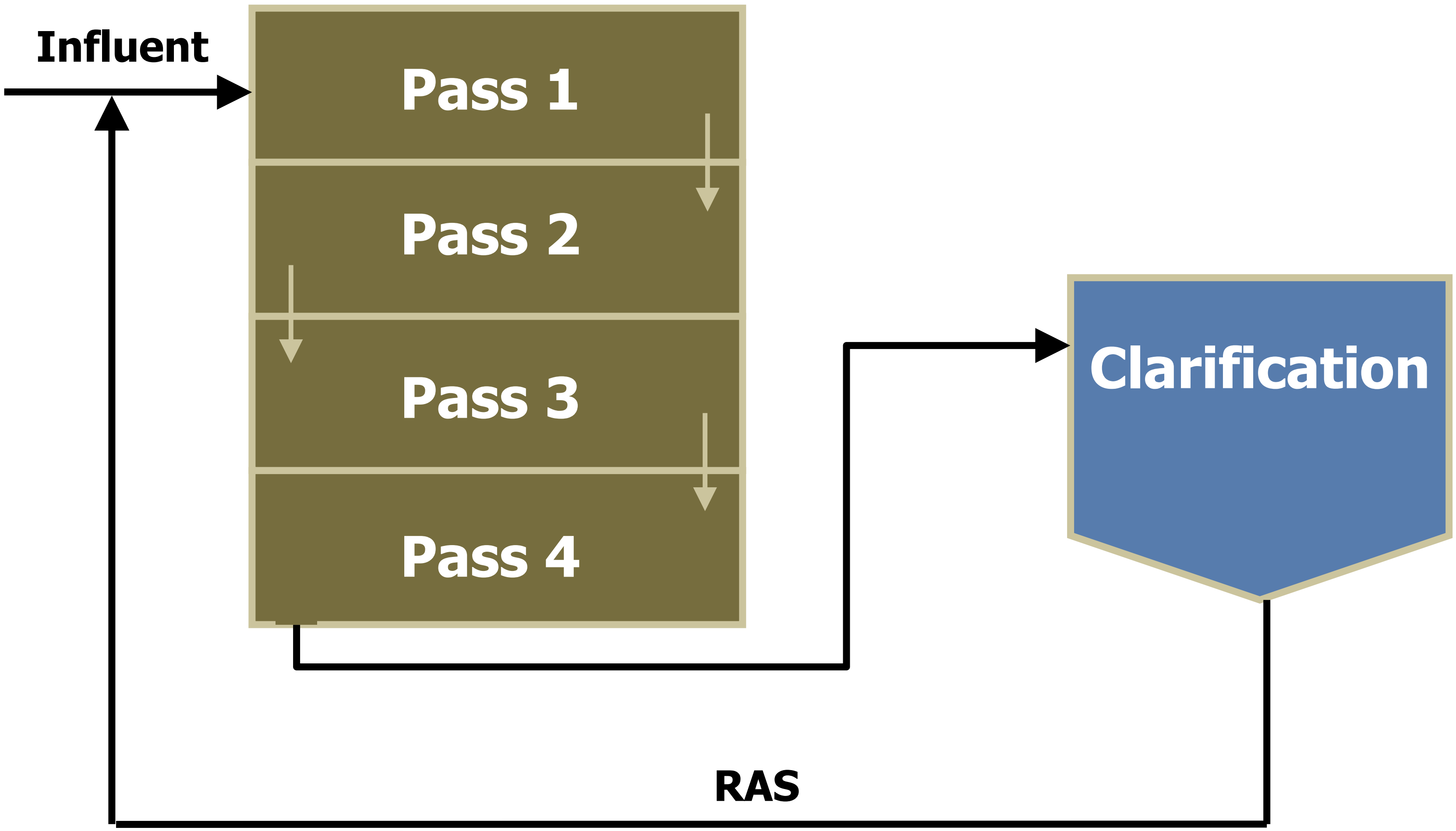
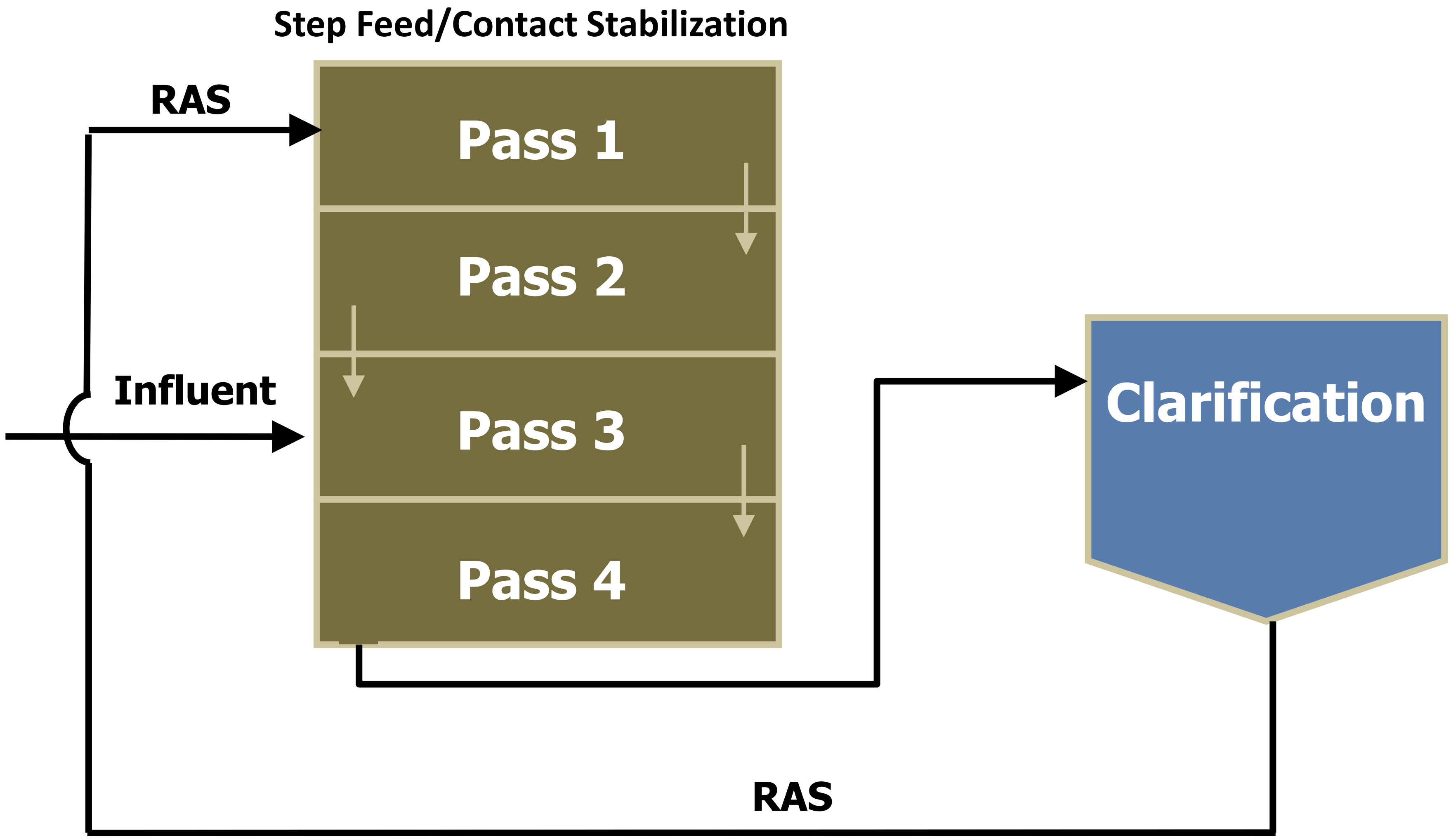
4 Pass Dry Weather Operation



Change to a 2 Pass Wet Weather Operation (Step Feed/Contact Stabilization)



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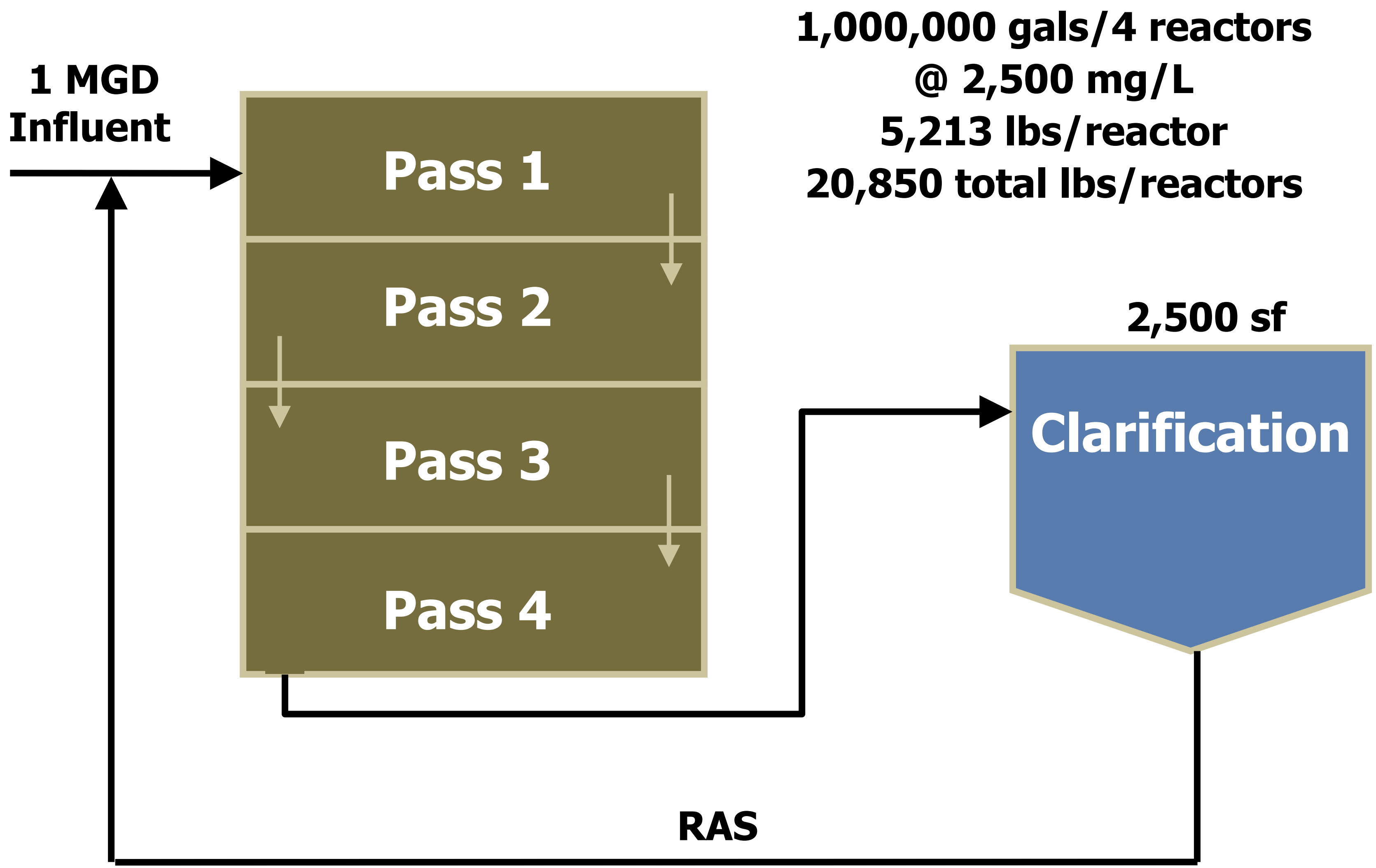
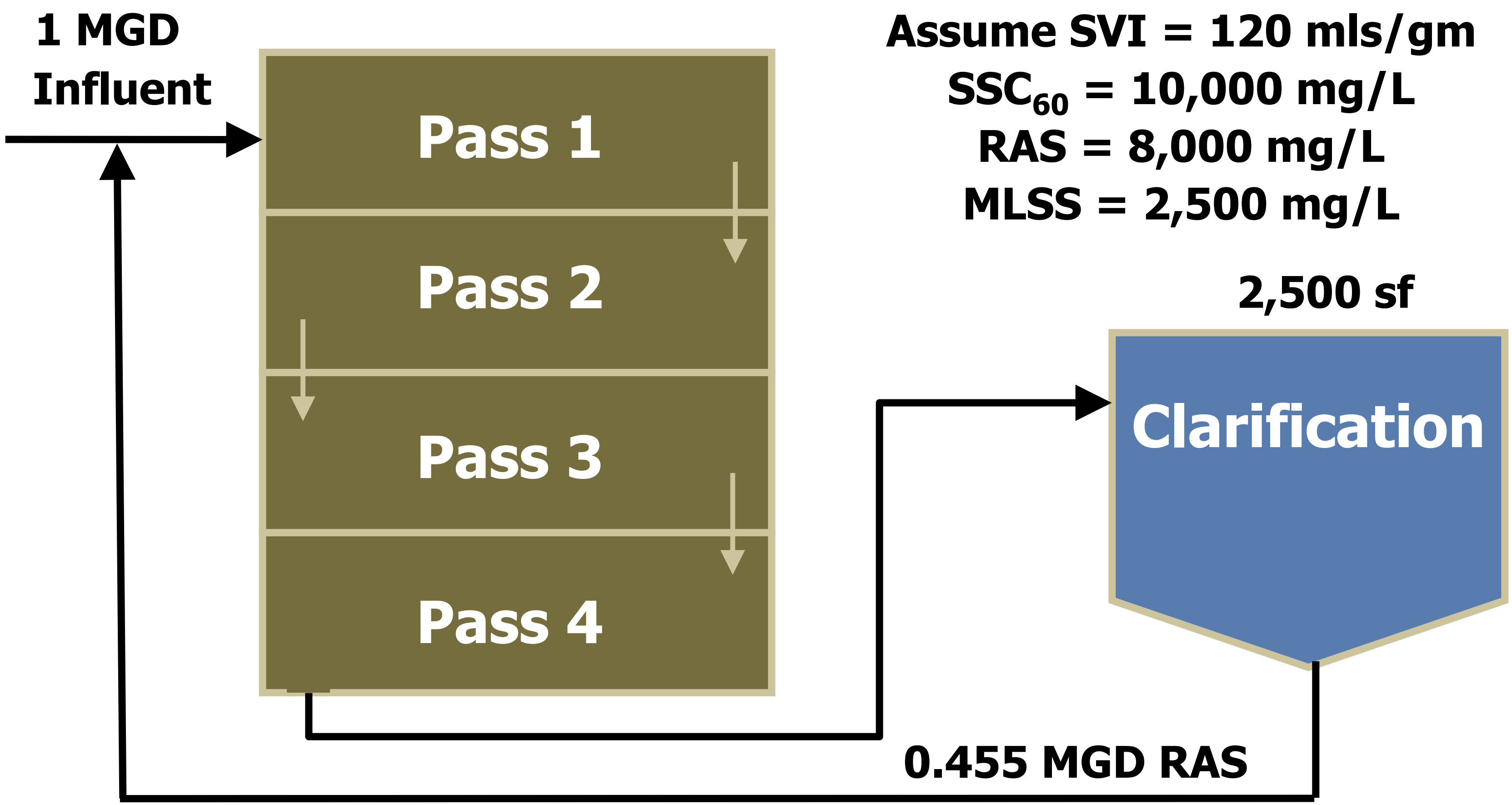


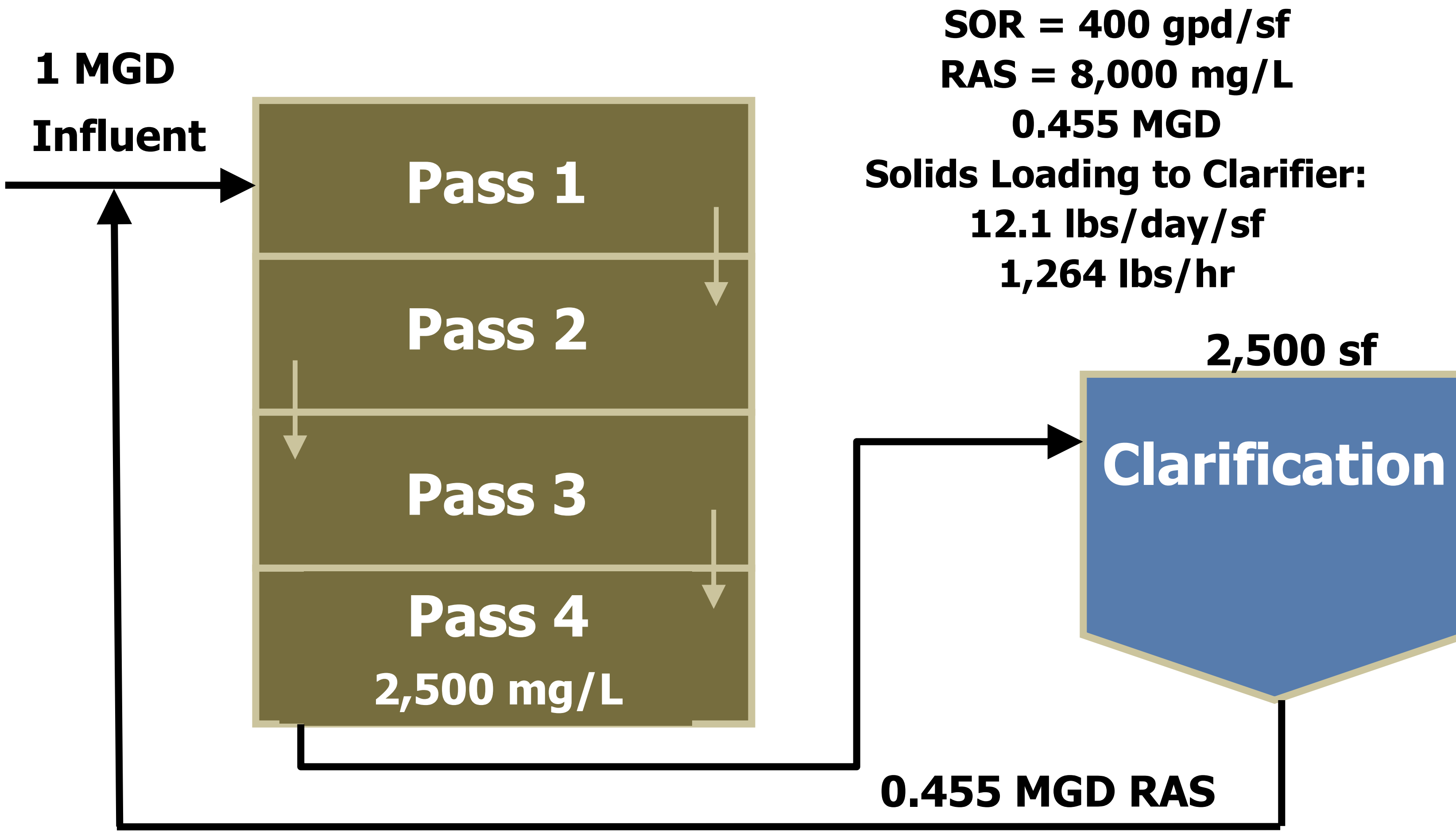
4 Pass Dry Weather Operation



RAS Flow in Equilibrium

$$\frac{(\text{Influent MGD} * \text{MLSS mg/L})}{(\text{RAS mg/L} - \text{MLSS mg/L})}$$

4 Pass Dry Weather Operation at Equilibrium

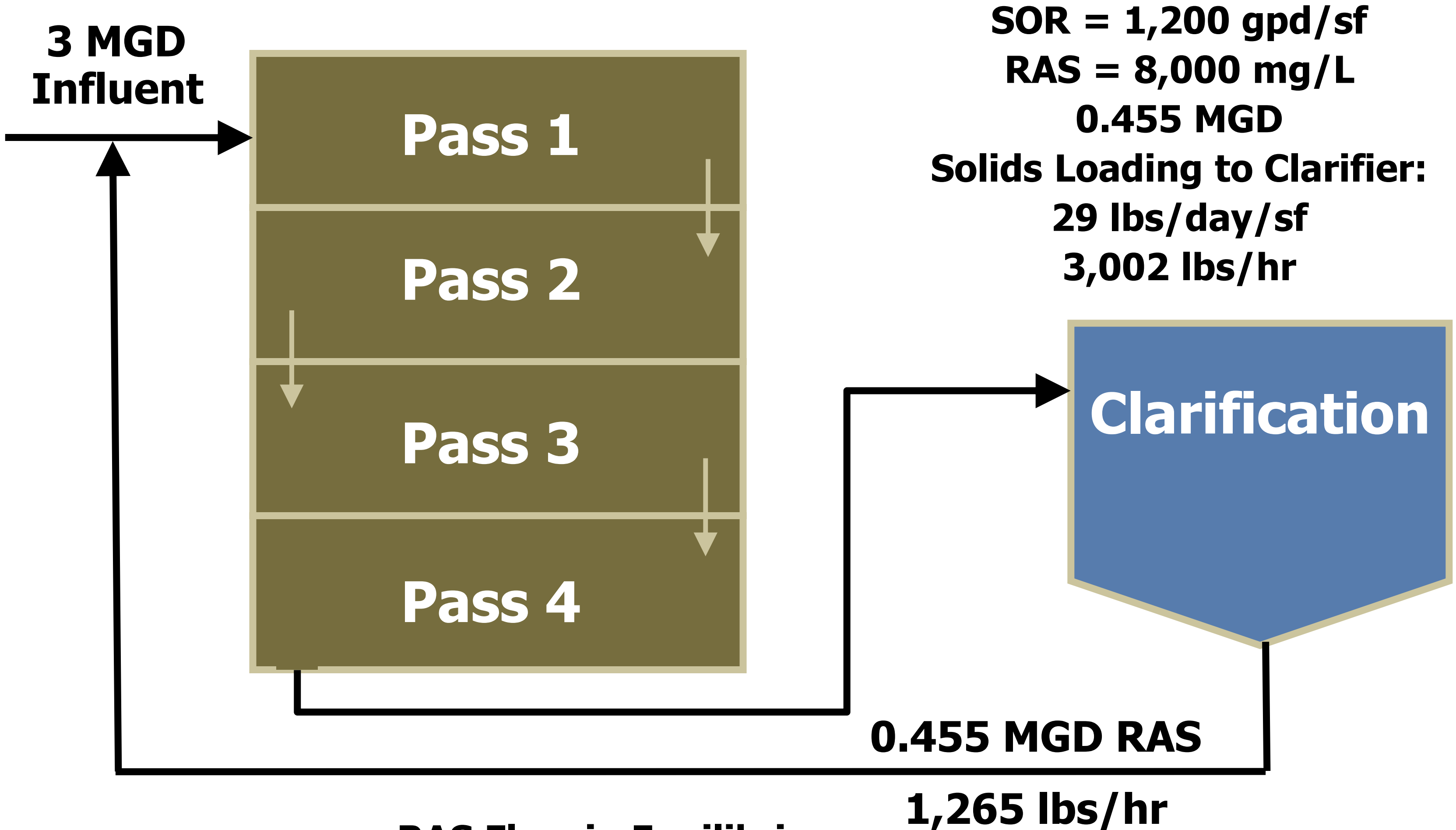


1,264 lbs/hr

RAS Flow in Equilibrium

$$\frac{(\text{Influent MGD} * \text{MLSS mg/L})}{(\text{RAS mg/L} - \text{MLSS mg/L})}$$

4 pass Dry Weather Operation: Wet Weather Flow – 3 MGD



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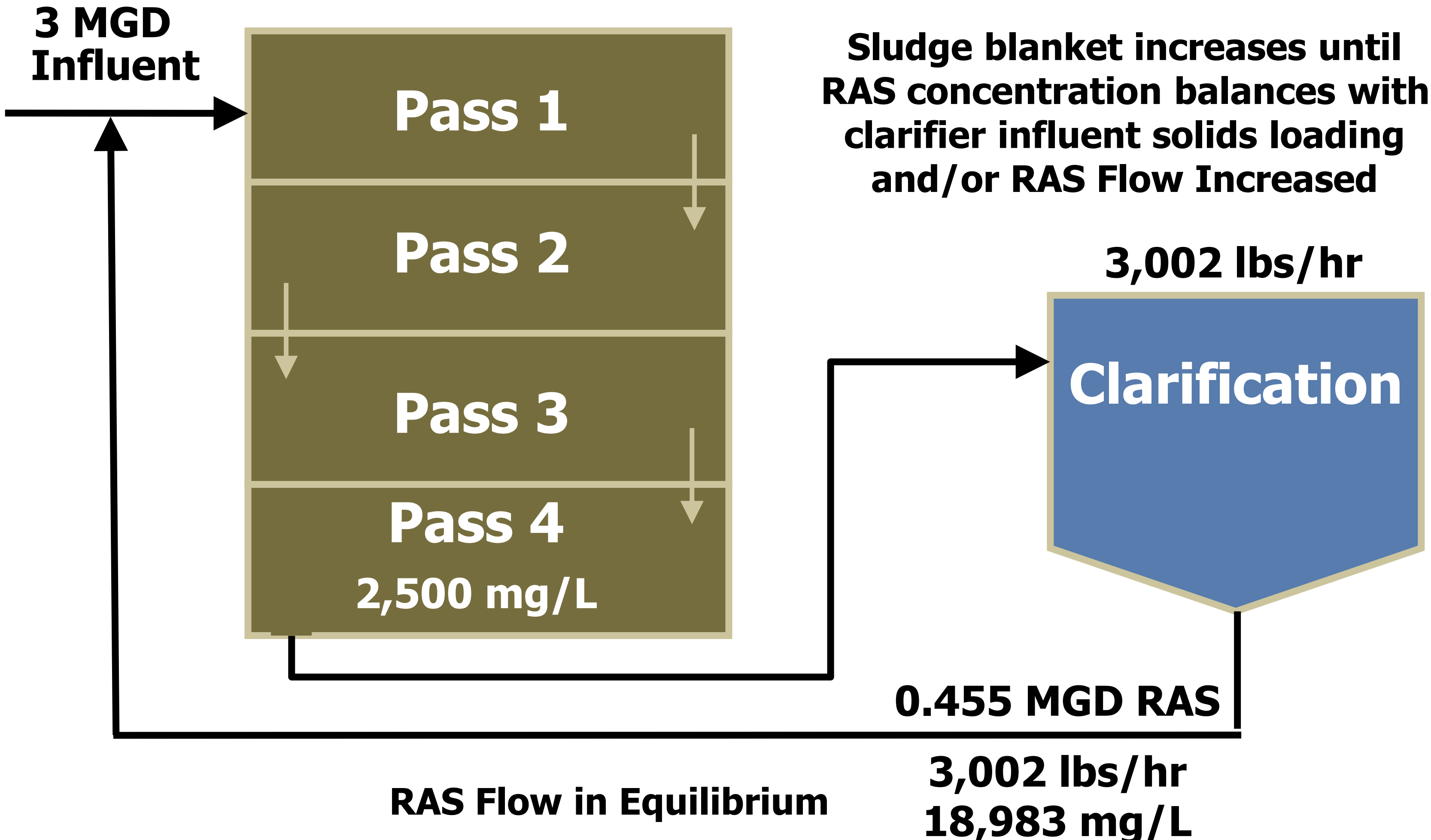
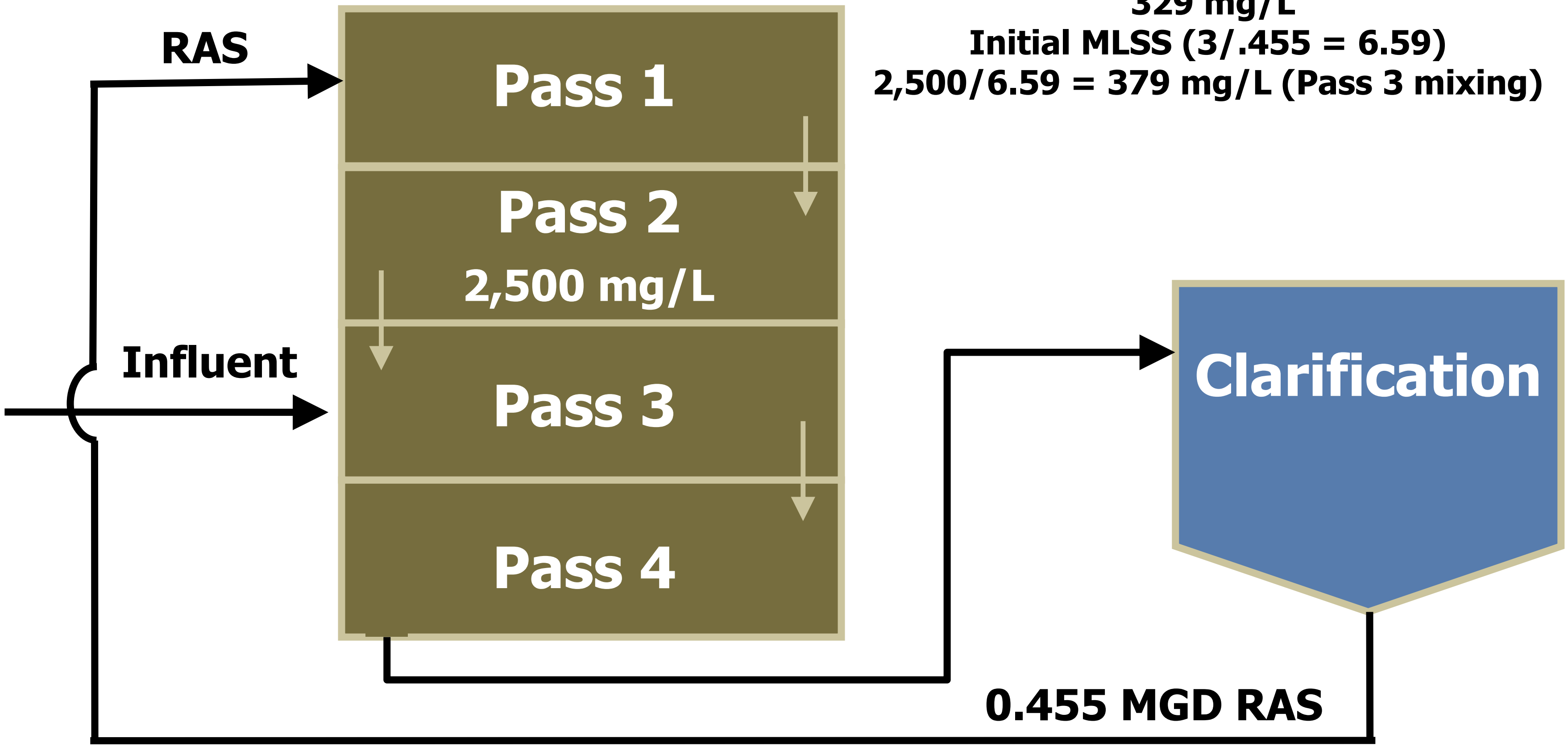


RAS Flow in Equilibrium

$$\frac{(\text{Influent MGD} * \text{MLSS mg/L})}{(\text{RAS mg/L} - \text{MLSS mg/L})}$$

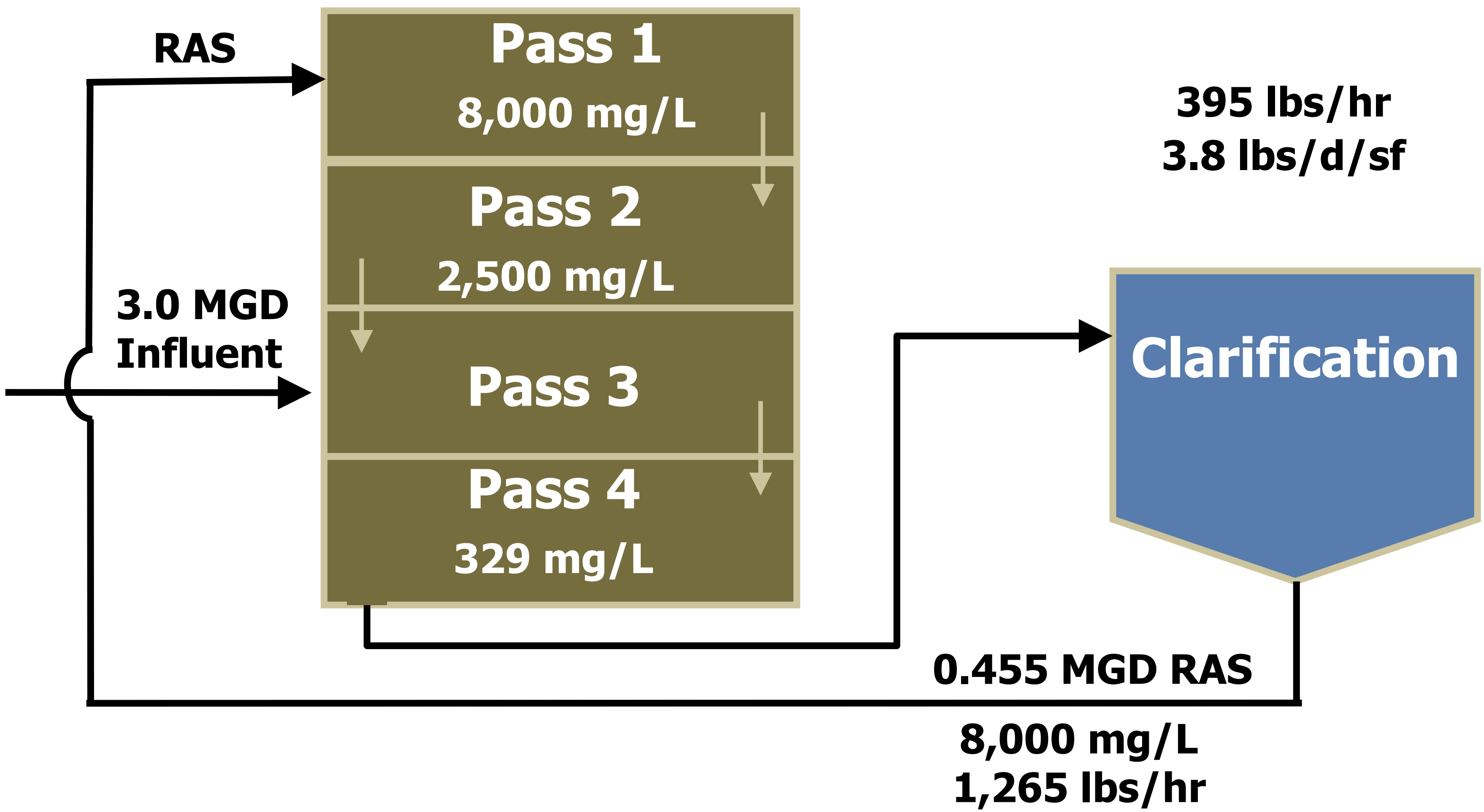
2 Pass Wet Weather Operation
Step Feed / Contact Stabilization

=(.455/3 MGD * 2,500 mg/L) / ((.455/3) + 1.0)
379/1.1517
329 mg/L
Initial MLSS (3/.455 = 6.59)
2,500/6.59 = 379 mg/L (Pass 3 mixing)

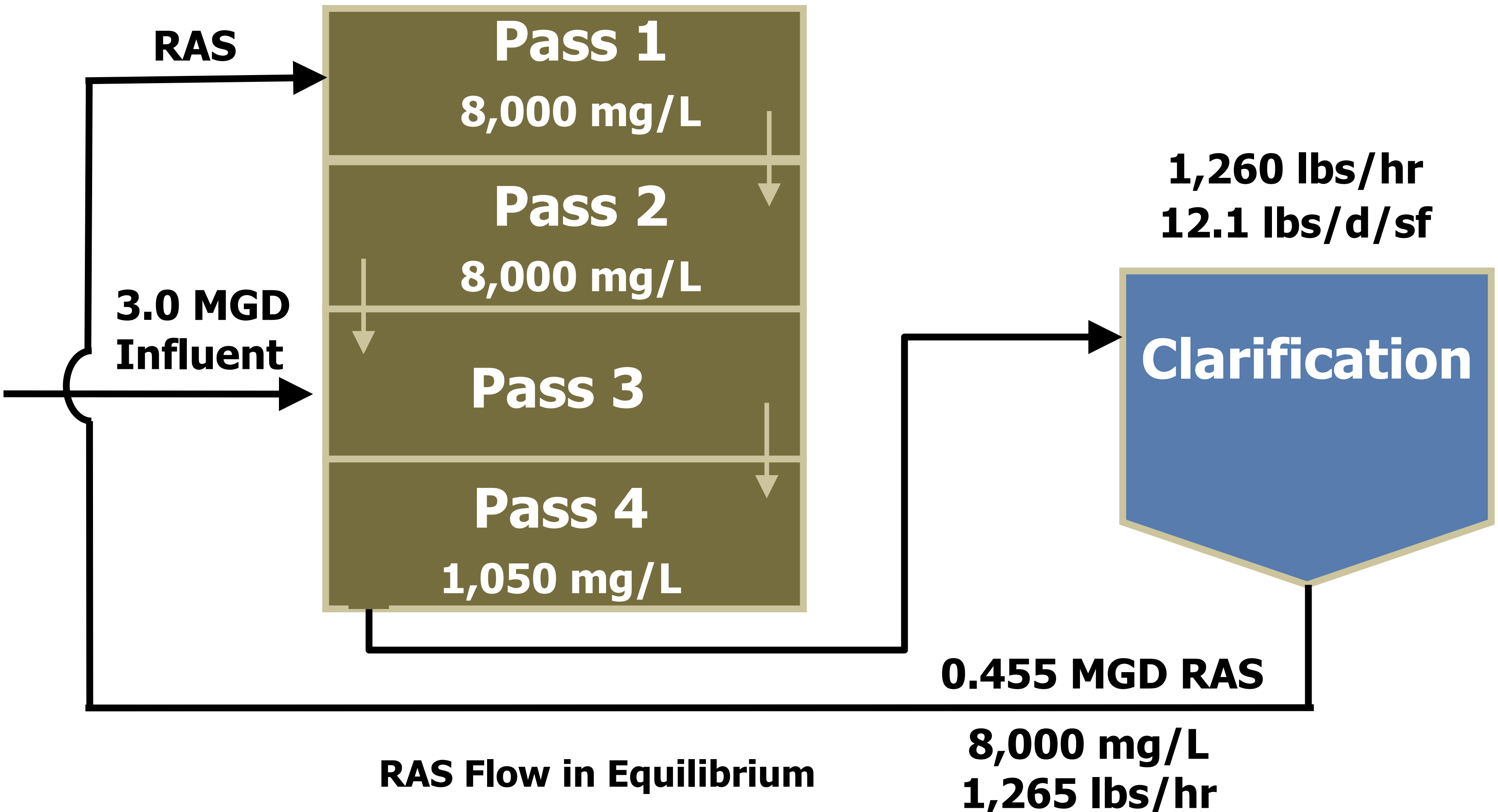


MLSS = (RAS Flow Percent * RAS_{tss}) / (RAS Flow Percent+ 1.0)

2 Pass Wet Weather Operation Transition



2 Pass Wet Weather Operation Steady State



RAS Flow in Equilibrium

$$\frac{\text{(Influent MGD * MLSS mg/L)}}{\text{(RAS mg/L – MLSS mg/L)}}$$

2 Pass Wet Weather Operation

- Initial hydraulic push has low concentration of MLSS blending into an aeration tank with dry weather MLSS concentration and treated water.
- Treated water is blended with first flush for treatment.
- As last RAS Stabilization tank begins blending with the first contact tank, MLSS concentration is immediately decreased.
- Solids reach equilibrium with solids inventory shifted out of secondary clarifiers and into off-line aerated holding (first 2 passes).

2 Pass Wet Weather Operation

- If re-configured as step feed/contact stabilization early in the peak flow event, clarifier stress is minimized.

- RAS rate can remain the same for dry weather and wet weather as clarifier solids loading is controlled.

- MLSS solids are taken off-line and stabilized while the solids loading rate to first stage settling typically remains equal to dry weather flow.

RAS Flow Equalization

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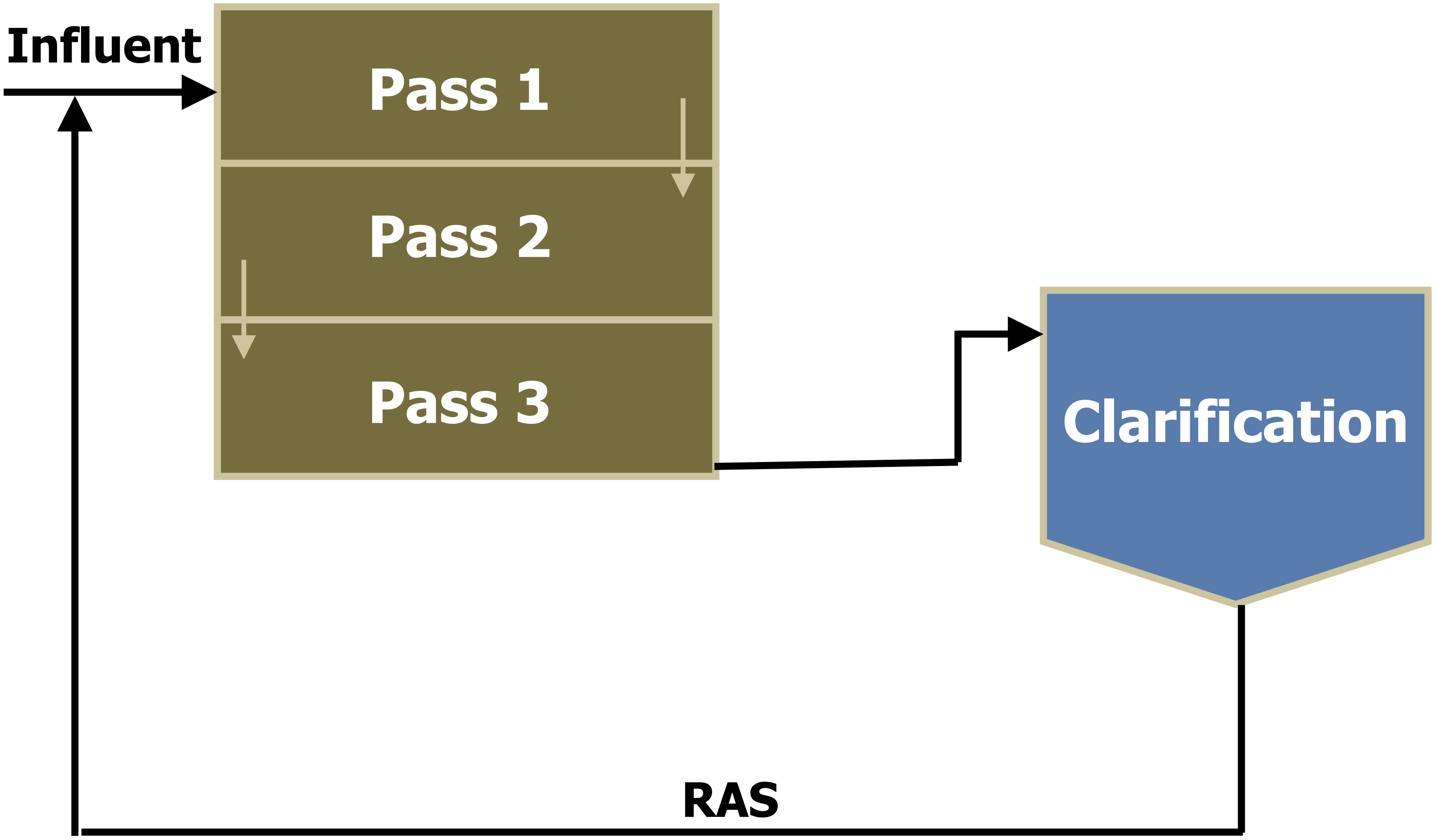
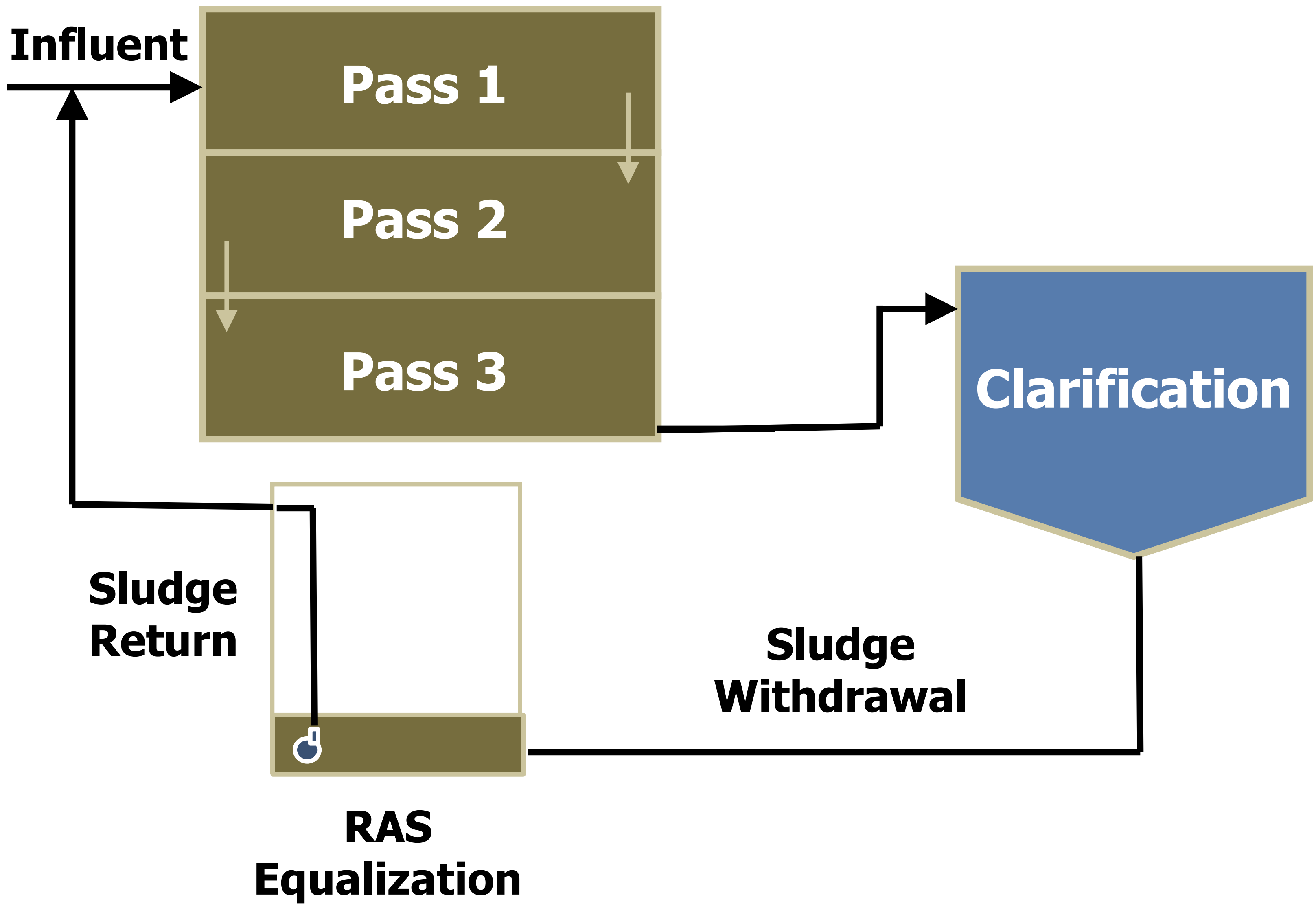
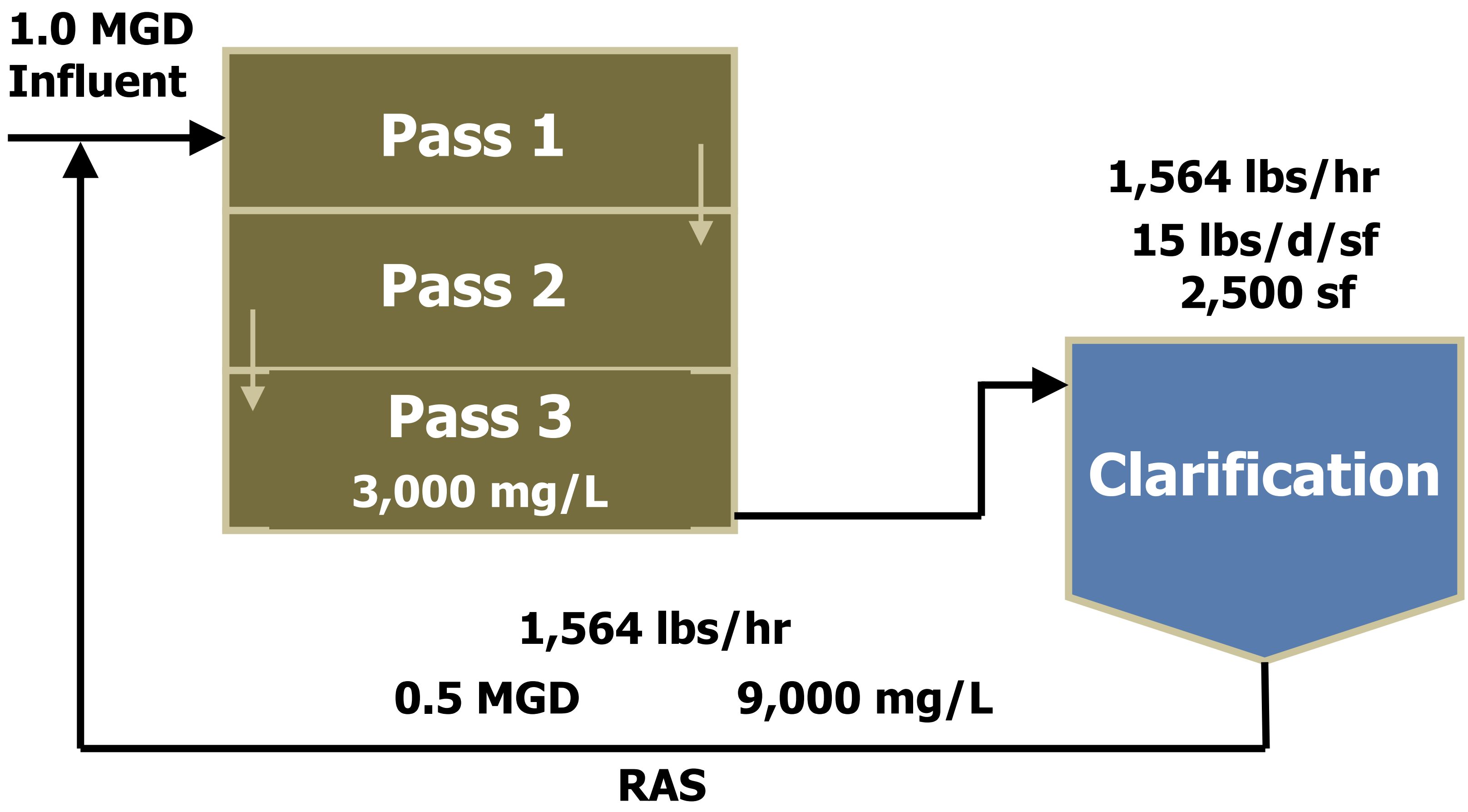
3 pass dry weather operation



3 pass with RAS Flow Equalization



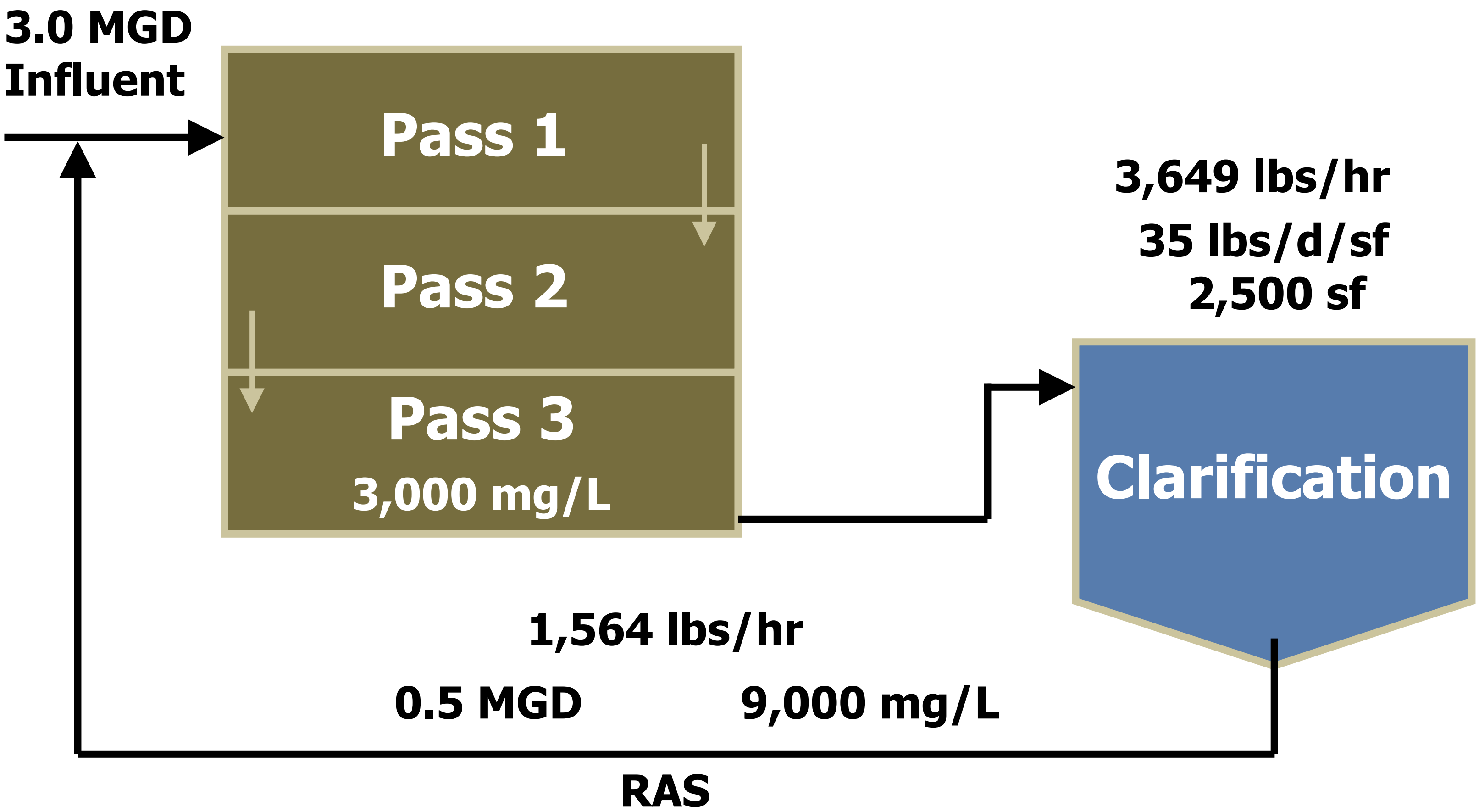
3 pass dry weather operation at equilibrium



RAS Flow in Equilibrium

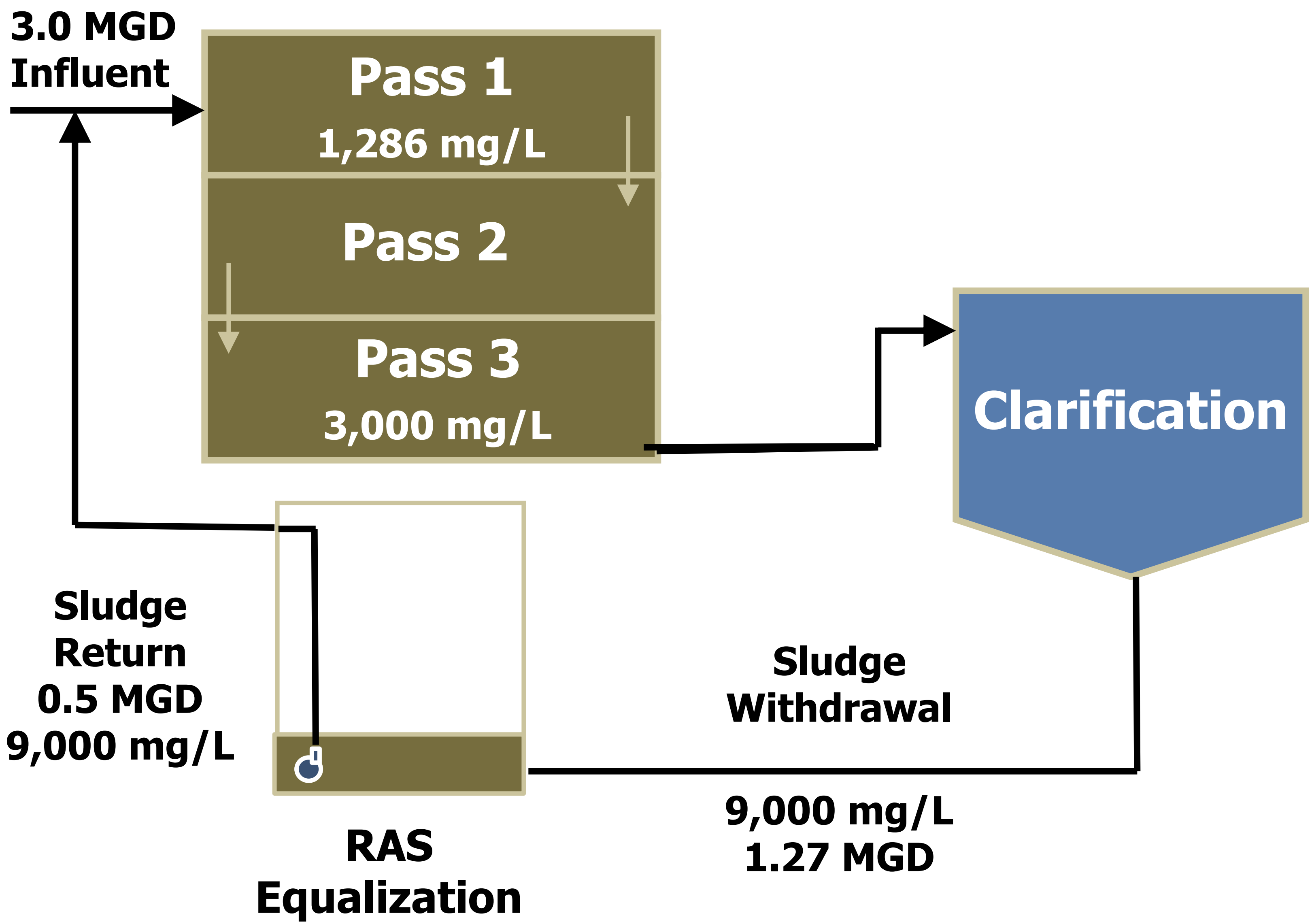
$$\frac{(\text{Influent MGD} * \text{MLSS mg/L})}{(\text{RAS mg/L} - \text{MLSS mg/L})}$$

3 pass dry weather operation wet weather flow

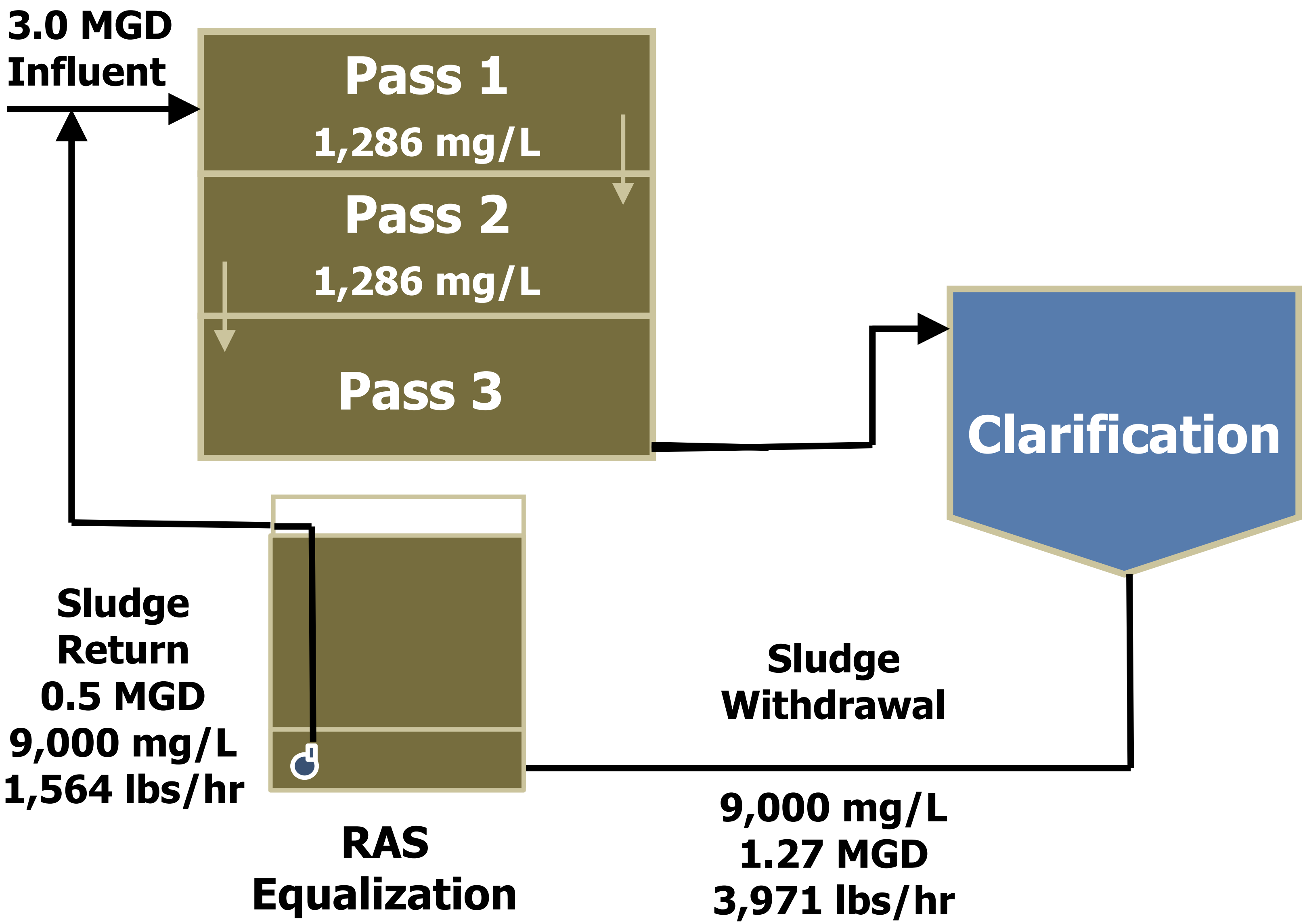


1.12 MGD RAS flow rate necessary to keep up with increasing solids loading or blankets have to thicken to 21,000 mg/L RAS to stop increasing. Increasing RAS flow rates contribute to even higher solids loading rates.

3 pass with RAS Flow Equalization Transition



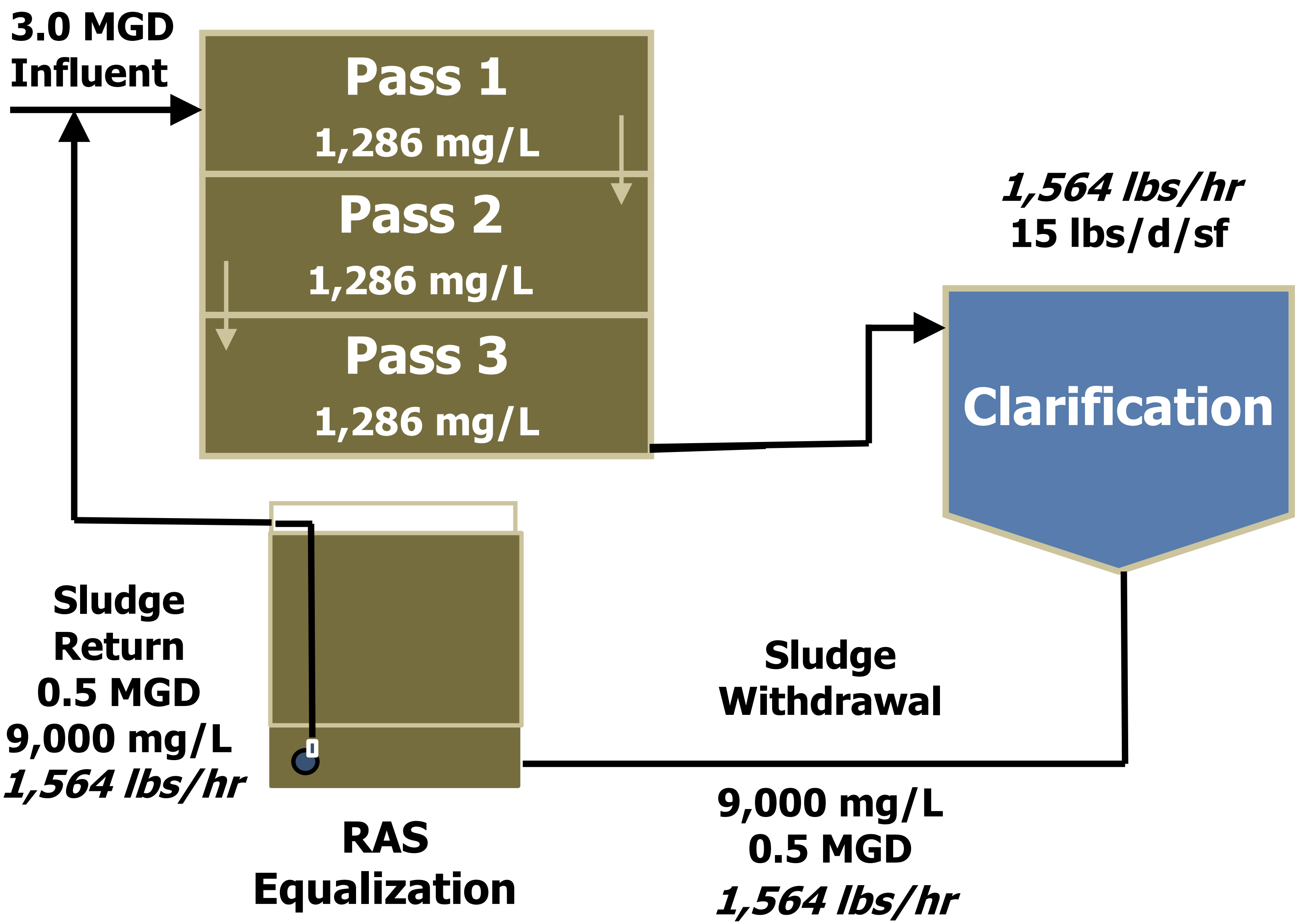
3 pass with RAS Flow Equalization Transition



RAS Flow Equalization:

- Assume aeration is 1,000,000 gallons. The pounds of MLSS that must be removed from aeration are (3,000 mg/L – 1,286 mg/L) are 14,295 lbs.
- The pounds returned to aeration are 1,564 lbs/hr while withdrawal out of the clarifiers is 3,971 lbs/hr. The difference (2,407 lbs/hr) must be held in the RAS Flow Equalization tankage (or temporary holding).
- At a concentration of 9,000 mg/L, RAS Flow Equalization would require 190,000 gallons of storage volume.
- The RAS Flow Equalization Tank would reach equilibrium in 6 hours where pounds going in equal pounds going out. Sludge withdrawal and sludge return are equal.
- The clarifiers would not have increased sludge blanket depth during this adjustment while solids loading rates decrease.

3 pass with RAS Flow Equalization steady state



RAS Flow Equalization:

- Enables aeration operation at existing dry weather MLSS concentration and withdraw the first flush of solids as sludge blankets begin to rise
- Returns RAS at a reduced flow rate to generate a new MLSS concentration (lower concentrations) while RAS withdrawal is increased to compensate for increasing sludge blanket depth.
- Allows solids to aerate and stabilize, rather than settle and collect in a clarifier.

RAS Flow Equalization:

- Aerates, mixes and further stabilize solids and improved effluent water quality at lower MLSS operation.
- RAS Equalization typically required to hold approximately 50% of MLSS solids at return sludge concentrations.
- Additional dry weather benefits for nutrient removal and sludge yield if integrated and controlled properly.

Optimum clarifier operation starts with settleability

Activated Bentonite

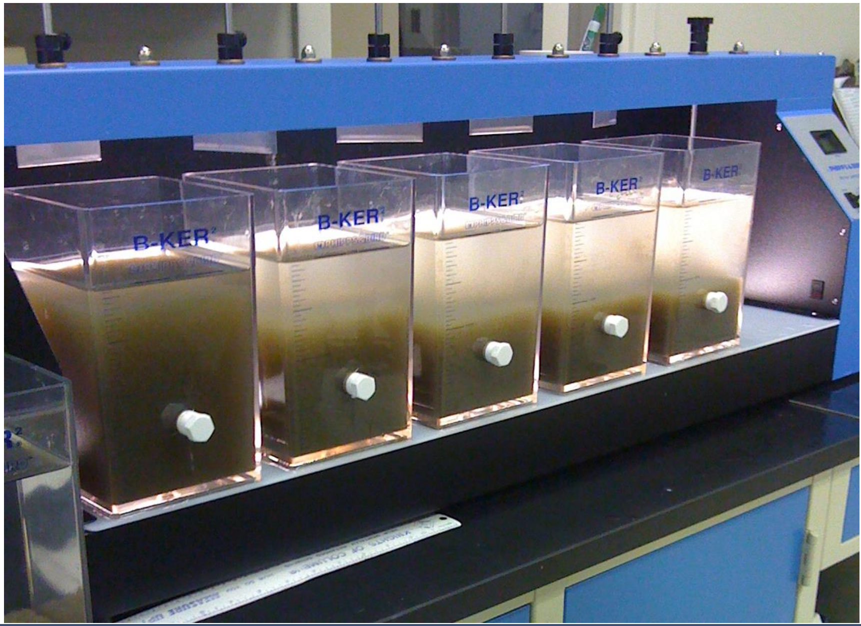
- Bentonite improves sludge settleability, therefore increasing clarifier capacity,
- Bentonite may prevent clarifier failure during high flow events,
- Flocculation time is needed with bentonite (adding upstream in aeration).
- Supernatant (after initial bentonite addition) has some fine colloidal inerts release. Clarity returns.
- Bentonite becomes incorporated into the floc and continues to maintain settleability when returned.

Activated Bentonite
Installation with simple mixing requirements

Dairy Operation outside of Munich that feeds bentonite directly to aeration for process settling.

Activated Bentonite to provide optimum settleability…

- **Control of the Clarifier Sludge Blankets begins with sludge quality control in aeration:**
  - Anoxic Selector for improved settling/settled sludge concentration.
- **Control of the Clarifier Sludge Blanket at the Settling Stage (enhance settling if dry weather control is not optimum).**
  - Polymer feed system to improve capture and compaction
  - Ballast is a longer-term option as the bentonite incorporates into the floc.
  - Unlike Polymer, once applied, the ballast settling properties remain



Sidney, OH Jar Testing for Wet Weather Treatment

Converting mls to SSV (as % of settling volume)

	minutes	5	11	16	20	30
Control		625	500	400	300	275
Terrana						
	0.5 gram	400	300	250	225	200
	1 gram	350	250	200	200	200
	1.5 gram	325	225	175	175	150
	2 gram	300	200	150	150	150

SVI by Settling (mls/gram)

	minutes	5	11	16	20	30
Control		539	431	345	259	237
Terrana						
	0.5 gram	241	181	151	136	120
	1 gram	162	116	93	93	93
	1.5 gram	122	85	66	66	56
	2 gram	95	63	47	47	47

Other Considerations for Wet Weather: "Sludge Juggling" if no high flow design options…

Sludge Juggling……

- During wet weather, RAS can be split, and part of the RAS flow stream pumped to an empty tank.
- This would effectively move sludge blankets to the empty tank and move MLSS inventory off-line (Clarksville, TN – 25 MGD plant during 2010 Flood Recovery).
- Prior to the storm, most of the RAS could be directed to an empty tank or an off-line portion of aeration.
- MLSS concentration would be decreased and prepared for a high flow entry into the on-line portion of aeration.

Other Considerations for Wet Weather: "Sludge Juggling" if no high flow design options…

Sludge Juggling……

- If all else fails, the last pass (or sections) of aeration can be shutdown during peak flow and rising blankets.
- Treated MLSS is settled and separated in aeration with reduced solids loading to the clarifiers.
- Upstream aeration does the treating, but eventually the MLSS must be re-suspended.
- Columbus, GA for example (42 MGD) alternates aeration different passes to resuspend different portions of the aeration system.

Summary

- Solids Loading to the secondary clarifier is typically the most significant performance limiting factor with high flows.
- Look into high flow strategies with step feed/contact stabilization.
- RAS Equalization has other benefits in addition to high flow operation.
- Activated Bentonite offers settleability improvements to withstand higher flows.
- Sludge juggling is an option by shutting down portions of aeration, filling empty tanks, or over wasting to reduce aeration inventory.

QUESTIONS?????