Ammonia Controlled Aeration

CSWEA 85th Annual Conference

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Brown AND Caldwell

Ammonia Controlled Aeration Goals

- Reduced energy consumption
- Reduced total nitrogen

Table 6: Overview of simulated and full-scale energy savings and improvements of total nitrogen removal

	WWTP Morgental 35,000 PE		WWTP Thunersee 130,000 PE		WWTP Werdhoelzli 600,000 PE
	simulation	full-scale	simulation	full-scale	simulation
Energy	-30%	-20%	-30%	-16.5%	-25%
TN removal	+48%	+40%	+60%	+40%	+32%

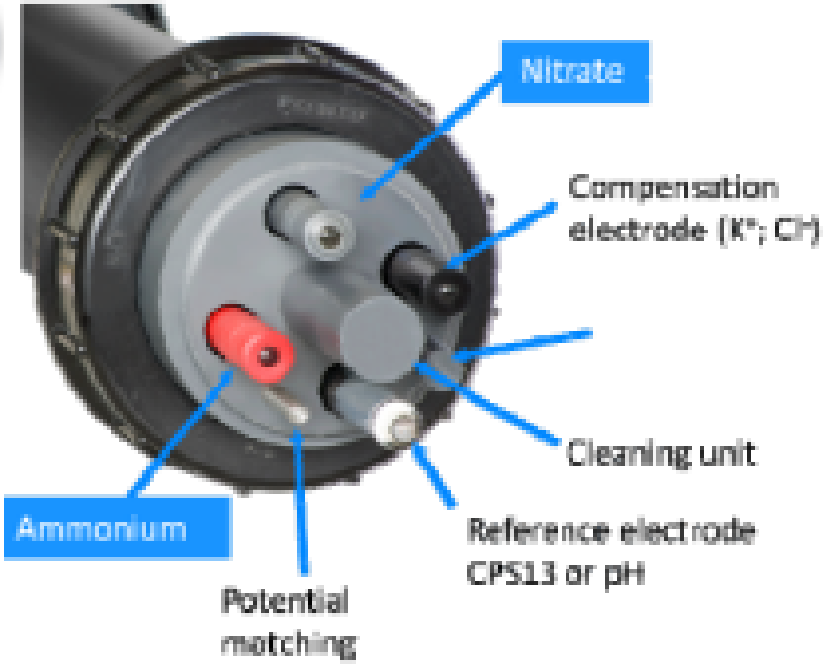
- Rieger, WEFTEC 2010

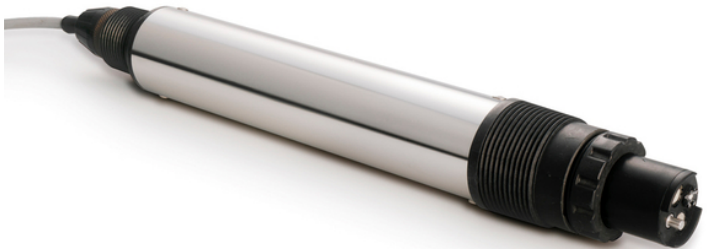
Outline

- Ammonia Sensors
- Ammonia Aeration Control Strategies
- Case Studies
- Close

Ammonia/Nitrogen Sensors

WTW

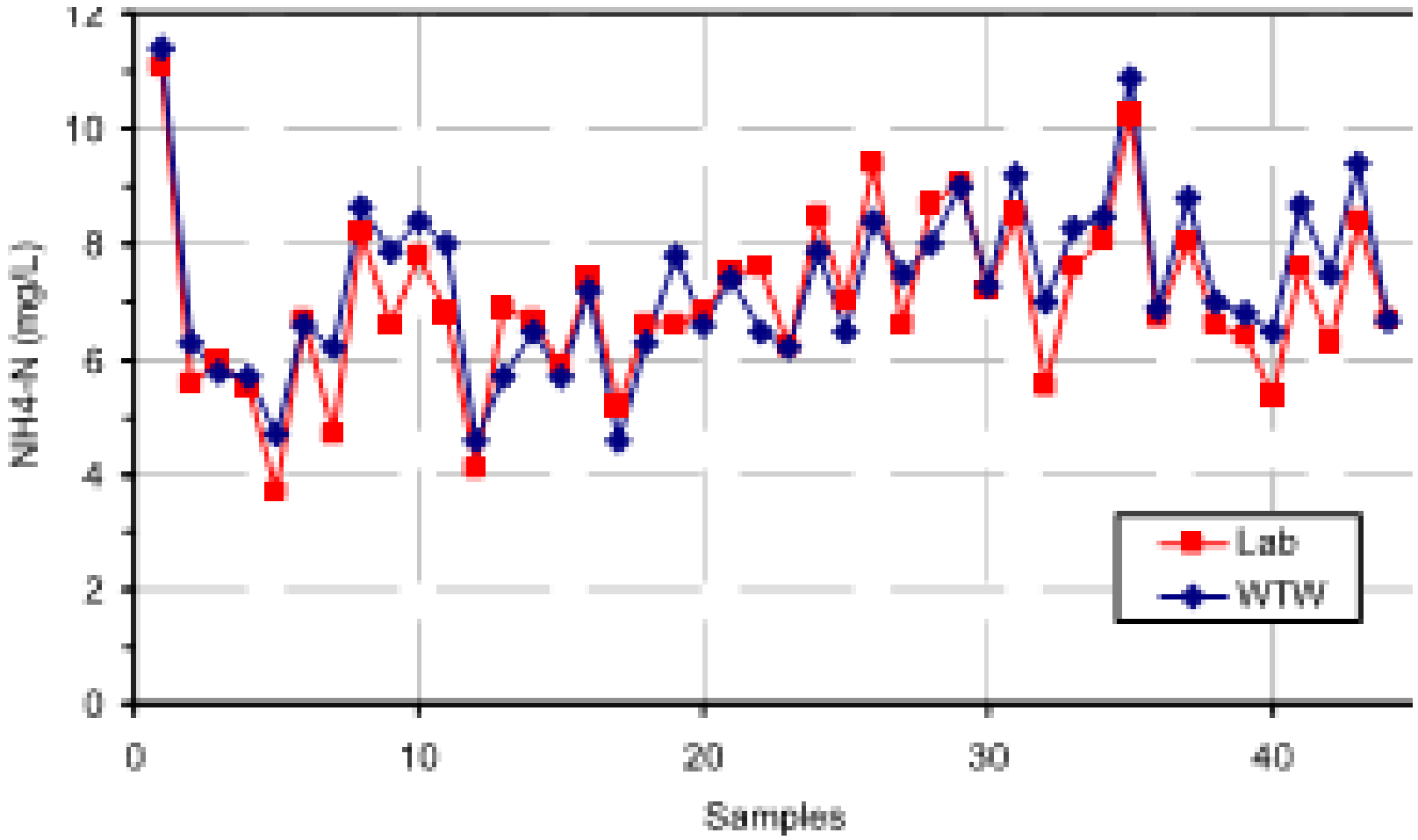




Hach

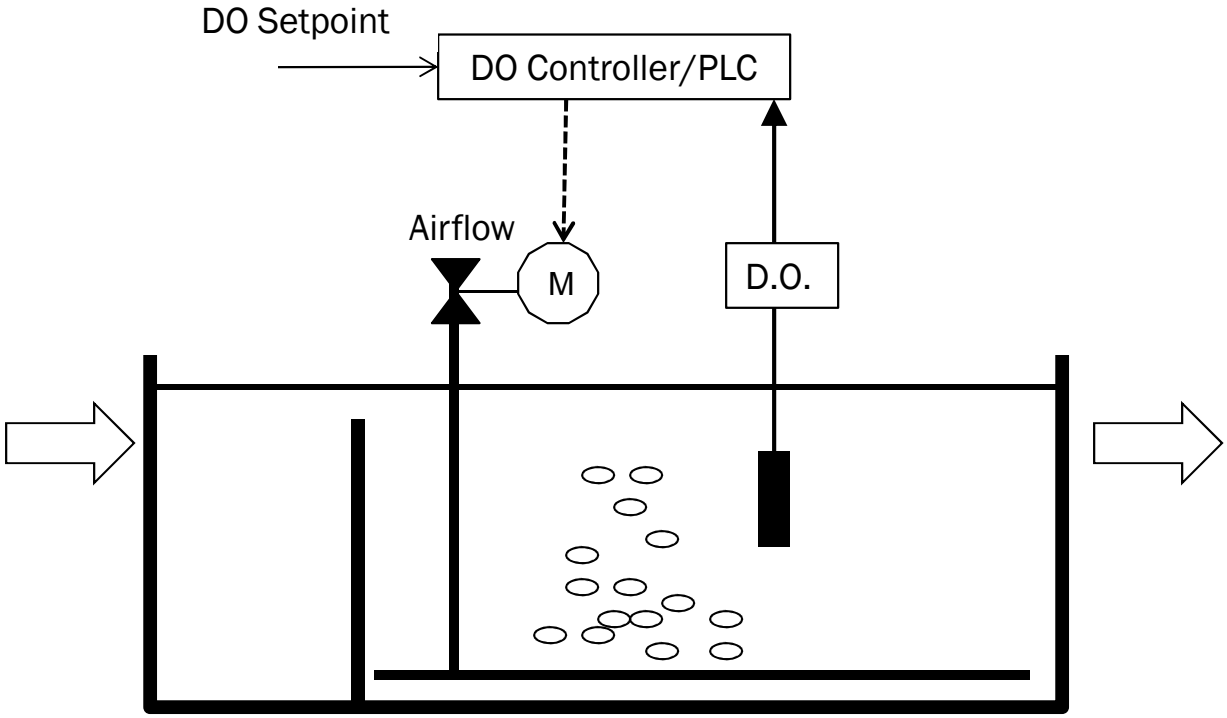
Endress + Hauser

Santa Clara/San Jose Ammonia Sensor Evaluation

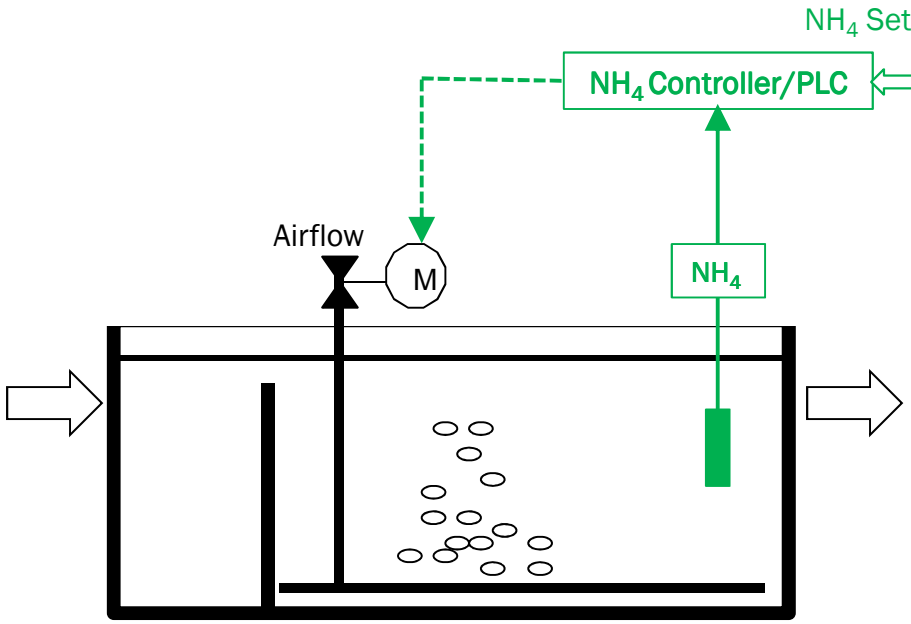


Source: WEFTEC 2010

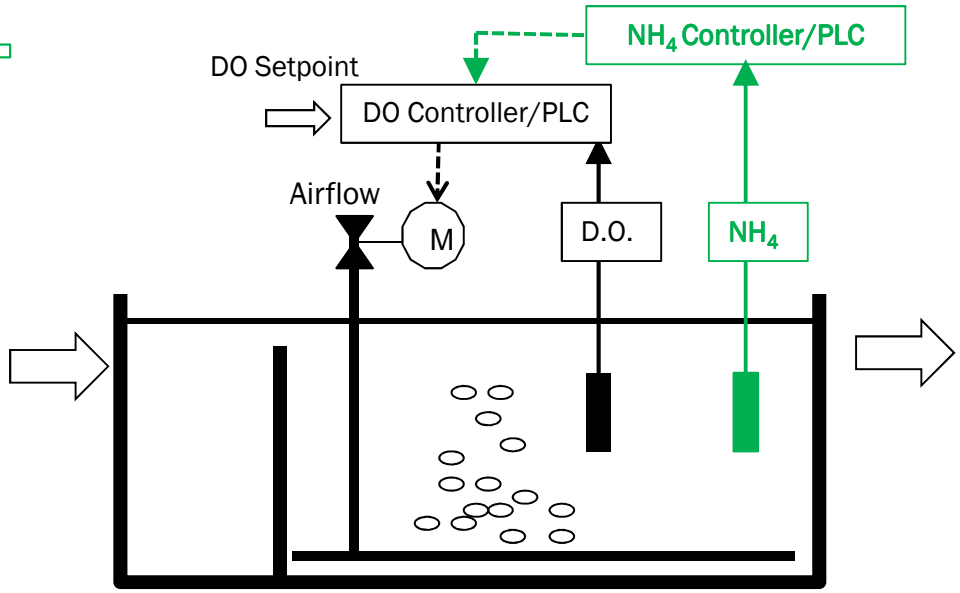
Typical Aeration Basin Control Strategy



Ammonia/Aeration Basin Control Strategies



Ammonia Feedback Control



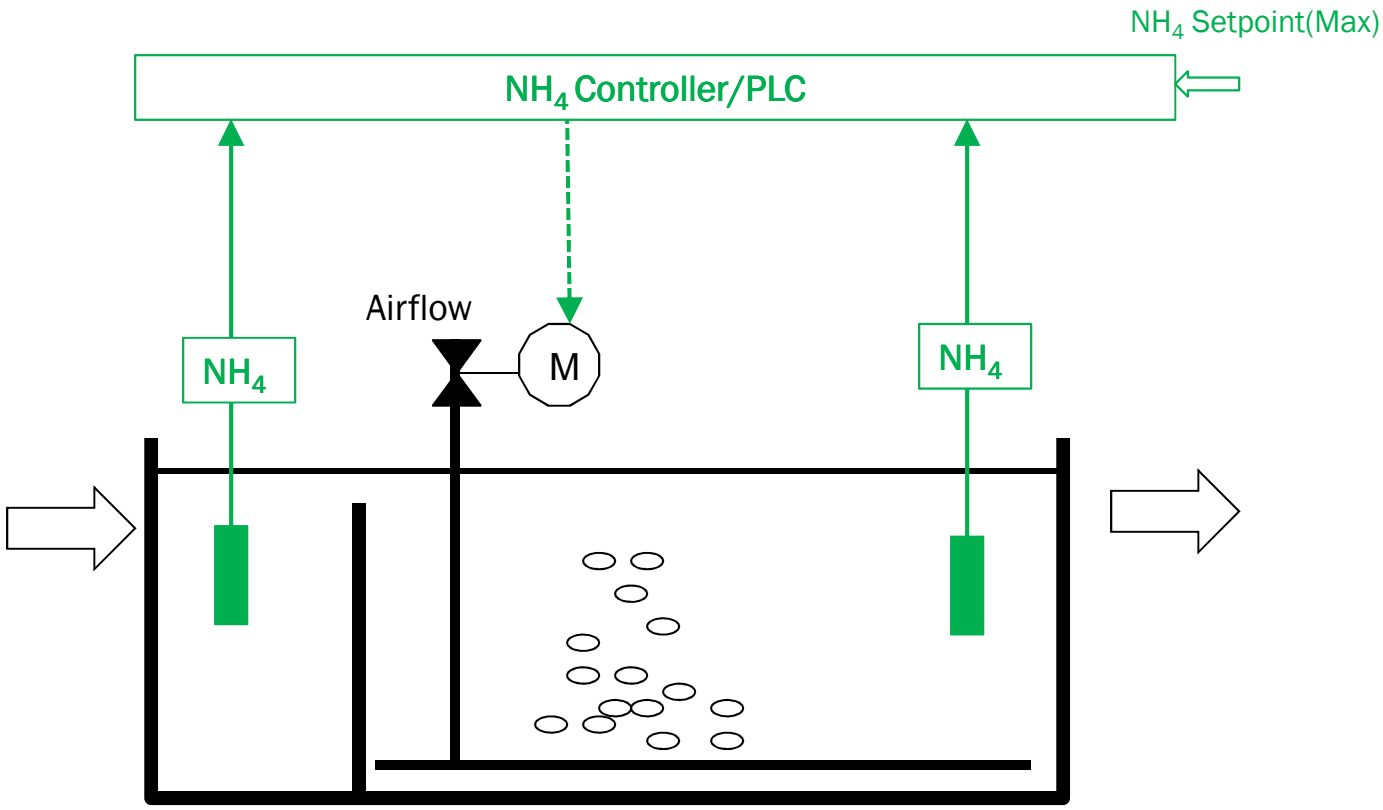
Cascade to DO set point (or visa versa)

Example

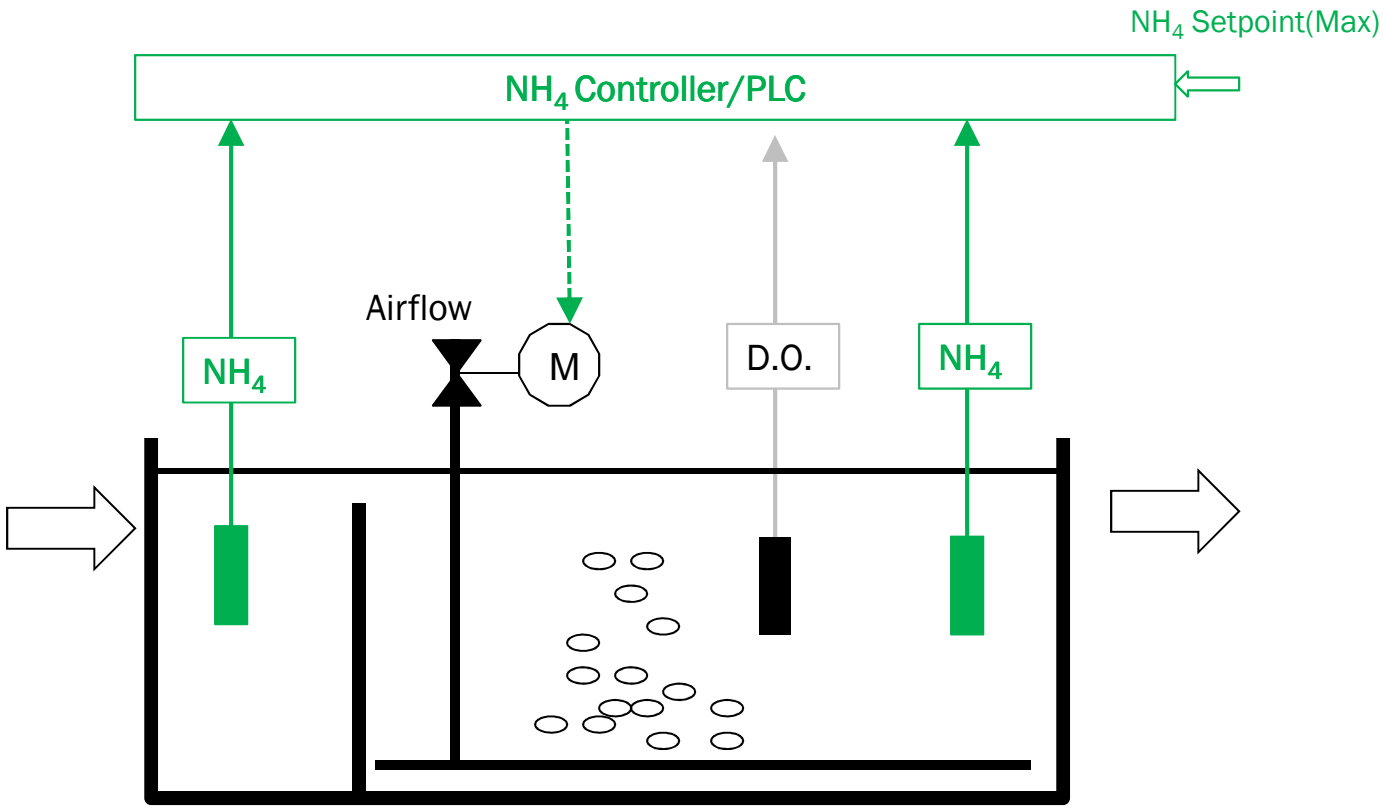
NH4 < 1.5 mg/L then DO setpoint = 0.5 mg/L

NH4 >1.6 mg/L then DO setpoint = 2.0 mg/L

Ammonia Feed Forward – Feedback Control



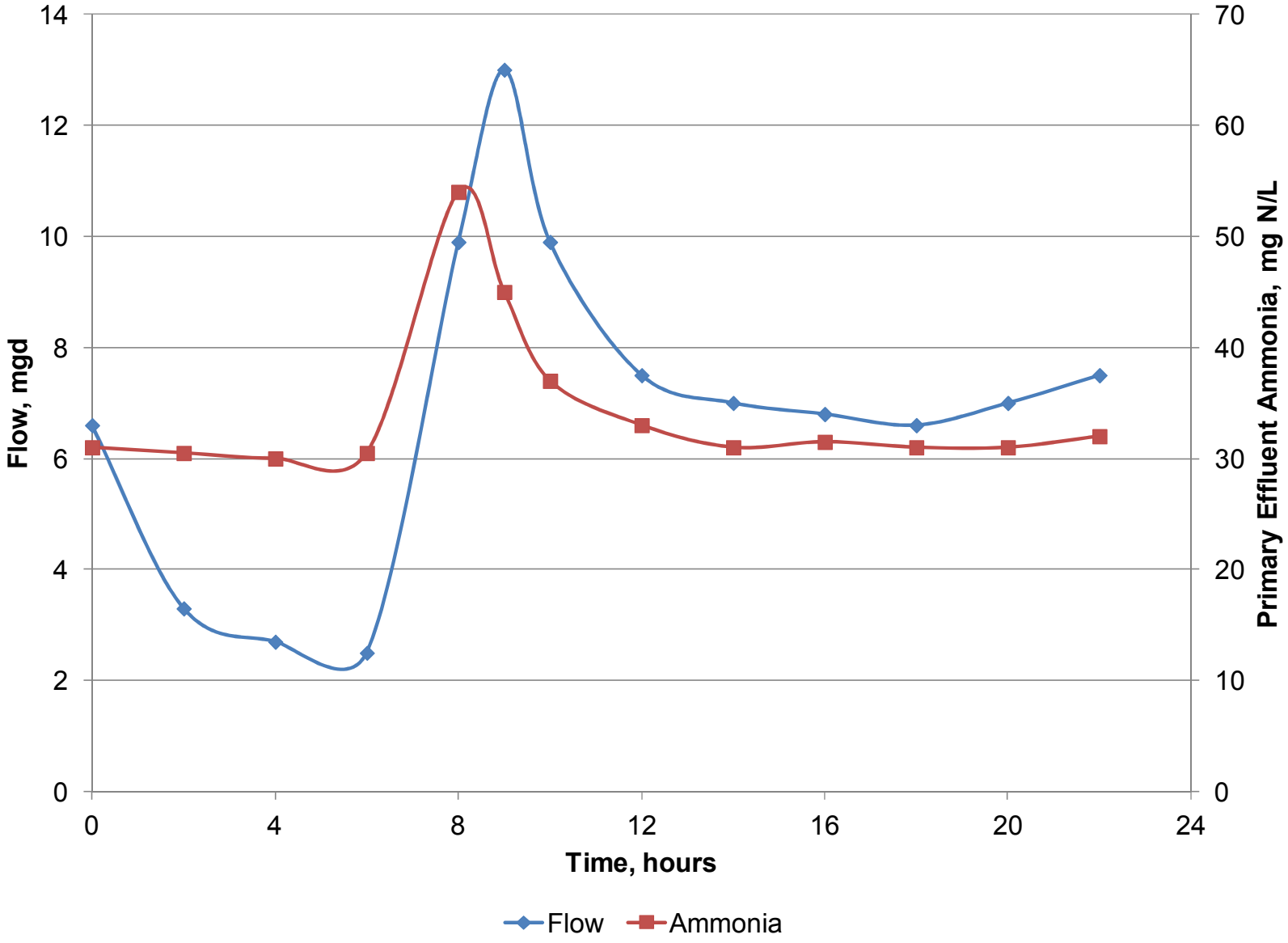
Ammonia Feed Forward – Feedback Control



Case Example: J.D. Phillips WRF

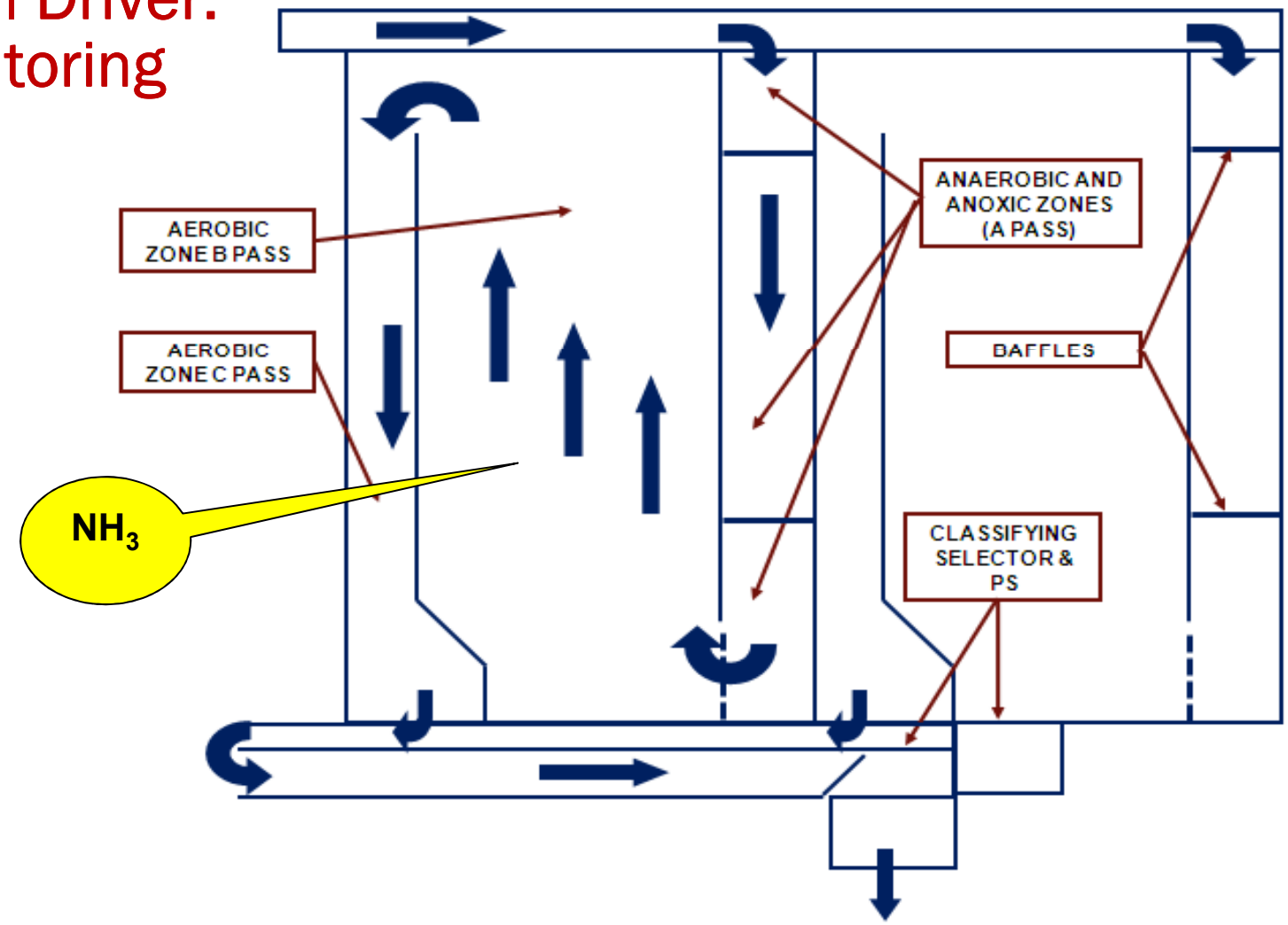
- Flow: 8 mgd
- Design Capacity: 23.6 mgd MLE facility
- Blowers
  - Small/Large
- Permit
  - Ammonia
  - pH

Case Example: J.D. Phillips WRF



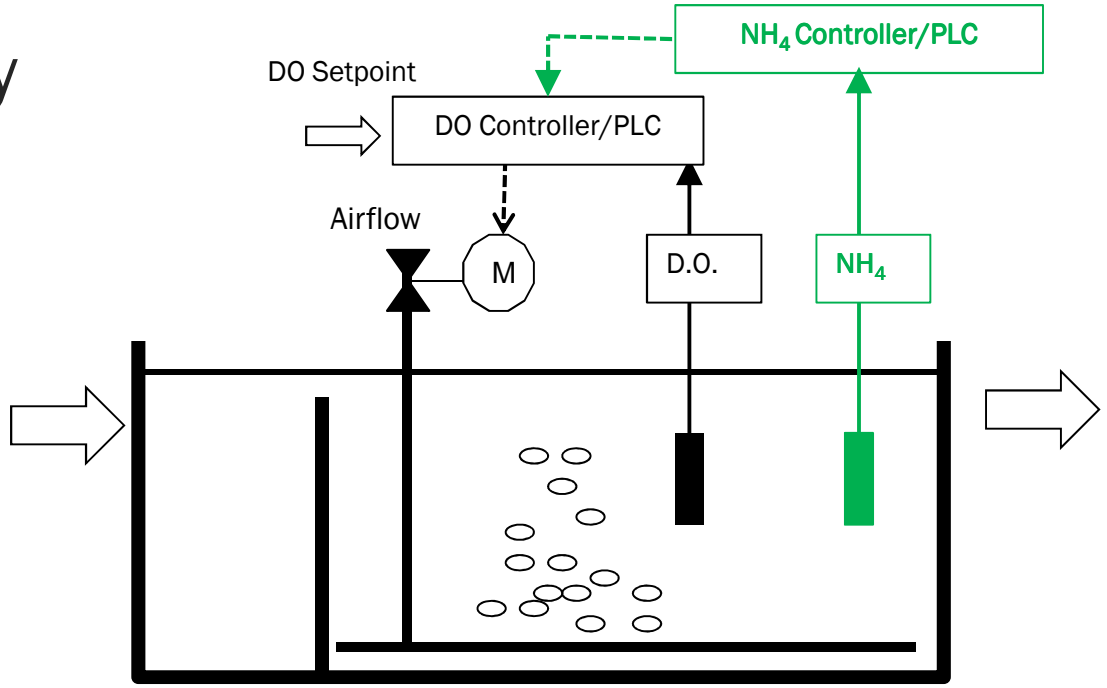
Case Example: J.D. Phillips WRF

- Initial Driver: Monitoring



Case Example: J.D. Phillips WRF

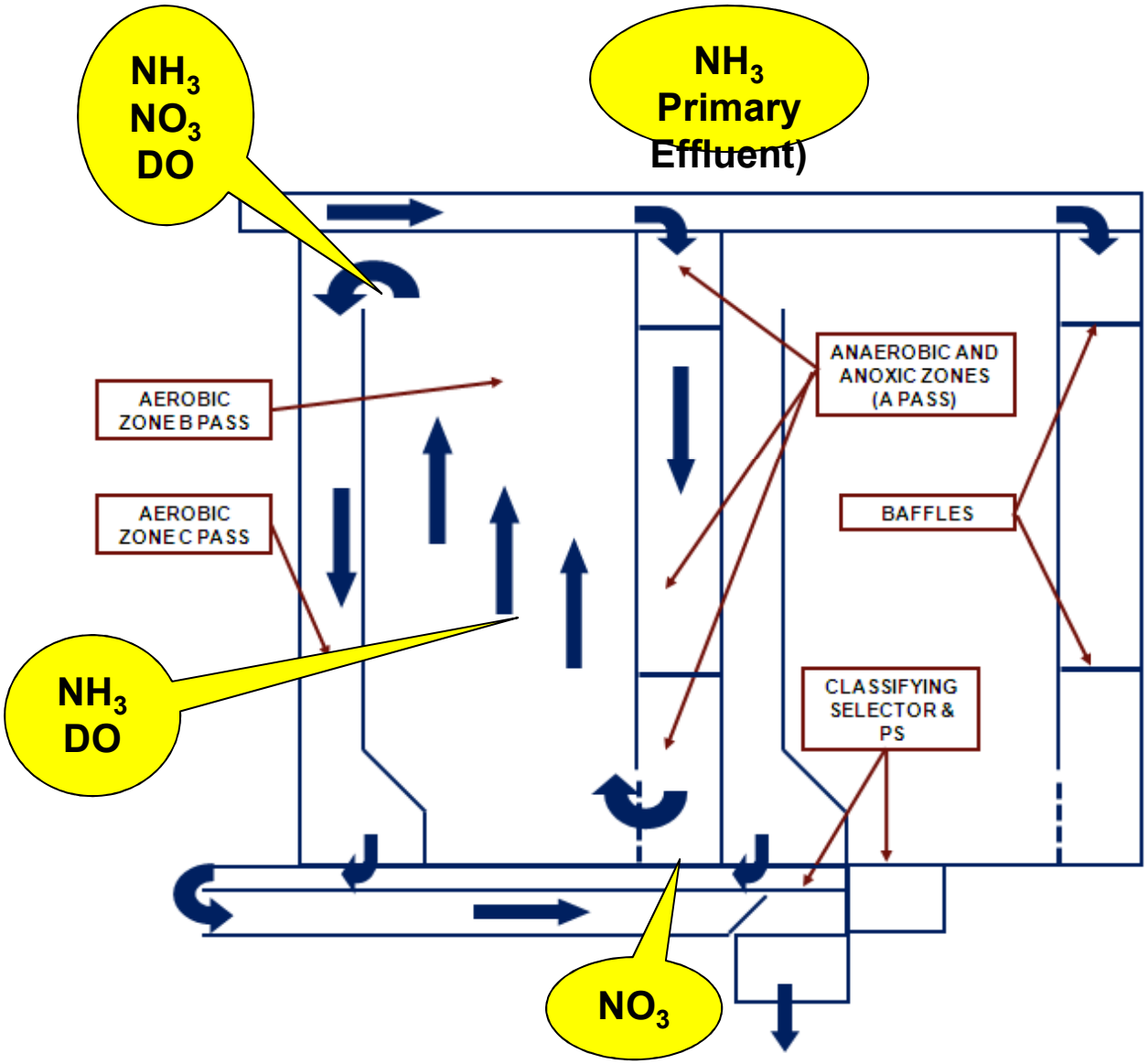
- Initial Control Strategy
  - Ammonia cascade loop w/DO control



Findings

- Biological response to ammonia “slug” was fast
- Control slow to adjust DO setpoint
- More complexity & difficult to control and tune

Case Example: J.D. Phillips WRF

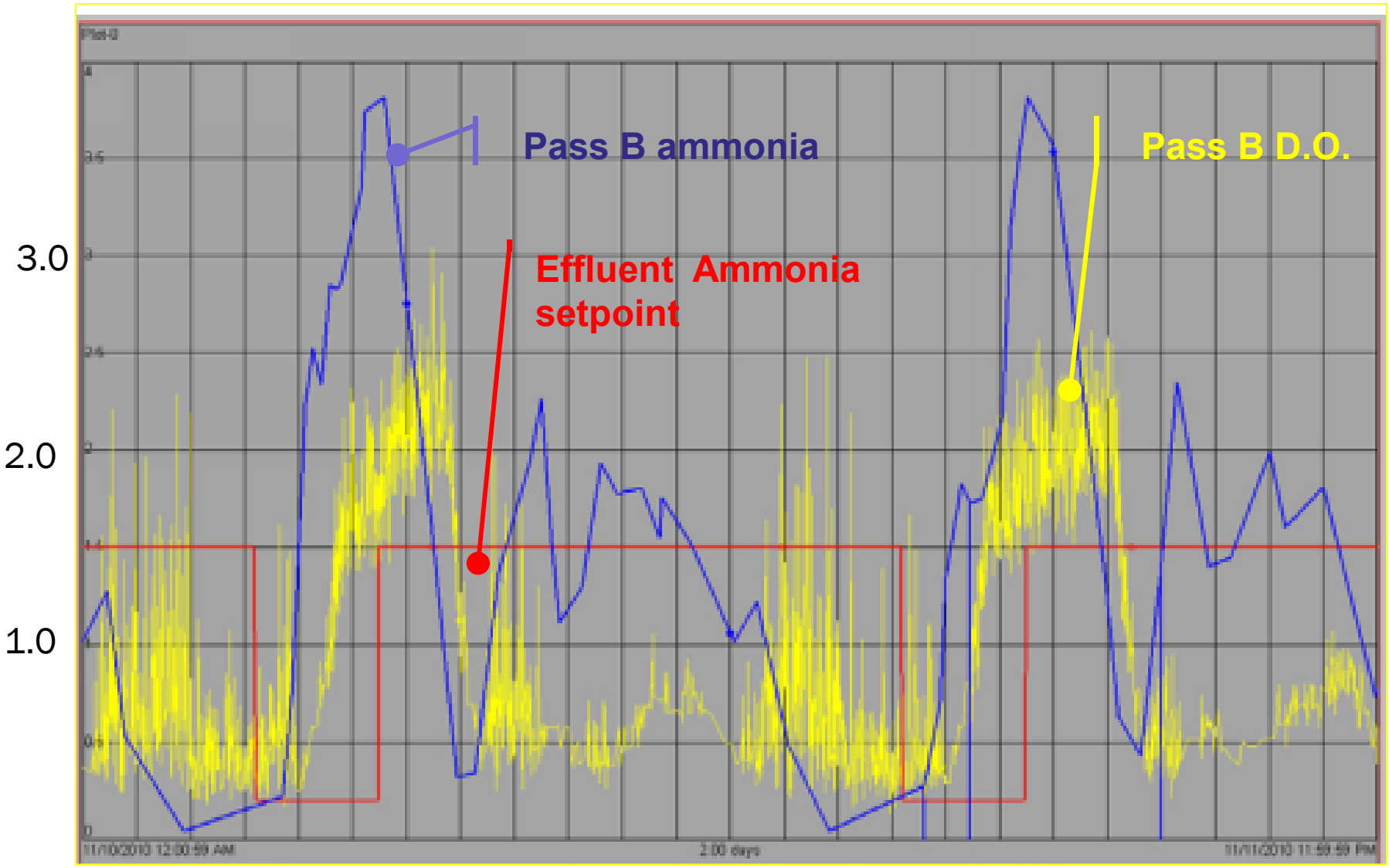


Case Example: J.D. Phillips WRF

- Base Aeration Control Strategy

Item	Value	Comments
<u>Pass B - Ammonia Control</u>		
Effluent NH_4 Setpoint	1.5 mg /L 0.2 mg/L (am only)	Operator input
Pass B Middle NH_4 Setpoint	Eff NH4 target * CF1 (70 % removal)	Algorithm from Historical trends
Pass C NH_4 Setpoint	Eff NH4 target * CF2 (90 % removal) Check on Pass B Sensor	
Target D.O (Secondary)	0.5 – 3.5 mg /L	Filament control
<u>Pass C – DO Control</u>		
D.O Setpoint	>0.5 mg /L	Prevent denitrification in secondary clarifiers

Case Example: J.D. Phillips WRF



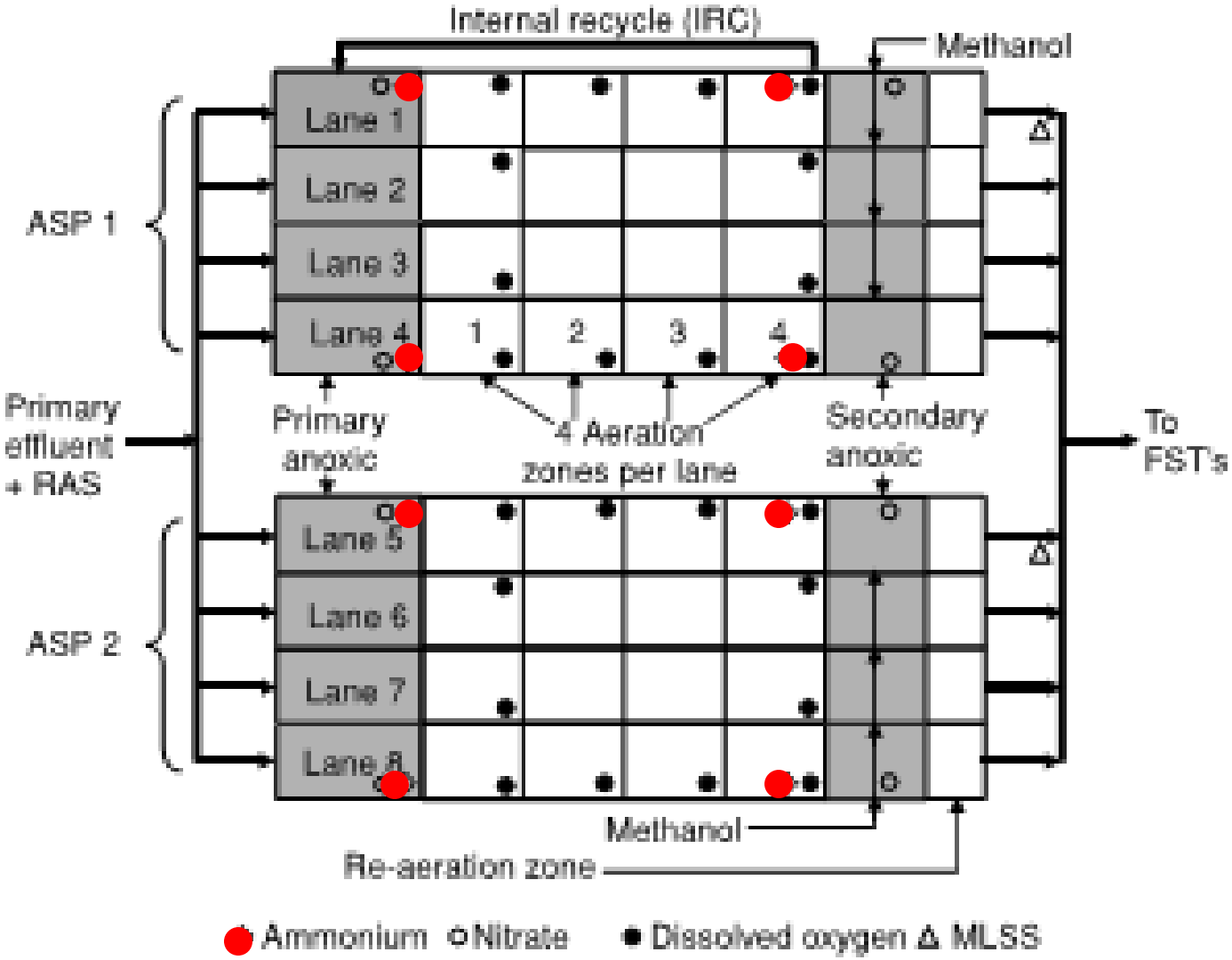
Source: WEFTEC 2010

Case Example: J.D. Phillips WRF

Lessons Learned

- Sensors are reliable with proper maintenance
  - Calibrate ≈ monthly
  - 1 -2 hours/calibration/probe (recommend Hach kits)
  - Replace sensor caps every 6 months
- Algorithm takes time to develop and change
- ≈20% energy savings
  - Save during off-peaks
  - Blower turndown essential
- Beneficial for plant nitrifier upsets
- PE difficult sensor application – head of bioreactor for feed forward control

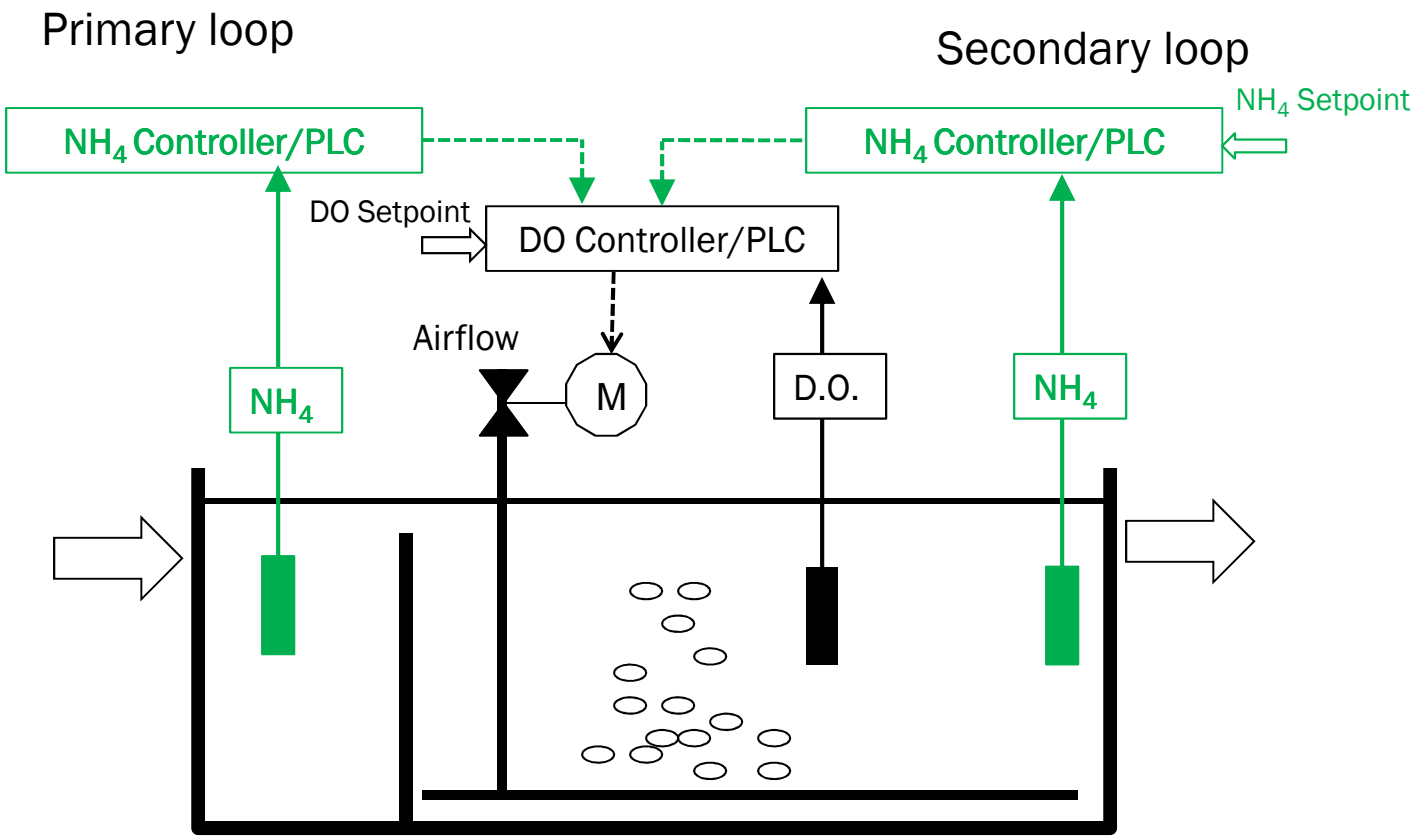
Case Example 2 – U.K. 4-Stage Bardenpho



Optimized DO
Zone 1 = 2.0 mg/L
Zone 2 = 2.1 mg/L
Zone 3 = 1.6 mg/L
Zone 4 = 0.5 mg/L

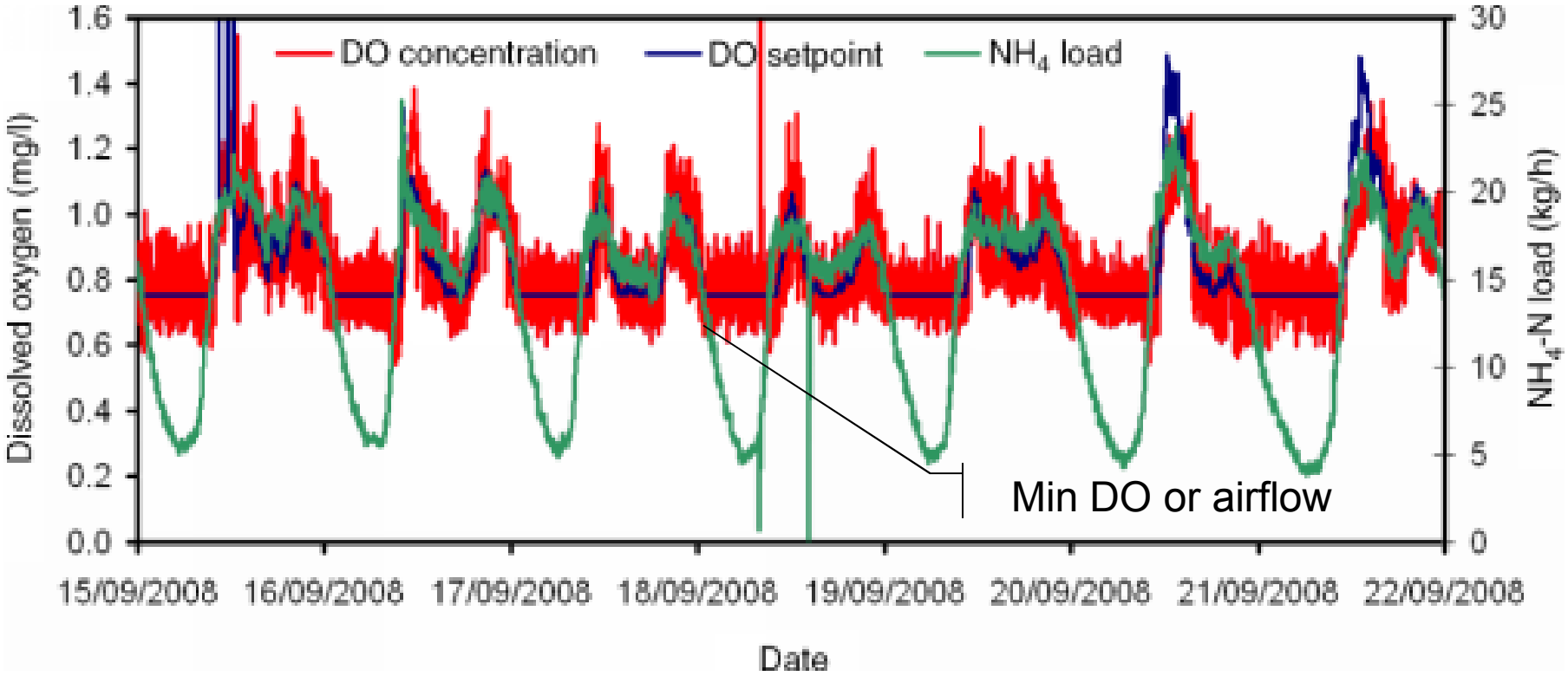
Source: WST, 61.9,2010

Case Example 2 – Aerated Zone Control



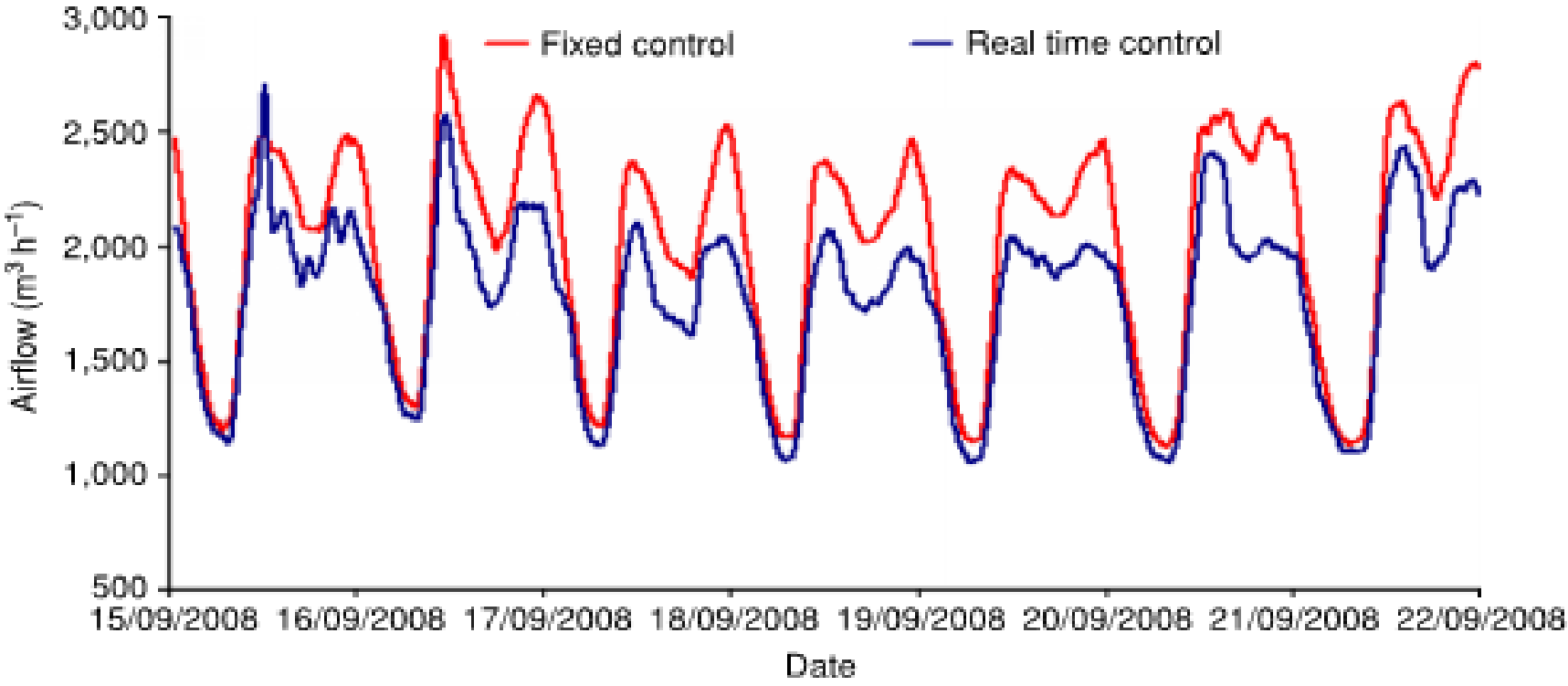
Aerated Zone DO setpoints based upon Feed-Forward anoxic zone ammonia using process model correlations

Case Example 2 – U.K. 4-Stage Bardenpho



Source: WST, 61.9,2010

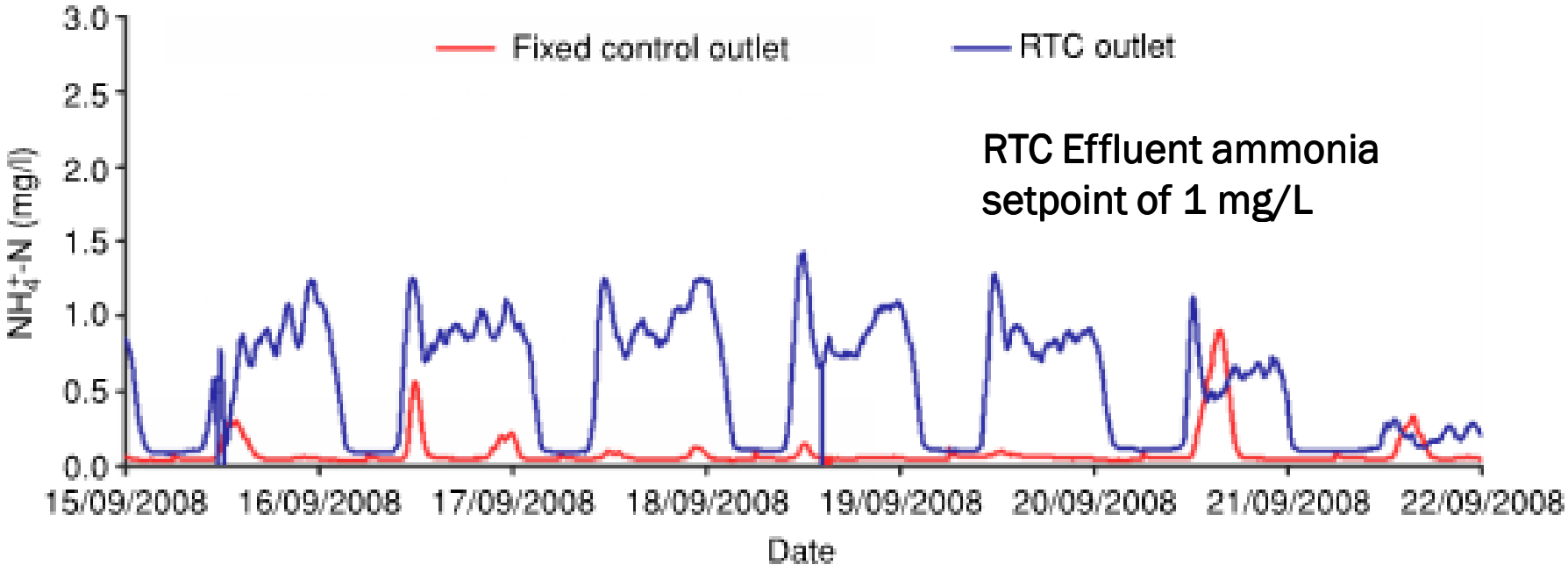
Case Example 2 – U.K. 4-Stage Bardenpho



20% airflow savings overall

Source: WST, 61.9,2010

Case Example 2 – U.K. 4-Stage Bardenpho



Source: WST, 61.9,2010

Ammonia Aeration Control - General

Need reliable and accurate sensors – test sensors for requirements

Control can be more complex

- Sensor outlay and maintenance
- More monitoring
- More maintenance (0.5 to 3 hours/week/device)
- Cascade loops – lag times/fine tuning
- Historical treatment or process model algorithms
- Feed-forward provides greater safety w.r.t peak loadings

Blower turndown

Low D.O. bulking a concern–especially if 1st aerobic zone D.O. <2.0 mg/L

Close

- Special Thanks

  Jay Hardison and Bill Hoyt, Colorado Springs Utilities

Questions

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