TACWA

November 15, 2019

CRWS Process Upset

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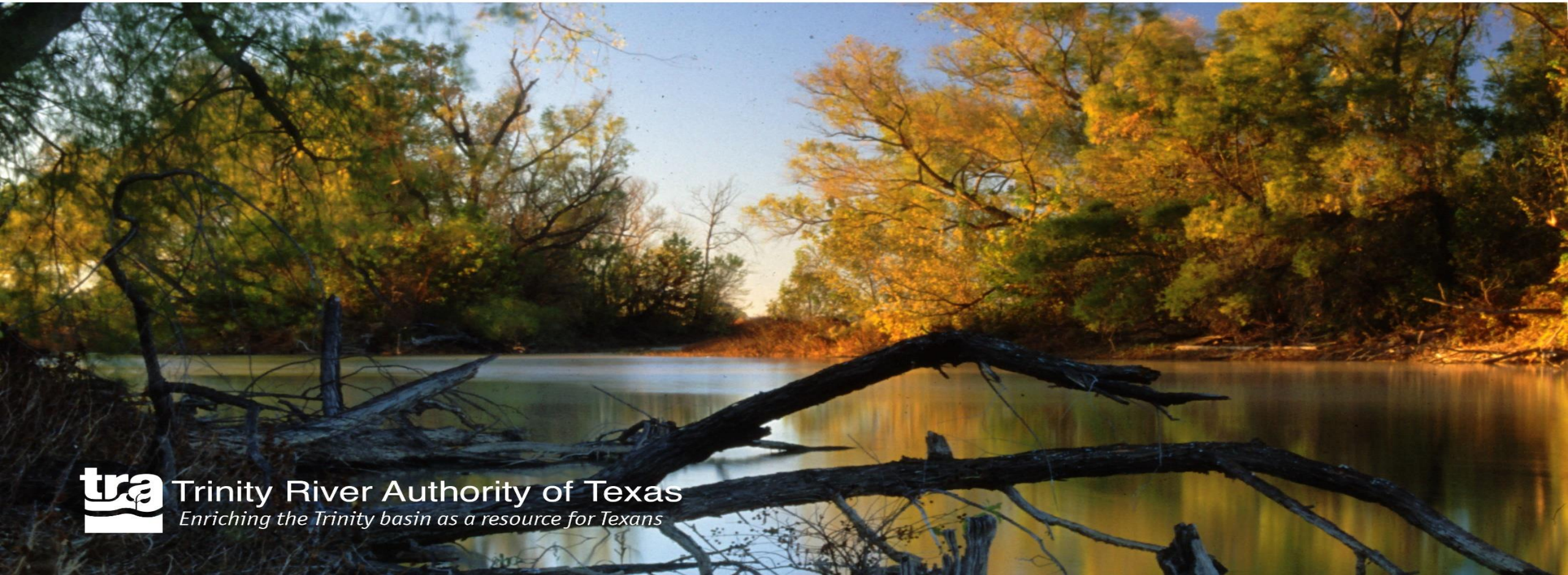


Agenda – Timeline of Events and Actions

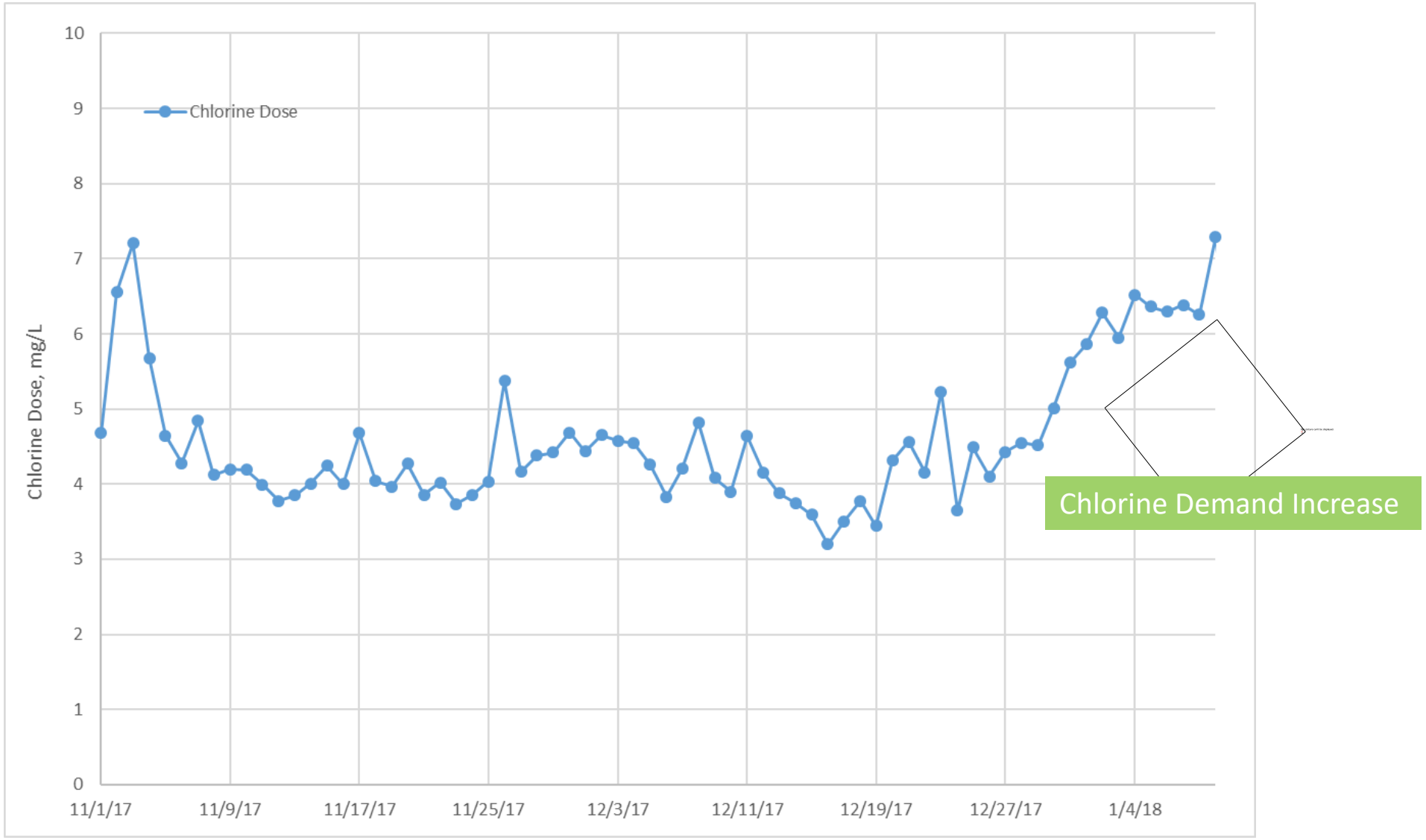
- CRWS Background
- Initial Indications and Counteraction
- Process Adjustment
- Recovery Summary

CRWS Background

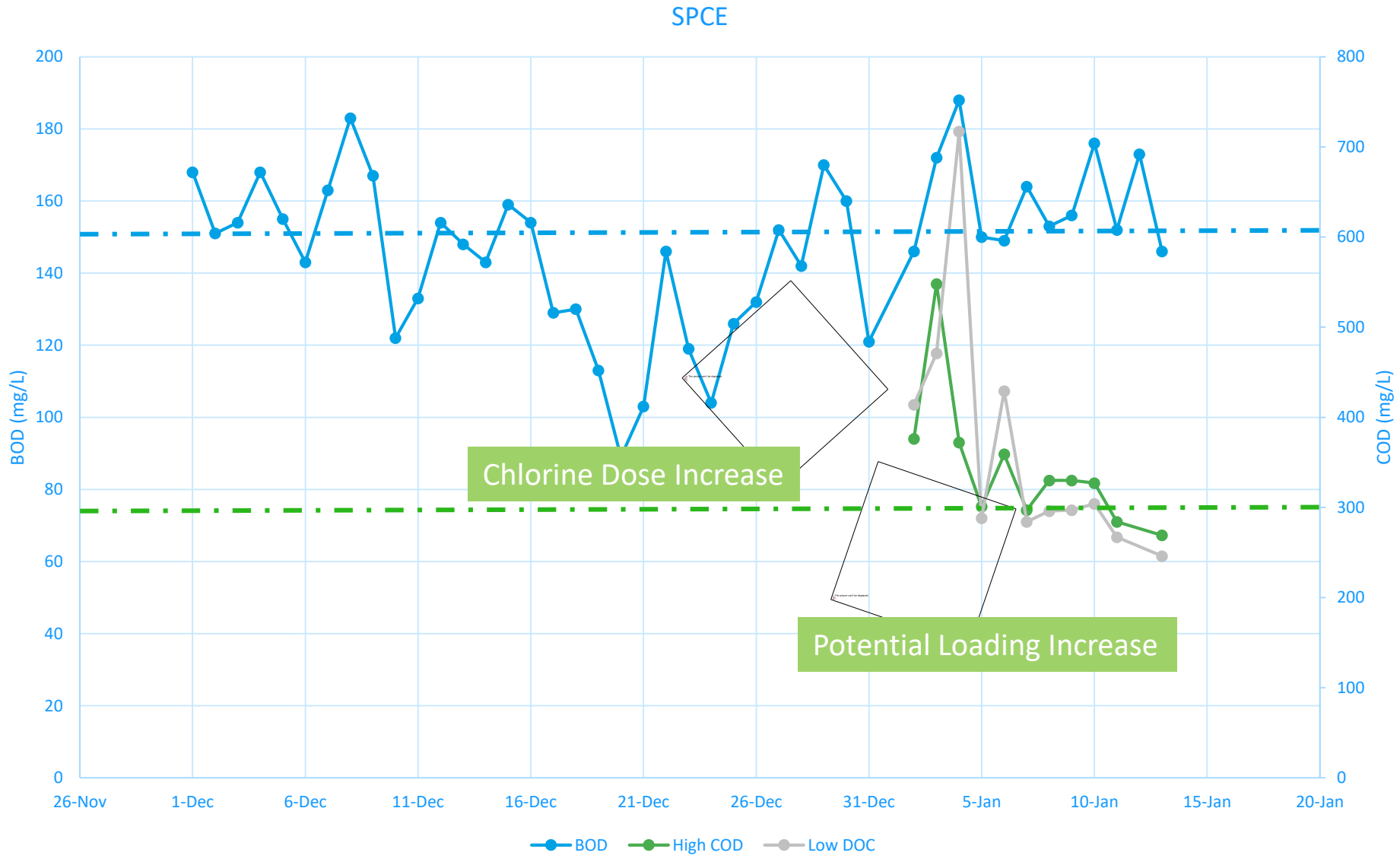
- Trinity River Authority of Texas Central Regional Wastewater System Treatment Plant
  - 162 mgd facility
  - Located outside of Dallas, Texas
  - Large collection system w/ multiple industrial users
- Secondary System
  - Seasonal 2-4 mg N/L NH4 limit
  - 12 Aeration Basins
  - Ammonium Based Airflow Controls (ABAC)

How did it start?

Late 2017 into 2018 – Increasing chlorine demand



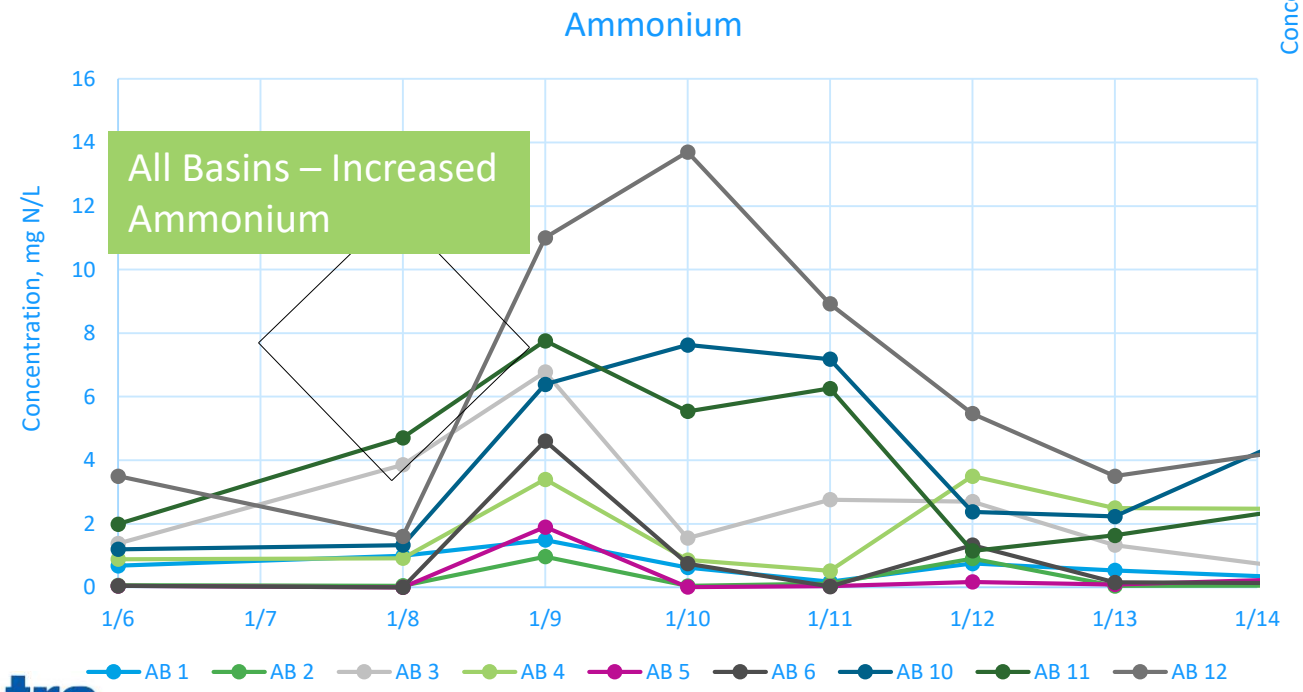
Initial Special Sampling – Was the influent loading higher?

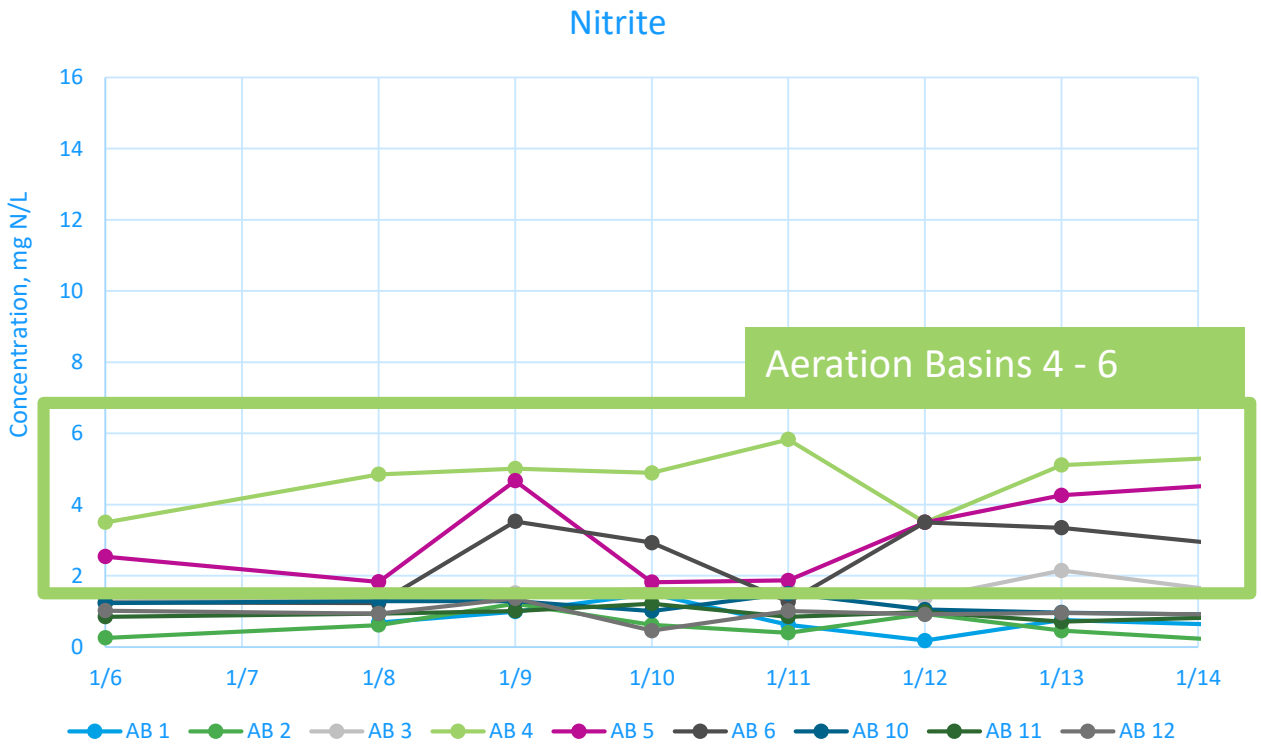


Timeline – Early January 2018

Initial Special Sampling – Were all basin performances equal?

- CRWS - 9 of 12 Aeration Basins in Operation
- Not all basins immediately impacted

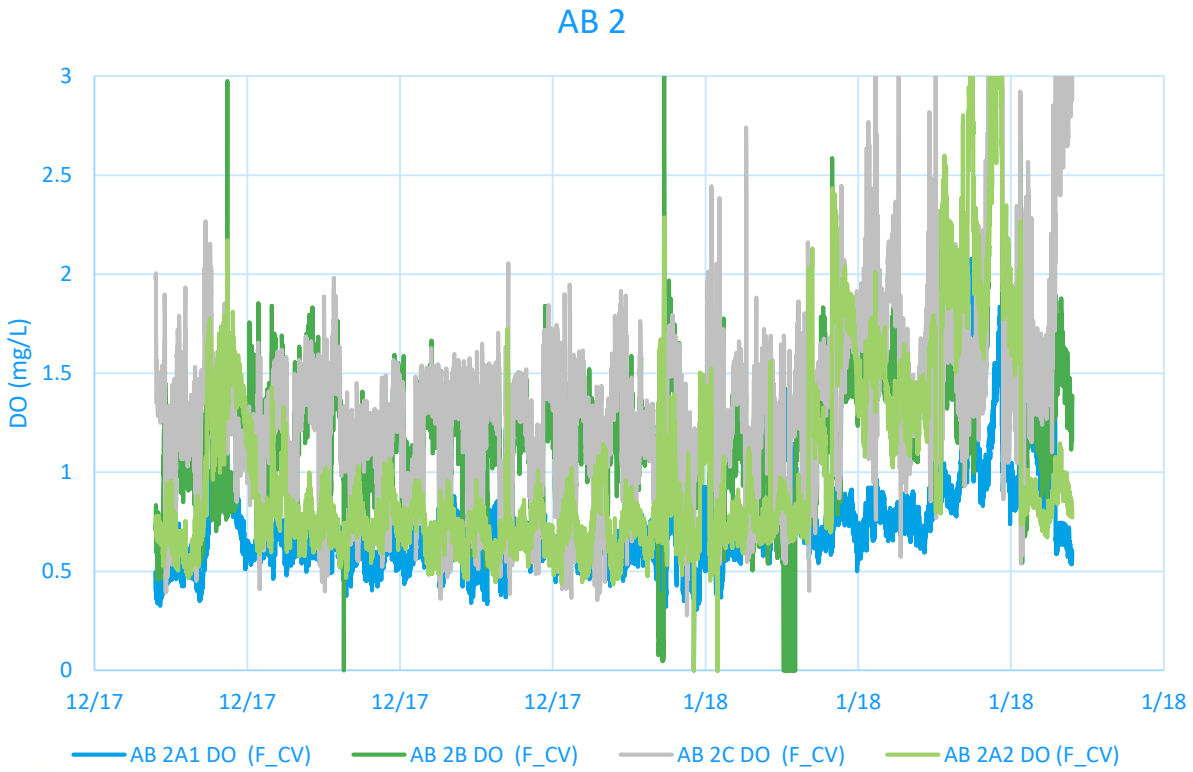


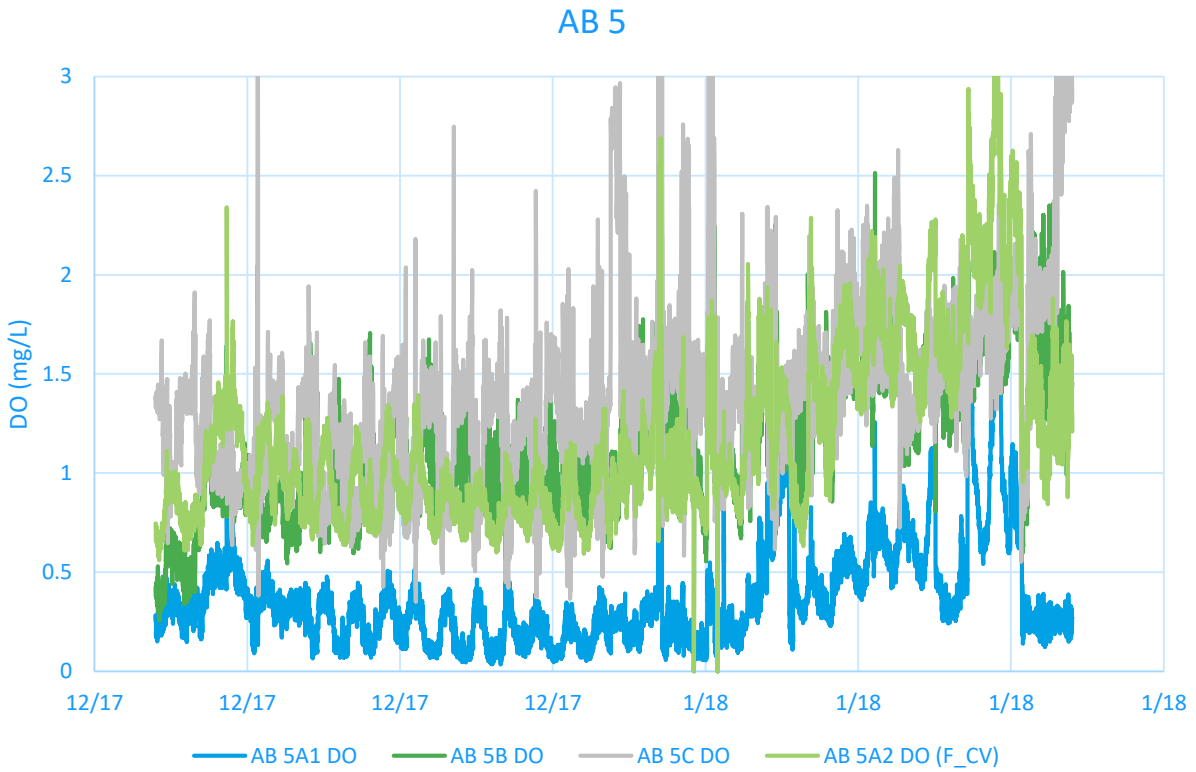


Timeline – Early January 2018

Initial Operational Adjustments – Increased Airflow and DO Setpoints

- Increase Nitrification Rates
- Detrimental impact – increased nitrite concentrations



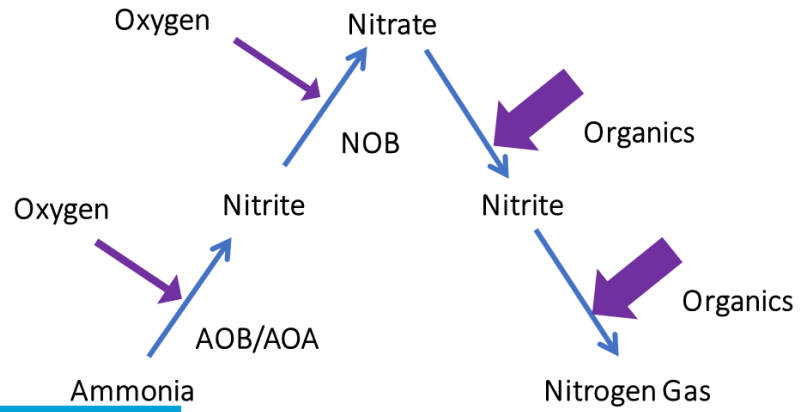


Timeline – Mid-January 2018

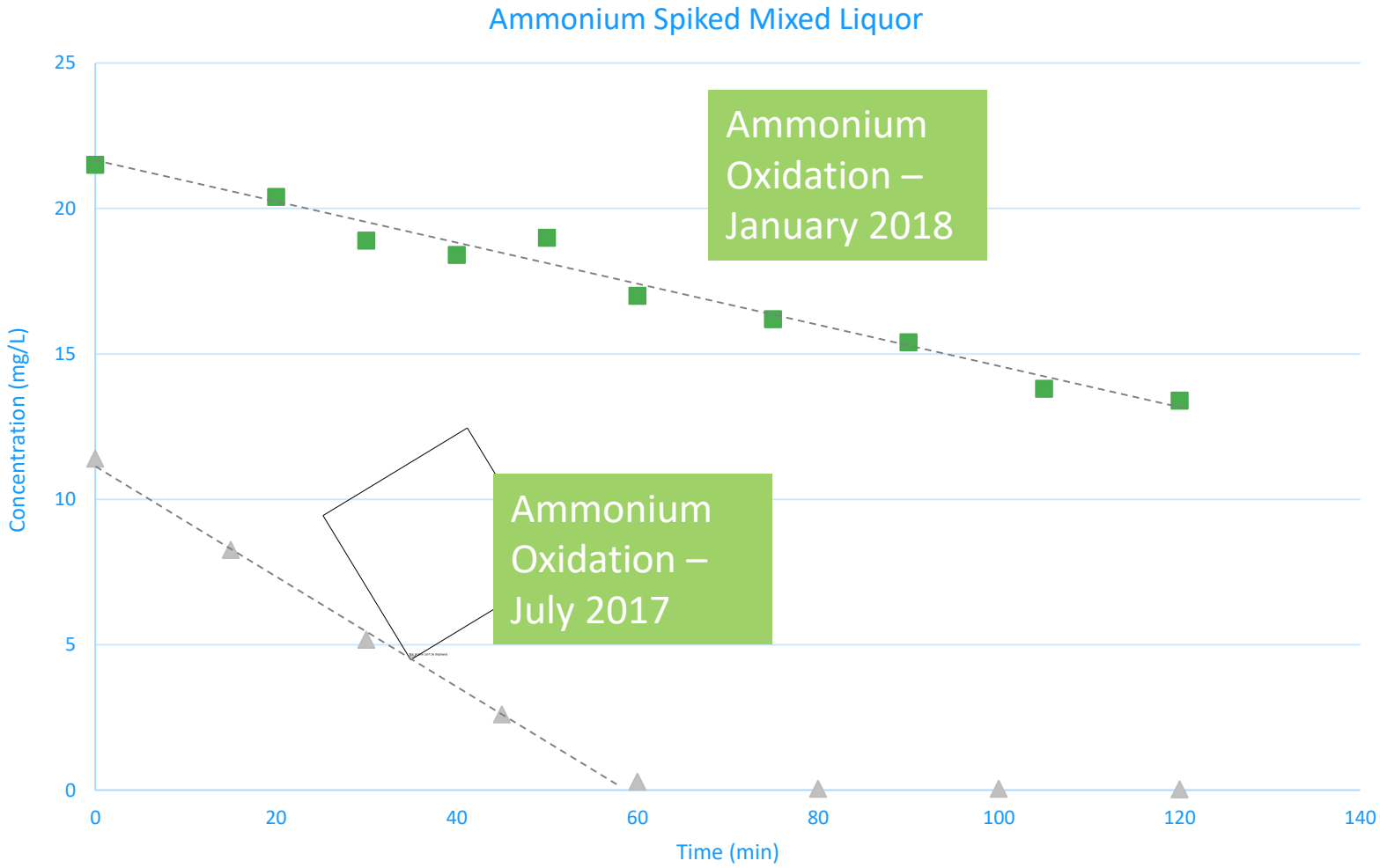
How are our bugs performing?

Nitrification Rate Testing – 1/17/2018

- Three Batch Tests (AB 4-6)
- Ammonium Spike
- Nitrite Spike
- Ammonium and Nitrite Spike
- Compare to Previous Rate Testing



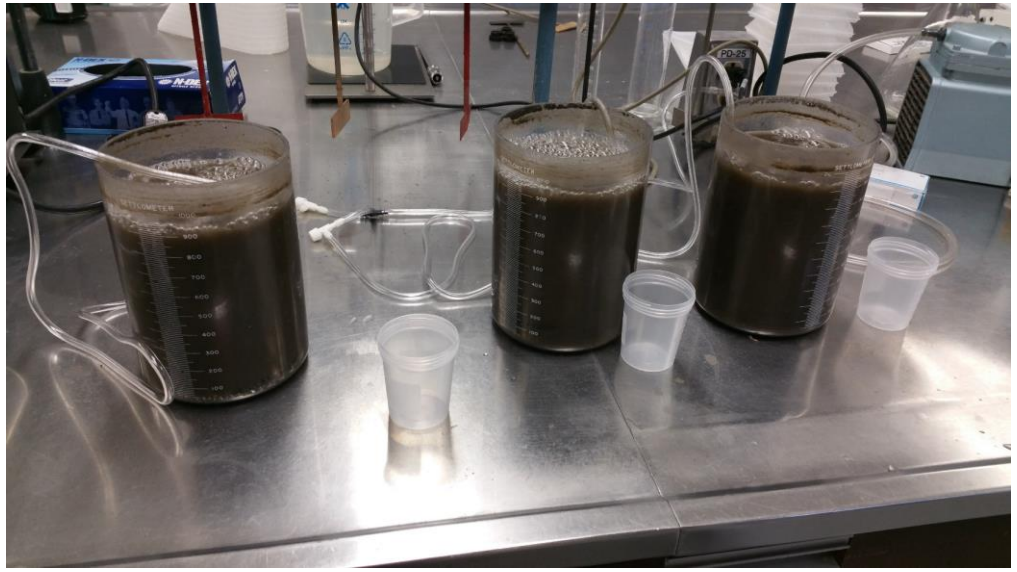
AOB/NOB:
2.0 moles O_2/mole NH_3

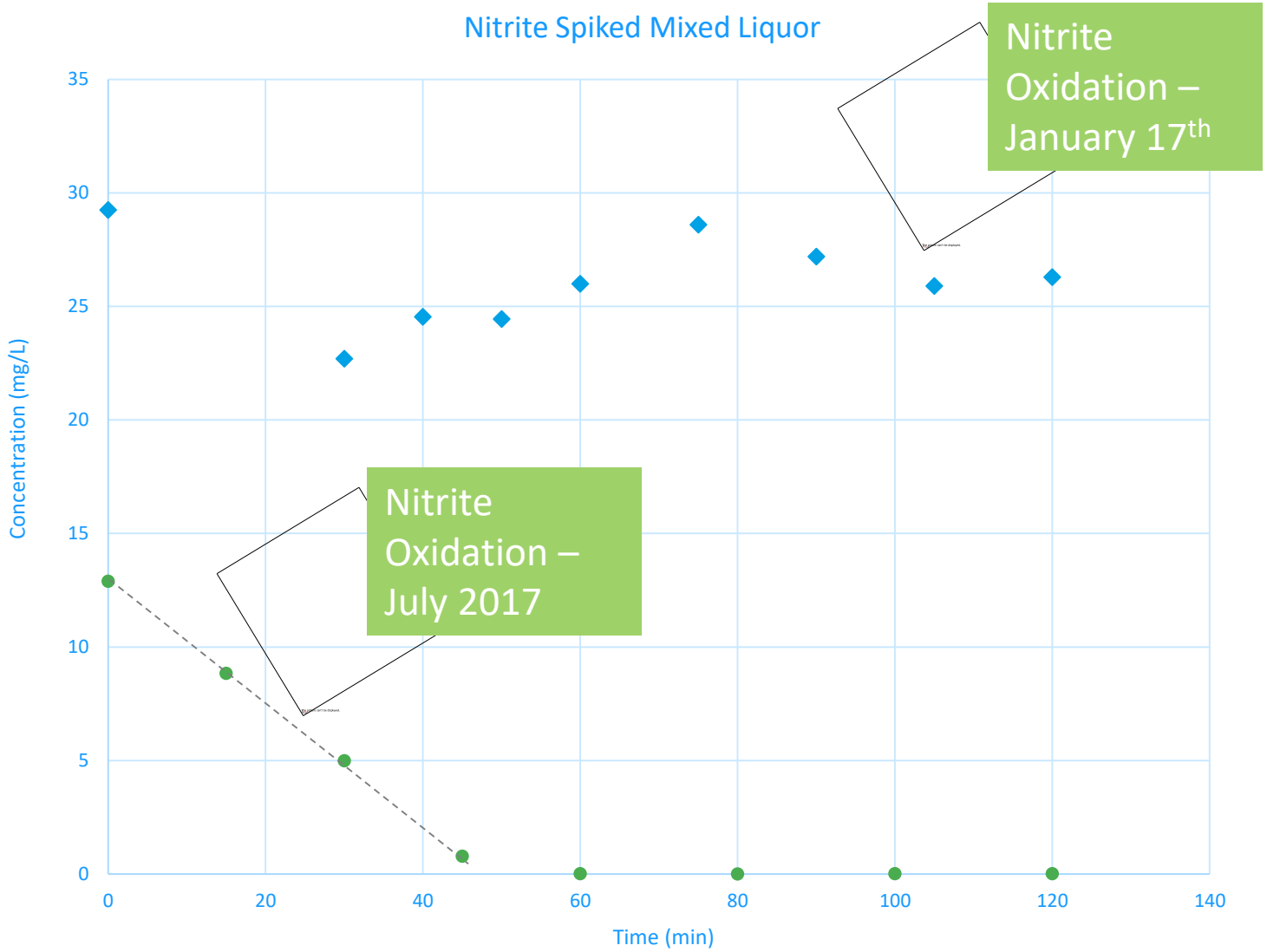


Timeline – Mid-January 2018

Nitrification Rate Testing – Nitrite Rate

- Ammonium oxidation rate – 50% of previous rates
- Nitrite oxidation rate – nearly non-existent

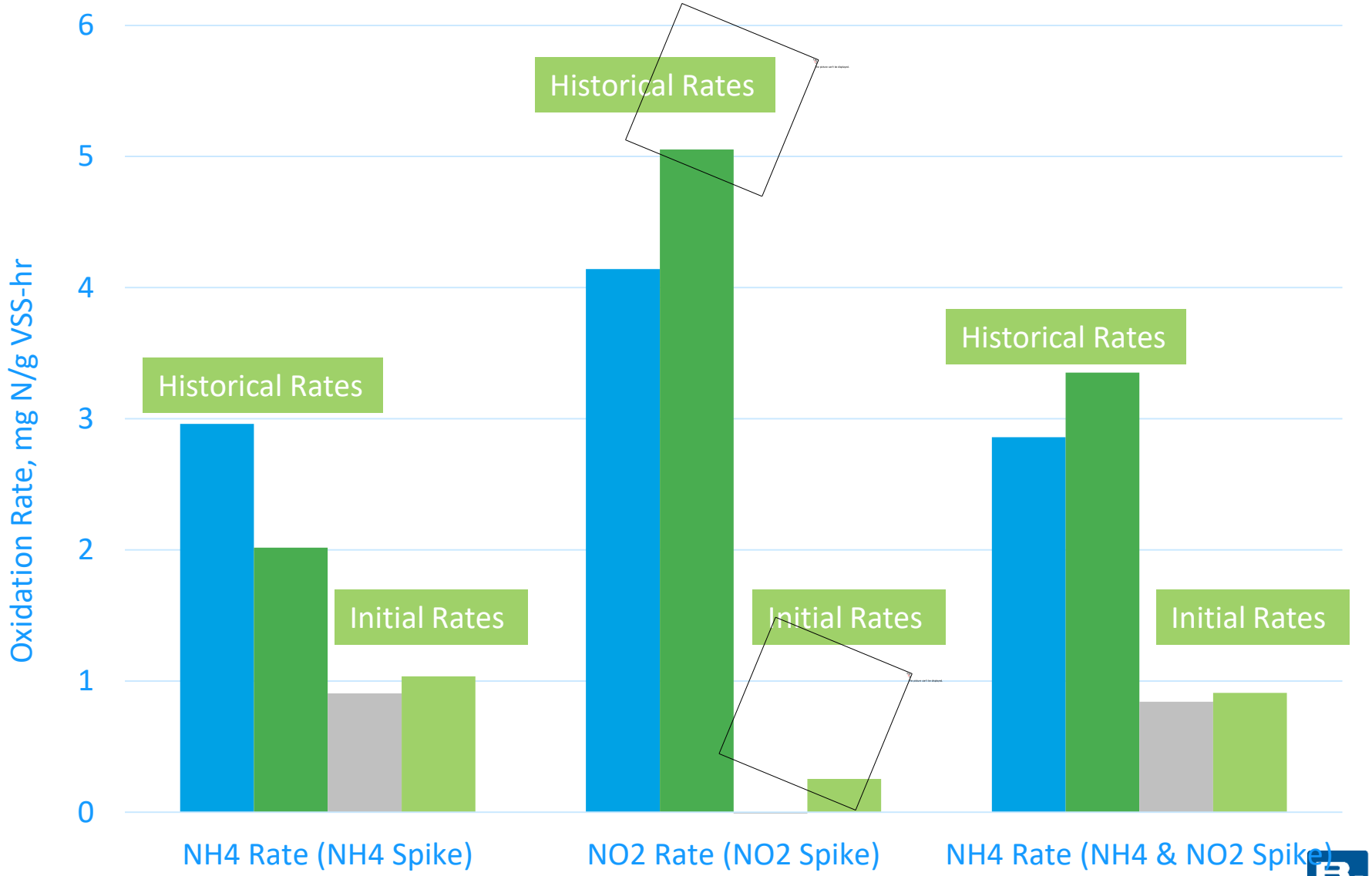




Timeline – Mid-January 2018

Nitrification Rate Testing – Comparison to Historical

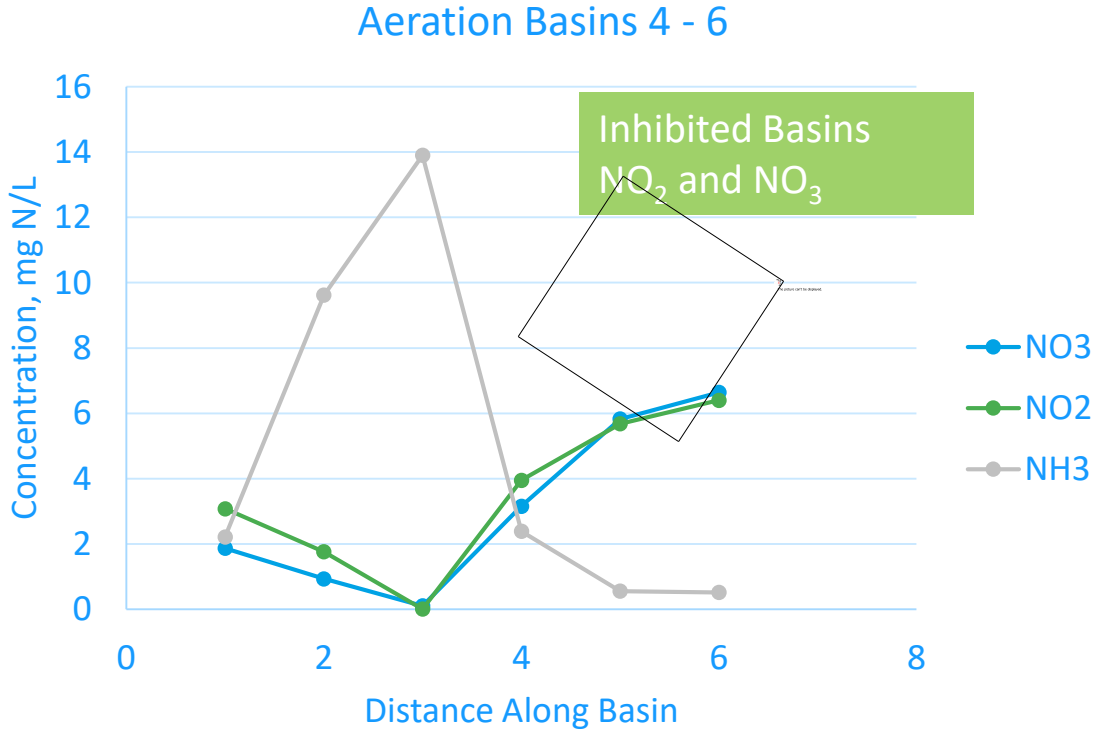
- A second nitrification test performed after initial results
- Ammonium oxidation rate is less than 50% of historical
- Nitrite oxidation rate near zero
- Tests use AB 4-6 biomass

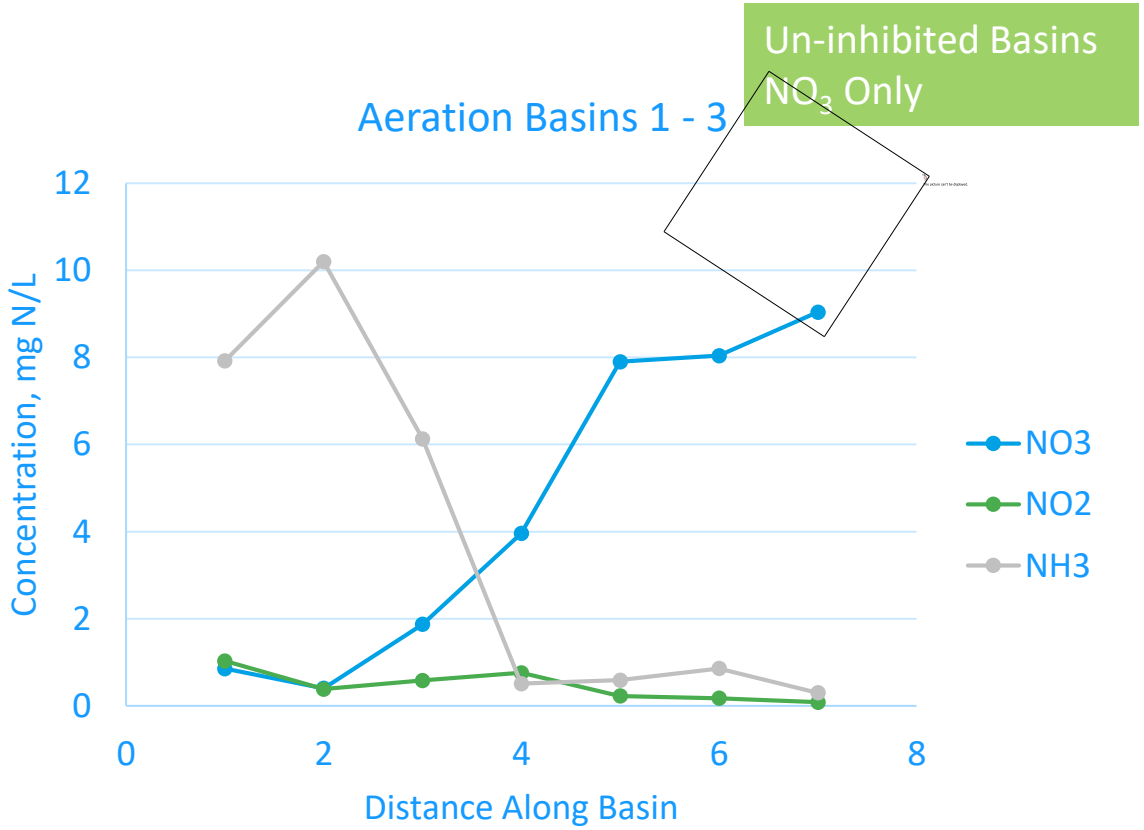


Timeline – Mid-January 2018

Additional Special Sampling - Basin Profiles

- Completed January 19th and 20th
  - Days immediately following nitrification rate testing
- ABs 4-6 show nitrite and nitrate at approximately same rate
- ABs 1-3 show minimal nitrite build-up

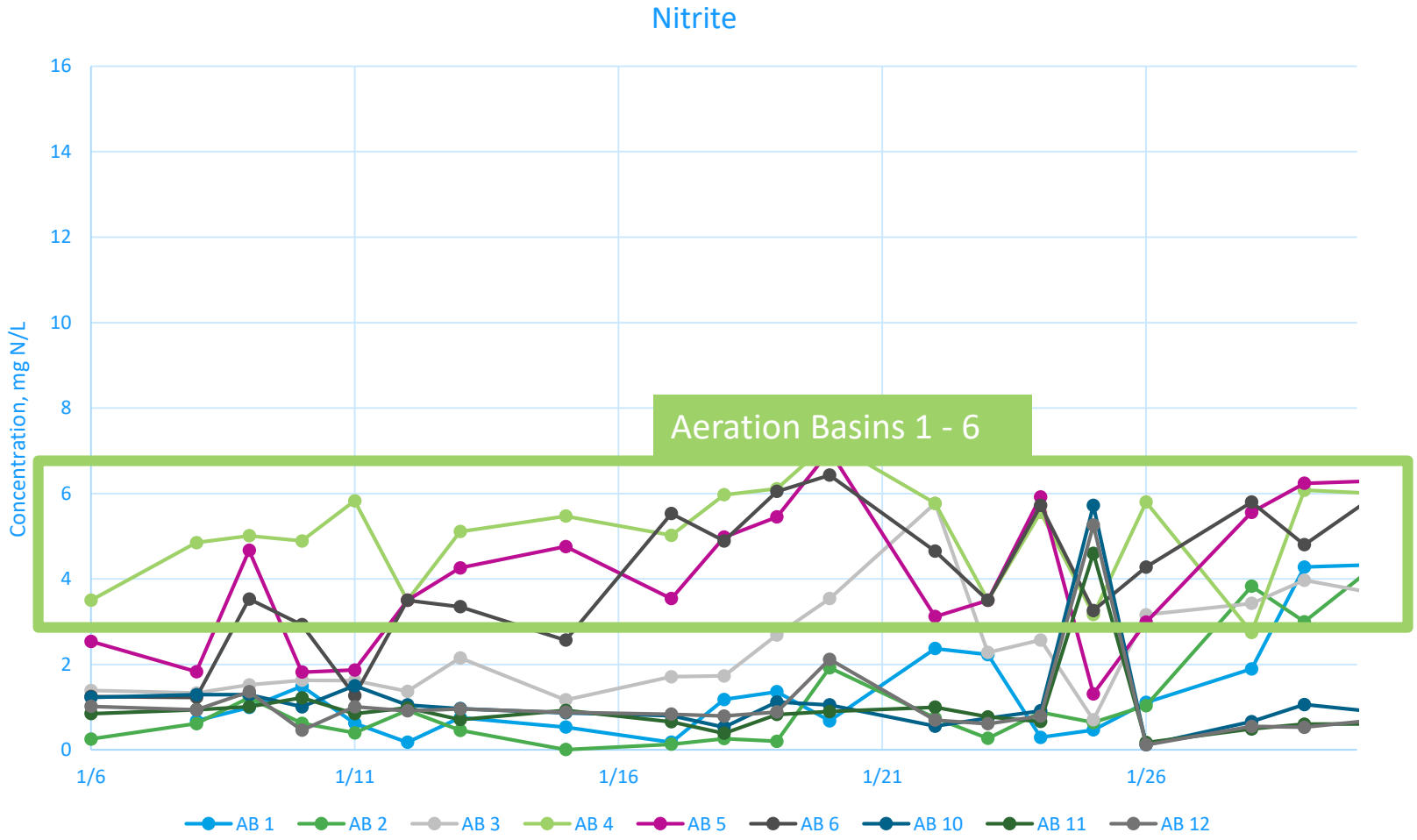




Timeline – Mid-January 2018

Continuous Special Sampling – Effluent Nitrite

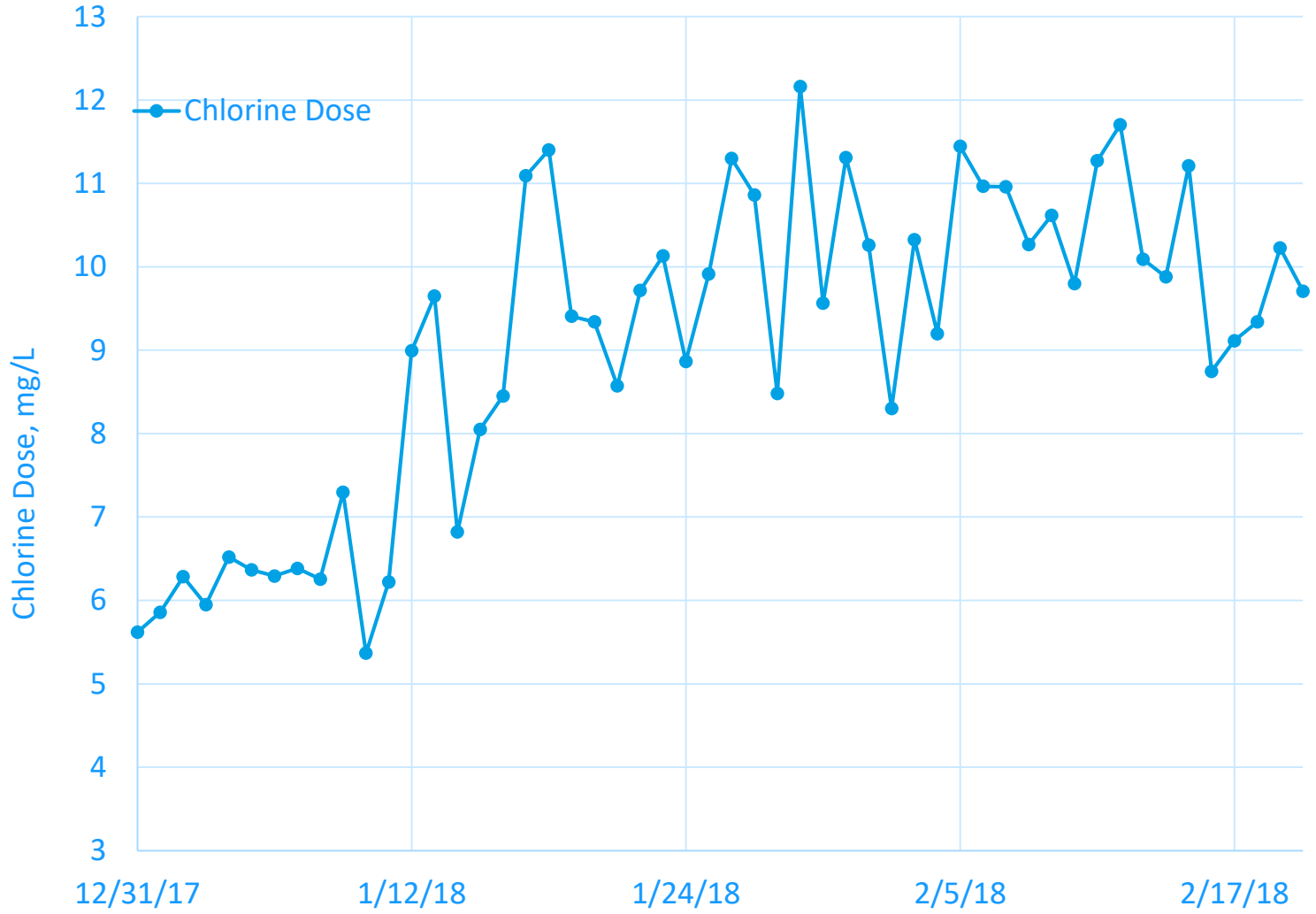
- Aeration Basins 1 – 6 now showing nitrite accumulation
- Aeration Basins 10 – 12 not showing signs of accumulation



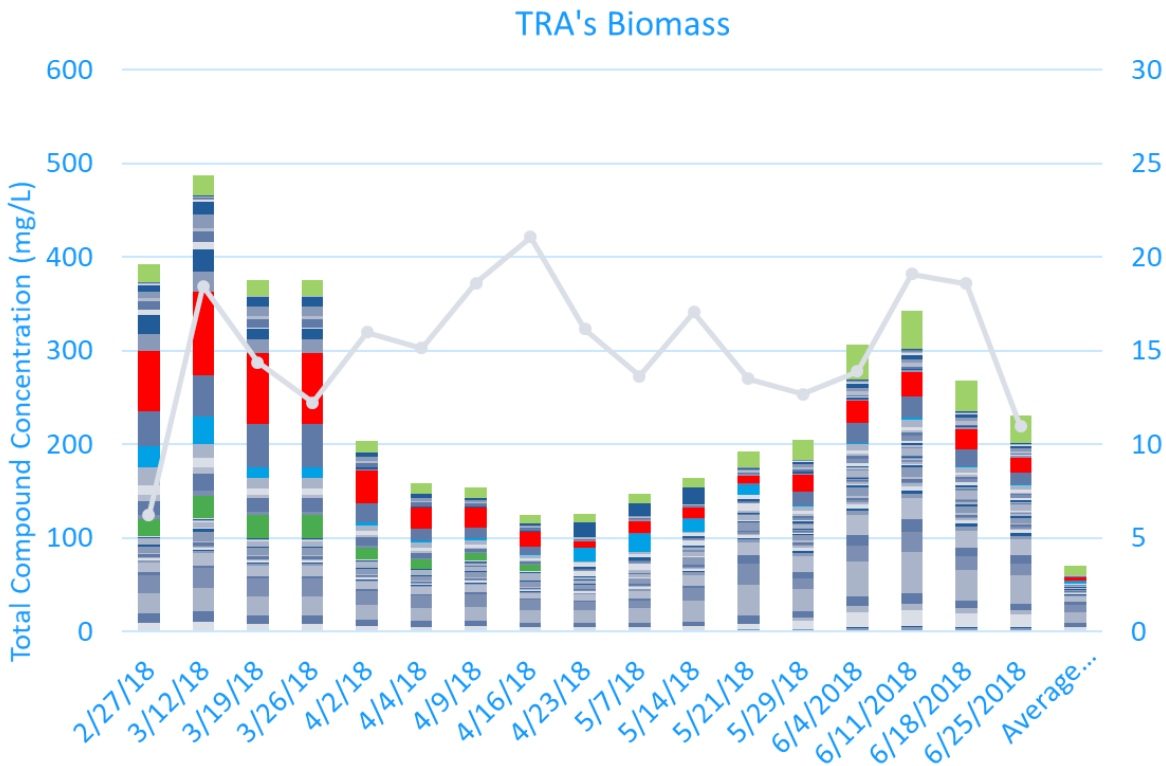
Timeline – End of January 2018

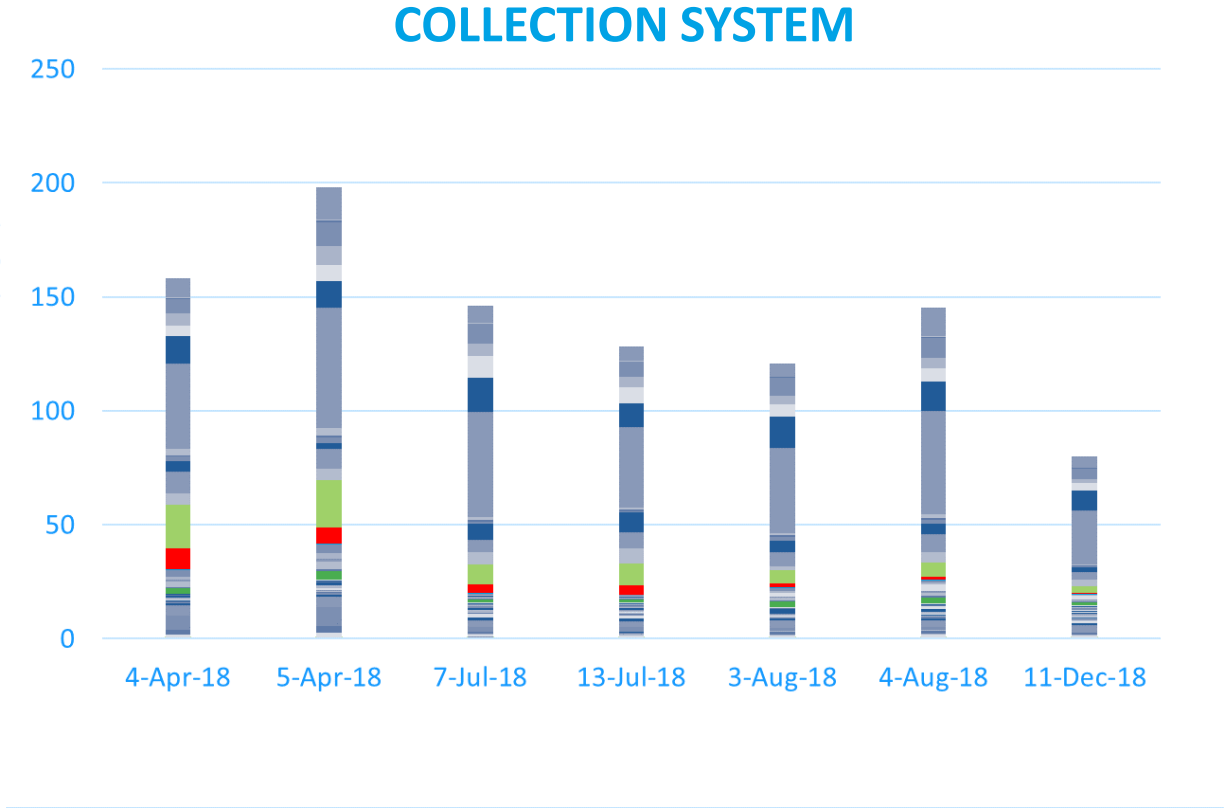
Chlorine Demand Trend

- Trend remains higher than historical for approximately 2 months
- 6 of 9 aeration basins showing nitrite accumulation



Inhibitory Compound Testing – Can we measure any known inhibitory substances?





Timeline – Started February 2018

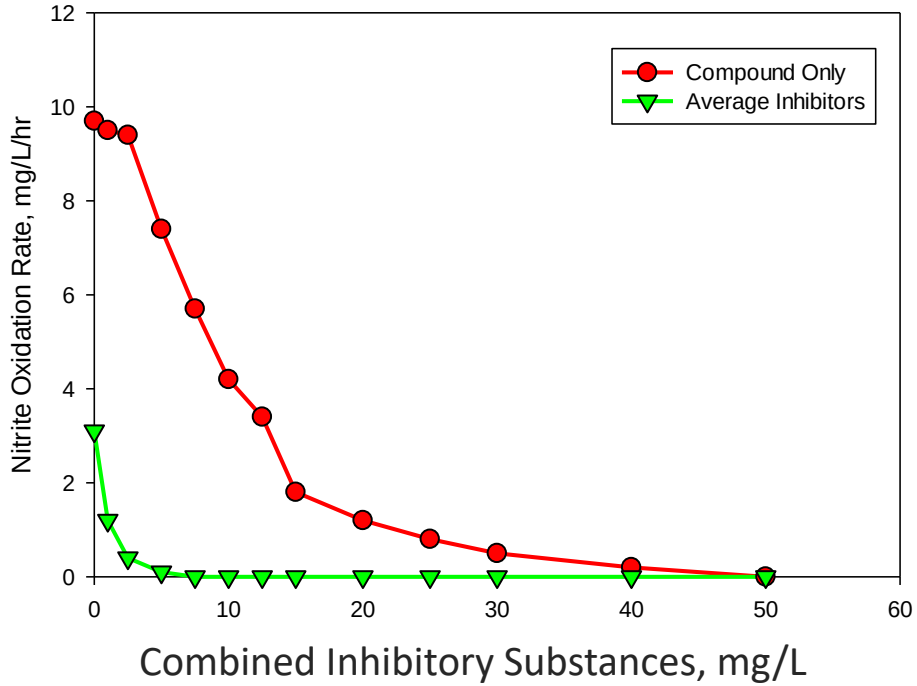
Inhibitory Substances – Now What?

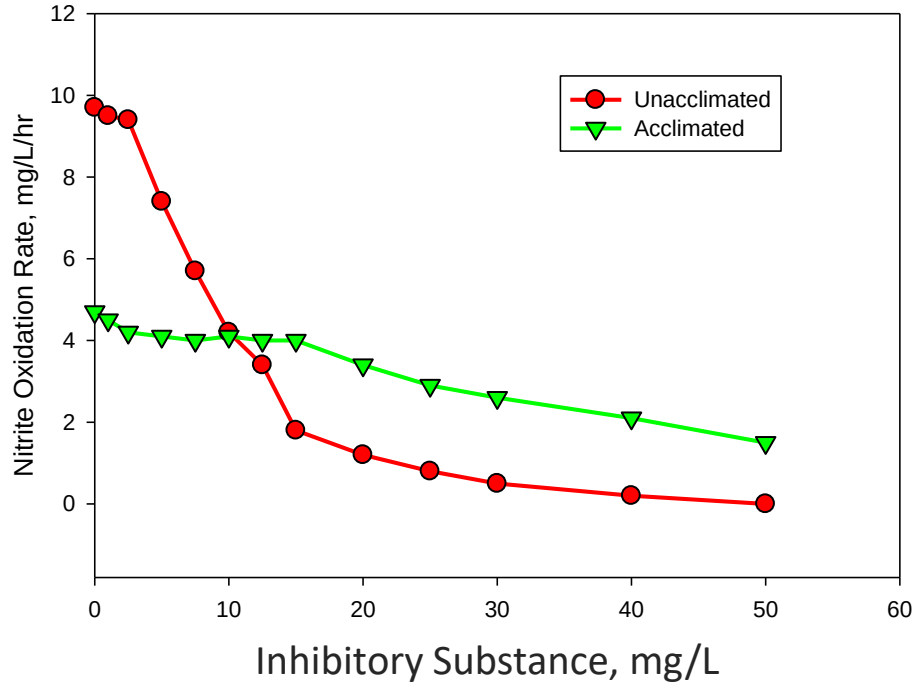
Process Adjustment and Troubleshooting Efforts

- Inhibitory Substance Sensitivity
- Modeling of varied aeration basin control
- Long period of high DO concentrations
- SBR operation
- Nitrification Rate Testing of Typical Plant compared to CRWS with varied PE
- Basin ecology comparisons
- WAS rate and inventory calculator developed
    - SRT adjustments to waste out substances
    - SRT adjustments to provide longer SRT for slower growth rates
    - Wasting to adjacent basins
- Review of influent data parameters – pH, alkalinity, WAS rates, loading and nutrients

What level or threshold are we targeting?

- Individual and combined compound acute toxicity testing
- Acclimated biomass less affected at higher concentrations
- Tested 5 individual compounds found in TRA biomass

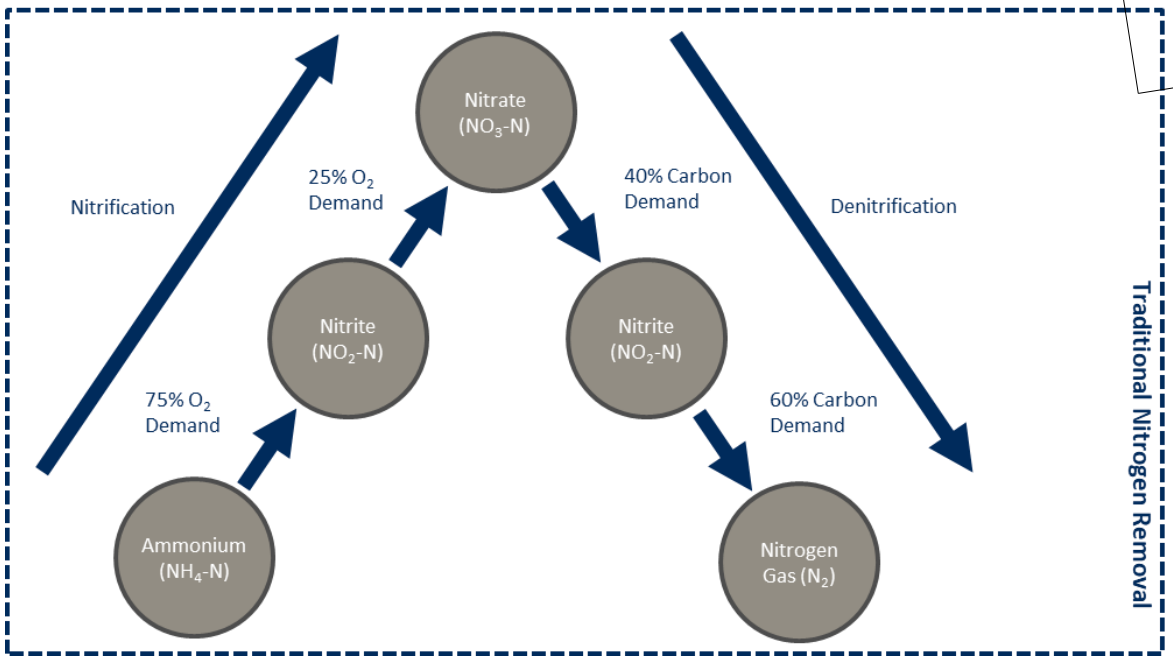


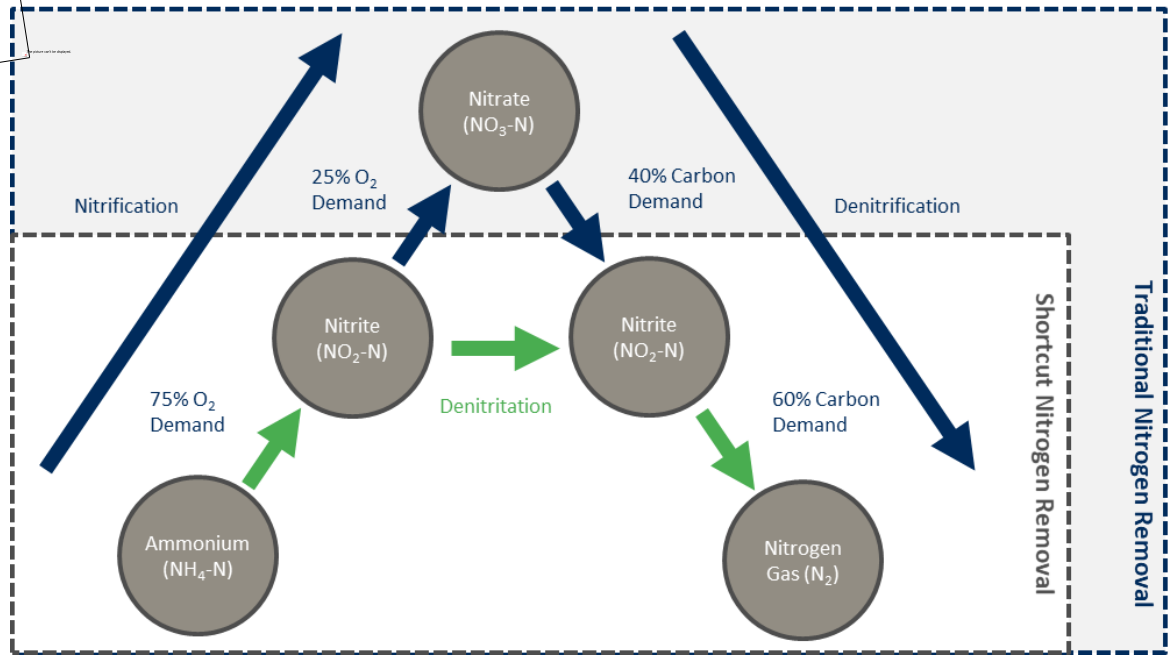


Timeline – July 2018

Modeling Simulations – Can we reduce chlorine demand from NO_2

- Leverage ABAC to provide conditions to denitritify (NO_2) rather than oxidize





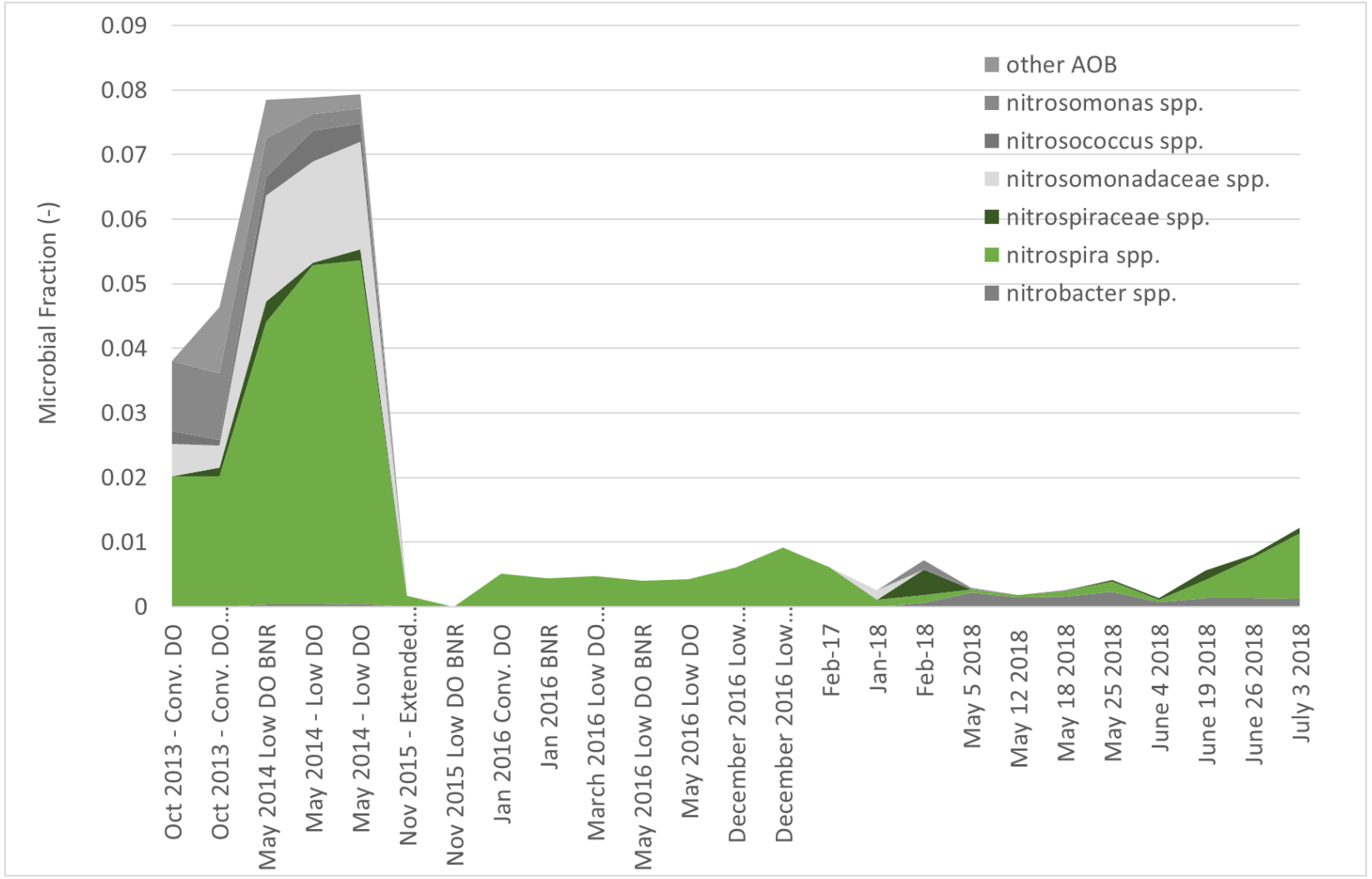
Timeline – February 2018

Sequencing Batch Reactor (SBR) Operation

- Two reactors setup and operated by CRWS operations
- Multiple setups
  - Recovery time period – feeding alternate influent
  - BNR vs. Fully Aerated System
  - Influent Substance Tracking
- Observing biomass recovery and nitrite accumulation within cycles
- Planned long-term implementation

Started February 2018 - Current

What nitrifying organisms do we have?



Timeline – Historical and Throughout Event

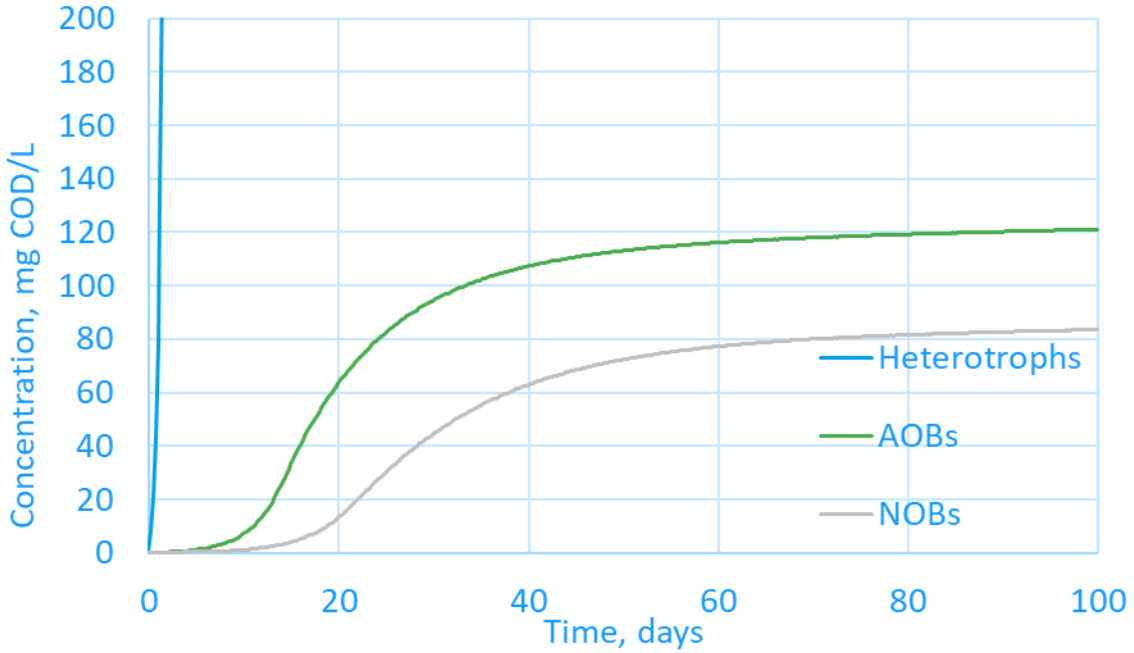
Basin Reseeding

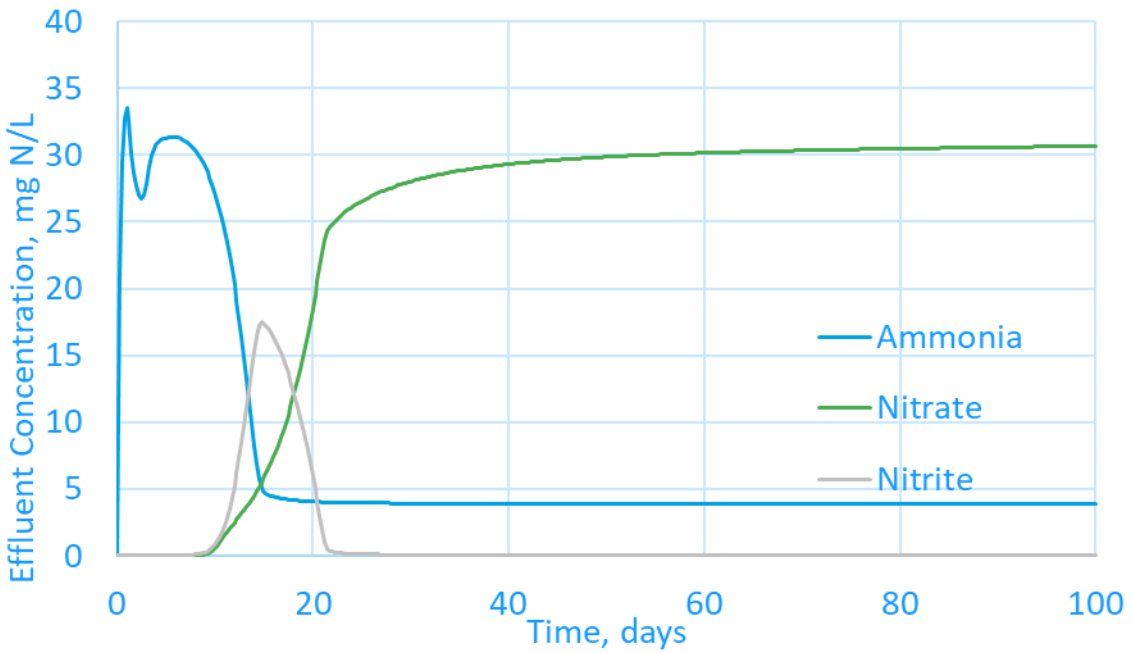
Questions with reseeding?

- 9 aeration basins online with 3 more prepared to come online, which should be reseeded first?
- Is reseeding sequentially staged through the sets of basins?
- How much reseeded sludge will it require?
- What will be the expected response time?

Can modeling assist with expectations and planning?

- Slower nitrifier growth rates
- NOB growth expected to lag behind that of AOBs
  - Lead to initial reseeding where no improvement observed
- How much sludge?

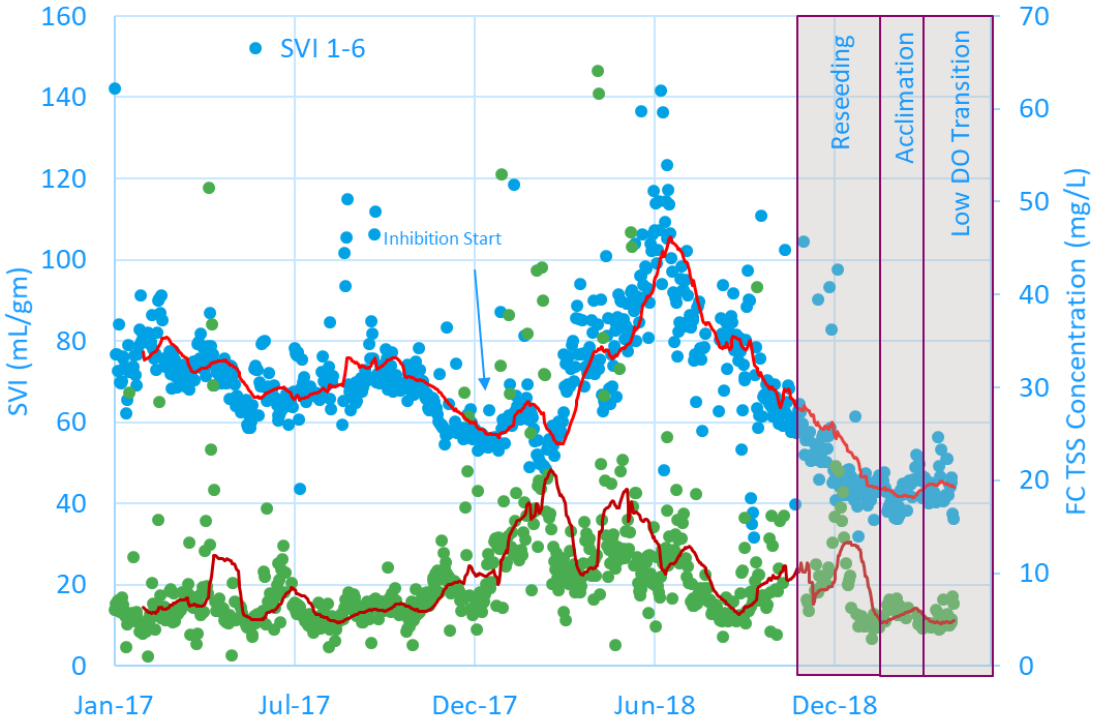


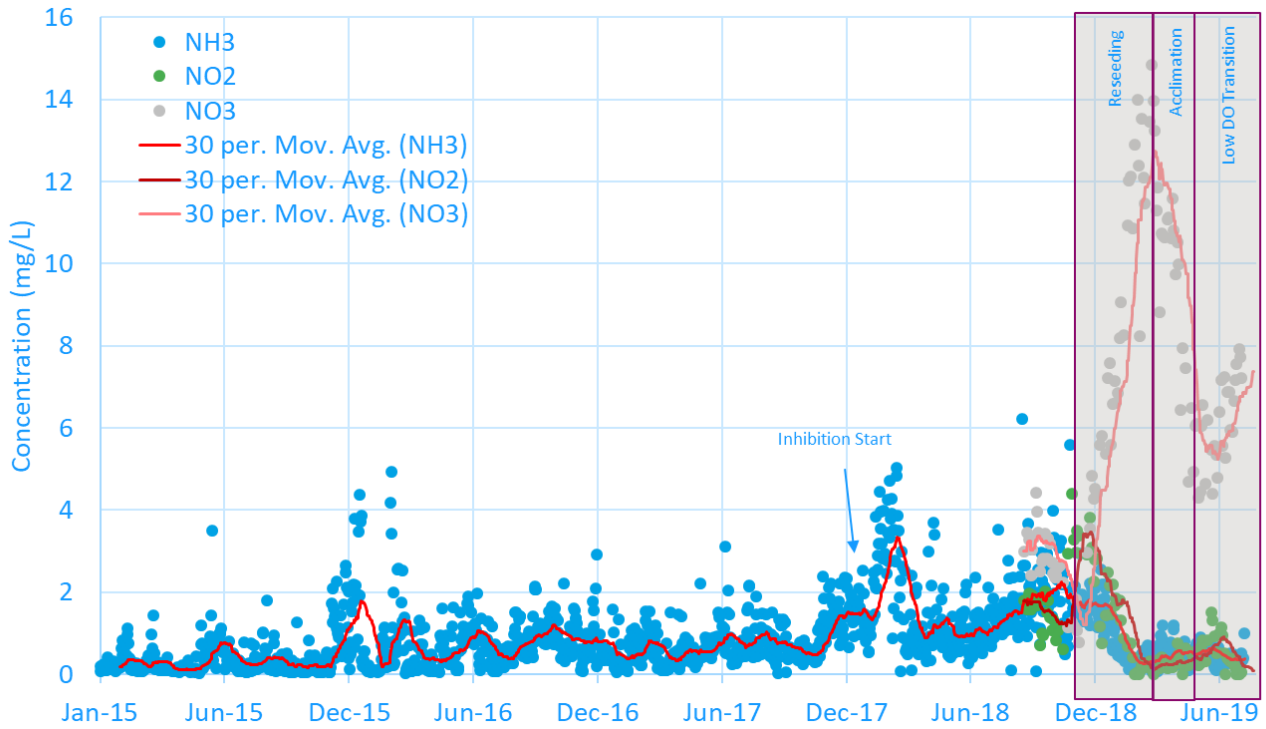


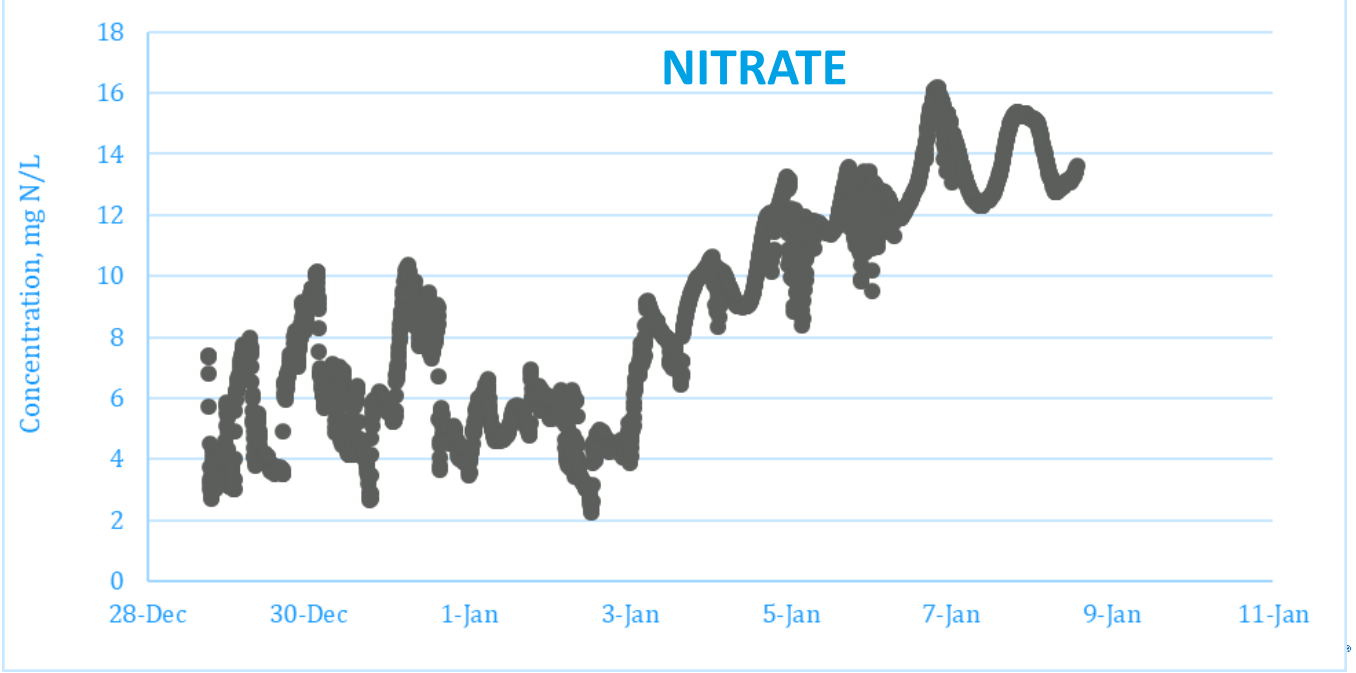
Timeline – October 2018

Signs of recovery

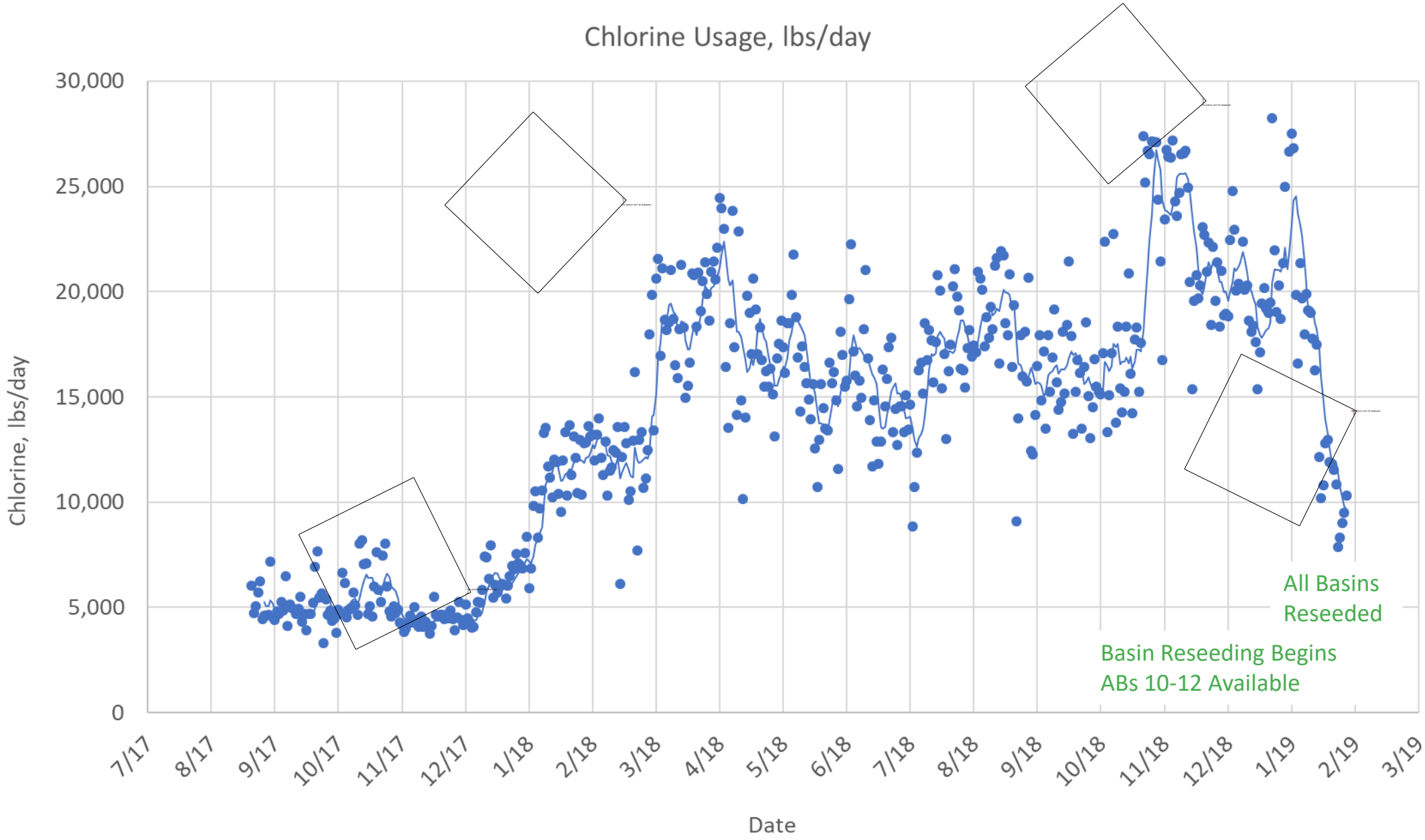
- Increased nitrate production
- Improved settling





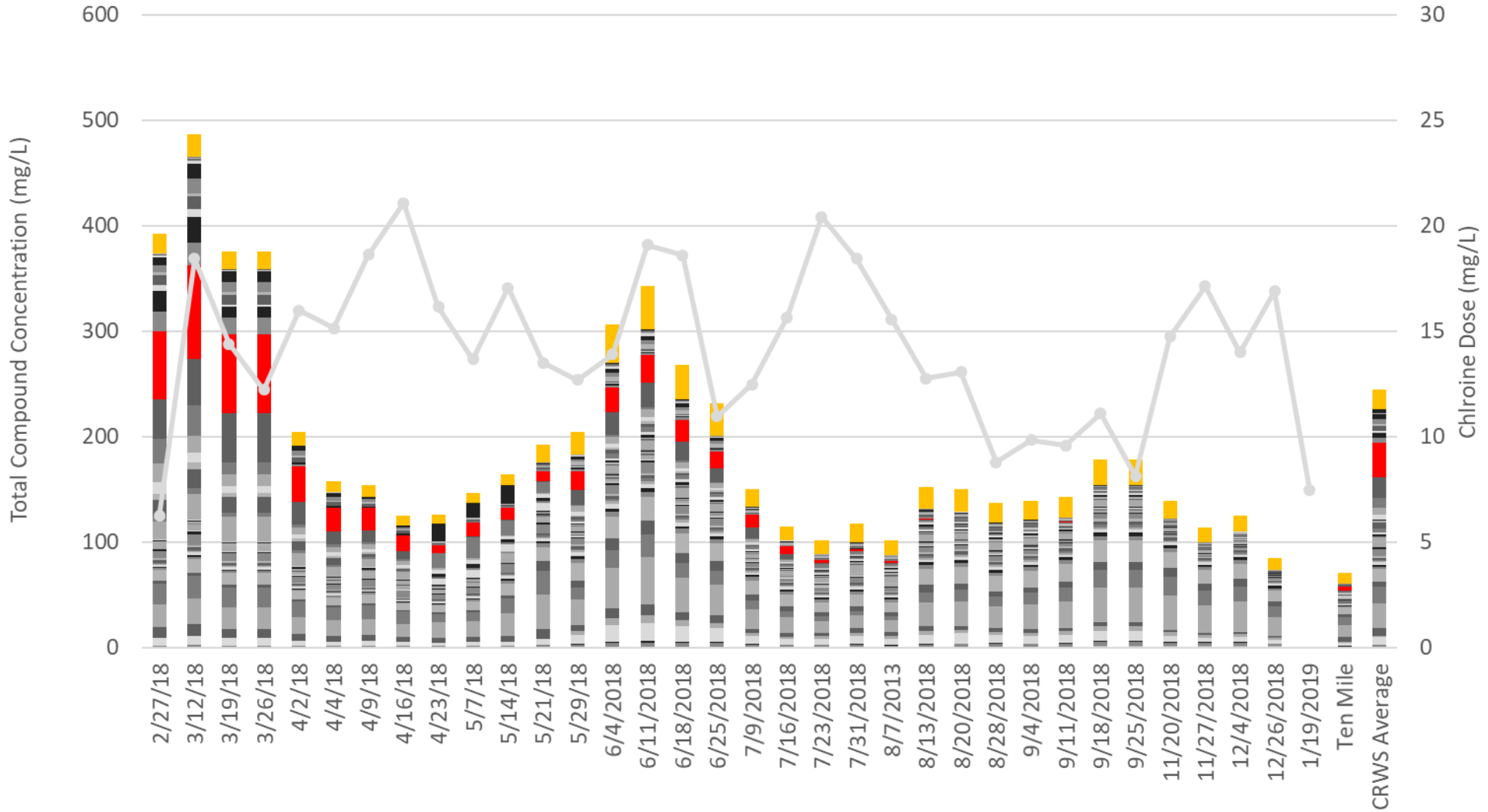


CRWS Timeline



Trinity River Authority of Texas

How did the inhibitory substances trend throughout?

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PYREX®
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No. 1003
AB-5
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AB-8
01-23-19
No. 1003
AB-11
01-23-19
No. 1000
TIMER
AT ZERO
TIMER
RUNNING
OUTLETS
POWER
SET
GRALAB
OFF
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