BAPPG Bi-Monthly Meeting, 8/2/2023

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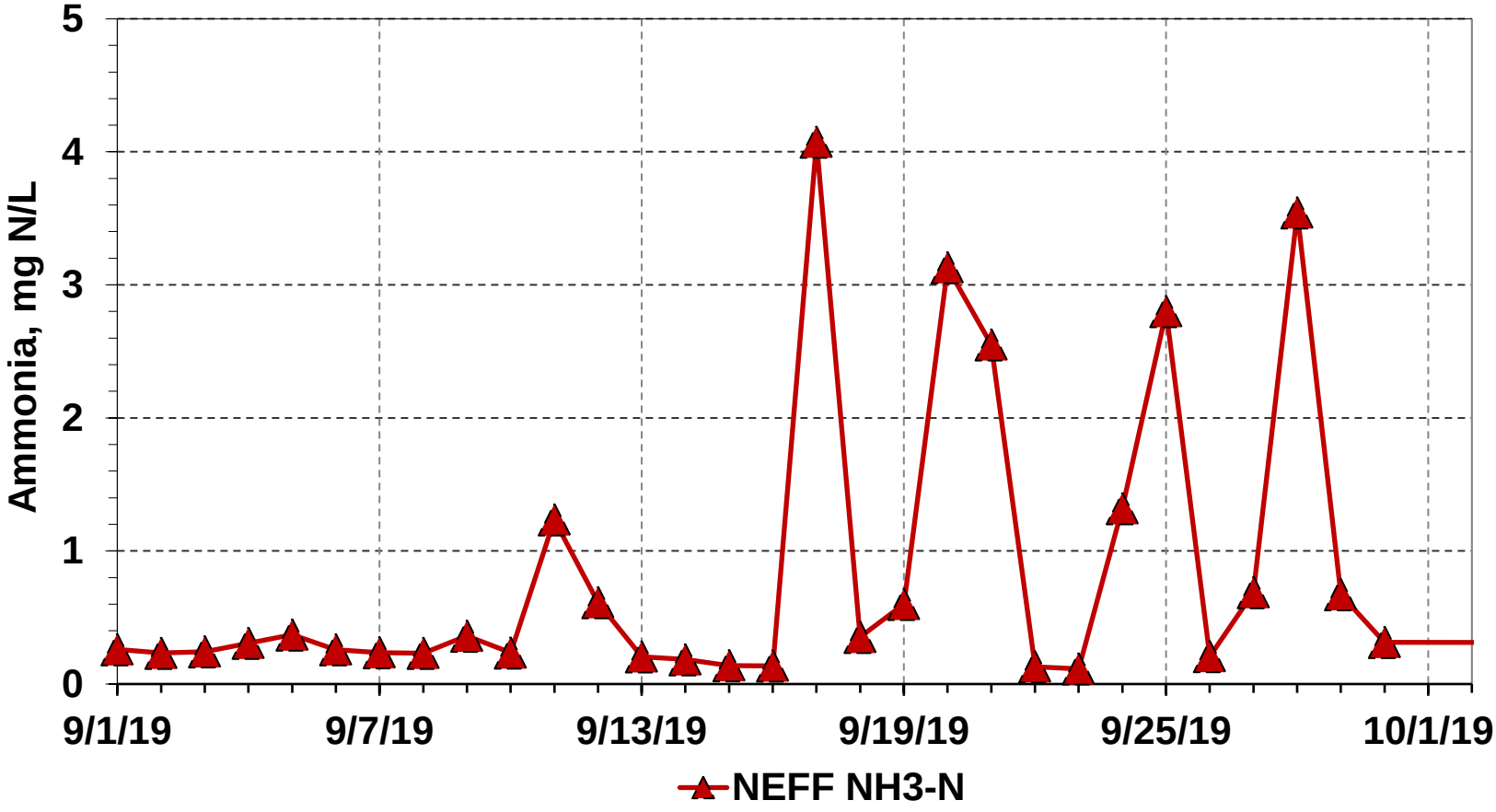
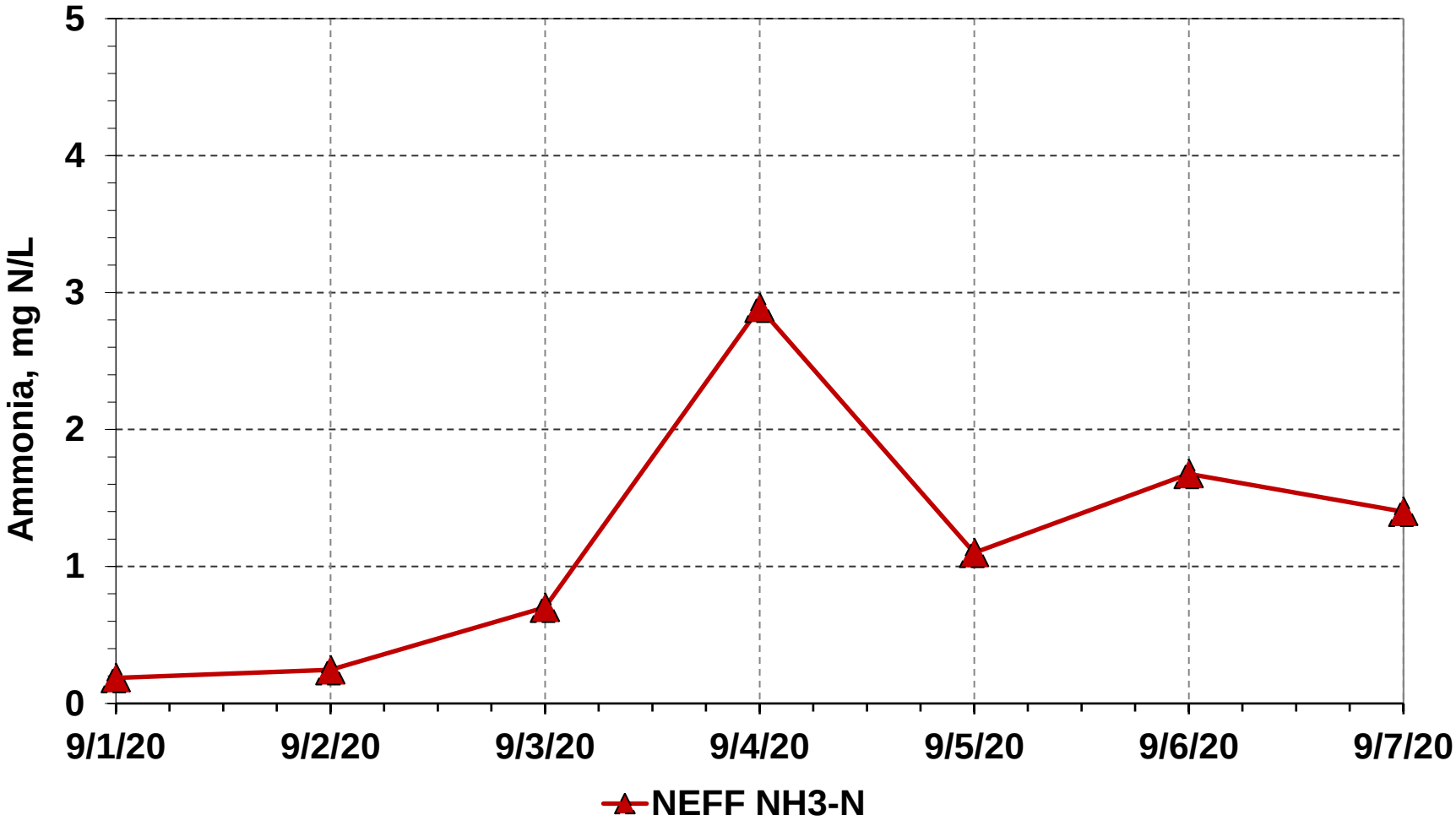
Lessons Learned – What's Normal? Example from Year 2019



NEFF = Final Clarifier Effluent

Early-Sept 2020: Looking Similar to 2019!



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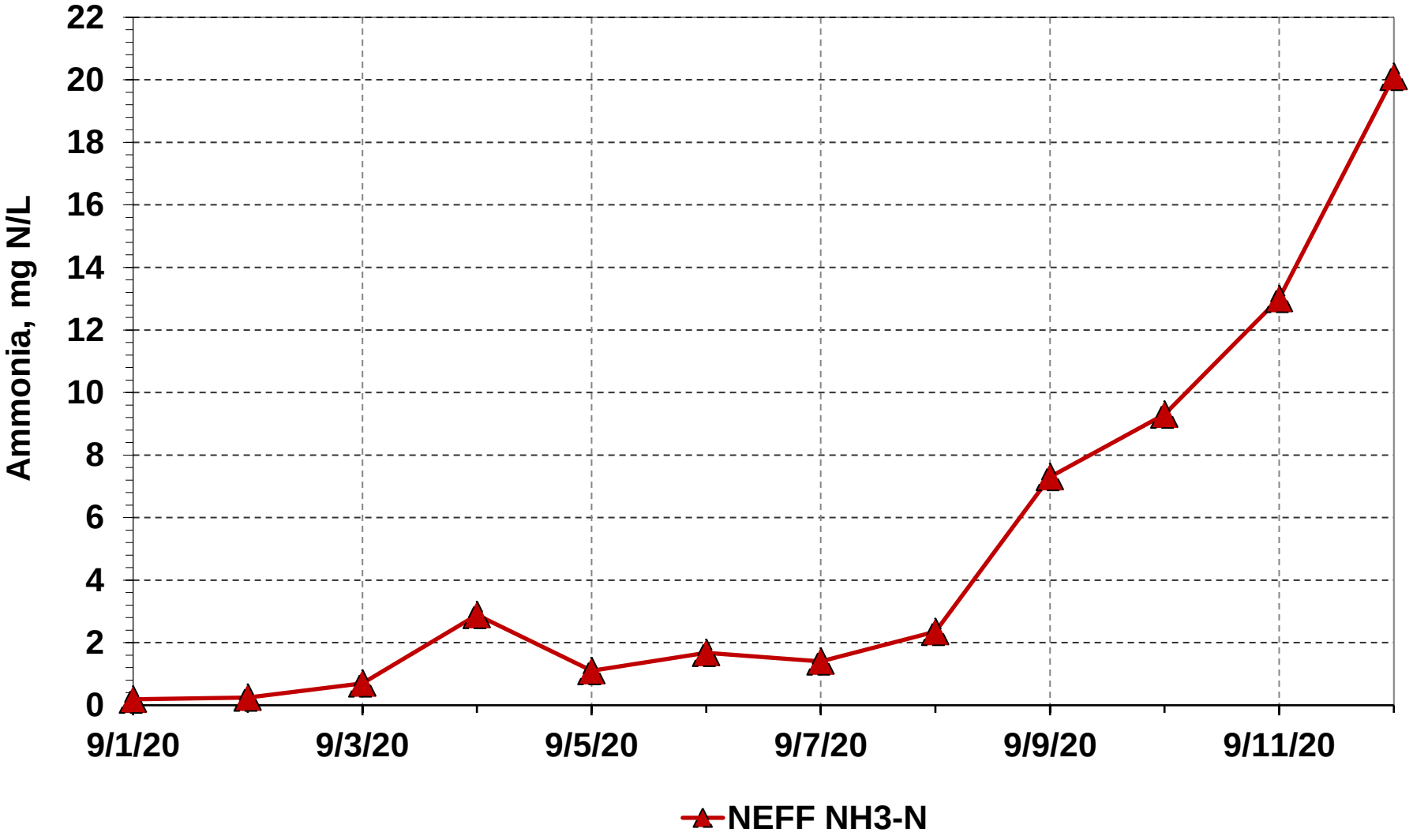
Mid-Sept 2020: Unprecedented Event



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Everything's OK until it isn't..

Taking Action – Initial Response

Comprehensive Key Performance Indicators (KPIs) Review

- **Solids Residence Time (SRT):** long enough?
- **Dissolved Oxygen (DO):** enough/excessive
- **Biosolids Return Stream (i.e., Sidestream):** monitoring process/return
- **Plant Unit Process Performance Loading:** Oxygen Uptake Rate (OUR), BOD, & Nitrogen Loads
- **Industrial:** Significant Industrial Users (SIUs)?
- **Research:** Monitoring (Cal Poly) research station

What did the KPIs tell us?

- Statistical Process Control (SPC) charts
- Microscopy indicators and trends
- Cal Poly research station performance

Non-Traditional Actions

- Seeding with a known working activated sludge
- Microbial Community Analysis (DNA)
- Seeding with Nitrifying Organisms (AOBs/NOBs) and Heterotrophs
- Monitoring for ATP
- Test for inhibitors: metals, sulfides, volatile fatty acids
- Bench testing OUR analyses with molasses
- Measuring for Quaternary Ammonium Compounds (QACs), our facility and in the region
- QAC inhibitor/ increased MLSS

Most Effective Actions

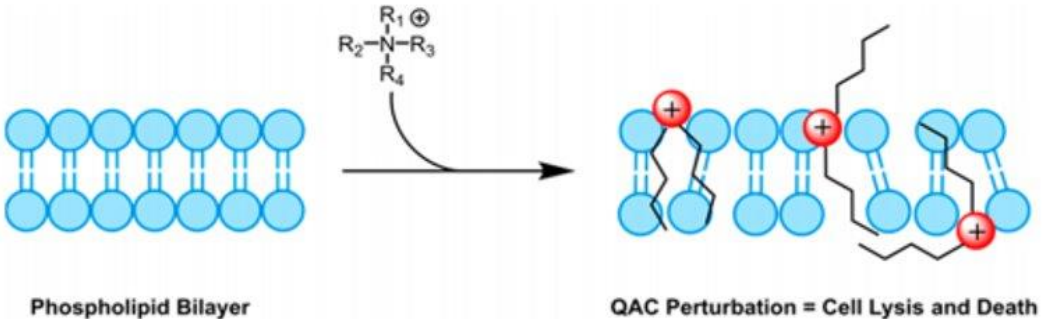
Outreach…

Dr. David Jenkins	The Floc Doc
JB Neethling	HDR
Mike Falk	HDR
Wyatt Troxel	WTr Science
Eric Wahlberg	WW Technology Trainers
John Crisman	Goleta Sanitary District
CWEA	Correspondance led to article calling for action
Steve Walker	Carollo (Colorado)
Brian Coday	Carollo (Colorado)
Jim Hagstrom	Carollo
Howard Brewen	Jacobs Engineering
Mark Scandalis	City of Paso Robles
Tryg Lundquist	California Polytechnic University

Shelley Blackwell	California Polytechnic University
Shabbir Basrai	Orange Country Sanitary District
Mark Kawamoto	Orange Country Sanitary District
Jon Bradley	Orange Country Sanitary District
Samuel Choi	Orange Country Sanitary District
Erik Rumbaugh	Aster Bio (Texas)
Paul Campbell	Aster Bio (Texas)
Ryan Hennessy	Midwest Contract Operations (Wisconsin)
Alex Ekster	Ekster & Associates
Greg Patterson	Kadence Resources
Allison Paine	Hydrosolutions (Kentucky)
Tyler Benz	Aquafix
Dave Tracey	Luminultra

What are Quaternary Ammonium Compounds (QACs)?

- Common in non-alcohol-based cleaning products (e.g., wipes)
- Come in various forms (BAC, DDAC, CG):
  - USEPA recognizes 4 Groups
  - They all have a chloride and nitrogen atoms
  - The nitrogen (+) atoms penetrate the membrane bilayer and lyse the cells

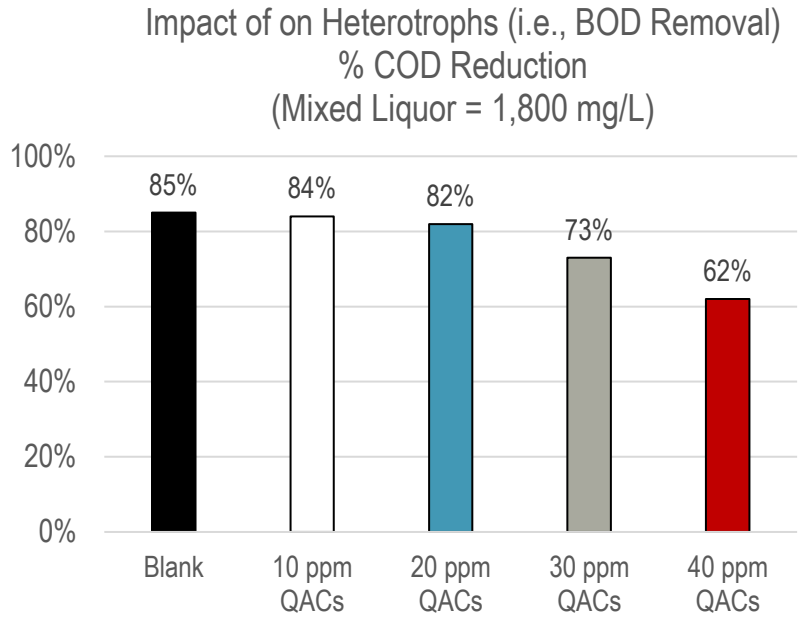


How are QACs Getting into Sewer Systems?

- QACs as additives increased in recent years with the ban on triclosans
- How are they getting into sewer systems:
  - The majority of QACs make their way to WRRFs (estimate ~75%; other eventual inputs are landfills and stormwater)
  - Sources:
    - Increased hand-washing with elevated soap use
    - Increased consumption of wipes/spray cleaners

How Much is Too Much?

- Raw Influent QACs:
  <0.6 mg/L during Pre-COVID19
- What QAC Levels Impact Biological Treatment Processes:
  a. cBOD removal: approx. 10 – 30 mg/L
  b. Nitrification: approx. 2 – 5 mg/L



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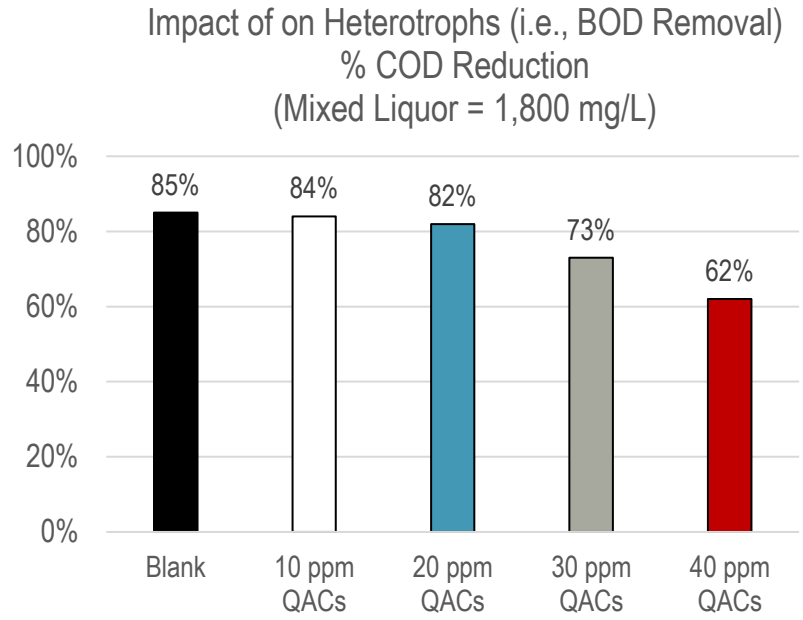
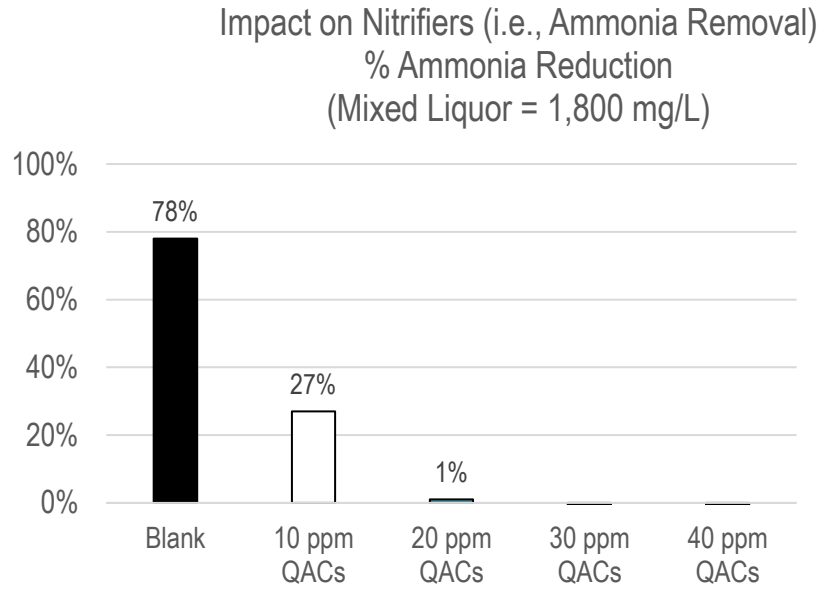




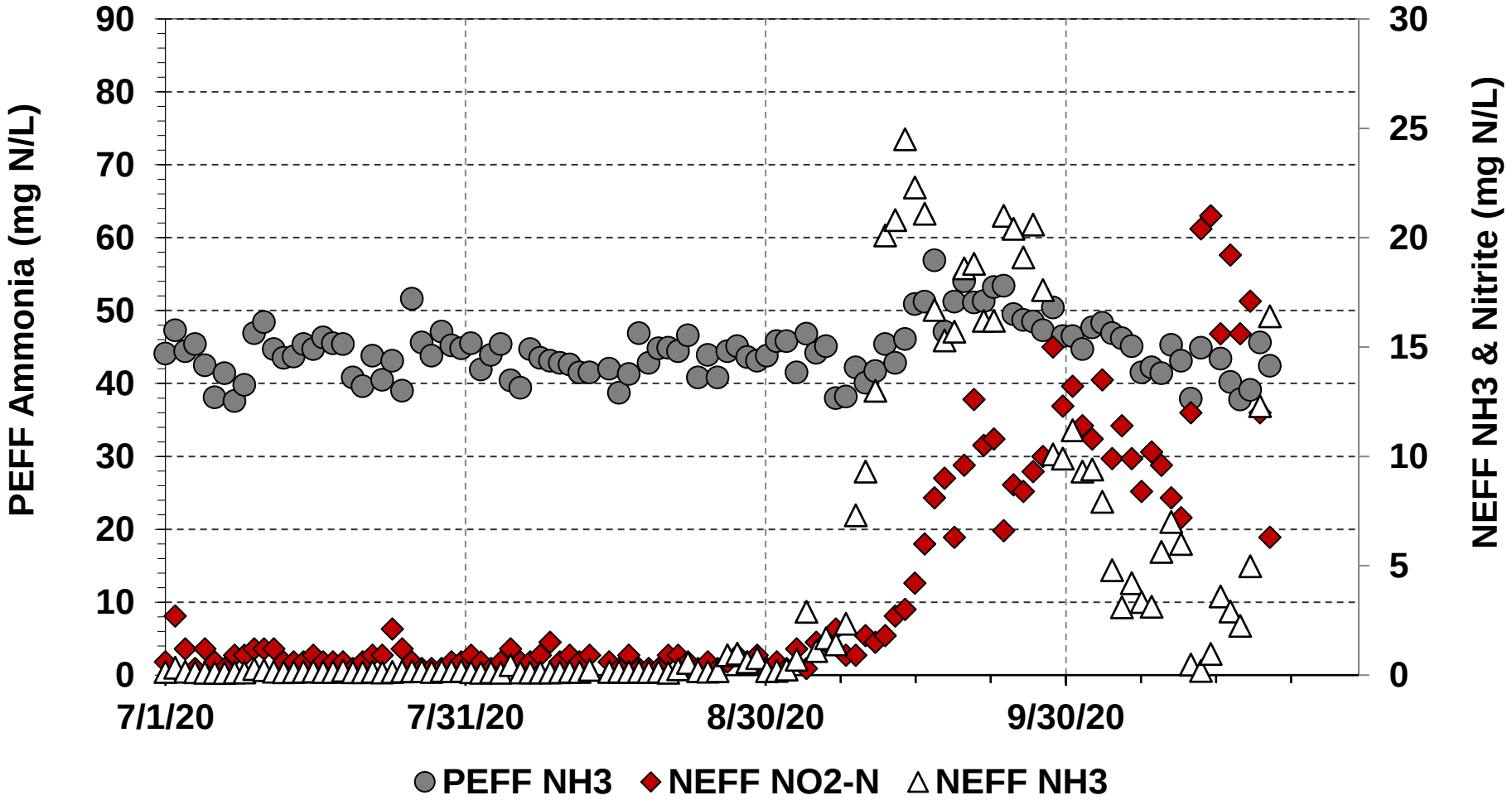
What QAC Levels did SLO WRRF Have?

Quaternary Ammonium Compounds (QACs)	Influent	
	Total	Free
Tetradecyl pyridine benzyl ammonium chloride	0	0
Hexadecyl pyridine benzyl ammonium chloride	0	0
Dioctyl dimethyl ammonium salt	0	0
Diallyl dimethyl ammonium chloride	0	0
3-methacrylamino-propyl trimethyl ammonium chloride	0	0
Diethylenetriamine-adipic acid polyamide	0	0
Decyl dimethyl ammonium salt	0	0
Dodecyl dimethyl ammonium salt	0.1	0
Tetradecyl dimethyl ammonium salt	0.2	0.1
Hexadecyl dimethyl ammonium salt	0.1	0
Octadecyl dimethyl ammonium salt	0	0
Dodecyl dimethyl benzyl ammonium salt	1.1	0.5
Tetradecyl dimethyl benzyl ammonium salt	3.4	1.8
Hexadecyl dimethyl benzyl ammonium salt	1.3	0.6
Benzyl triethylammonium chloride	0	0
Cetyl Pyridinium chloride	4.1	1.2
Tetradecyl dimethyl ethyl benzyl ammonium salt	0.4	0.1
Total	10.7	4.3

Signs that QACs are Impacting a WRRF

- Note: QACs do not build up in a WRRF
- Nitrification impacted (for WRRFs that nitrify)
- Incomplete nitrification (nitrite build-up)
- Increase in secondary effluent turbidity/TSS levels
- Increase in chlorine demand due to nitrite buildup

SLO WRRF Indicator: Nitrogen Species



PEFF = Primary Effluent

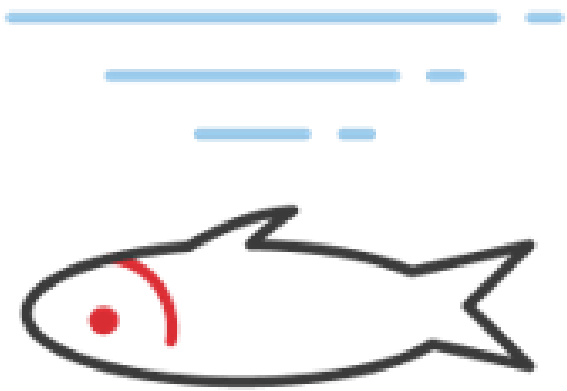
NEFF = Final Clarifier Effluent

Strategies to Measure QACs at your WRRF

- Test strips: Hydrion, LaMotte, EM Quant; (limited to 50-100 mg/L)
- Hach: low range test kits (<5 mg/L)
- Potentiometric titration most accurate (ASTM Method D5806-95)

Bioassays for QACs

- Whole Effluent Toxicity Testing (WET)
- Microtox: in vitro testing system which uses bioluminescent bacteria to detect toxic substances
- Toxicity of tetramethylammonium hydroxide (TMAH) to aquatic organisms with potassium iodide
- Acute Lethal Toxicity of TMAH 25% aqueous solution to Daphnia magna.



What to do if Your WRRF is Impacted with QACs?

- Process Modifications:
  - Reduce your biological wasting
  - If biology is lost, it takes weeks to recover
- Treatment: Non-surfactant-based chemistry to bind the QACs (e.g., NeutraQuat)

Pro-Active Source Tracking by a WRRF

- Identify events that could result in slug loads (e.g., school returning)
- Dischargers inventory: whom could be a heavy user (e.g., meat-packing), coordinate, and identify other potential chemicals
- Public education outreach efforts

Lessons Learned from the SLO WRRF Experience

- Effluent Ammonia ⇧
- Effluent turbidity/TSS ⇧
- Chlorine demand (nitrite lock) ⇧
- Recovery: about 2 months (external seed can accelerate)
- QAC Treatment is Available (e.g., NeutraQuat)

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