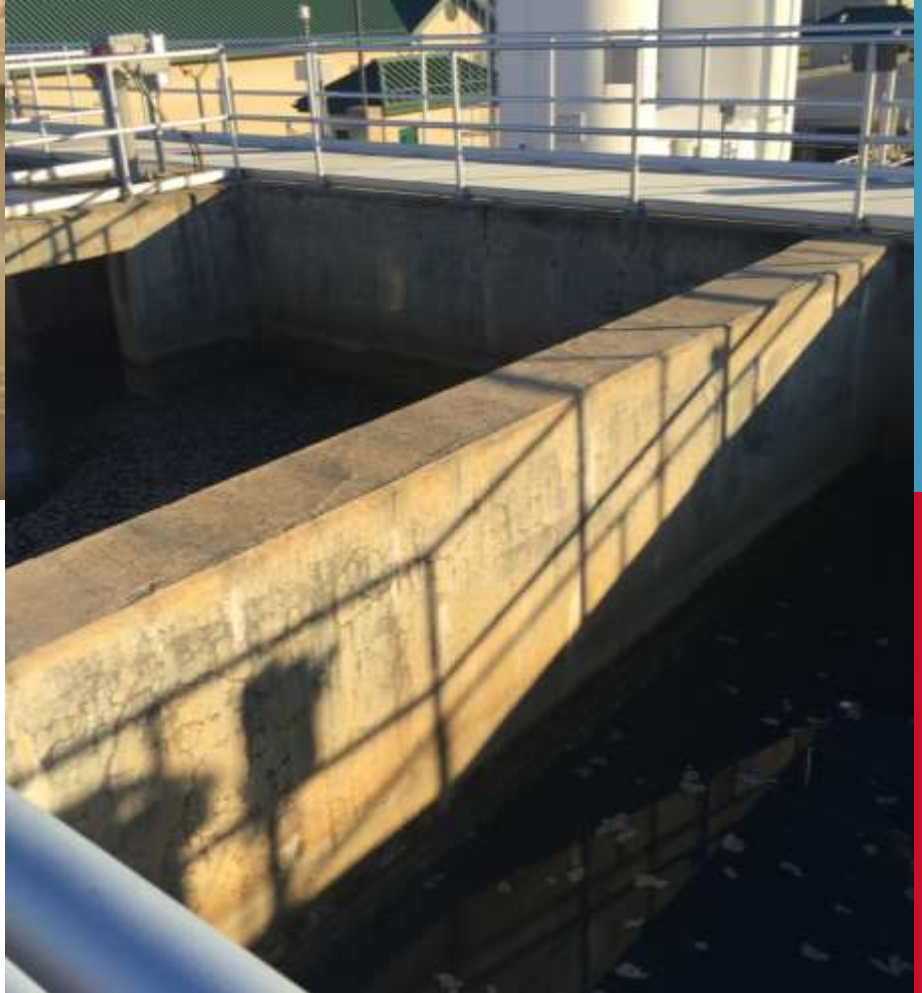




Breaking a Paradigm: Benefits of Chlorine and other Oxidants on Biofiltration

Pete D'Adamo, PE, PhD
Chance Lauderdale, PE, PhD



Where we are heading...

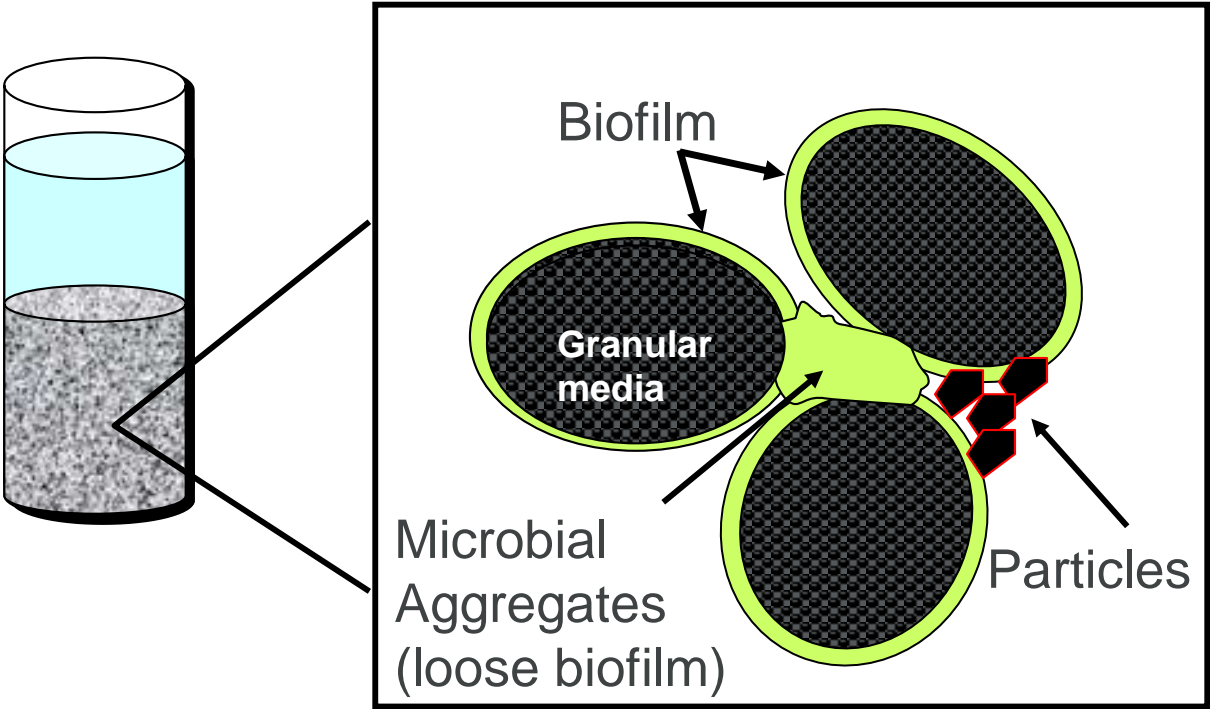
1. Background and Quick Survey of Oxidants and Biofilters
2. Breaking Paradigms – Chlorine and Biofiltration
3. Observations at Newport News Water Works
4. Observations at Arlington, TX
5. Conclusions and Ongoing Research



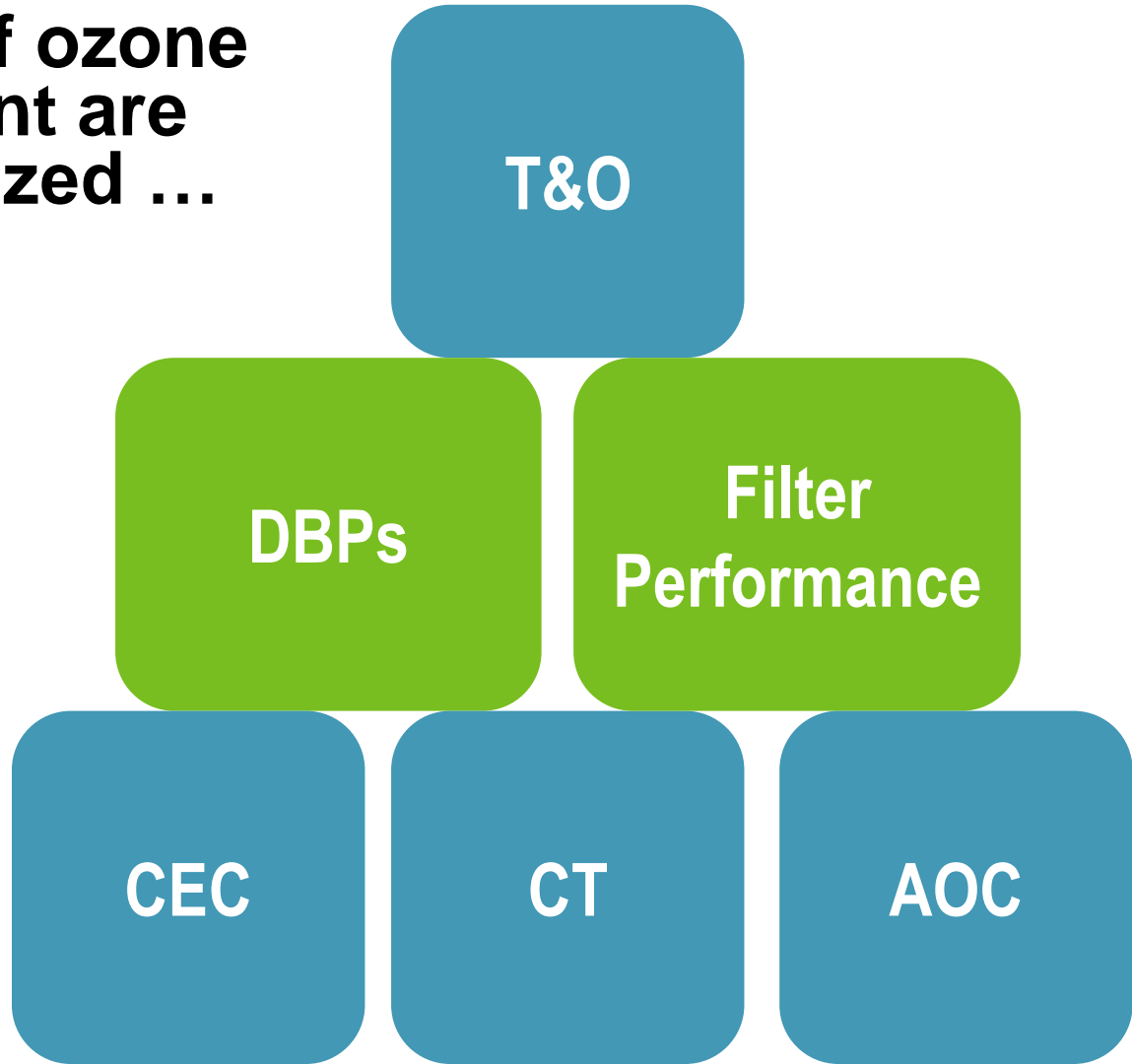
01

Project Background and a Quick Survey of Oxidants in Biofilters

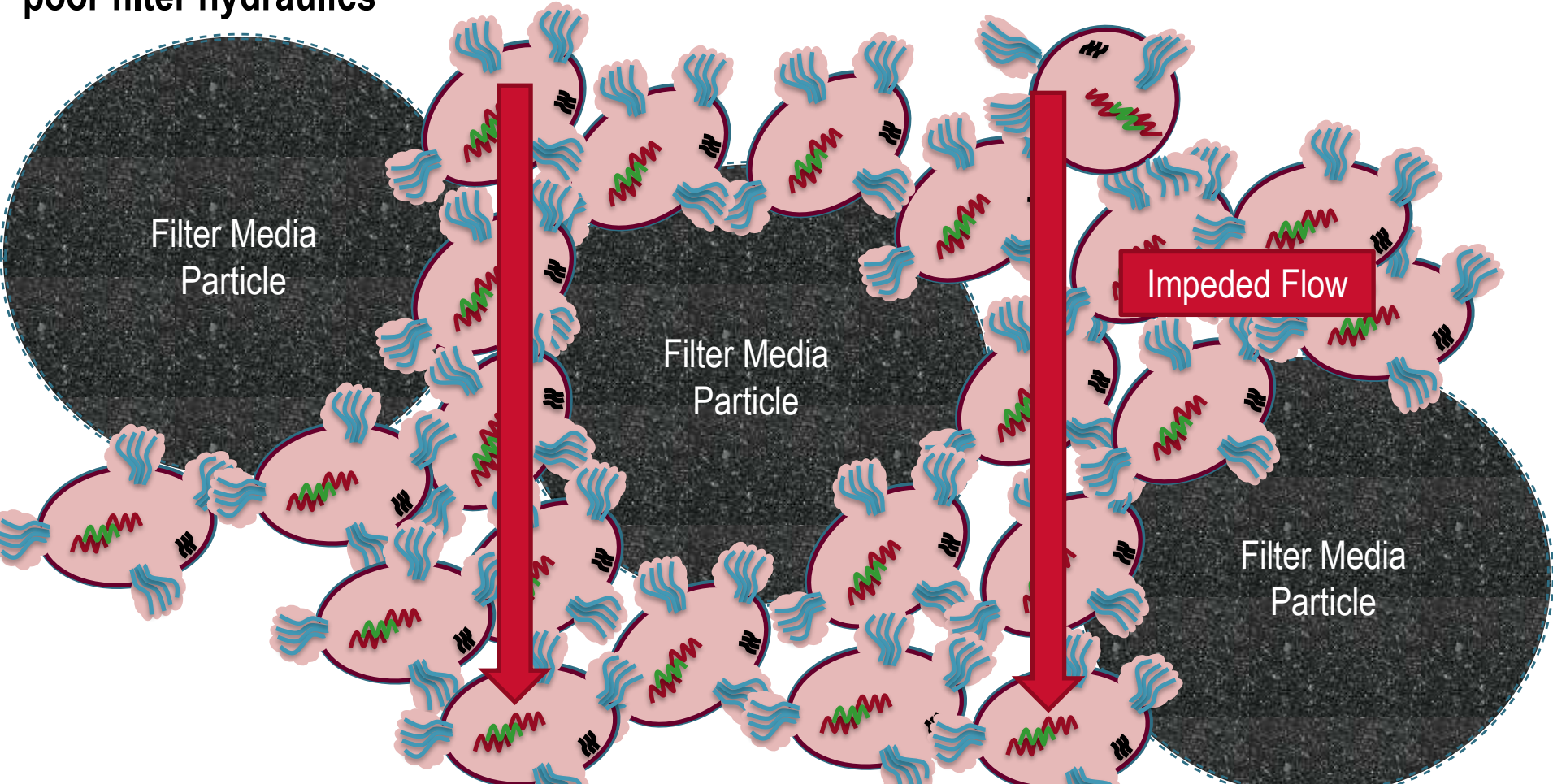
Biofilters are both simple and complex



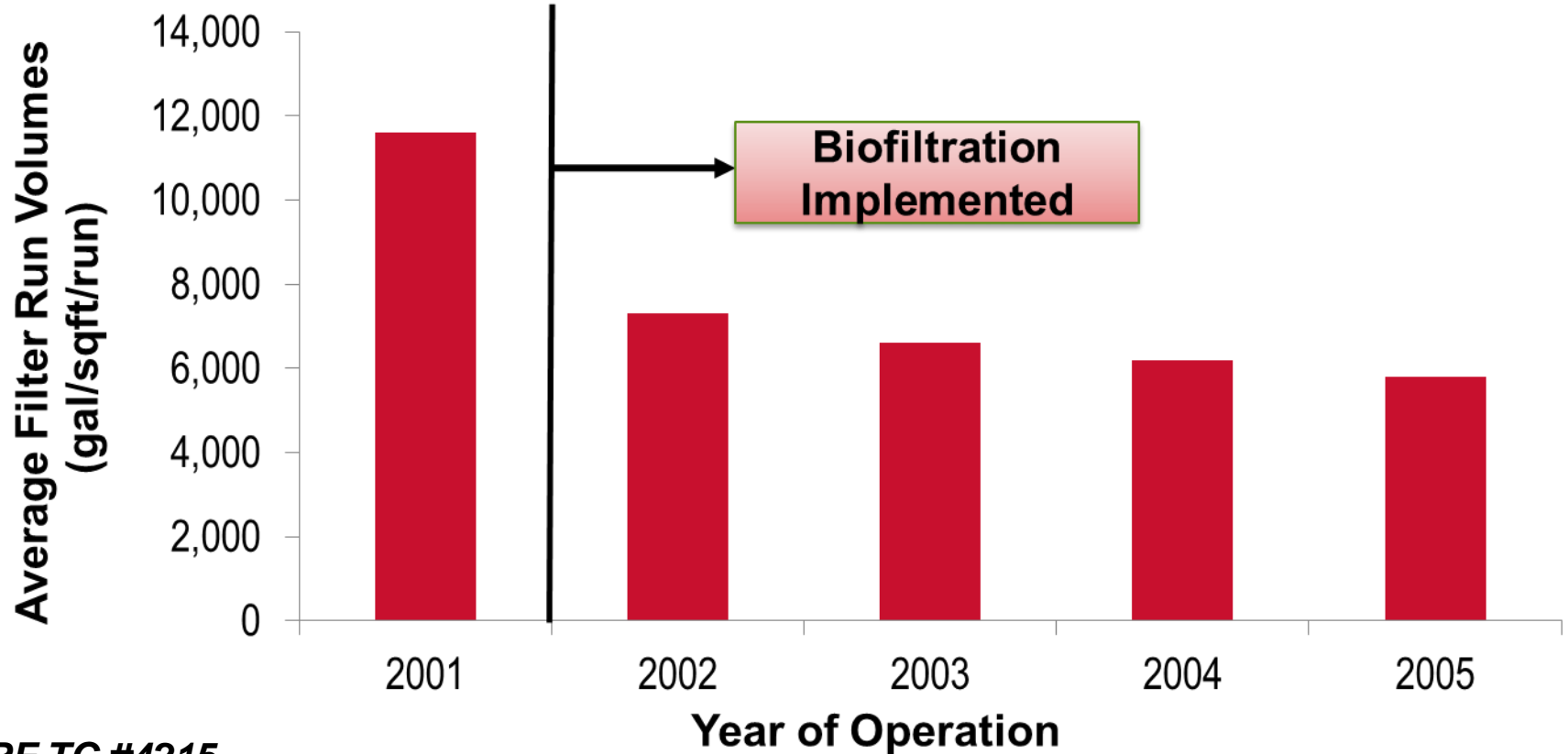
**The benefits of ozone
as a pre-oxidant are
well characterized ...**



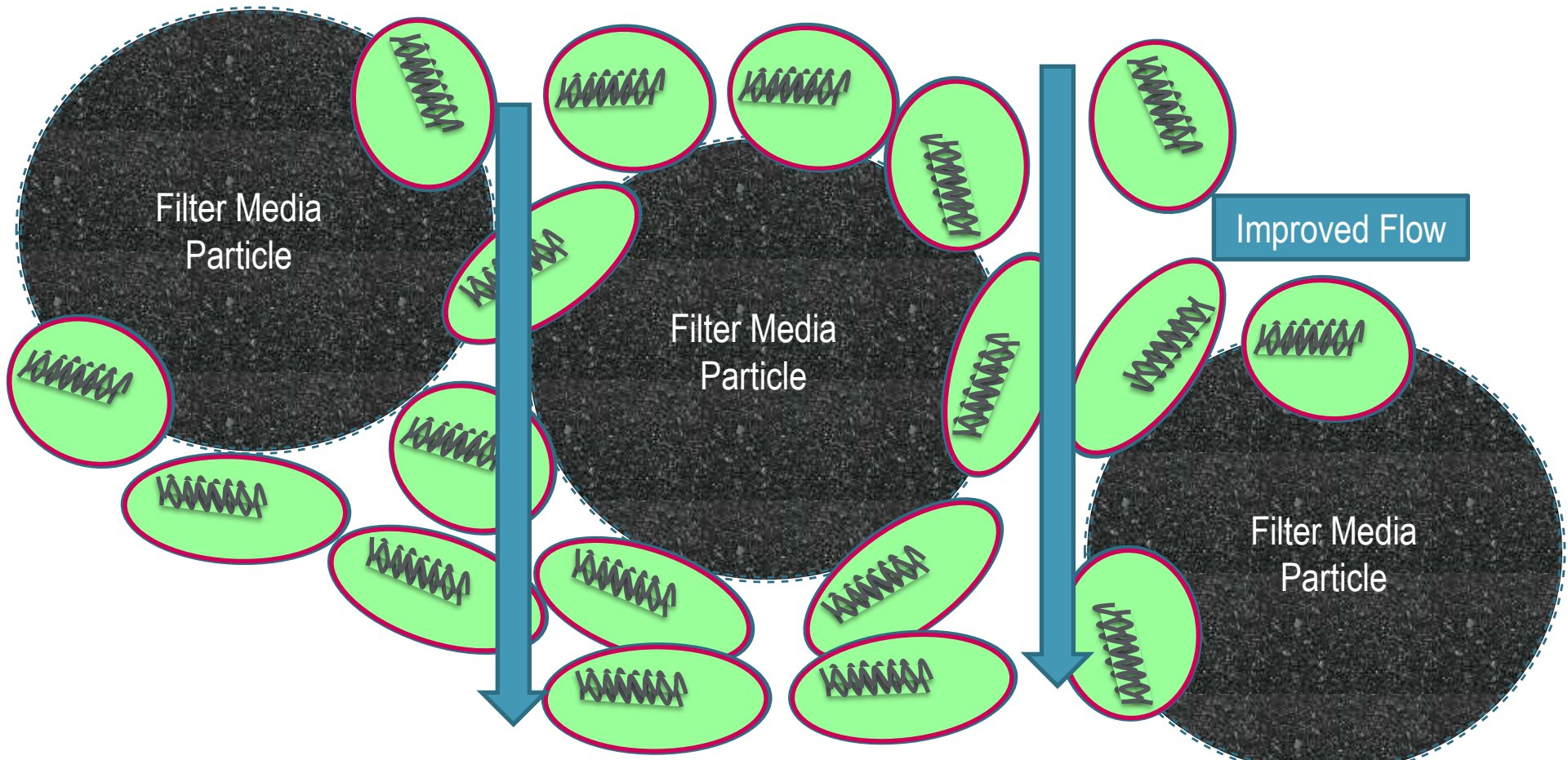
However too much AOC or a nutrient imbalance can lead to excess microbial growth and poor filter hydraulics



Filter productivity may decrease after conversion to biofiltration



WRF 4555 focused on identifying robust optimization strategies that yielded enhanced and reliable effluent water quality



WRF 4555: Optimization Strategies & Targeted Studies

1) Enhancing Microbial Activity

- Nitrogen/ Phosphorus Supplementation
- Trace Metals

2) Upstream Coagulation/ Sedimentation

- Floc Carryover
- Physical/Chemical Effects

3) Pre-Oxidants

- Effects of Pre-Oxidants (Single or Multiple Synergies)
- Acceptable Residual Levels

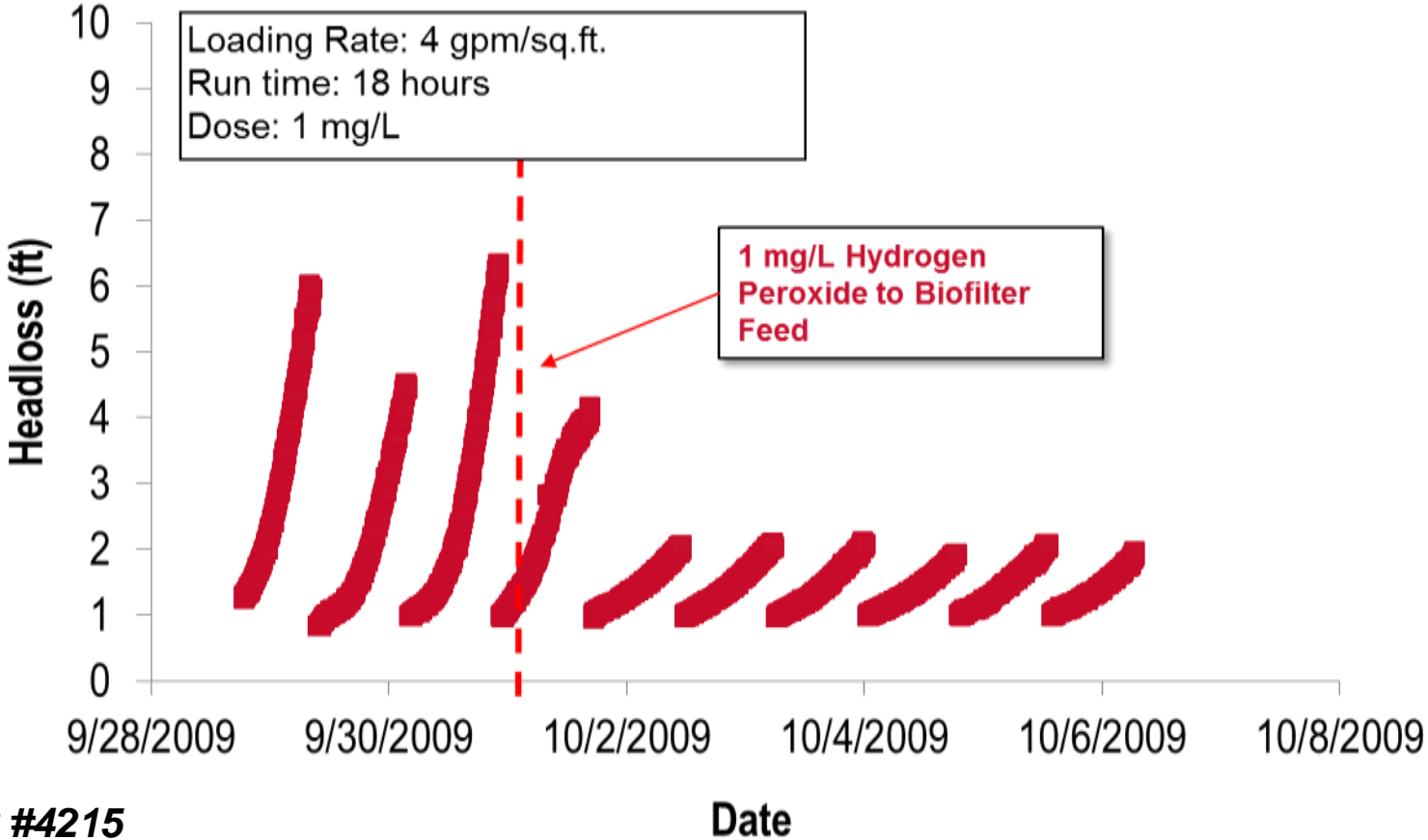
4) Filter Backwashing Strategy

- Backwash Duration, Air Scour
- Dechlorinated Back Wash

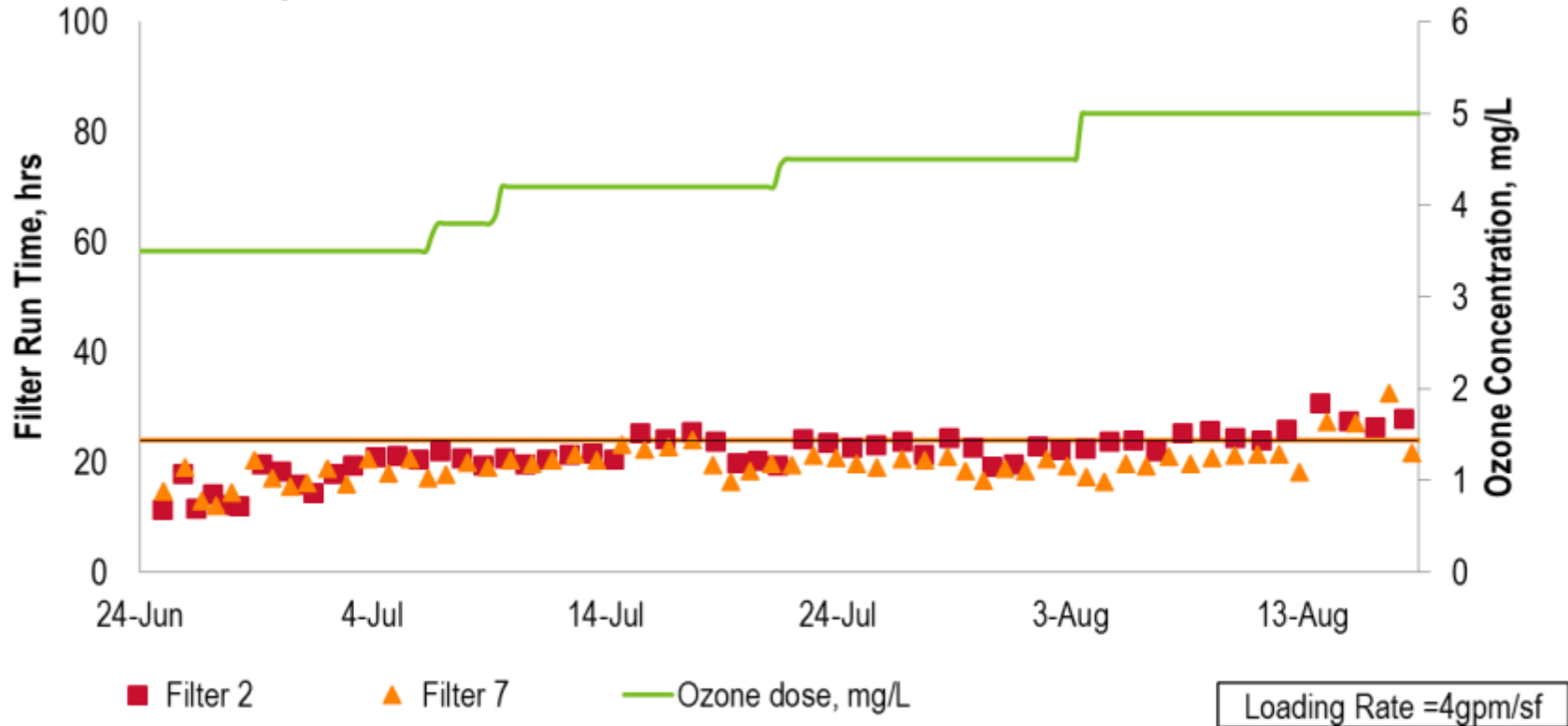
5) Filter Media

- GAC/Anthracite, Filter Caps

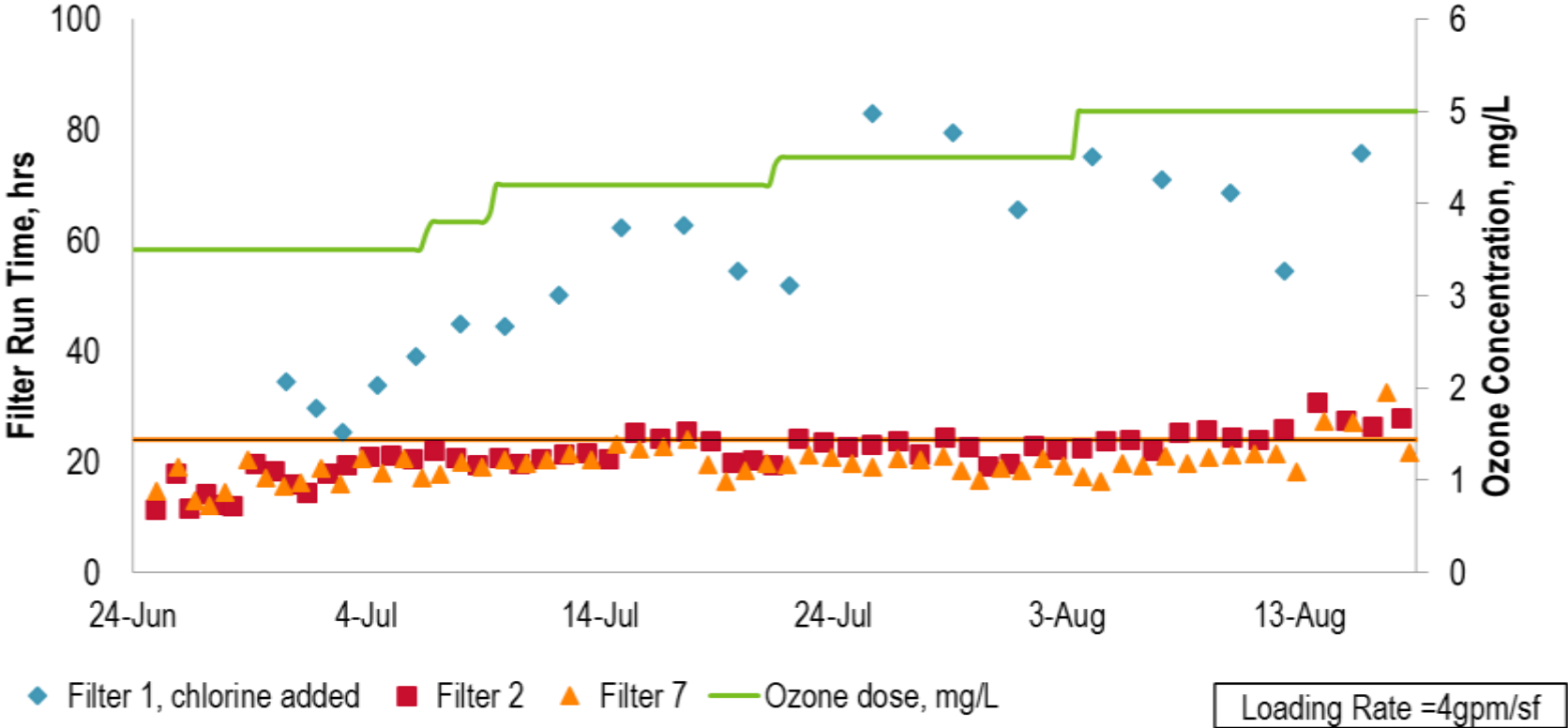
Oxidants, like peroxide, applied to the filter influent can decrease headloss



While ozone has distinct benefits to biofilter hydraulics, diminishing return may prevent achievement of hydraulic goals.



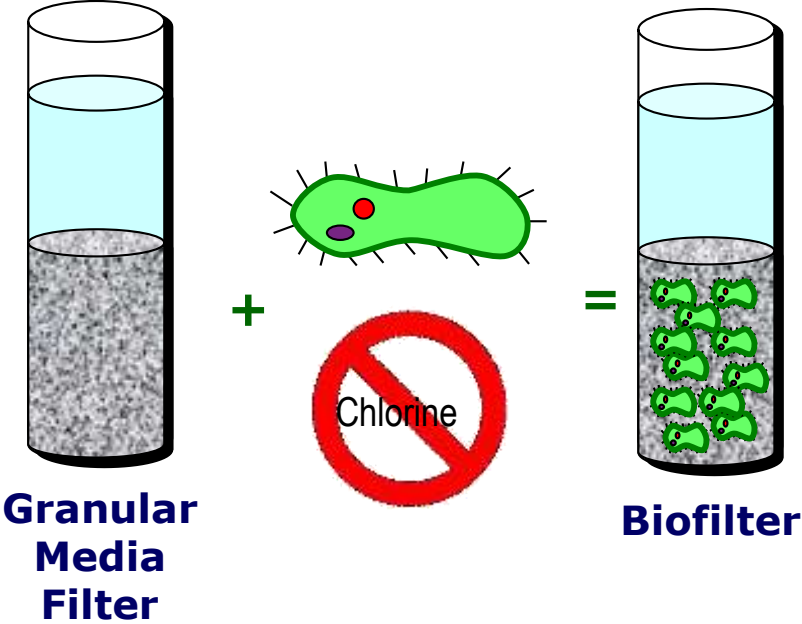
The benefits of free chlorine on filter performance are well documented



02

Breaking Paradigms – Chlorine and Biofiltration

But, you don't chlorinate a biofilter...



Chlorinated Filters v. Biological Filters

Technologies at odds...

- Chlorinated filters
 - Particle/colloid conditioning
 - Minimization of biological fouling
 - Control nuisance organisms
 - Dissolved metals removal
 - Disinfection byproduct formation
 - No biological treatment benefits!
- Biological filters
 - Biological treatment benefits
 - Biological fouling potential
 - Optimization often needed for metals removal, hydraulics, and particle conditioning objectives



Chlorination and Biofiltration

Surprising synergies?

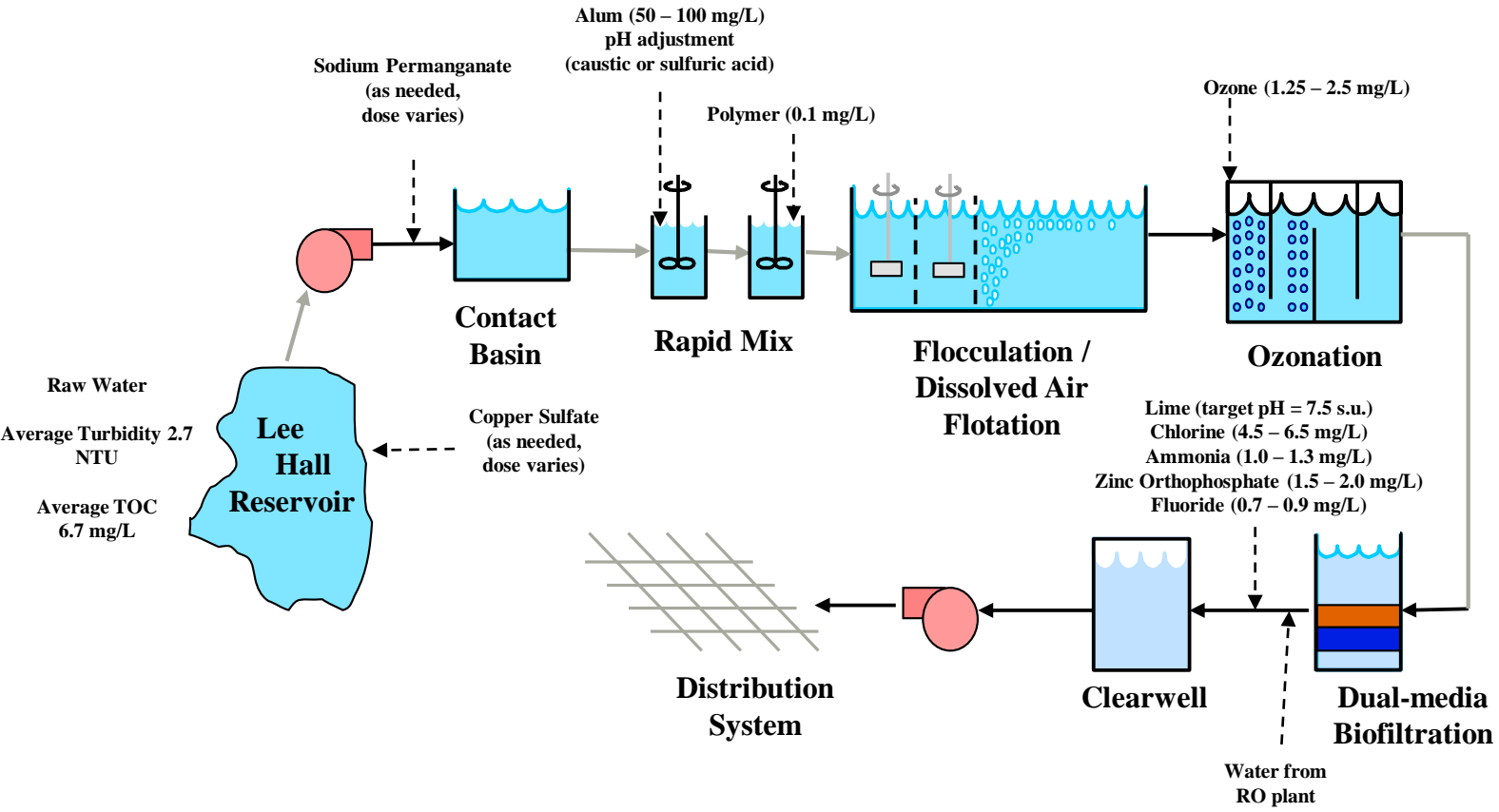
- Minimize/mitigate DBP formation
- Optimize filtration and hydraulics
- Achieve biological treatment objectives



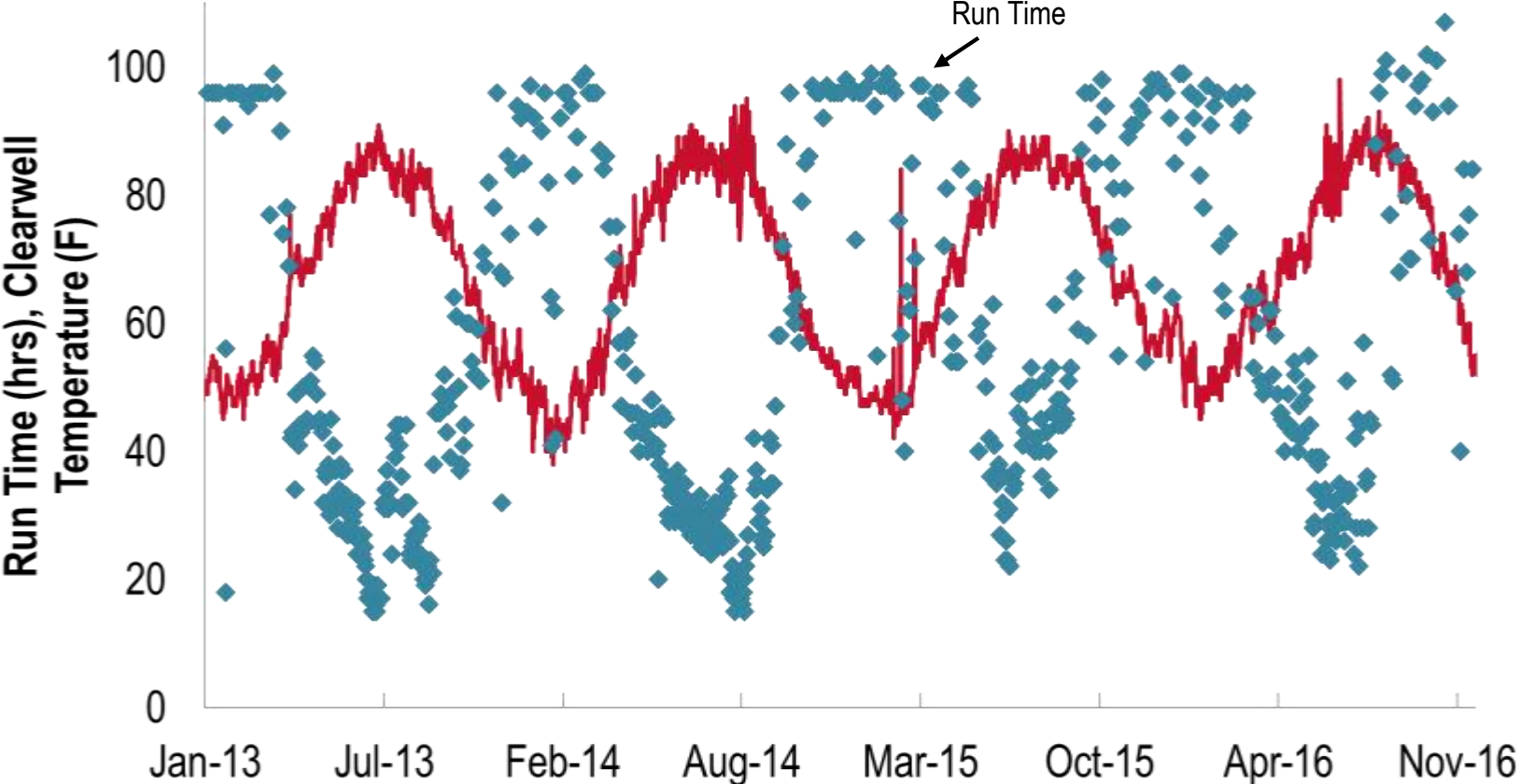
03

**Case Study 1:
Full-Scale Demonstration
of Chlorinated Biofilters at
NNWW**

Lee Hall WTP Process Schematic

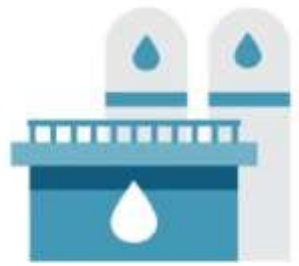


Historically, Lee Hall has suffered from shortened run times during summer months



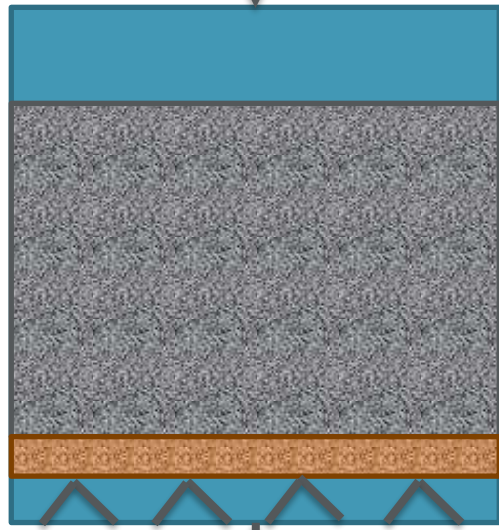
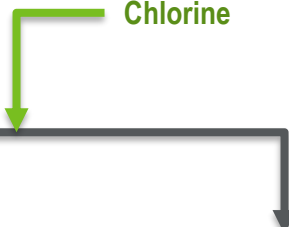
NNWW – Improving Filter Hydraulics with Seasonal Growth Issues in Full-Scale Testing

Algae issues in Water Supply



Filter Characteristics:

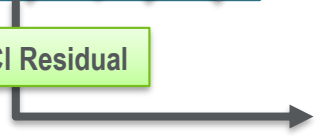
Ozonated feed from full-scale



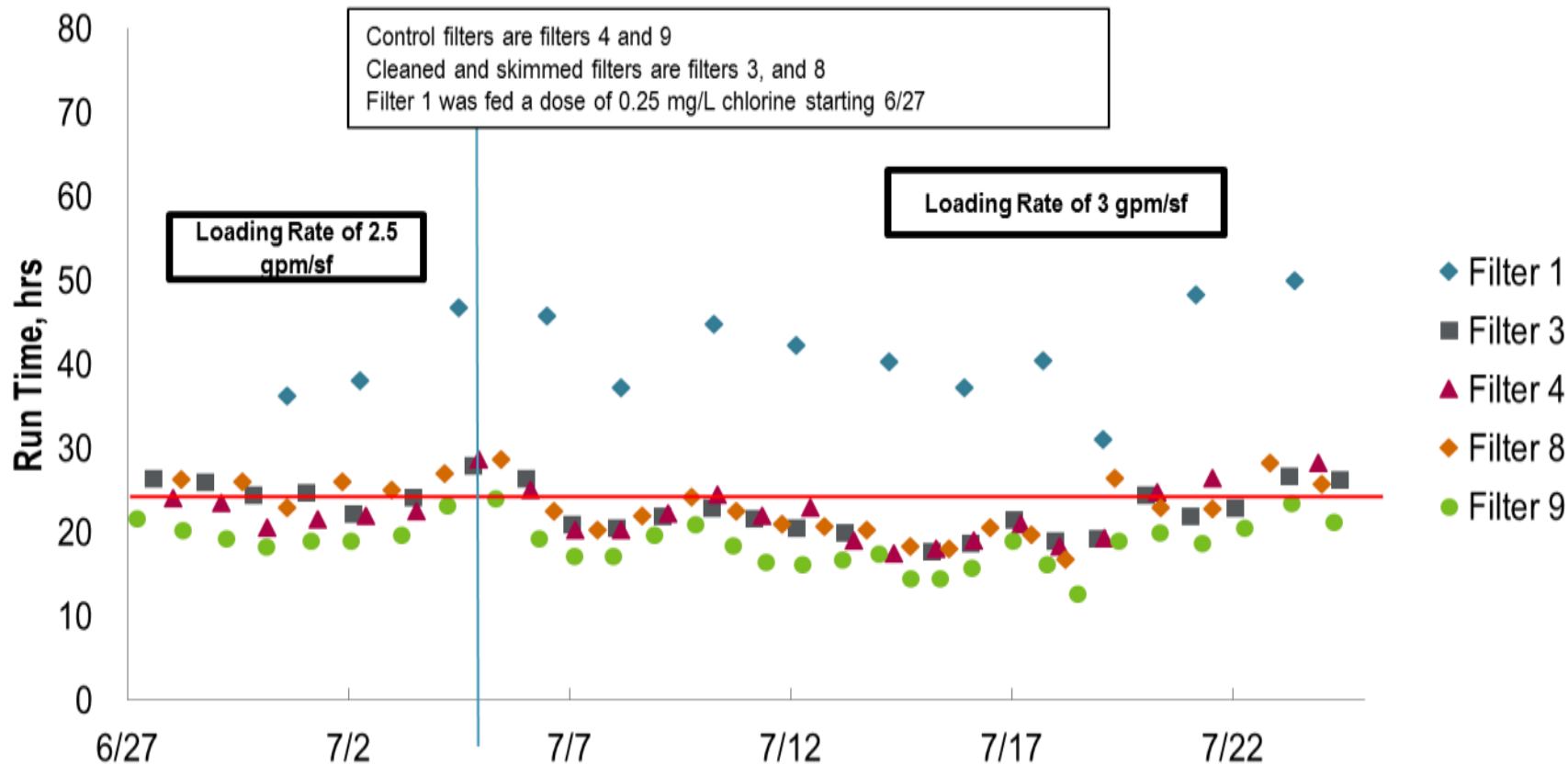
36" Anthracite

12" Sand

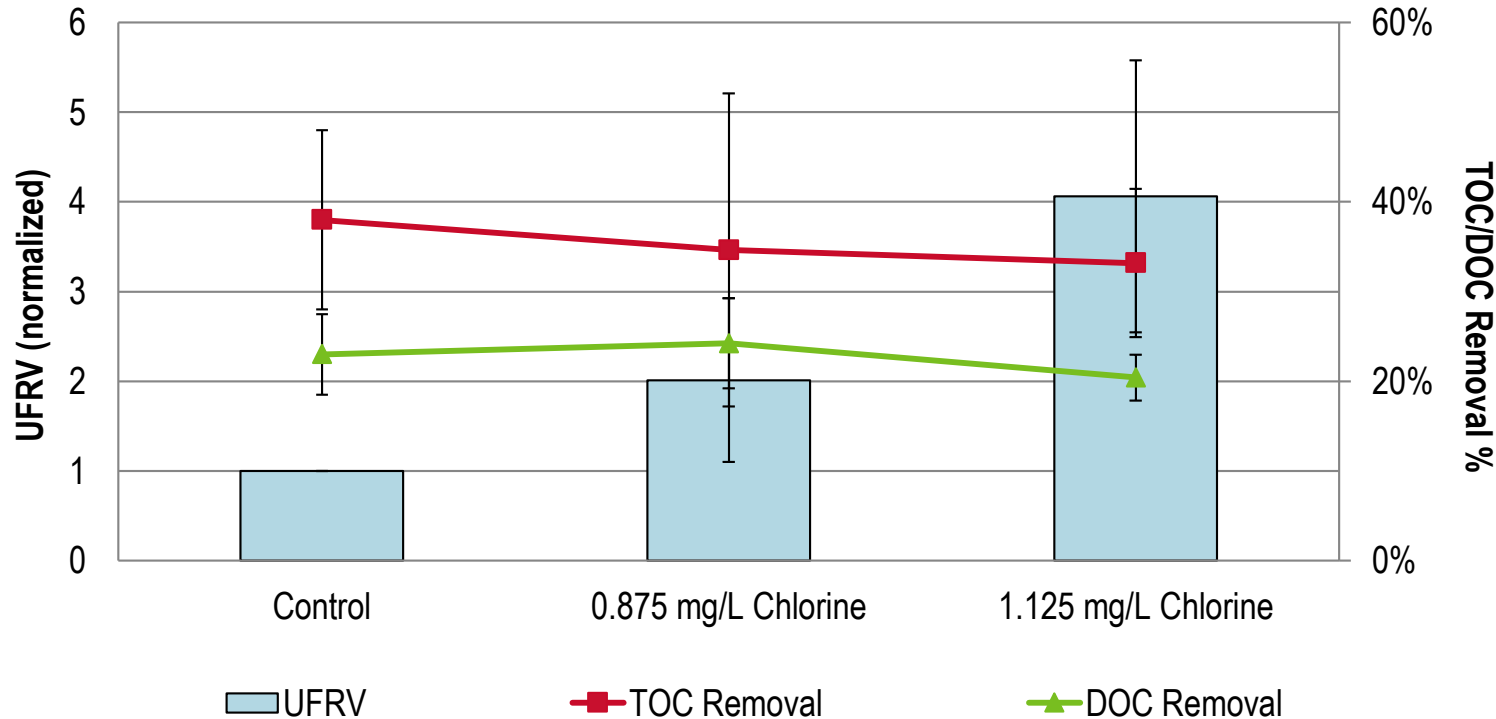
No Cl Residual



Chlorine Enhancement Results

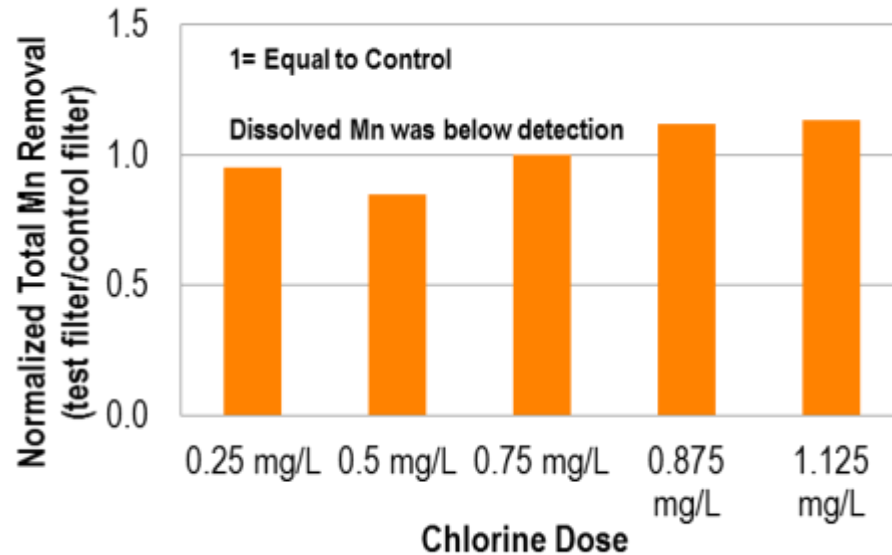


Filter run times were greatly improved with low doses of chlorine, while limited impact on organics removal was observed

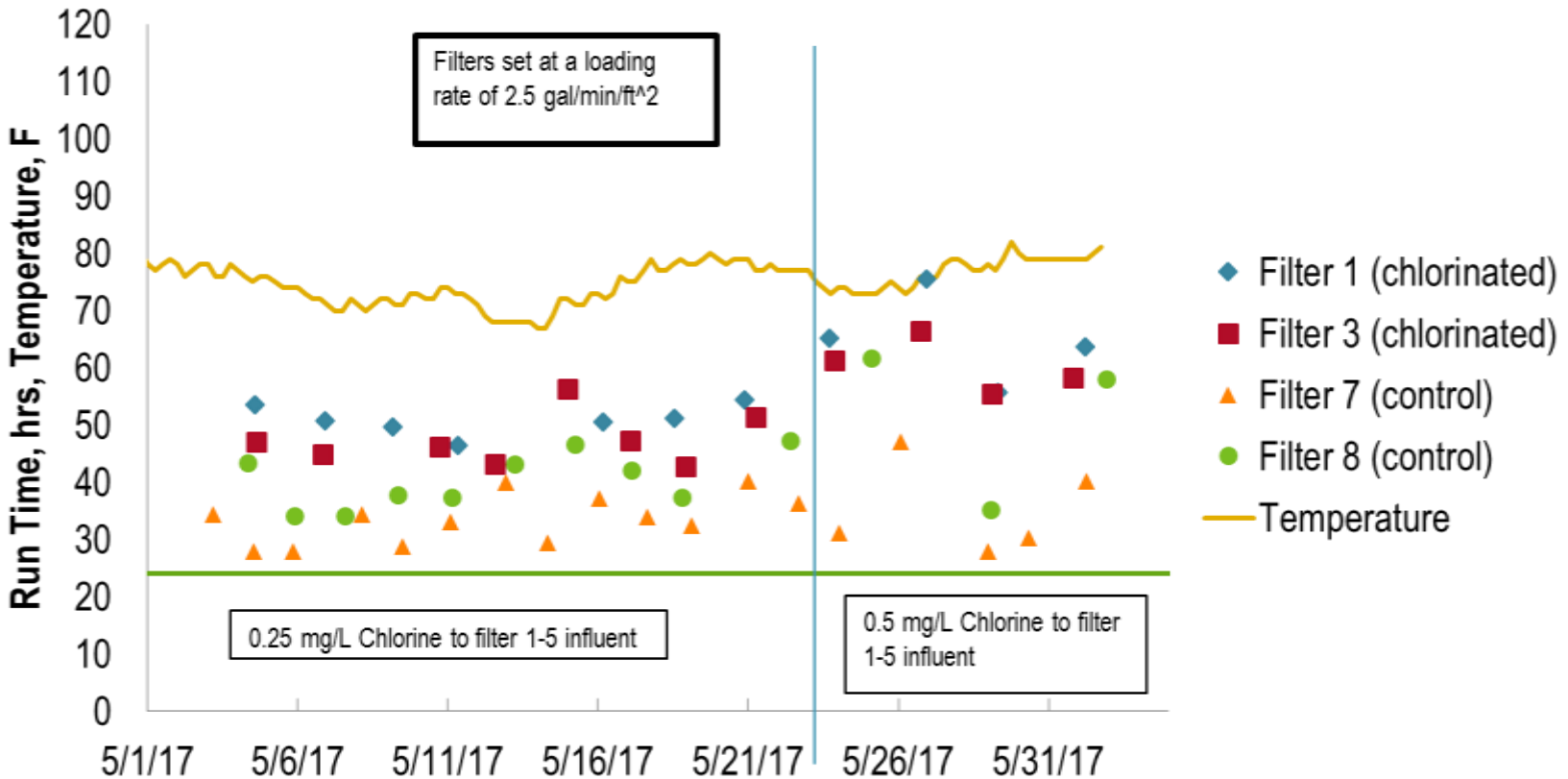


Manganese removal and DBP-FP were not impacted by chlorine addition

Condition	THM	THM-FP (mg/L)
1.125 ppm Cl Influent	<1	258
1.125 ppm Cl Effluent	<1	216
Control - Influent	<1	271
Control - Effluent	<1	347



Testing in 2017 – Filters fed low doses of chlorine continue to perform better



04

**Case Study 2:
Pilot-Scale Demonstration
of Chloramines at
Arlington, TX**

AWU – Understanding the impacts of chloramine on biofilter performance (pilot)

Water supply fed
up to 1.5 mg/L
chloramine



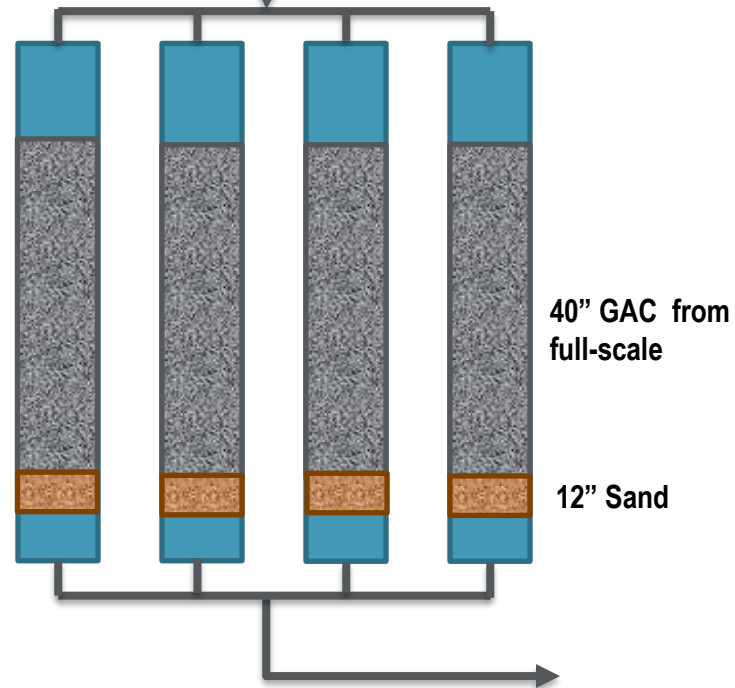
Zebra Mussel
Overgrowth



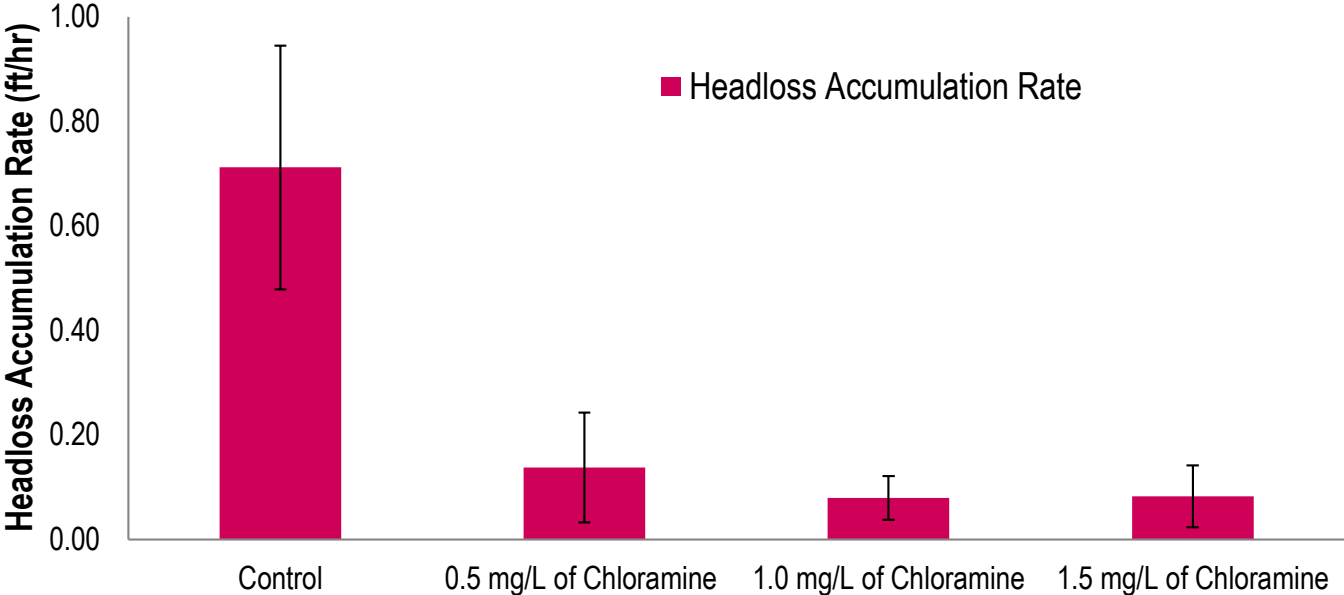
Filter Characteristics:

Ozonated feed
from full-scale

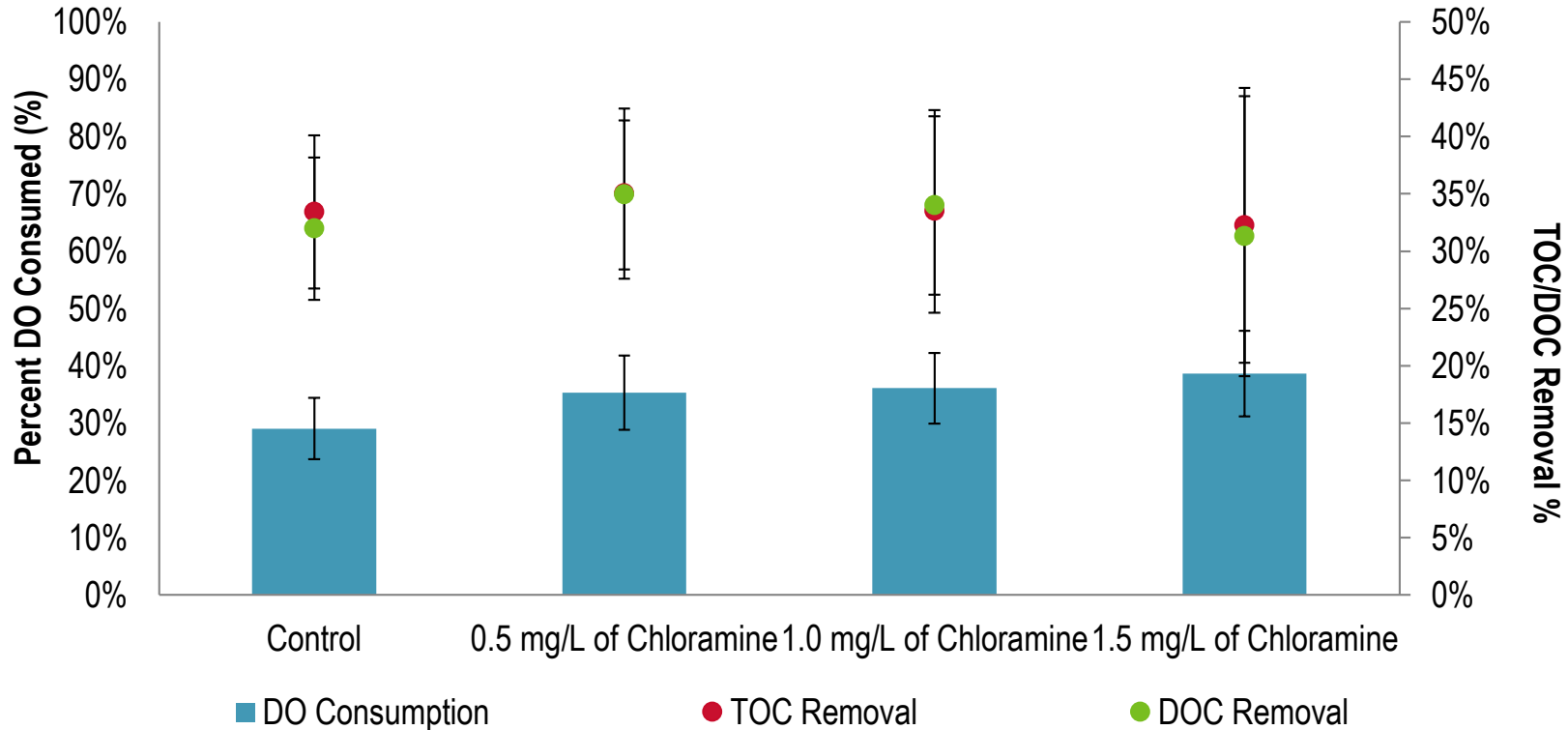
Chloramine
pH
Nutrients



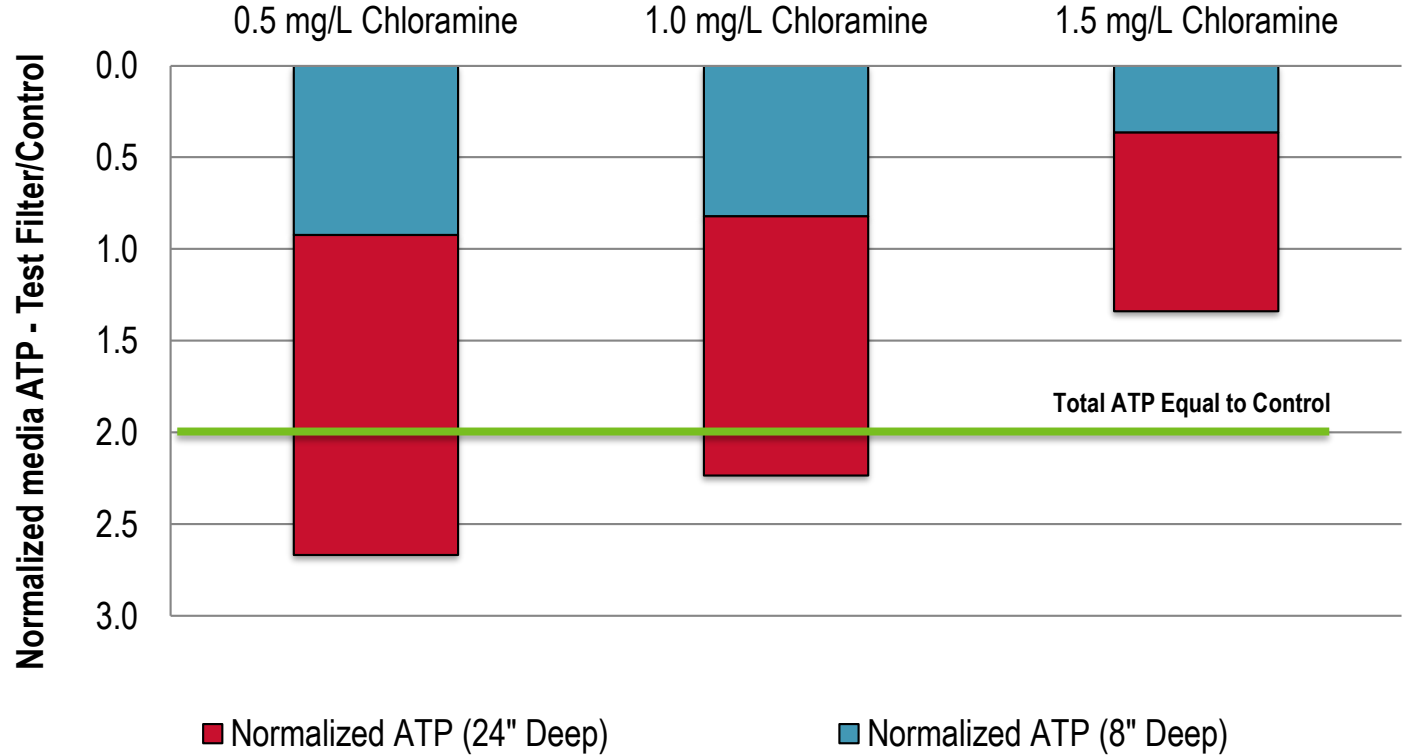
Chloramine addition drastically reduced filter headloss



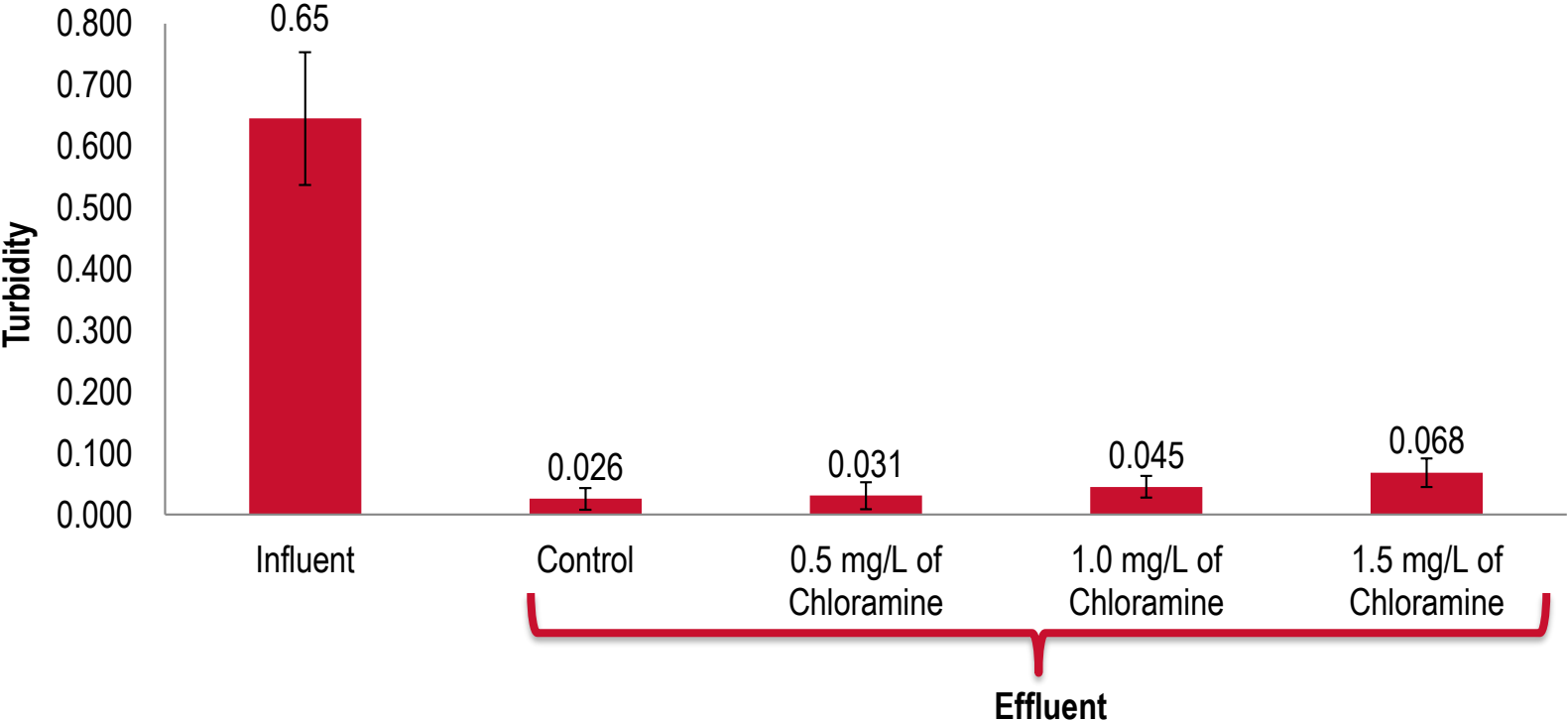
Slight DO consumption increased with chloramine addition (nitrification); no difference in TOC/DOC removal was observed



Filter Media ATP was pushed deeper in GAC bed



Chloramines had some but limited impact on turbidity breakthrough & TTHM-FP



05

Conclusions and Ongoing Research

The synergistic benefits of chlorination and bio filtration merit additional investigation

- Can chlorination help with biological and particulate fouling? Can we develop guidance to allow others to easily investigate and optimize?
- Can we predict/modify particulate fouling based on charge/zeta, particle size, pH, etc?
- What are the downstream water quality and stability impacts of biofilter chlorination?
- Can we further optimize media selection/design to provide even further robustness over our current strategies?



Acknowledgements

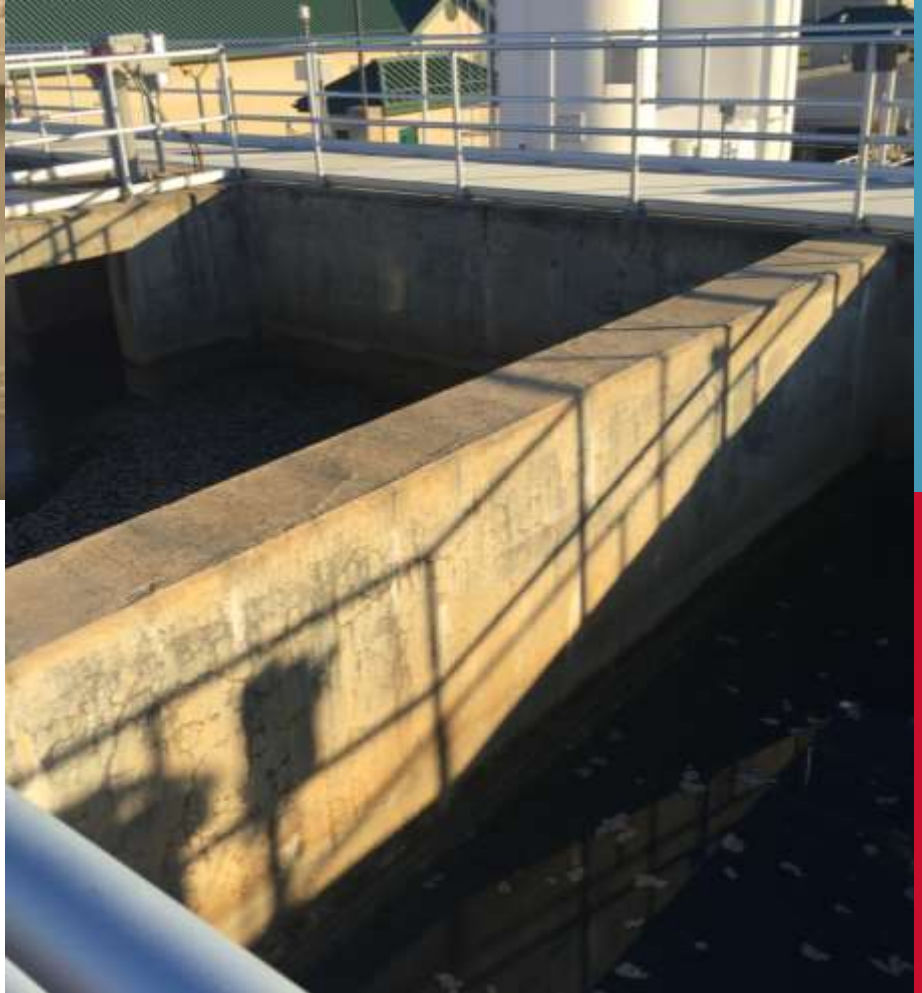
- **HDR** – Christina Alito, Rob Hoffman
- **CDM Smith** – Kate Dowdell, Pat Evans
- **SNWA** – Holly McNaught, Julia Lew, Joseph Paul, Mary Murphy, Janie Zeigler, Brett Vanderford, Eric Dickenson, Mac Gifford
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- **University of Texas at Austin** – Mary Jo Kirisits, Sarah Keithley
- **Vendors** – Hach (Vadim Malkov), LuminUltra (Dave Tracey), ManTech (Rob Menegotto)
- **Participating Utilities** – Arlington Water, Aurora Water, Denver Water, Fairfax County, City of Tampa, Gwinnett County, Newport News, City of Raleigh, Toronto Water, Halifax Water, Halton



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Breaking a Paradigm: Benefits of Chlorine and other Oxidants on Biofiltration

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