



Impact of New Enterococcus Criteria on Disinfection Operations and Other Plant Effluent Criteria

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**NEWEA/NYWEA Spring Meeting
Mystic CT June 6-8, 2016**

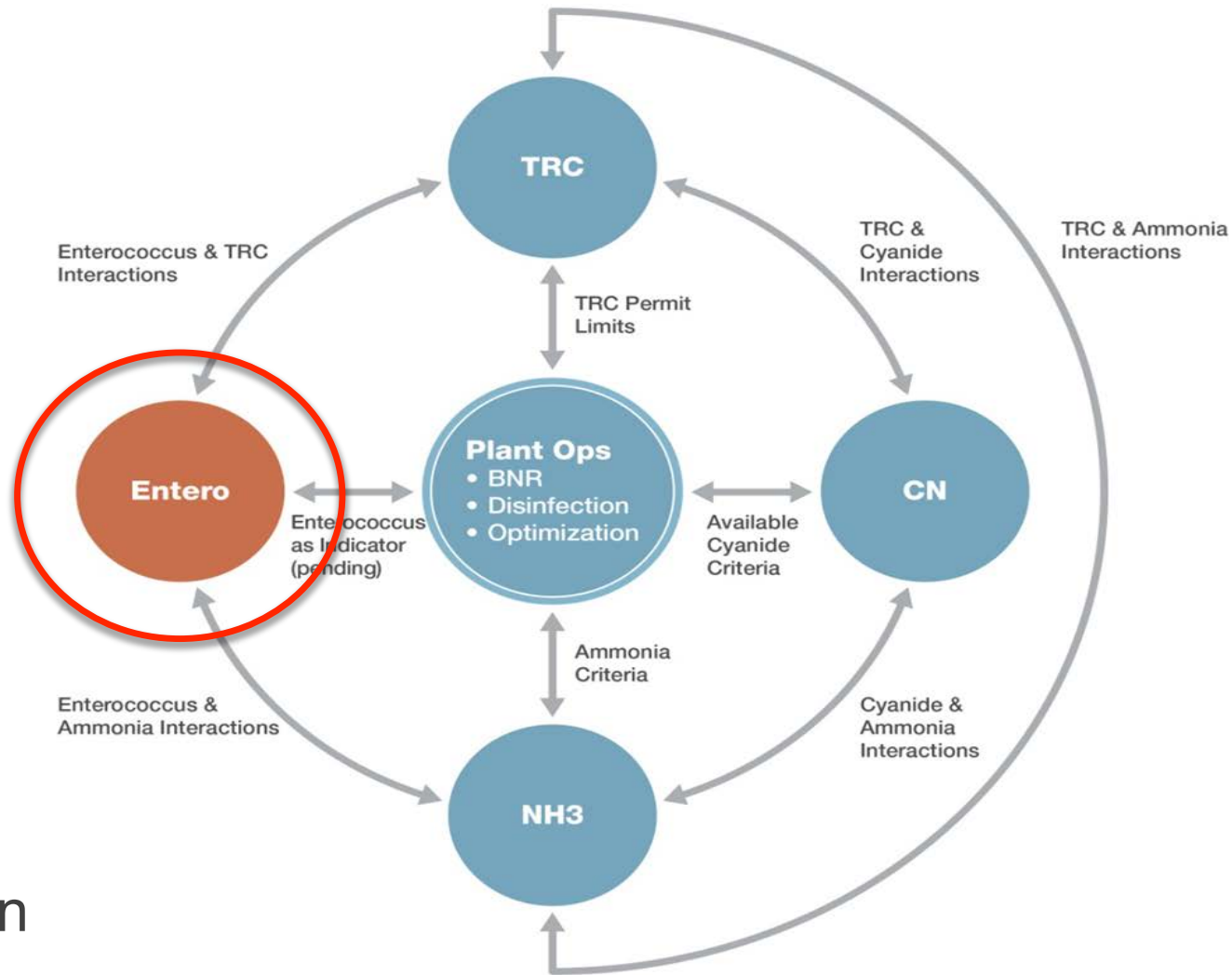


Outline

- Effluent Criteria Impacted by TRC
 - Enterococcus Criteria
 - Dose Response Study
- Fecal vs. Entero Inactivation
 - Chlorine
 - PAA
 - Chlorine and PAA Decay
- Wet Weather Entero Inactivation\
 - Chlorine and PAA
 - Free Cyanide
 - Low Ammonia
 - Additional Work

Simultaneous Compliance

Rapidly Changing Regulatory Environment



- TRC
- Ammonia
- Free Cyanide
- Enterococcus
- BNR Operation

Fecal Coliforms Vs. Enterococcus as Indicator Organism

- Switch to be implemented in future permit
- Enterococcus identified as “better” indicator – more difficult to disinfect and may require higher hypo dose/dechlor dose
- Current Fecal Coliform permit criteria
 - 6 Hour Max = 800 col / 100 ml
 - 7 day Geo. Mean = 400 col / 100 ml
 - Monthly Geo. Mean = **200** col /100ml
- Pending *Enterococcus* criteria
 - BAV = 110 or 130 col / 100 ml
 - STV = 60 or 70 col /100 ml
 - Monthly or 30 Day Rolling Geo. Mean = 30/**35** col /100 ml

Typical Ratio for Fecal:Entero ~ 7

Possible Concerns with New Enterococcus Criteria

- Pending with new Enterococcus criteria
- Possible issues at all WWTPs based on 5 plant study
 - Relationship between TRC, ammonia, etc.

Exceedances for Fecals

WWTP	Daily > 2,000	Monthly GM > 200
1	5	0
2	1	1
3	3	2
4	8	6
5	0	0

2002 – 2005
Comparative
Sampling

Exceedances for Entero

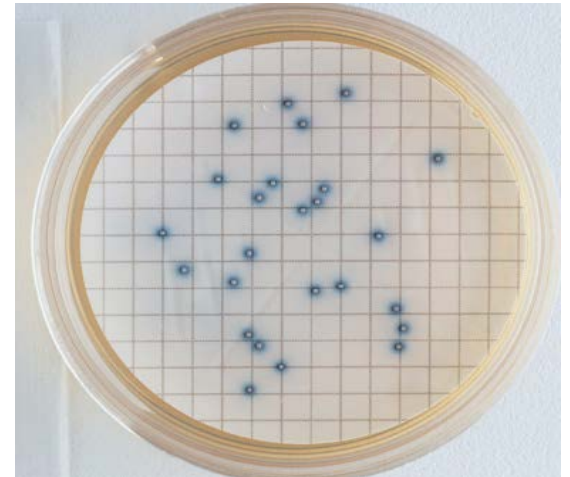
WWTP	Daily > 130	Monthly GM > 35
1	34	7
2	37	10
3	58	15
4	24	9
5	8	5

Fecal Coliforms vs. Enterococcus

Saltwater Discharges – proposed change in pathogen indicator from Fecal Coliforms to Enterococcus

Potential Impacts

- Increased Chlorine Dose
- Increased Dechlor Dose
- Impact on TRC compliance



Enterococcus Inactivation – Chlorine and PAA

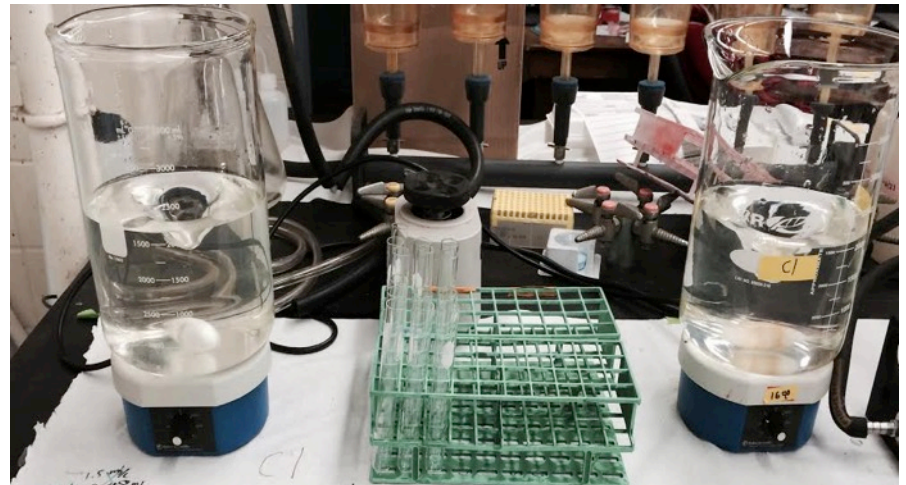
Purpose of Study: To determine the dose of disinfectant needed to meet the potential new indicator organism criteria.

- Higher doses needed to inactivate Entero vs. Fecal Coliforms?
- Currently all NYC plants use hypochlorite as disinfectant

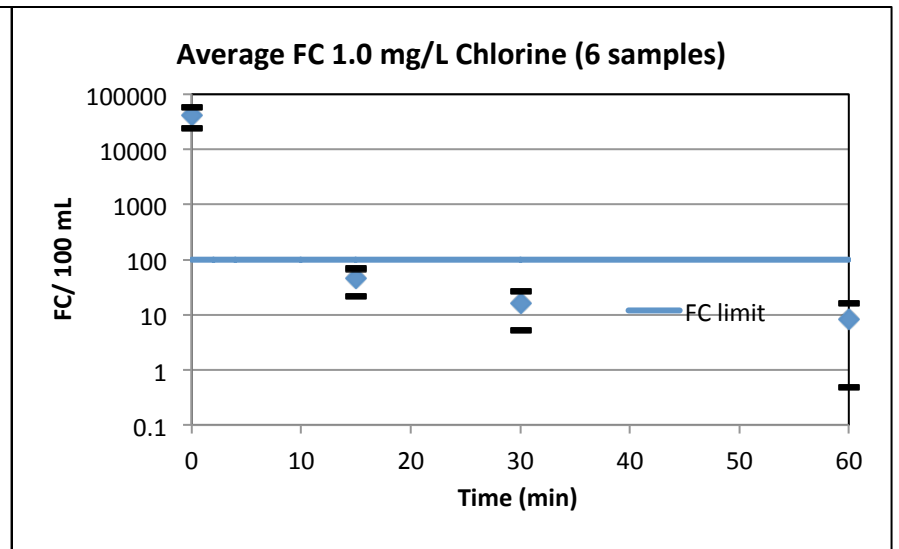
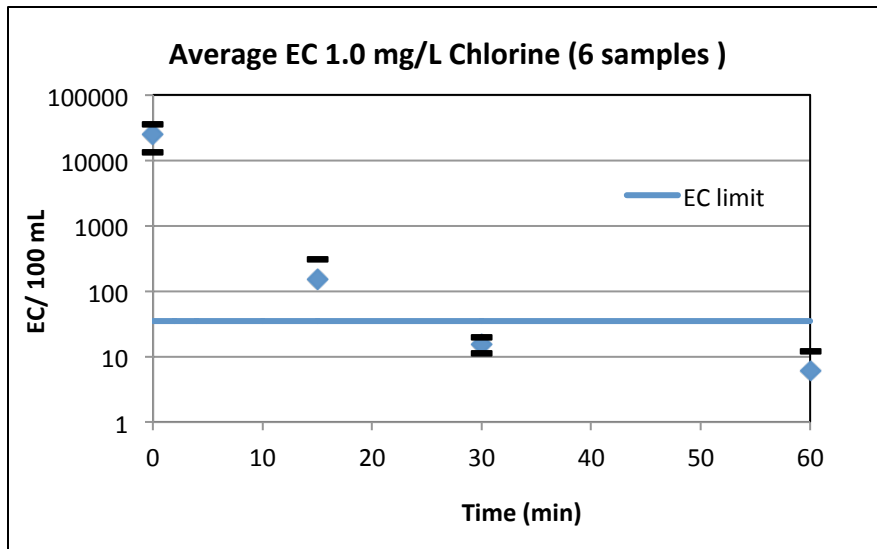
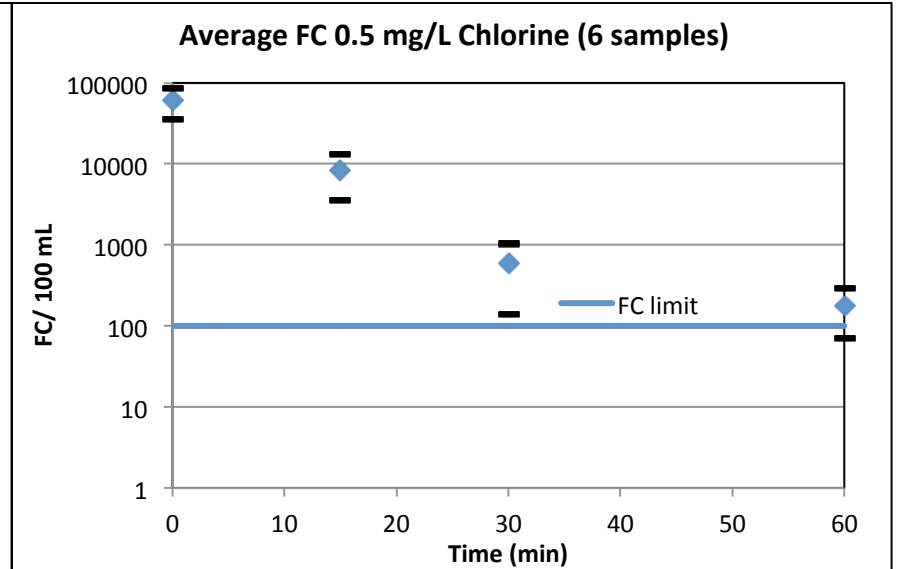
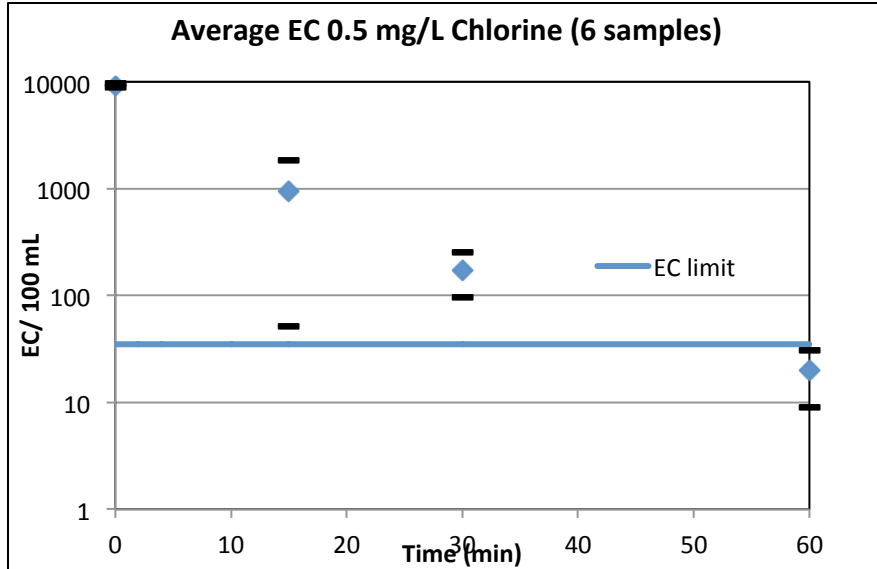
Secondary effluent from treatment plant were dosed with hypochlorite and measured Enterococcus concentration. Comparisons were made to Fecal Coliform inactivation results.

Chlorine dose response for Enterococcus were measured at 4 WWTP

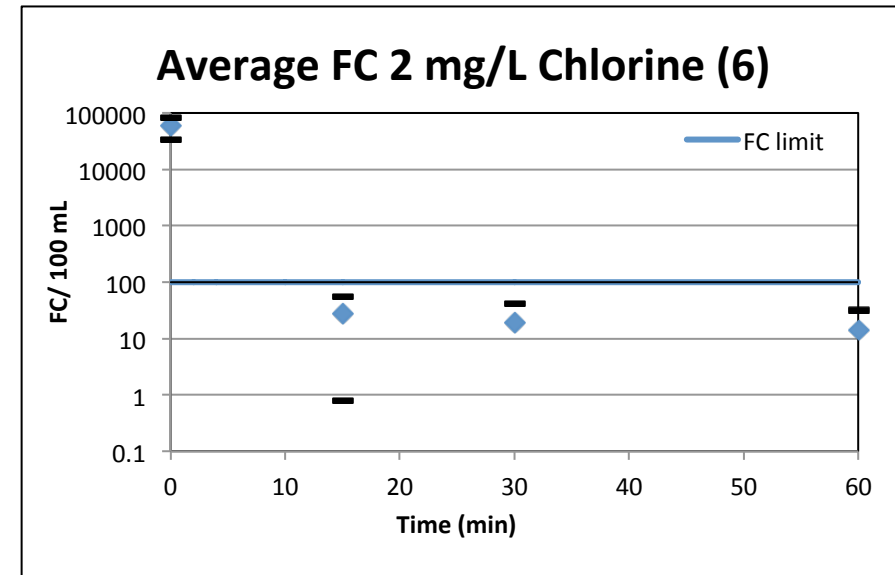
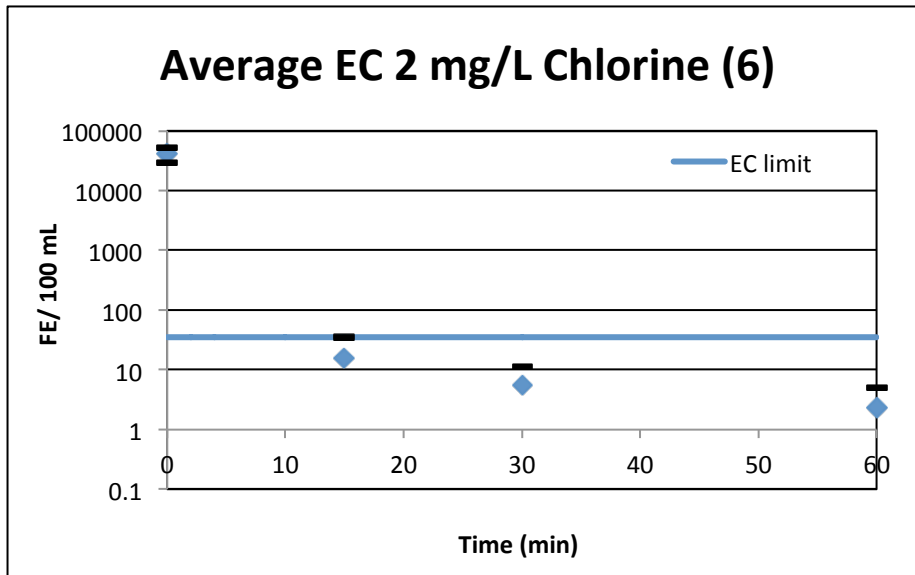
- 26th Ward
- Newtown Creek
- Tallman Island
- Oakwood Beach



Tallman Island Effluent Chlorine Dose Response



Tallman Island Effluent: Chlorine Dose Response

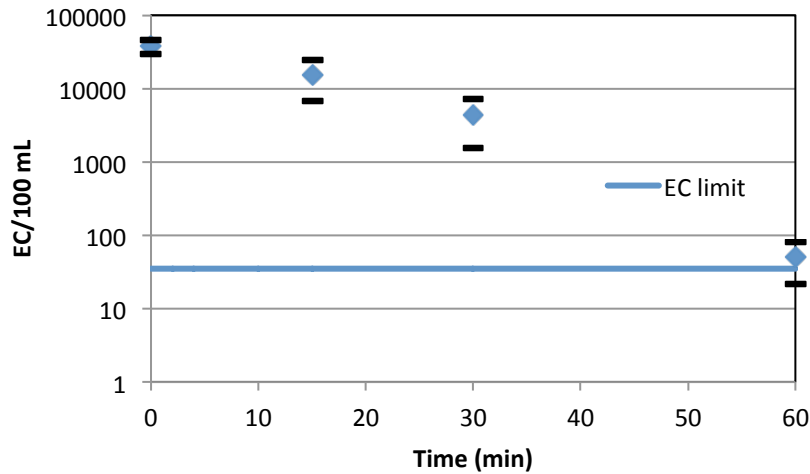


Chlorine Results

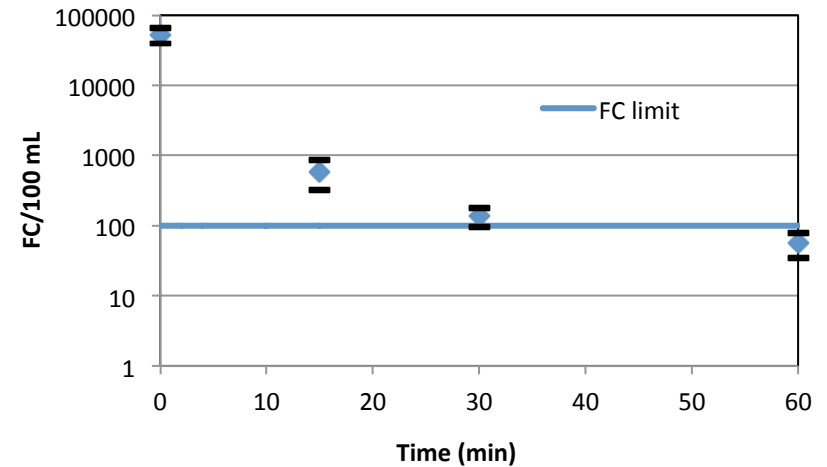
- At dose of 1.5 mg/l is sufficient to meet both FC and EC criteria
- At 2 mg/l FC is met at all times \geq 15 minutes
- At 2 mg/l EC is met at most times $>$ 15 minutes
- At 1 mg/l FC criteria met at all times \geq 15 minutes
- At 1 mg/l EC criteria met only at times $>$ **15 minutes**
- Generally EC requires greater Ct to inactivate than FC at lower doses, but FC has higher Ct at high disinfection doses

Tallman Island Effluent: PAA Dose Response

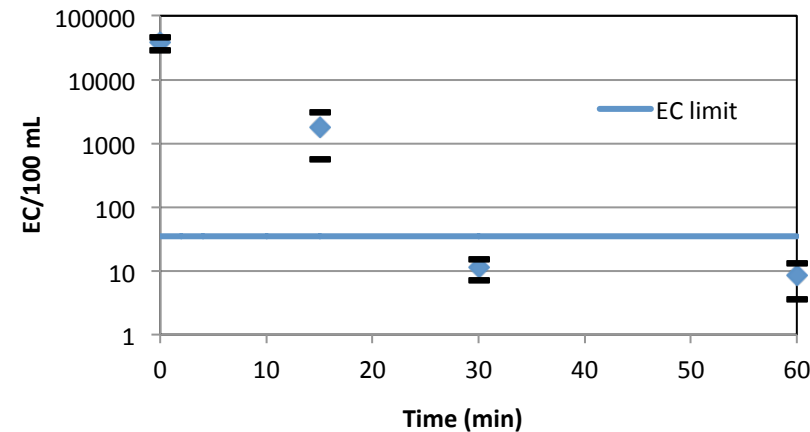
Average EC 1 mg/L PAA Dose (7)



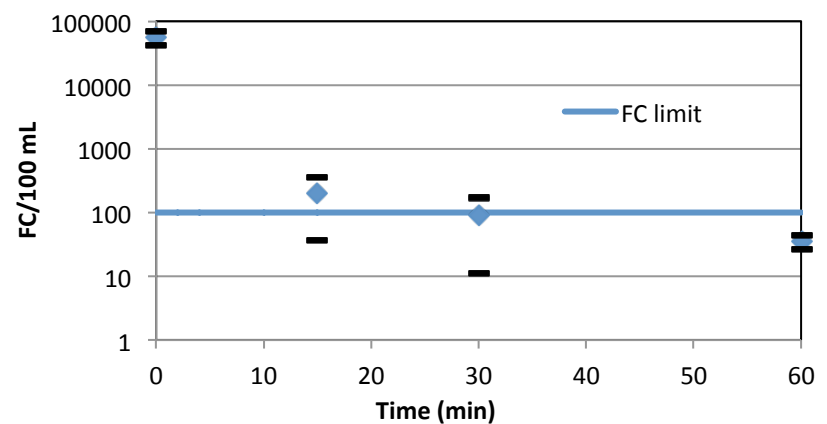
Average FC 1 mg/L PAA Dose (7)



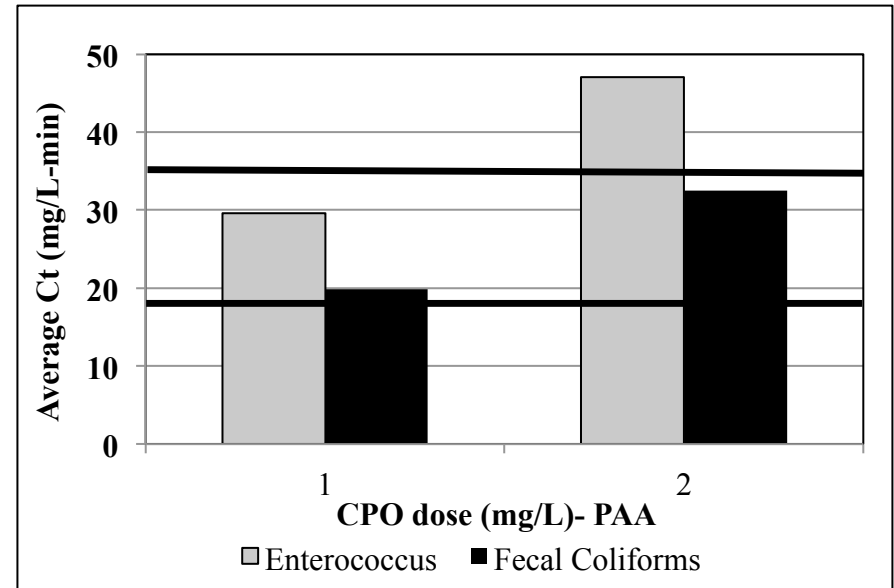
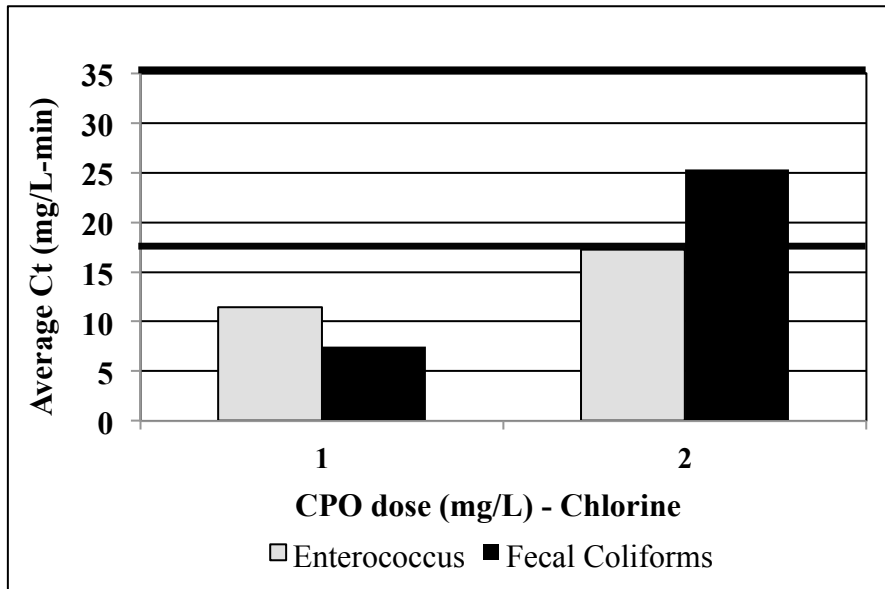
Average EC 2 mg/L PAA Dose (6)



Average FC 2 mg/L PAA Dose (6)



Tallman Island Effluent: Chlorine and PAA



Average Chlorine Ct for Compliance

Ct FC (mg/L - min) = 16.5

Ct EC (mg/L- min) = 14.35

Average PAA Ct for Compliance

Ct FC (mg/L - min) = 26.1

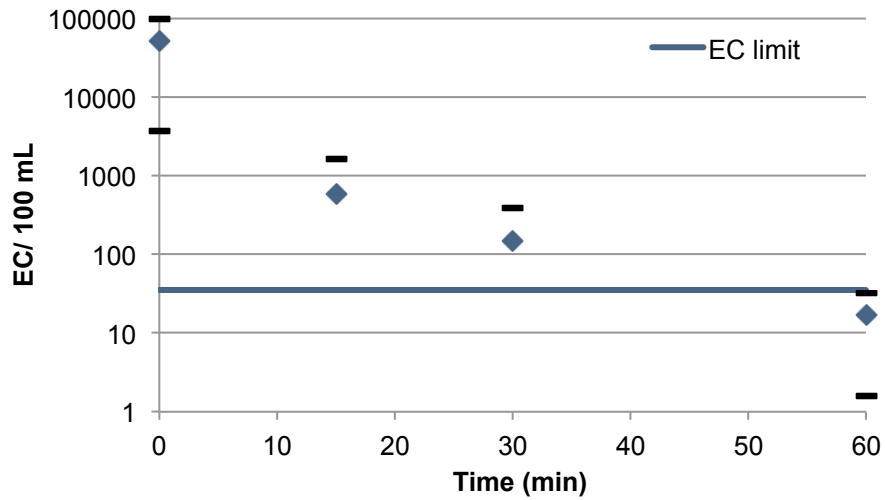
Ct EC (mg/L - min) = 38.35

Results

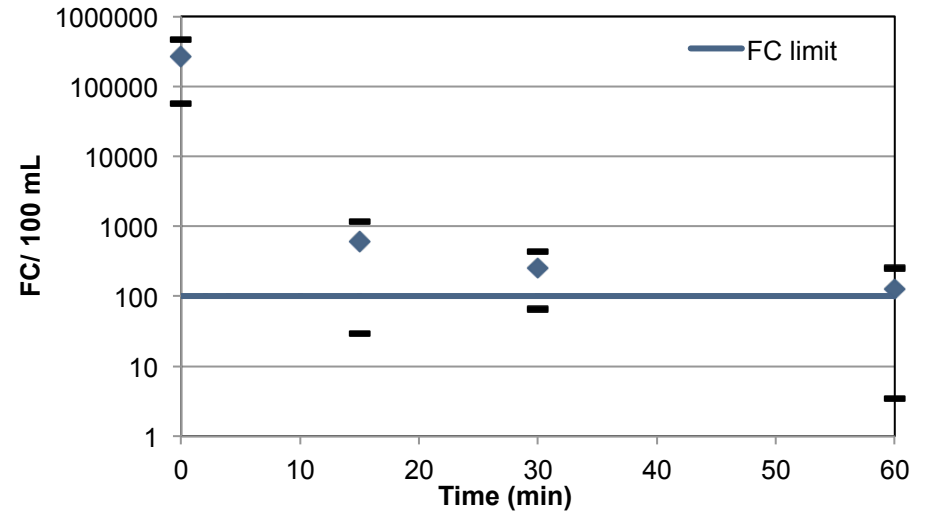
- Need PAA dose > 2 mg/l to consistently achieve FC criteria
- PAA Dose of 2 mg/l EC criteria met consistently at 30 minutes
- Higher PAA Ct for EC compared to FC - expected results
- EC at TI appears more resistant to PAA especially at low dose (< 1.0 mg/l)

26 W Effluent - Chlorine

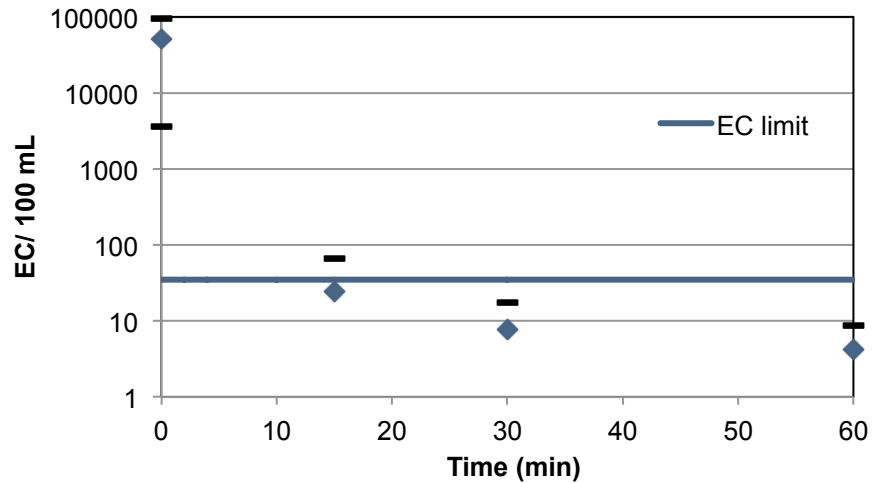
Average EC 1 mg/L Chlorine (8)



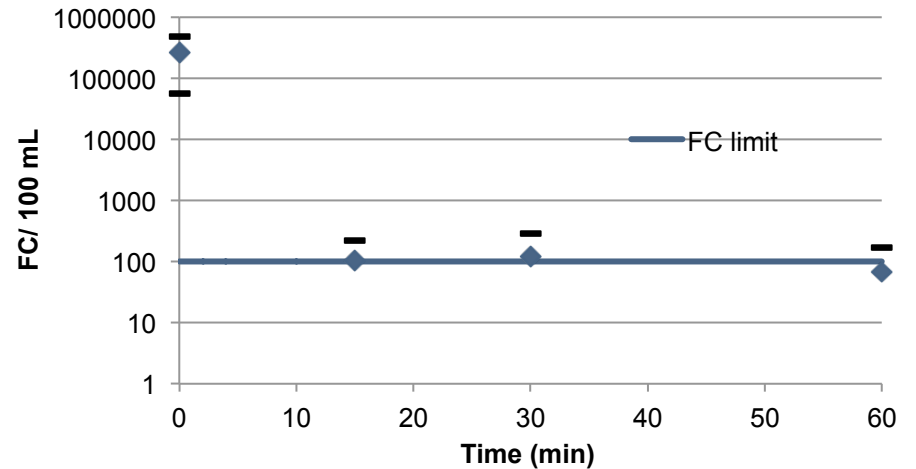
Average FC 1 mg/L Chlorine (8)



Average EC 2 mg/L Chlorine (8)

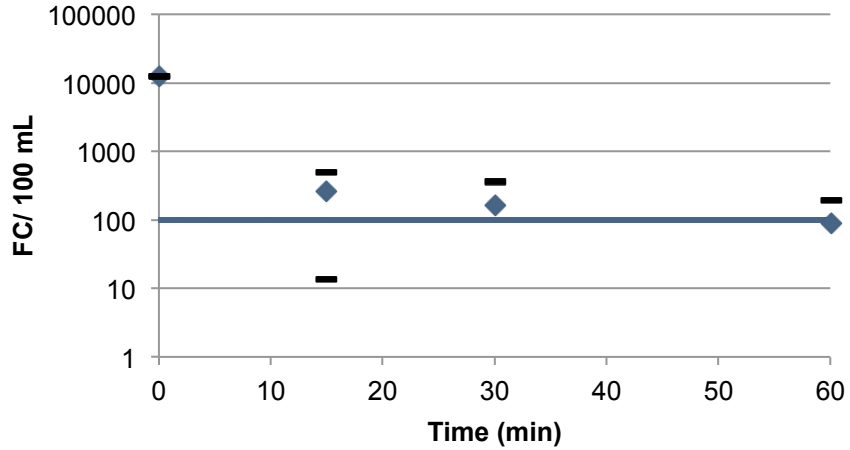


Average FC 2 mg/L Chlorine (8)

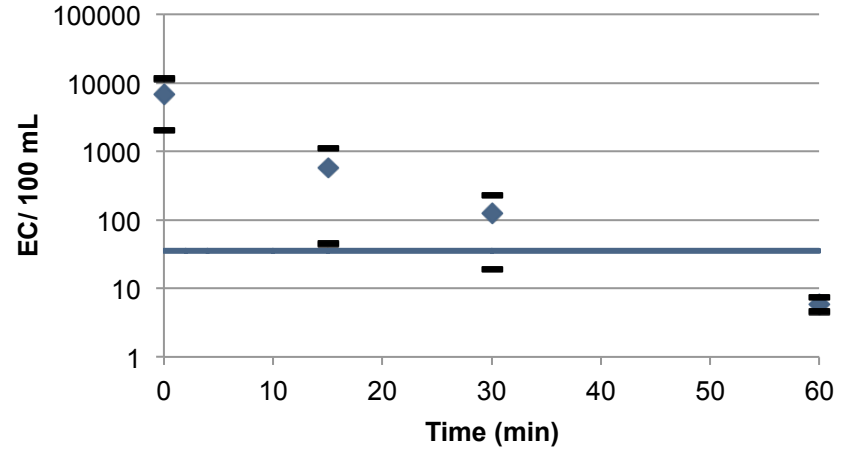


26 W Effluent PAA

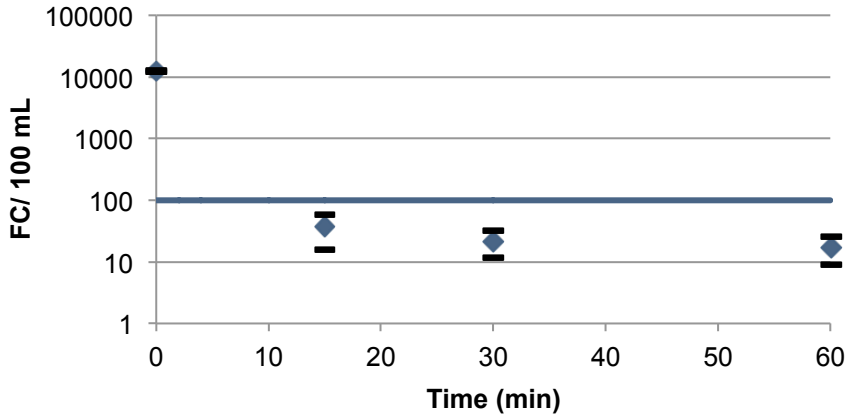
Average FC 1 mg/L PAA (2)



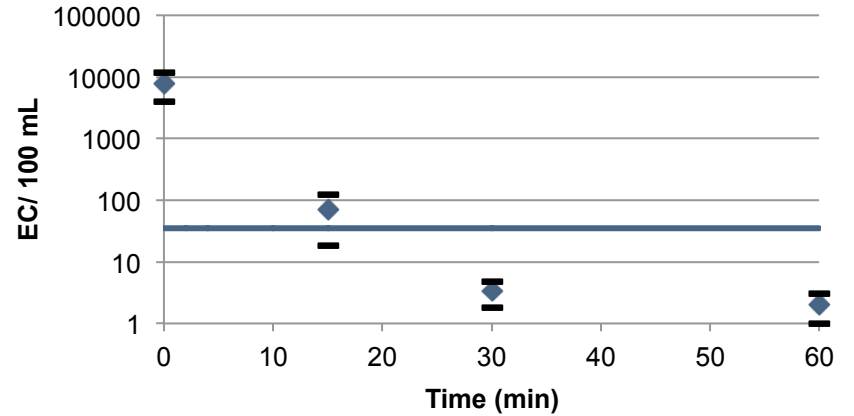
Average EC 1 mg/L PAA (2)



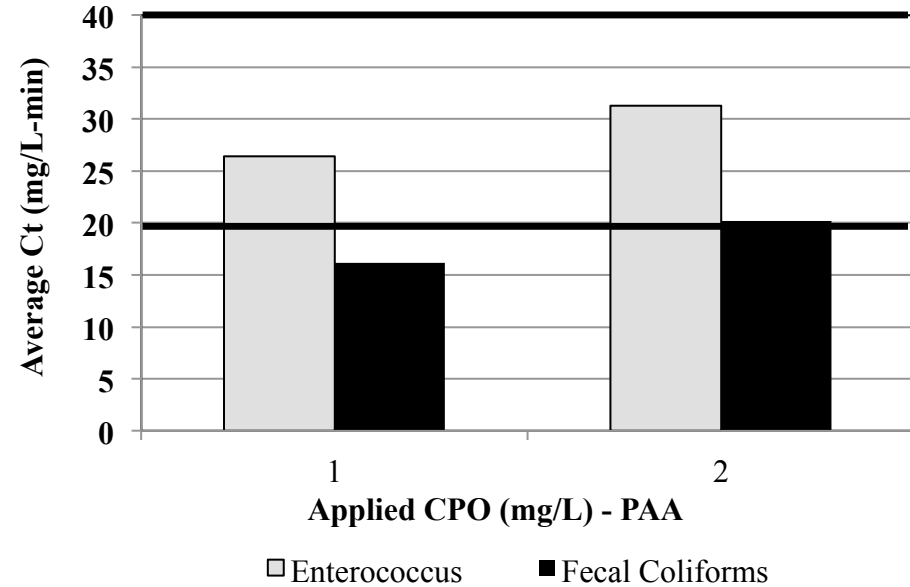
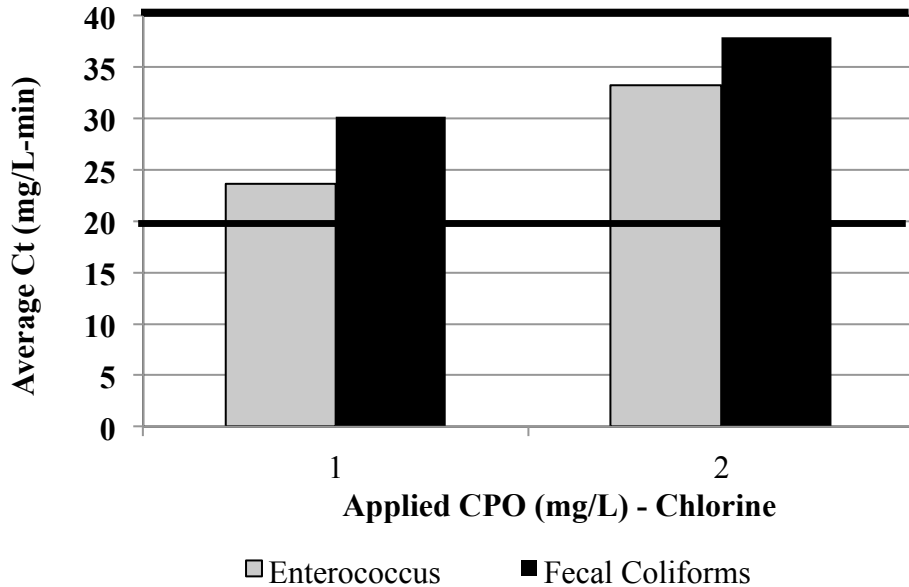
Average FC 2 mg/L PAA (3)



Average EC 2 mg/L PAA (3)



26 W: Effluent Disinfection: Chlorine and PAA



Average Chlorine Ct for Compliance

Ct FC (mg/L=min) =	34
Ct EC (mg/L=min) =	28

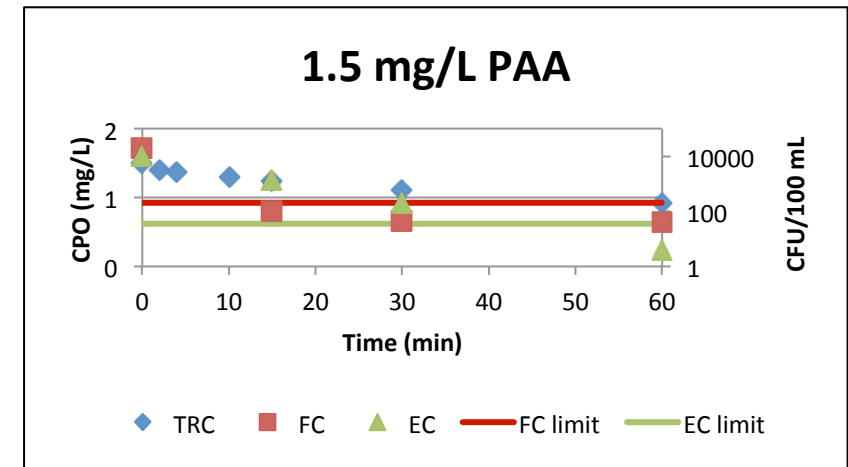
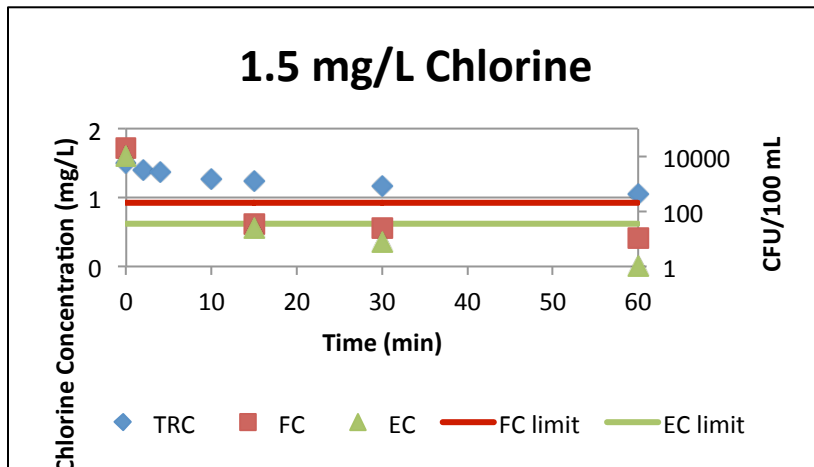
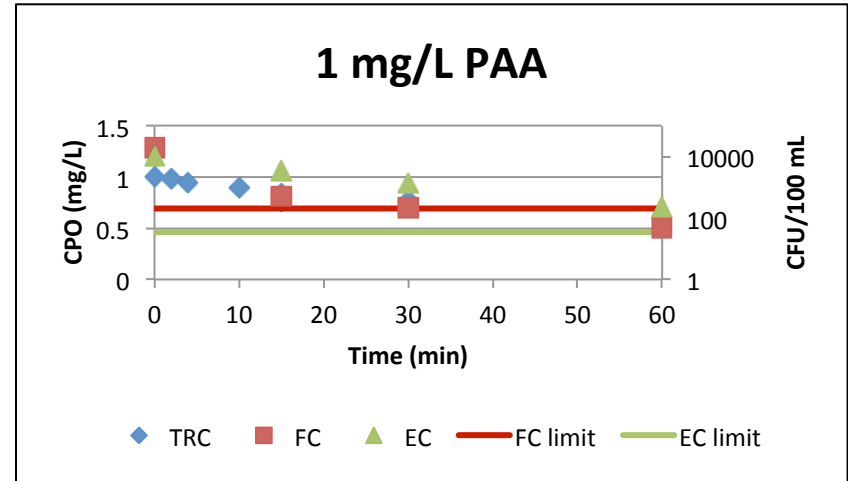
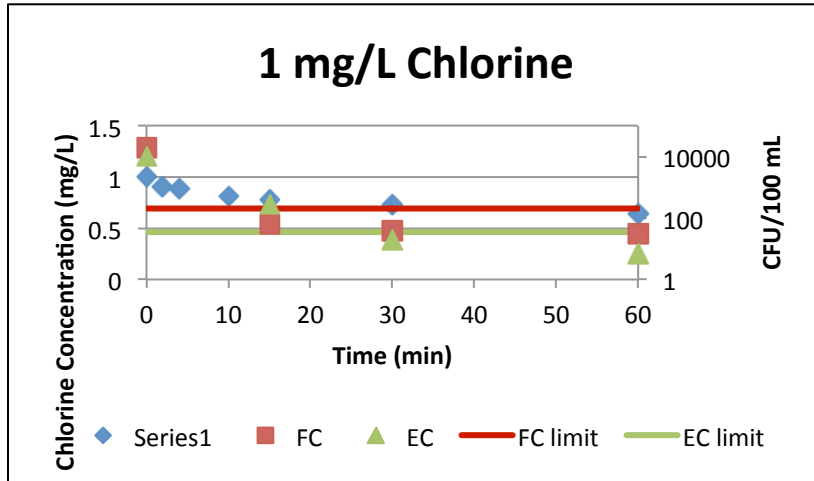
Average PAA Ct for Compliance

Ct FC (mg/L=min) =	18.2
Ct EC (mg/L=min) =	28.8

Results

- Need Chlorine dose >2 mg/l to consistently achieve EC and FC criteria
- Higher PAA Ct for FC compared to EC - Contrary to TI and expected results
- PAA more effective on FC than EC – opposite of chlorine
- PAA of 2 mg/l - EC and FC criteria consistently met
- Higher Chlorine Ct for EC compared to FC - expected result

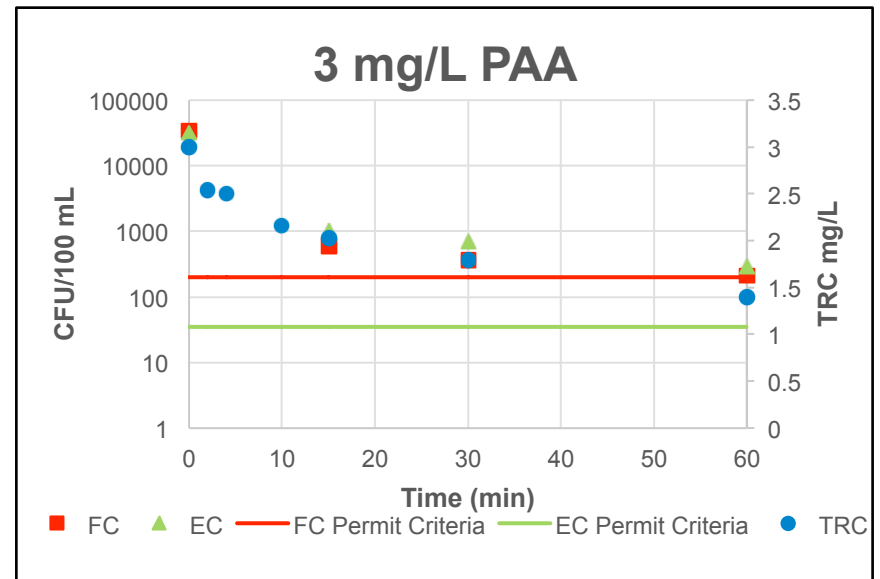
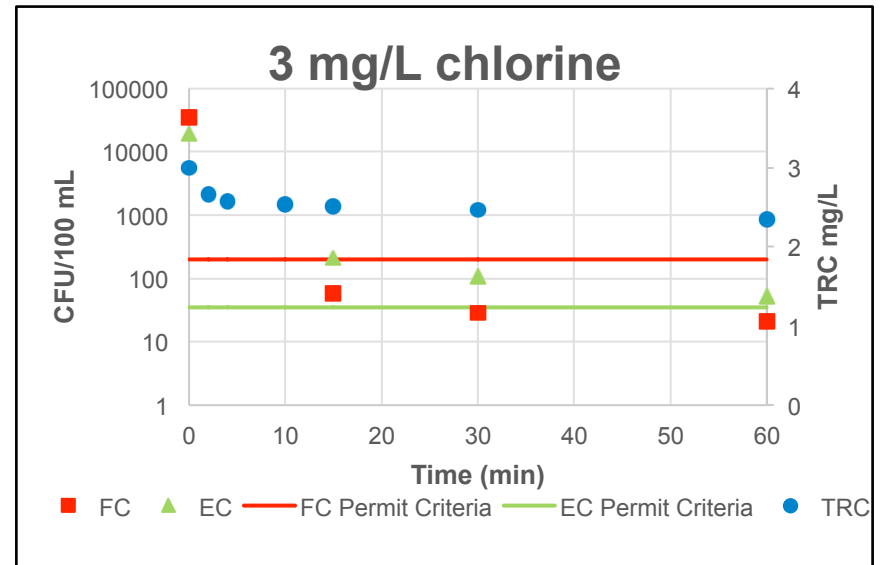
Oakwood Beach Effluent PAA and Chlorine



- Chlorine dose of 1 mg/l can meet both criteria at 30 minutes contact time
- Higher PAA dose or increased Ct is needed for PAA to meet both FC and Enterococci criteria compared to Chlorine

Newtown Creek – Chlorine and PAA

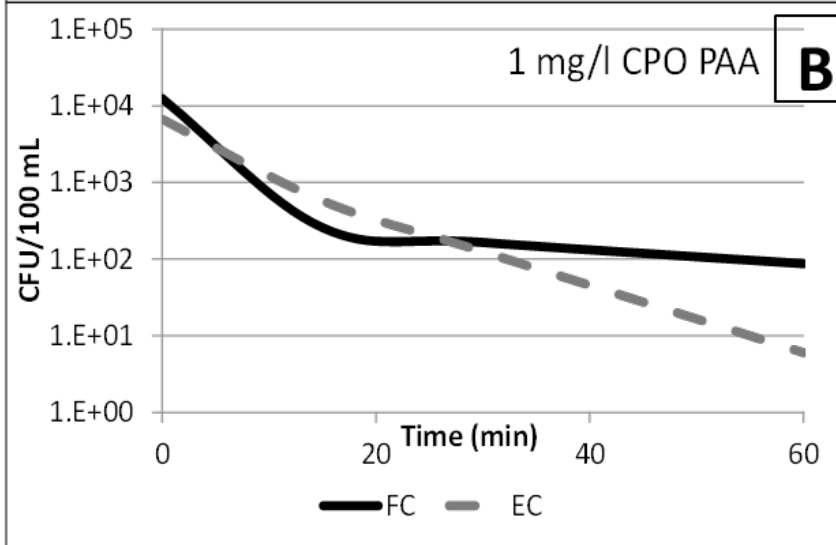
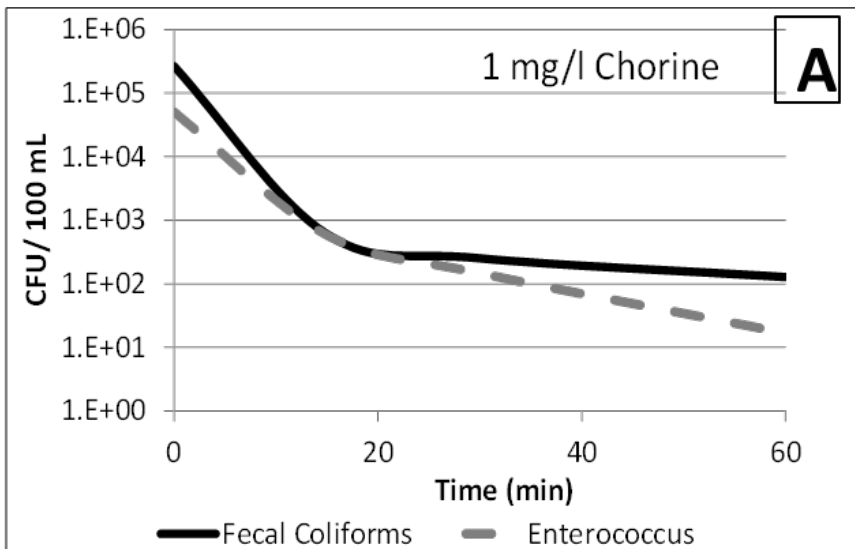
- Chlorine doses of 2, 2.5, and 3 mg/L
- PAA doses of 2.5, 3, 3.5 and 4 mg/L
- Chlorine and PAA are not effective at inactivating FC or EC up to 3.5 mg/L
- PAA never meets FC or EC permit criteria at the doses tested
- Chlorine had a slightly higher initial uptake when compared to PAA, but PAA decayed faster
- Significant PAA decay in NTC effluent, but doesn't meet 1 mg/L criteria
- Newtown Creek has low UVT, increased color, TSS and COD compared to other effluents



Dynamics of EC and FC Inactivation

PAA and Chlorine inactivation
Enterococcus and Fecal Coliforms

- Different inactivation curves/rates for Fecal vs. EC for both PAA and Cl
- Difference in how PAA and Cl inactivate Enterococcus
- At long Cts, chlorine and PAA may appear to be more effective for Enterococcus vs. Fecal Coliforms



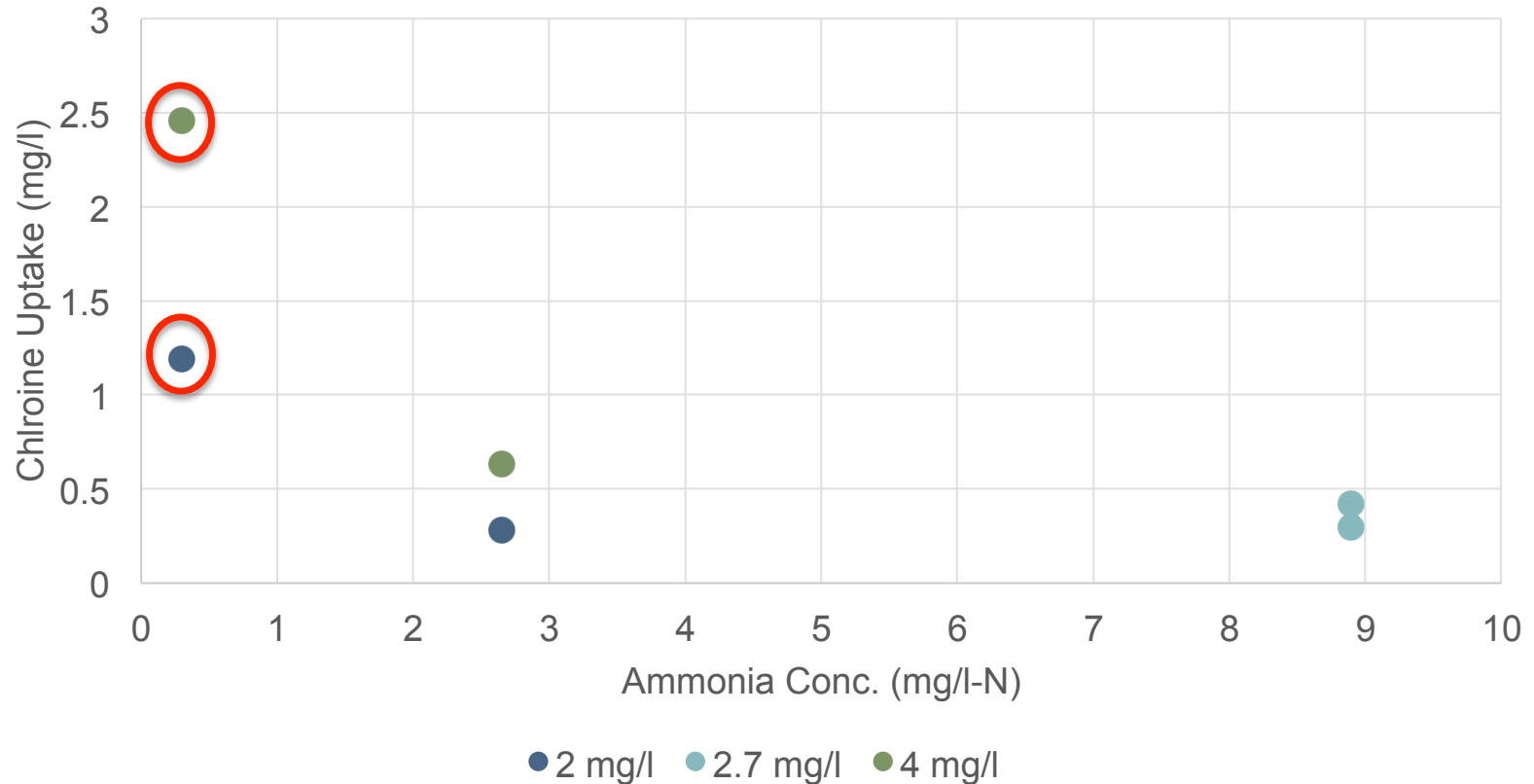
Findings to Date – Effluent Disinfection

- Both chlorine and PAA had variable effectiveness for inactivation of FC and EC for the different plant effluent – site specific
- Higher chlorine Ct needed to meet entero criteria compared to FC
 - 0.5 mg/l increase
- Ct for enterococcus and FC inactivation impacted by initial concentration of [EC] or [FC]
 - Impacted by level of treatment
- Different inactivation dynamics for FC and EC for both chlorine and PAA
- PAA does appear to be less effective at Entero inactivation
 - Higher PAA doses (0.5 – 1.0 mg/l) or longer Ct is needed to be as effective as hypo
- PAA does not typically decay significantly after initial uptake, except for Newtown Creek



Chlorine Uptake Under Low Ammonia Conditions

Chlorine Uptake vs. Ammonia Level



- Chlorine Uptake Impacted by Low Ammonia Concentrations (< 1.0 mg/l) and applied chlorine dose
- Low ammonia can lead to break-point chlorination

Chlorine and Peracetic Acid Uptake and Decay

DI, Secondary Effluent, Hendrix Creek and 1/2 SE/ 1/2 Hendrix Creek

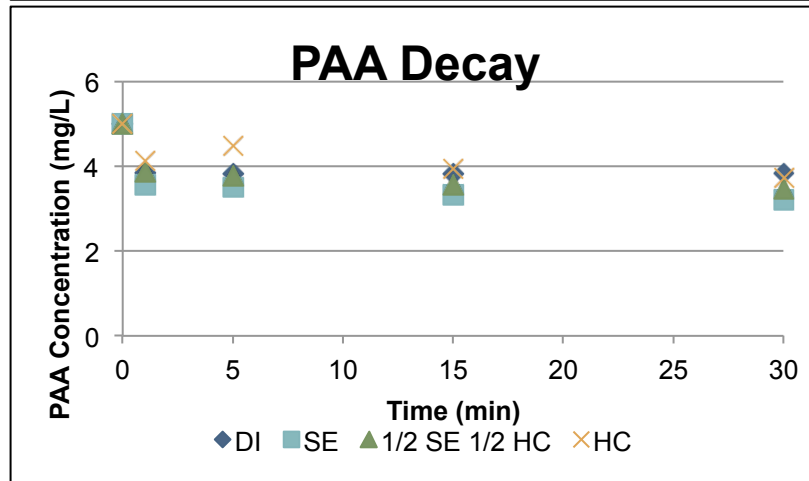
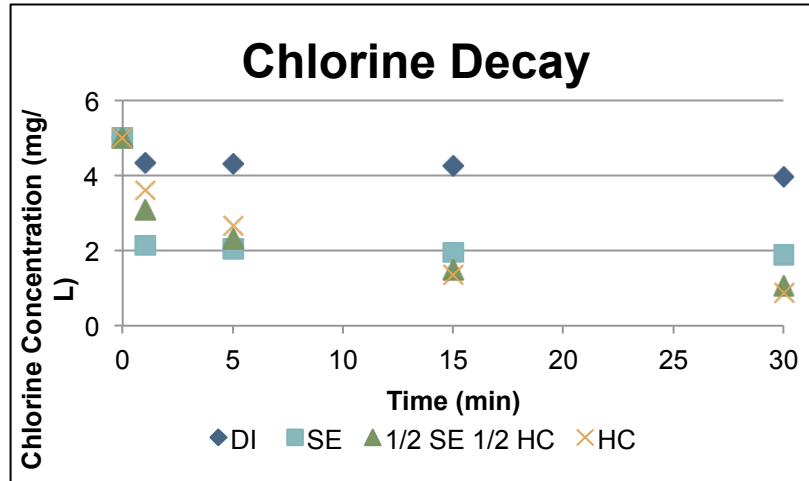
5 mg/l CPO

Hendrix Creek Water Characteristics

Nitrate	0.287
Nitrite	0.123
Ammonia	0.08
COD	823
TSS	7.8
TDS	20,433
pH	7.46

Secondary Effluent Water Characteristics

Nitrate	2.87
Nitrite	0.858
Ammonia	0.353
COD	19.9
TSS	3
pH	6.56



Chlorine

Sample Type	Initial Δ CPO (mg/L)
DI	0.66
SE	2.86
1/2 SE 1/2 HC	1.91
HC	1.4

PAA

Sample Type	Initial Δ CPO (mg/L)
DI	1.15
SE	1.44
1/2 SE 1/2 HC	1.12
HC	0.88

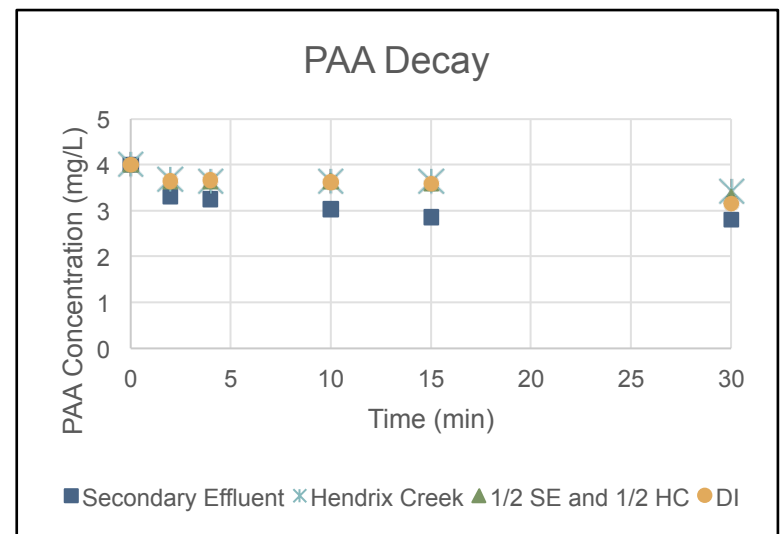
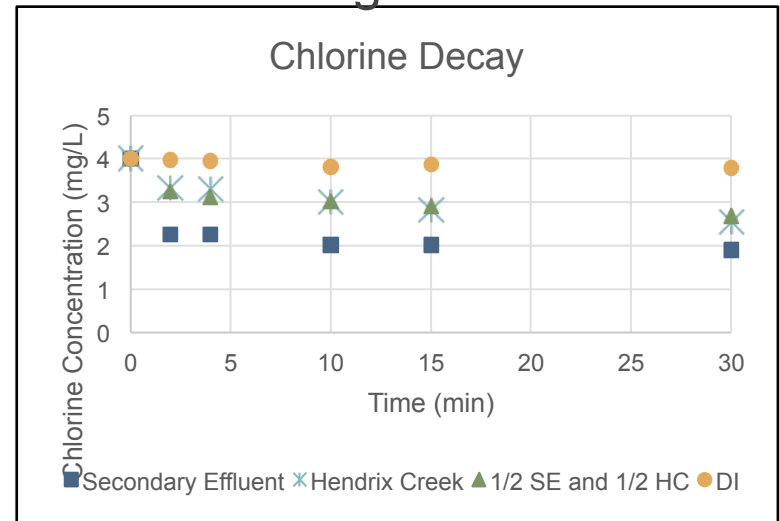
Decay/Degradation of Chlorine-Produced Oxidant (CPO) in Disinfected Hendrix Creek Discharges

- Significant initial uptake for chlorine compare to PAA
- Chlorine continues to decay, where PAA remains the essentially the constant after initial decay
- Greatest uptake and decay in effluent/ HC mix and HC alone

Wastewater	
COD	19.8
Nitrite	0.745
Nitrate	8.21
Ammonia	1.67
TSS	2
pH	6.89

Hendrix Creek	
COD	28
Nitrite	0.2
Nitrate	1.06
Ammonia	0.82
TSS	9.50
pH	6.91

4 mg/l CPO



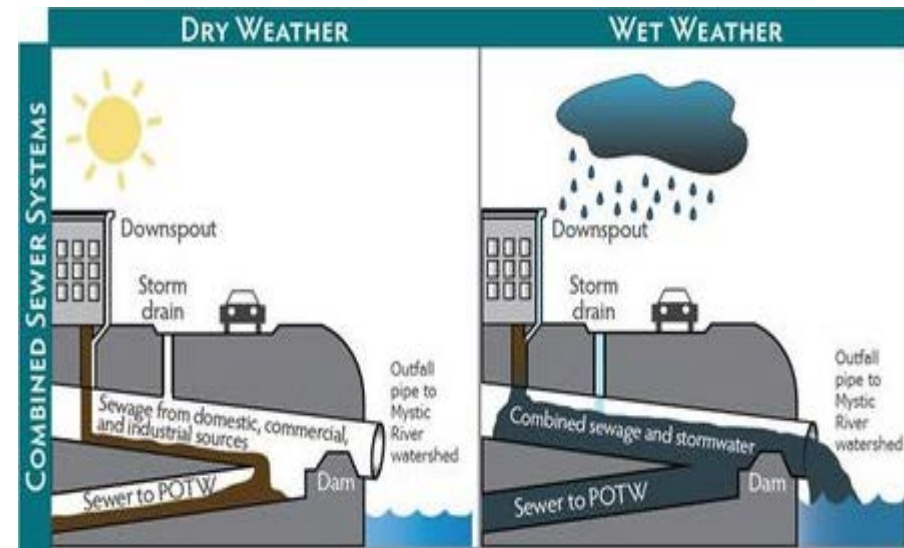
PAA Summary

- Overall PAA was less effective at inactivating FC and EC than chlorine at equivalent CPO applied doses:
 - Approximately 0.5-1.0 mg/l greater dose needed compared to Chlorine
- At 26th Ward PAA consistently performed better at inactivating FC when compared to chlorine
- PAA doesn't appear to have as large an initial uptake, both PAA and chlorine uptake dependent upon effluent quality and dose
- Overall PAA seems to decay slower than chlorine – except Newtown Creek and Wet Weather Samples
- In all cases PAA decay slowed with time and PAA residual did not fully dissipate

CSO Disinfection Sampling

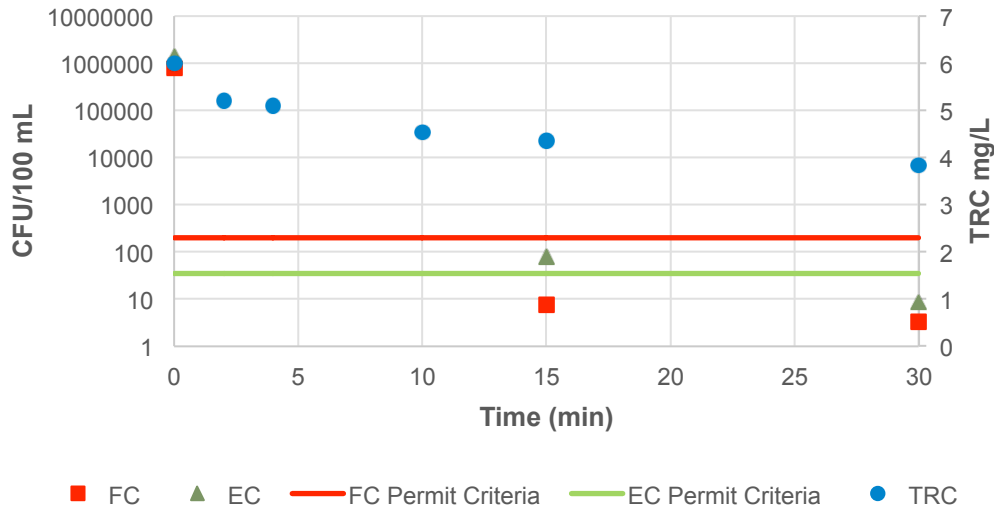
Purpose of this study: to determine whether it is a viable option to disinfect CSO tanks with chlorine or PAA, and to determine how much disinfectant is needed to meet FC and EC criteria

- Primary influent from WWTP
- Batch reactors - one dosed with PAA and one dosed with chlorine
- Chlorine and PAA residuals at 2, 4, 10, 15, and 30 minutes
- Fecal and enterococcus inactivation at 15, and 30 minutes
- Tallman Island and 26th Ward Wet Weather samples



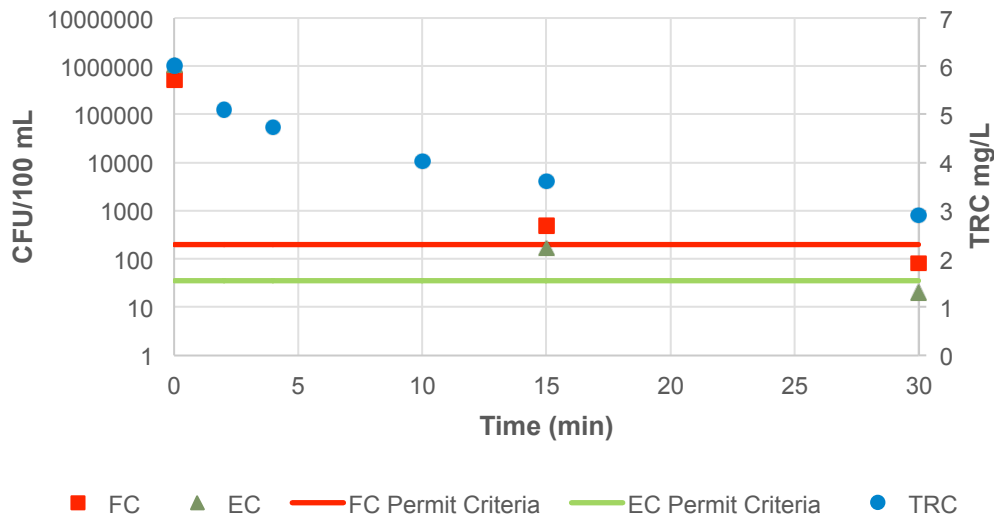
26th Ward Wet Weather

6 mg/L Chlorine



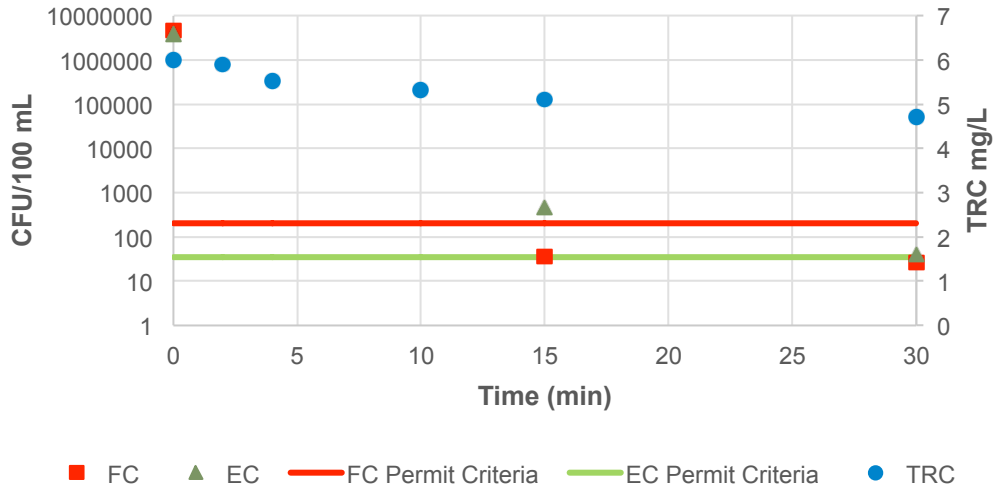
- Chlorine doses of 4,5, 6 and
- PAA doses of 4, 5, 6 and 8 mg/L
- At Cl dose of 6 mg/L FC meets criteria in 15 minutes; EC at 30 minutes
- PAA less effective than chlorine but achieves permit criteria at 30 minutes
- Like Tallman Island, PAA decays faster than chlorine
- The initial uptakes for PAA and chlorine are similar

6 mg/L PAA



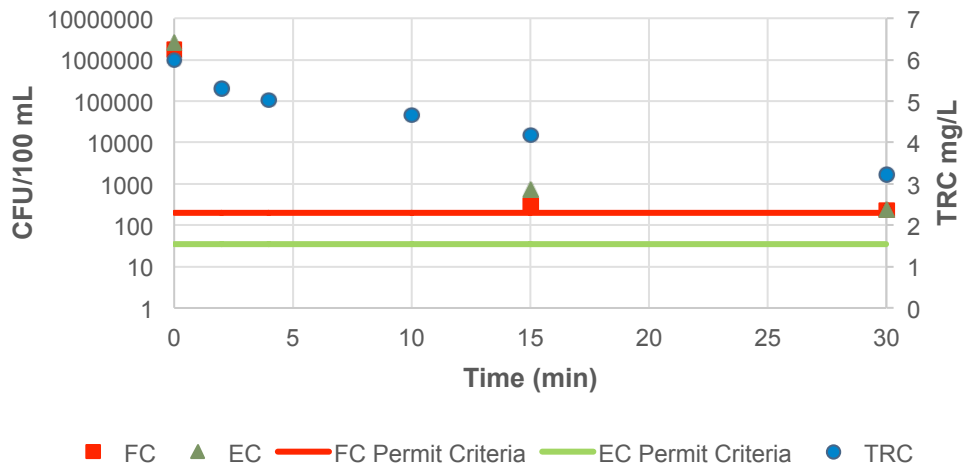
Tallman Island – Wet Weather Surrogate

6 mg/L chlorine



- Chlorine dose - 3, 4, and 6
- PAA dose - 3, 4 and 6 mg/L
- Cl dose 6 mg/L - FC meets criteria at 15 minutes; EC at 30 minutes
- PAA had higher initial uptake and decay rate than chlorine
- Higher dose of PAA (> 6.0 mg/L) needed to meet both FC and EC criteria

6 mg/L PAA



Wet Weather PAA and Chlorine Summary

- Chlorine doses of ~ 6 mg/l can meet both FC and EC criteria in 30 minute contact time for most W/W events
- PAA had higher initial uptake and more rapid decay than chlorine
- PAA was less effective at inactivating FC and EC than chlorine
- 26th Ward wet weather - PAA dose of 6 mg/L effective at reaching both FC and EC permit criteria by 30 min
- For Tallman Island a PAA dose > 6.0 mg/l needed to meet both FC and EC criteria at 30 minute contact time
- On-going testing to determine needed dose to meet criteria in 15 minute contact time

Acknowledgements

NYC DEP

- Oakwood Beach Plant Staff
- Newtown Creek Plant Staff
- Tallman Island Plant Staff
- 26th Ward Plant Staff

- Xiao Lin
- Derrick Caponigro
- Erin McGovern



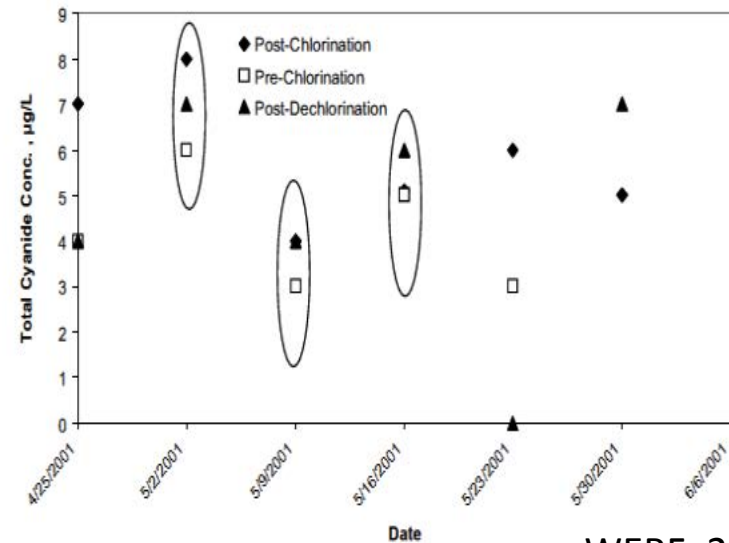
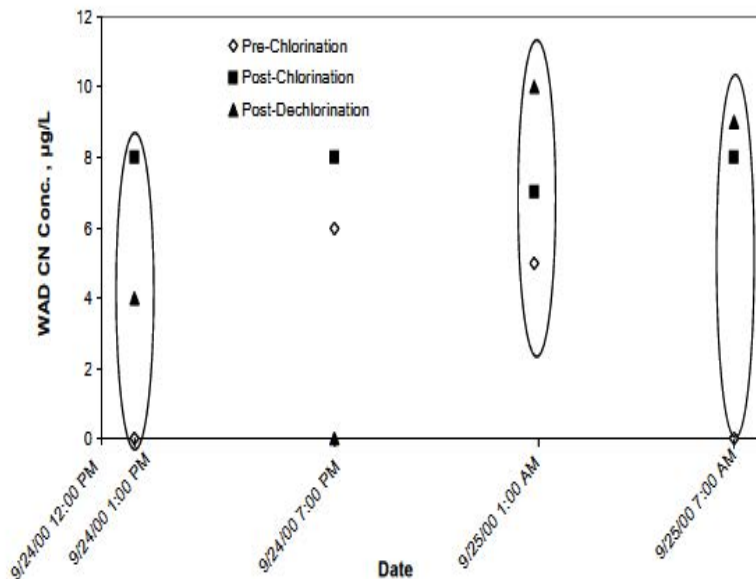
Free Cyanide Limits

- Possible compliance issues at 8-9 plants depending on percent of total cyanide measured as available cyanide
 - No issues with previous total cyanide permit limits
 - No significant cyanide in raw wastewater at any WWTPs
- New analytical method being implemented at DEP labs
- PVSC study showed site specific available cyanide for marine waters is 2.7 x greater than current WQS
- Highlighted plants have possible issue with Avail. CN limit – confirm with monitoring to find % of total cyanide that is available.

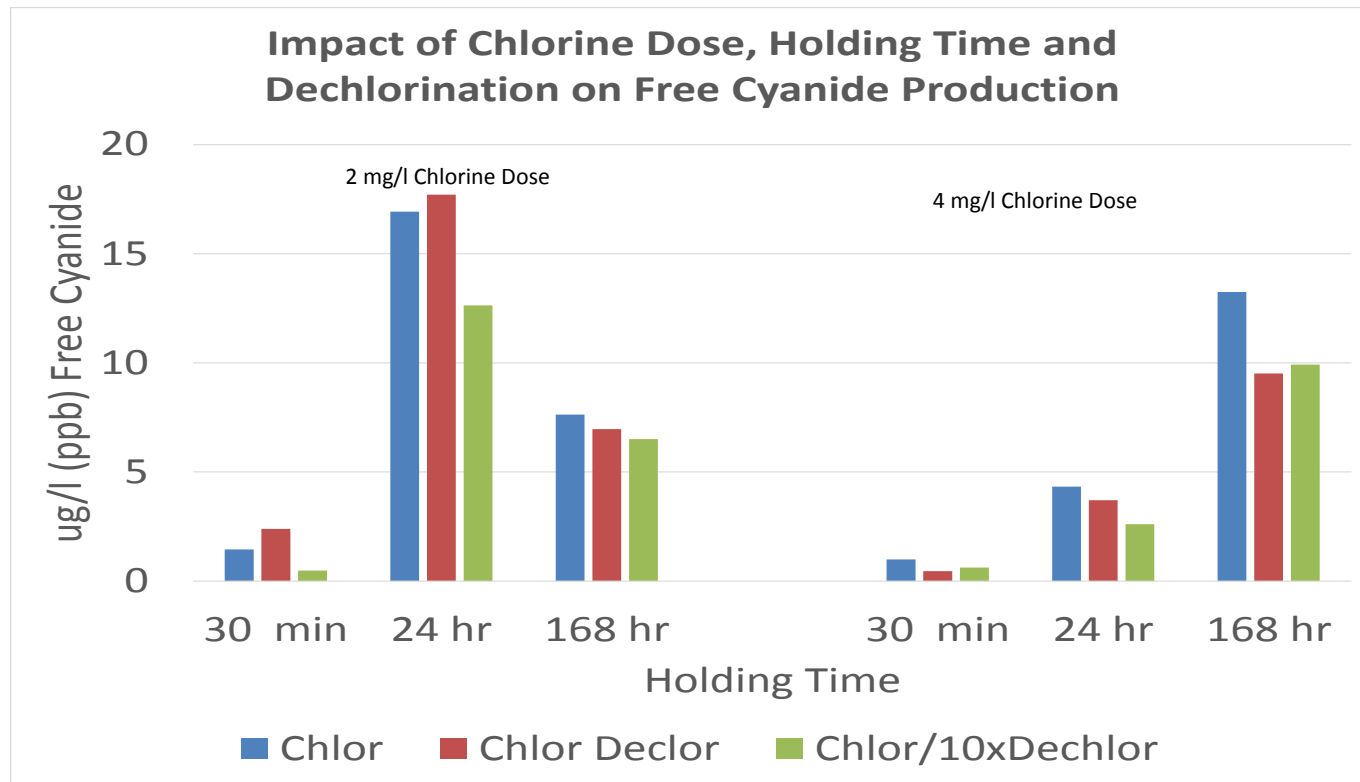
Plant	Avail. Cyanide (lbs/day)
26th Ward	0.92
Bowery Bay	13
Coney Island	10
Hunts Point	19
Jamaica	6.8
Newtown Creek	11
North River	11
Oakwood Beach	6.4
Owls Head	15
Port Richmond	3.2
Red Hook	30
Rockaway	3.5
Tallman Island	2.1
Wards Island	15

New limit - potential issues at numerous WWTPs

- Impacted by disinfection and dechlorination
- Need to implement new analytical method and collect data per Compliance Schedule
- Possible Relief with Site Specific Salt Water Criteria
 - Need DEC on board with salt water CN criteria



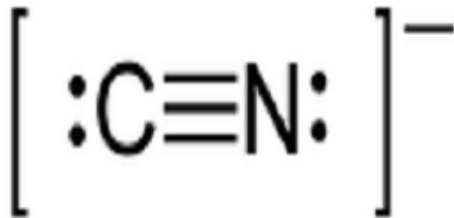
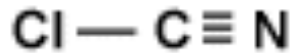
Free Cyanide Formation During Disinfection



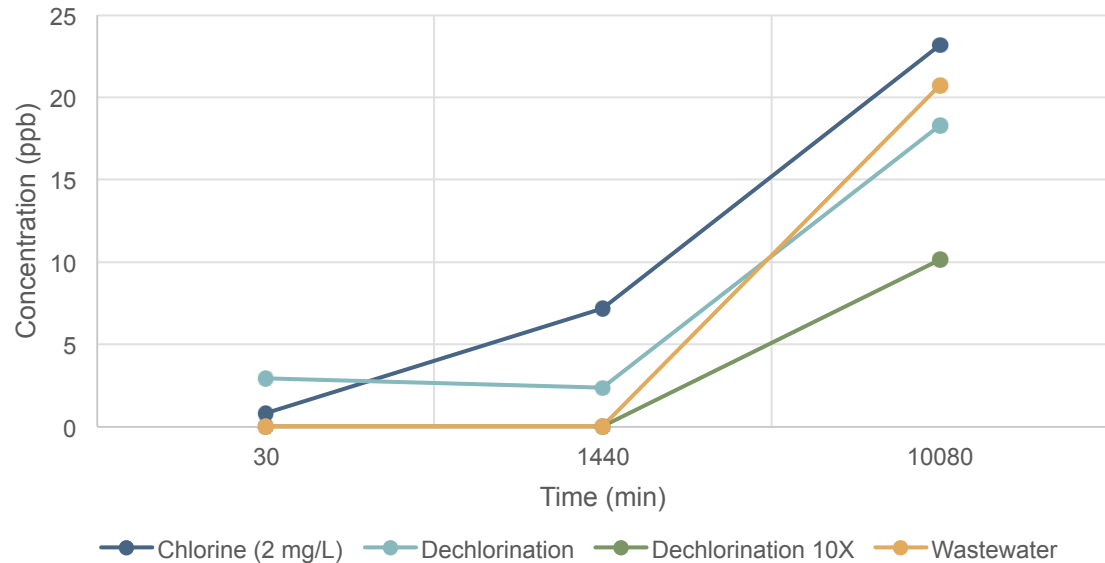
- Without preservation there is no significant cyanide in samples at any holding times with or without dechlor
- No significant cyanide produced in 30 minute contact time
- Lower Chlorine Doses appear to result in higher cyanide levels
- High dechlor doses appears to impact measured cyanide levels
- Preservation and holding times impact on measured cyanide

Cyanide Formation Studies

Cyanogen Chloride
(CK)



Cyanide Production With Preservation



- Essentially Non-detect free-cyanide in most chlorinated effluent samples
- Cyanide concentration increases over time in preserved samples

Average TI plant data 2015

TSS: 11.0 mg/L

TRC: 0.428 mg/L

UVT: 76.4 %

Average OB plant data 2015

TSS: 8.0 mg/L

TRC: 0.801 mg/L

UVT: 68.3 %

Average 26 Ward plant data 2015

TSS: 6.0 mg/L

TRC: 0.596 mg/L

UVT: 75.6%

Average NTC plant data 2015

TSS: 11.0 mg/L

TRC: 1.77 mg/L

UVT: 55.0 %