PHARMACEUTICAL WATER PRE-TREATMENT FOR USE IN FISH HATCHERIES

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INTRODUCTION

Fresh Water In High Demand –
Municipalities Often Take Priority

Fish Hatcheries Are Large Users

Applications For WWTP Effluent Are Possible

WWTP Effluent Poses Risks - Nutrient Limits - PPCPs

What Are Safe Limits For Constituents?

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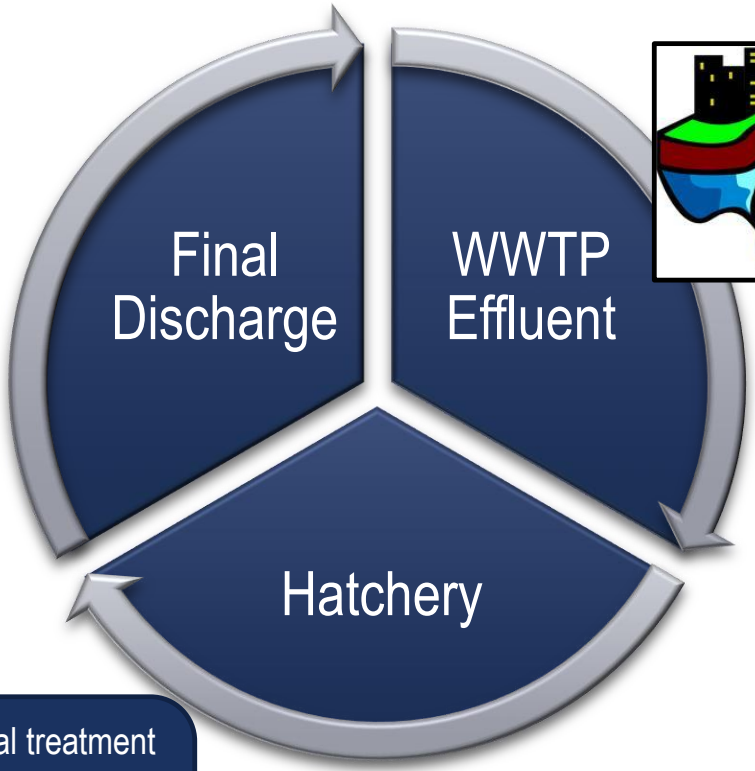
REUSE WATER FOR FISH HATCHERIES



- Macronutrients
- Pathogen vectors
- Bio-active Organics

Will additional treatment be required to prevent deleterious effects to growth and reproduction?

PRESENTATION AGENDA

PPCPs

Fish Accumulation

Biological Effects

WWTP Removal Effectiveness

Conclusion

PPCPS

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS

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PPCPS

- Over 3,000 different chemicals in wastewater
- Can enter wastewater directly or indirectly
- Each chemical has different characteristics

MANY CLASSES OF PPCPS

Pharmaceuticals

- Endocrine disrupters
- Neuro-receptors
- Steroids

Personal Care Products

- Sunscreens
- Perfumes

FISH ACCUMULATION

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PPCP ACCUMULATION IN FISH NOT DOCUMENTED UNTIL RECENTLY

Main challenge is difference in uptake

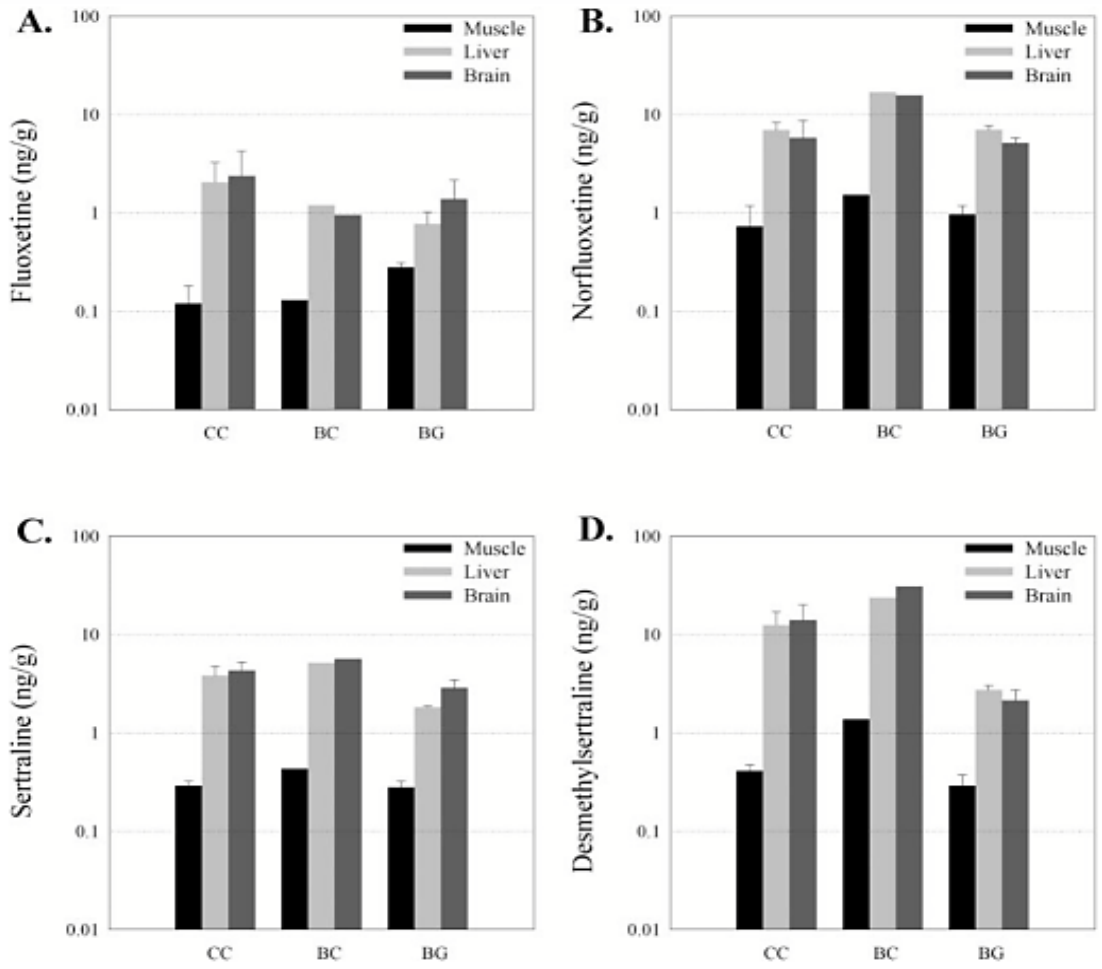
Mammals through liver

Fish uptake through gills and directly into bloodstream, so much more sensitive

FISH ACCUMULATION STUDIES SUMMARY

- PPCPs can bioaccumulate in fish species downstream of WWTPs
- SSRIs are of considerable concern
- Higher treatment processes appear to reduce bioaccumulation

CONCENTRATIONS OF SELECT SSRI IN FISH EXPOSED TO WASTEWATER FOR 3 SPECIES



CC = Channel Catfish

BC = Black Crappie

BG = Bluegill

(Brooks et al., 2005)


BIOLOGICAL
EFFECTS
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BIOLOGICAL EFFECTS: QUESTIONS TO DETERMINE HATCHERY LIMITS:

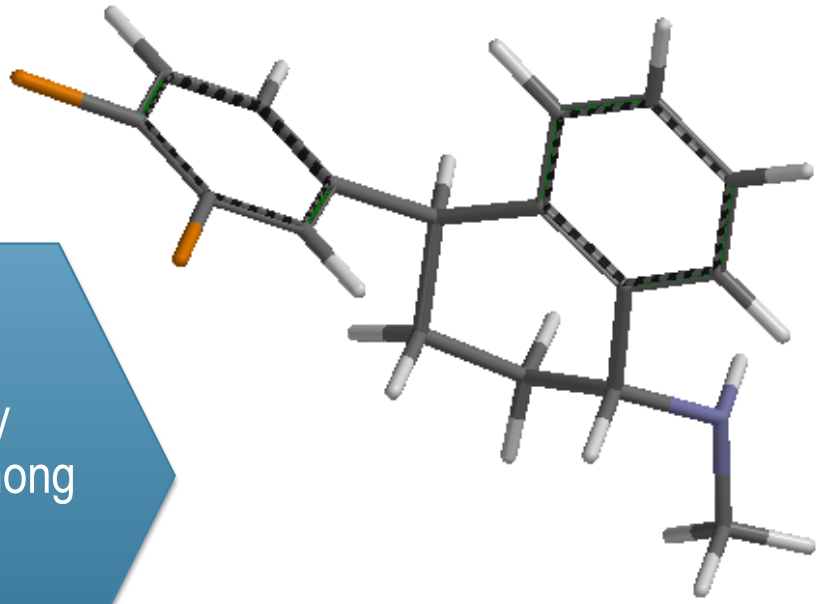
- What constituents cause consumption concern?
- What constituents cause fish reproductive or biological effects?
- What constituents have available data?

BIOLOGICAL EFFECTS OF SSRIS (ZOLOFT, LUSTRAL)

Documented biological fish effects

Commonly measured among studies

Appears to follow treatment level versus removal, with highest disparity between advanced and basic treatment methods



BIOLOGICAL EFFECTS

Jamieson, 1995

- Reduced nest guarding behavior to fish exposed to sertraline and other SSRIs

Black et al., 2005

- Other SSRIs such as fluoxetine reduce viability to some degree in concentrations as low as 1 ng/l

Anti-depressants such as venlafaxine

- Likely also cause adverse effects

BIOLOGICAL EFFECTS - VALENTI (2012)

- Experimented on fathead minnows
- Mean water concentrations of 5-25 ng/l of sertraline resulted in tissue concentrations of 500-2500 ng/l
- Water concentrations as low as 3 ng/l resulted in reduced shelter-seeking behavior

BIOLOGICAL EFFECTS

Estrogenics

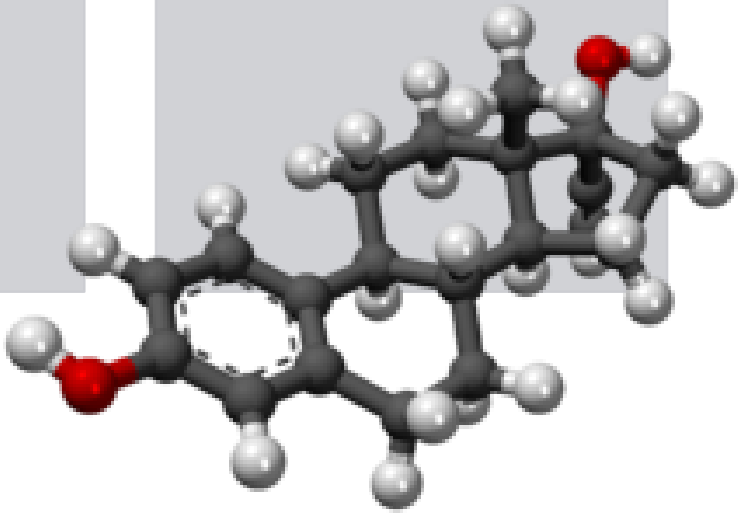
- Metabolized birth control compounds (ethynylestradiol)
- Documented fish effects
  - Reduced viability
  - Higher F:M ratios (may double)

Purdom et al., 1994

- Trout effects from ethynylestradiol concentrations as low as 10 ng/l

Routledge et al., 1998

- Trout effects at concentrations from 25-40 ng/l



BIOLOGICAL EFFECTS SUMMARY

Relative lack of studies of other PPCPs affecting fish

Fish effects documented by SSRIs and estrogenics

- Sertraline: 1 ng/l
- Ethynylestradiol: 10 ng/l
- Functional groups have similar effects at similar dosages

WWTP REMOVAL EFFECTIVENESS

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STAGES OF WASTEWATER TREATMENT

Primary Treatment

- Removes 50% of solids, 25% of BOD
- Primary clarification

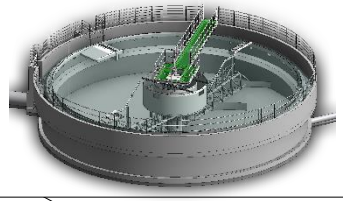
Secondary Treatment

- Required for all public WWTPs, consists of biological treatment
- Trickling filters, aeration basins, MBRs, etc.
- Removes up to 85% of BOD

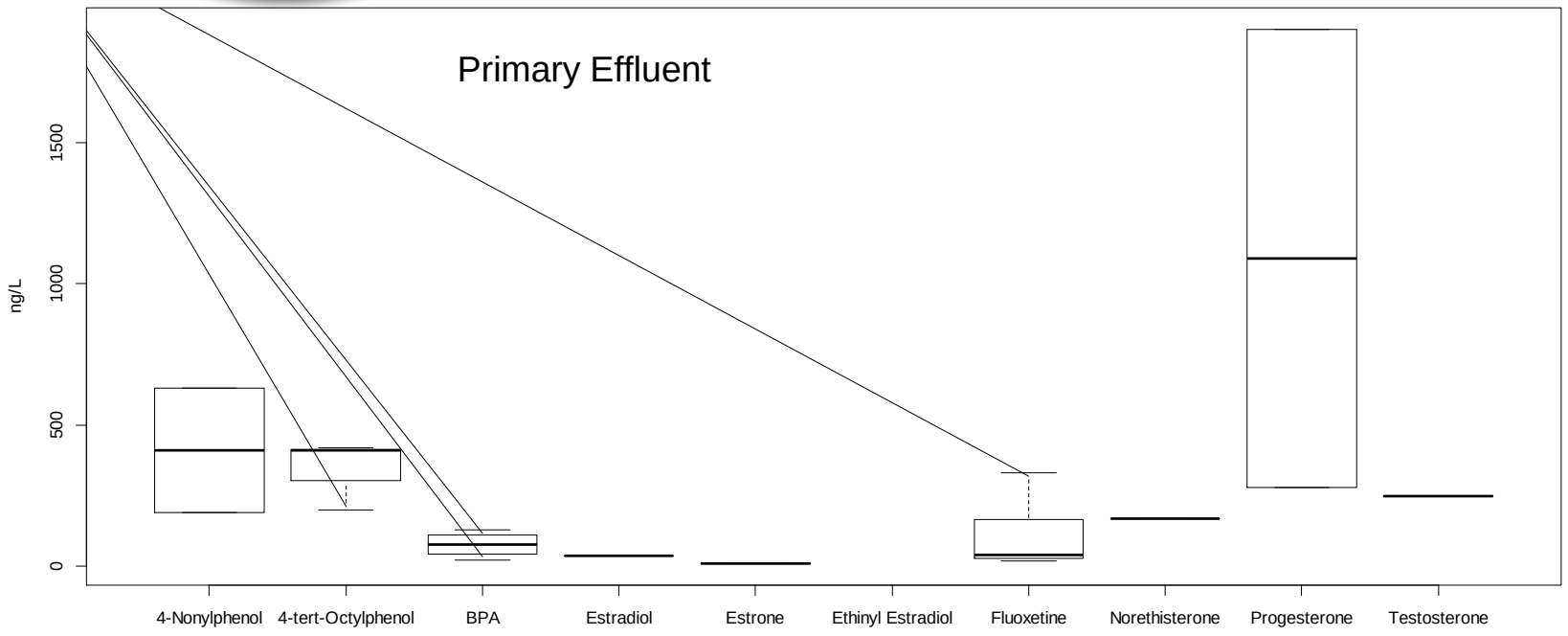
Tertiary Treatment

- Emphasis typically on more stringent discharge limits such as phosphorous or nitrogen
- Denitrification filters, sand filters, cloth media filters, membranes

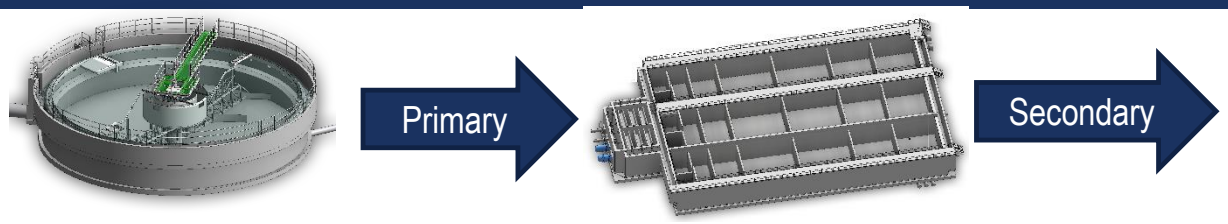
THREE POTW EFFLUENTS FROM TX, AR & OK SAMPLED IN 2014 (PRIMARY)

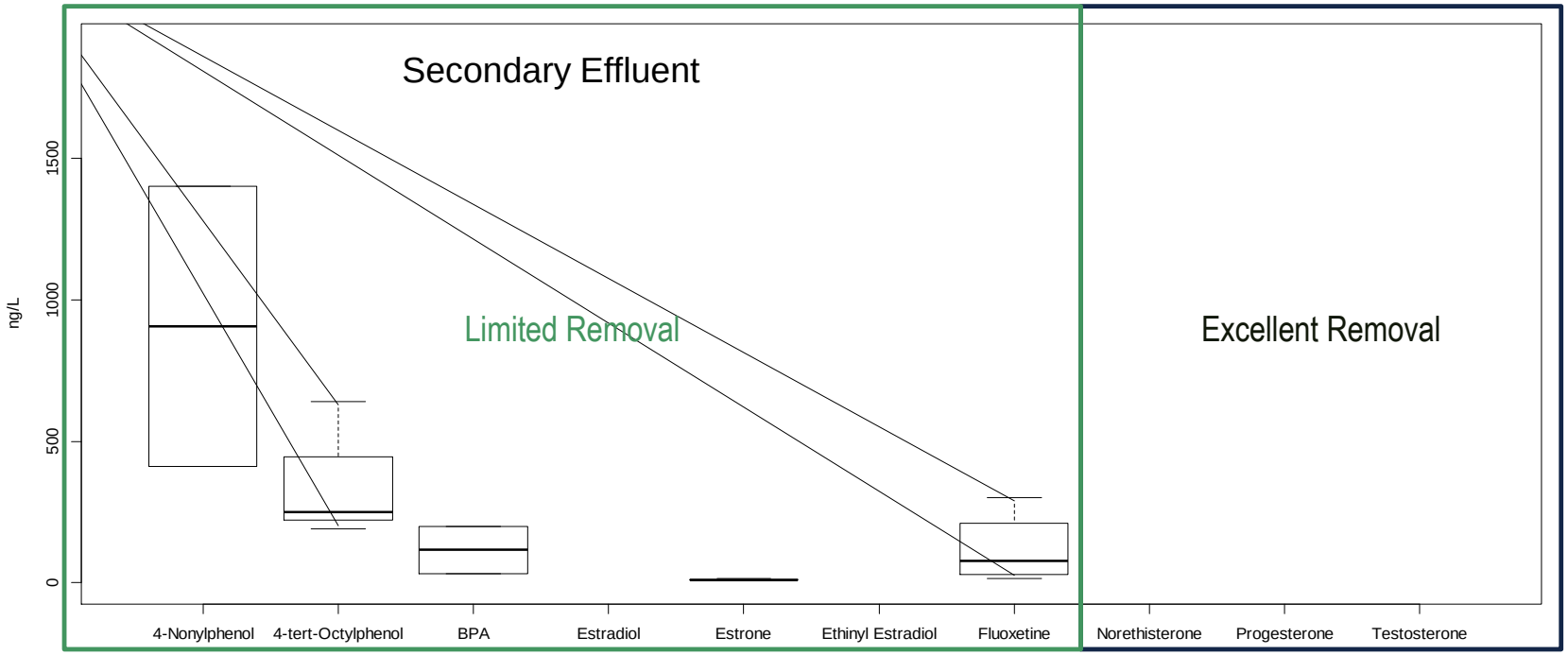


Primary

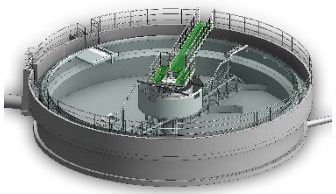


THREE POTW EFFLUENTS FROM TX, AR & OK SAMPLED IN 2014 (SECONDARY)

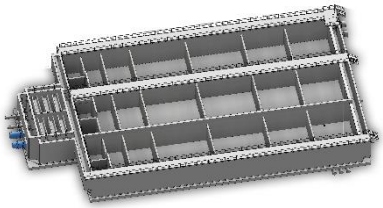




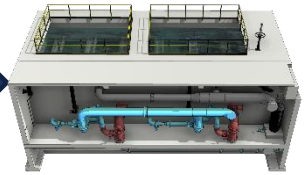
A POTW EFFLUENT FROM OK SAMPLED IN 2014 (GRANULAR MEDIA FILTER EFFLUENT)



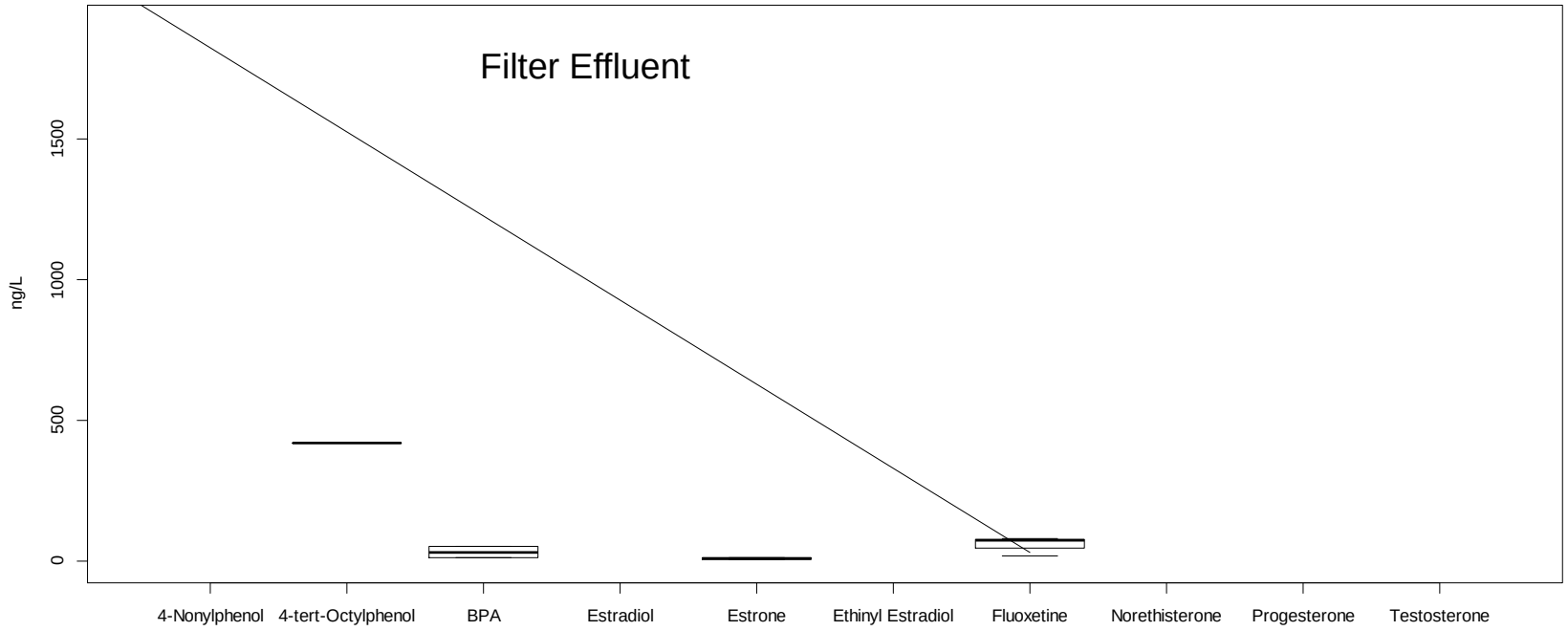
Primary



Secondary



Tertiary



SMALL-FOOTPRINT, ADVANCED TREATMENT PROCESSES FOR MANAGING RESIDUAL PHARMACEUTICALS

Activated Carbon

- Phys-Chem sorption and filtration
- Granular Media (filter beds, pressure filters)
- Powdered Media

Advanced Oxidation

- Ozone
- Peroxide + Ozone

ADVANCED TREATMENT: ACTIVATED CARBON FOR PPCP SORPTION

- Excellent PPCP removal rates across all classes of PPCPs
- Granular media can be regenerated
- Powdered media is typically disposed with other residual solids (clarifier sludge)

ACTIVATED CARBON FILTERS

Effective in gravity-beds or pressure filters

Achieve additional filtration removal

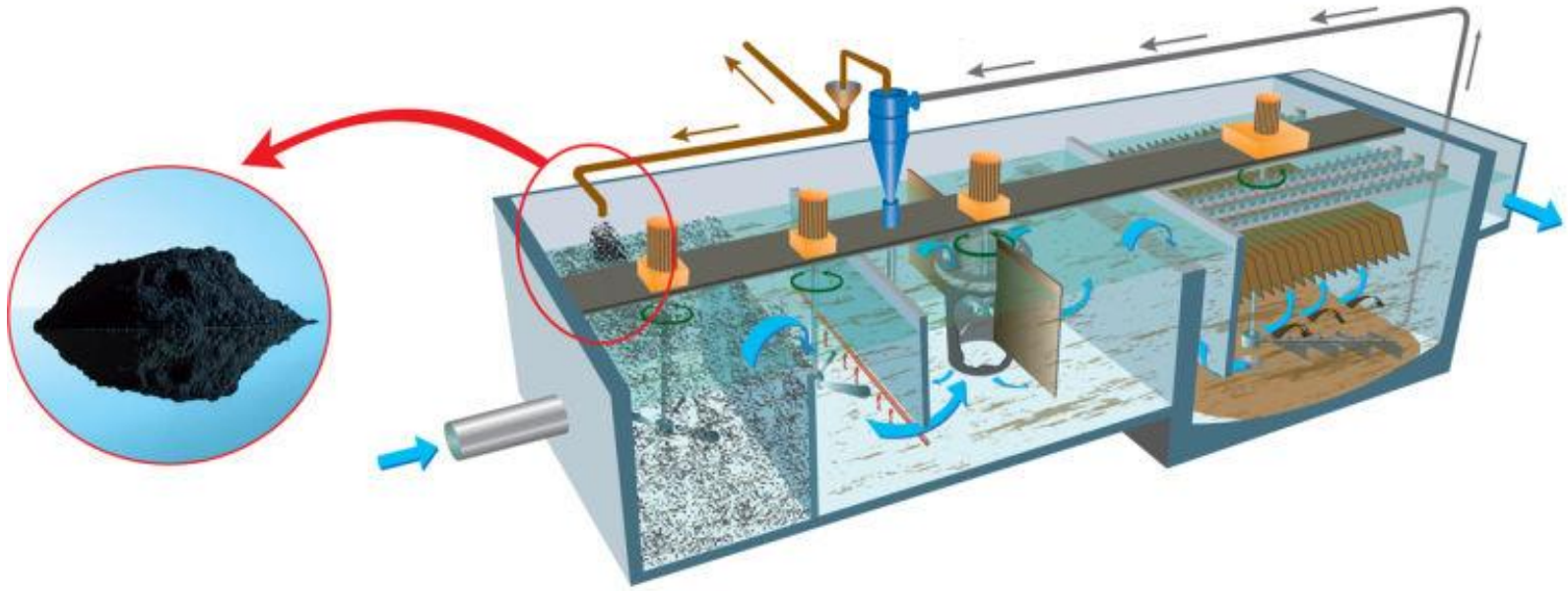
- Turbidity

Removes most organics (not just PPCPs)

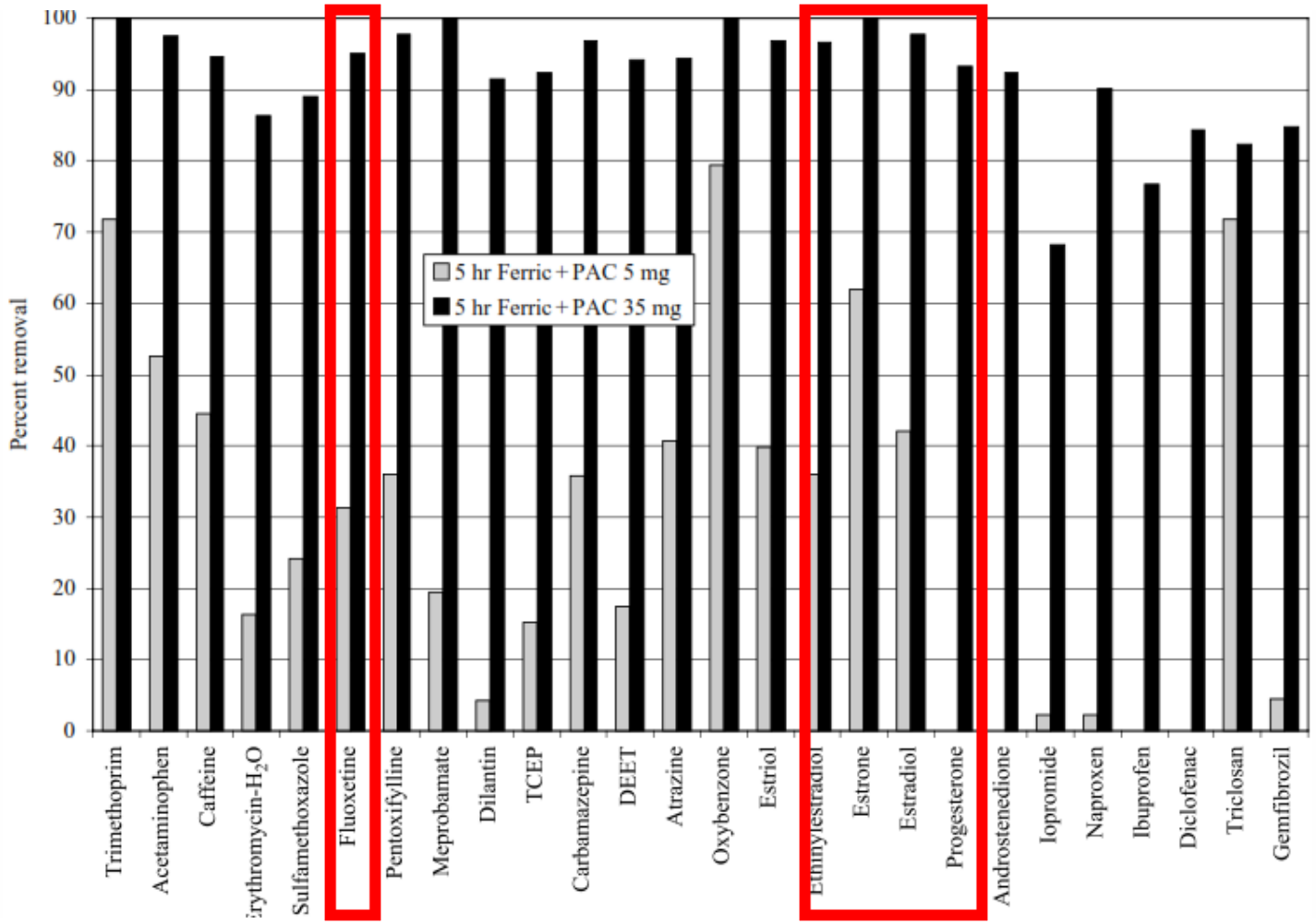
POWDERED ACTIVATED CARBON IN A HIGH-RATE CLARIFIER

Small form factor

- Multi-stage coagulation/flocculation mixing
- Powdered activated carbon injection (some systems offer PAC capture and reuse)



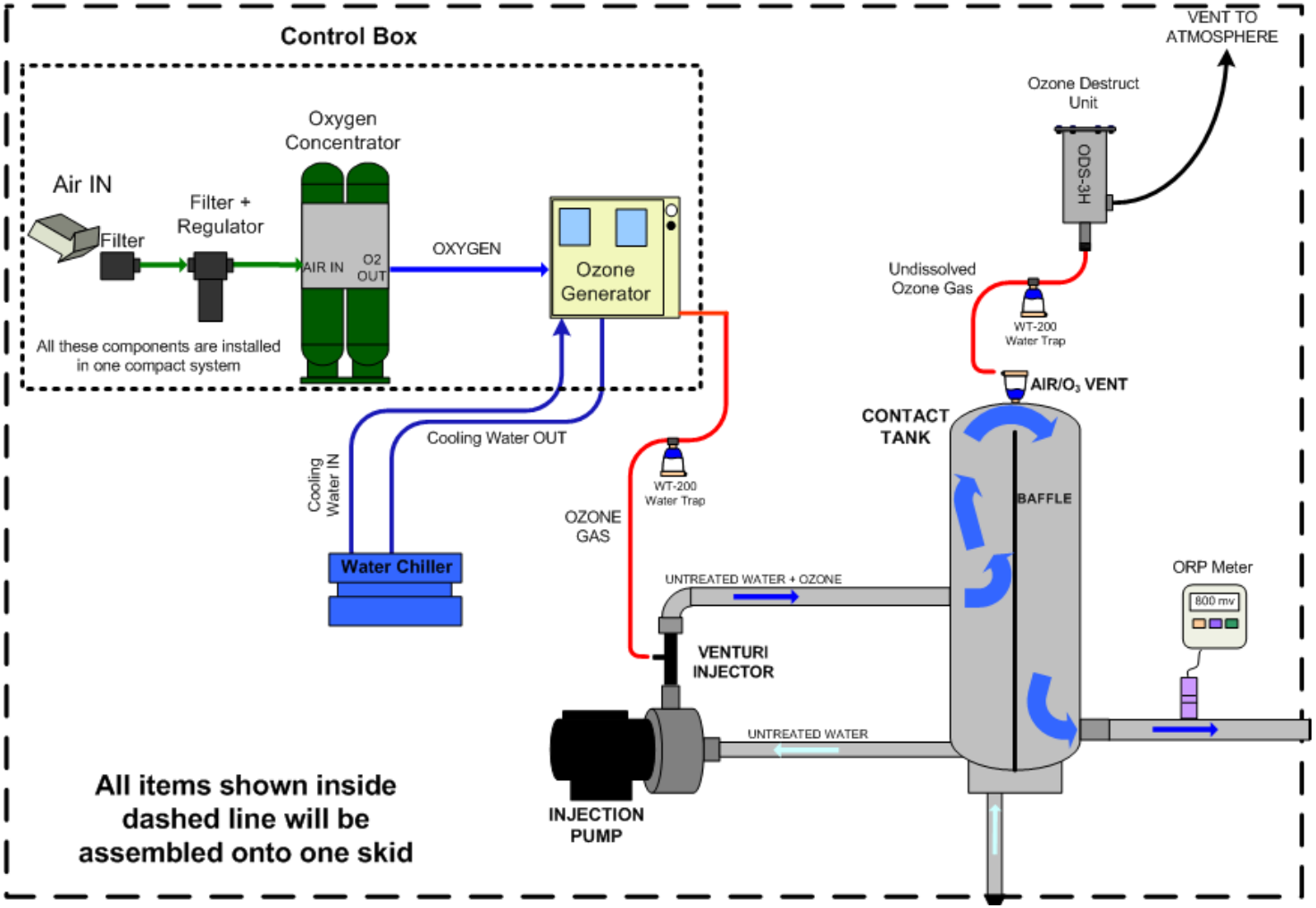
REMOVAL OF PPCPS BY COMBINED COAGULANT AND PAC DOSING



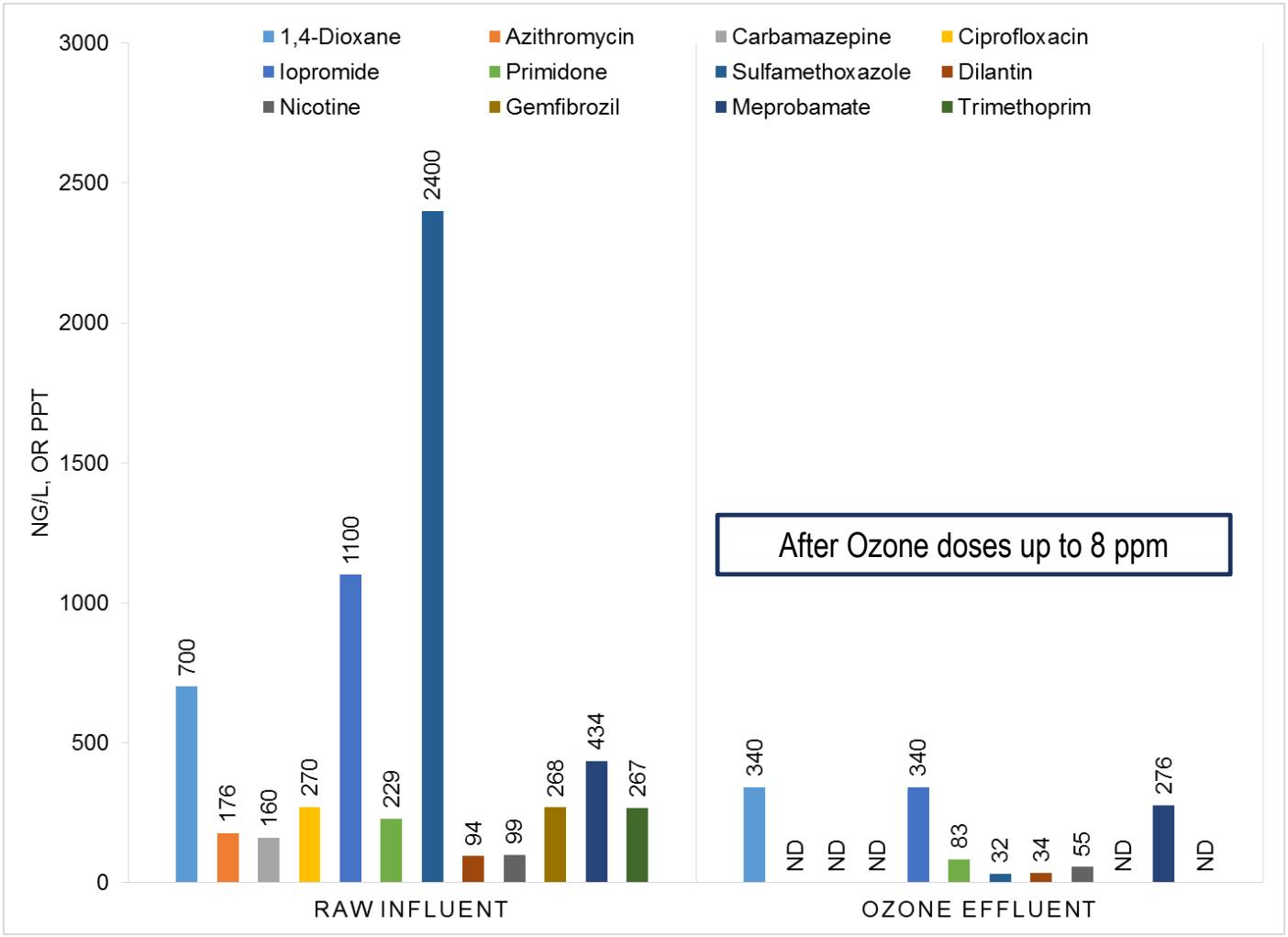
COMPACT, COMPLETE-SYSTEM OZONE SKIDS CAN BE TAILORED TO ANY APPLICATION

600 g O_3/hr Complete Generation/ Injection Skid

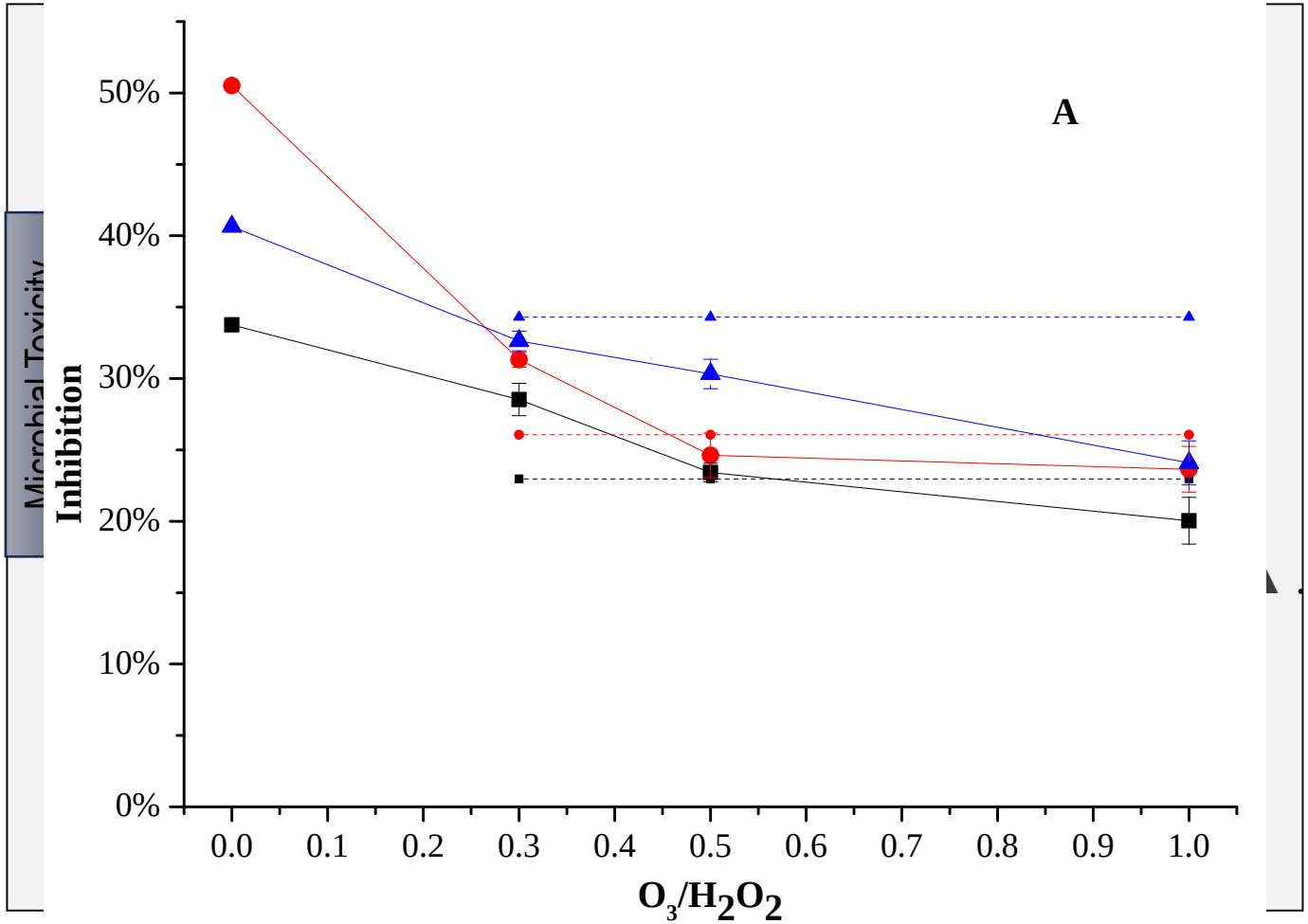
COMPACT, COMPLETE-SYSTEM OZONE SKIDS CAN BE TAILORED TO ANY APPLICATION



EFFECT OF OZONE ON RESIDUAL CECS IN WASTEWATER

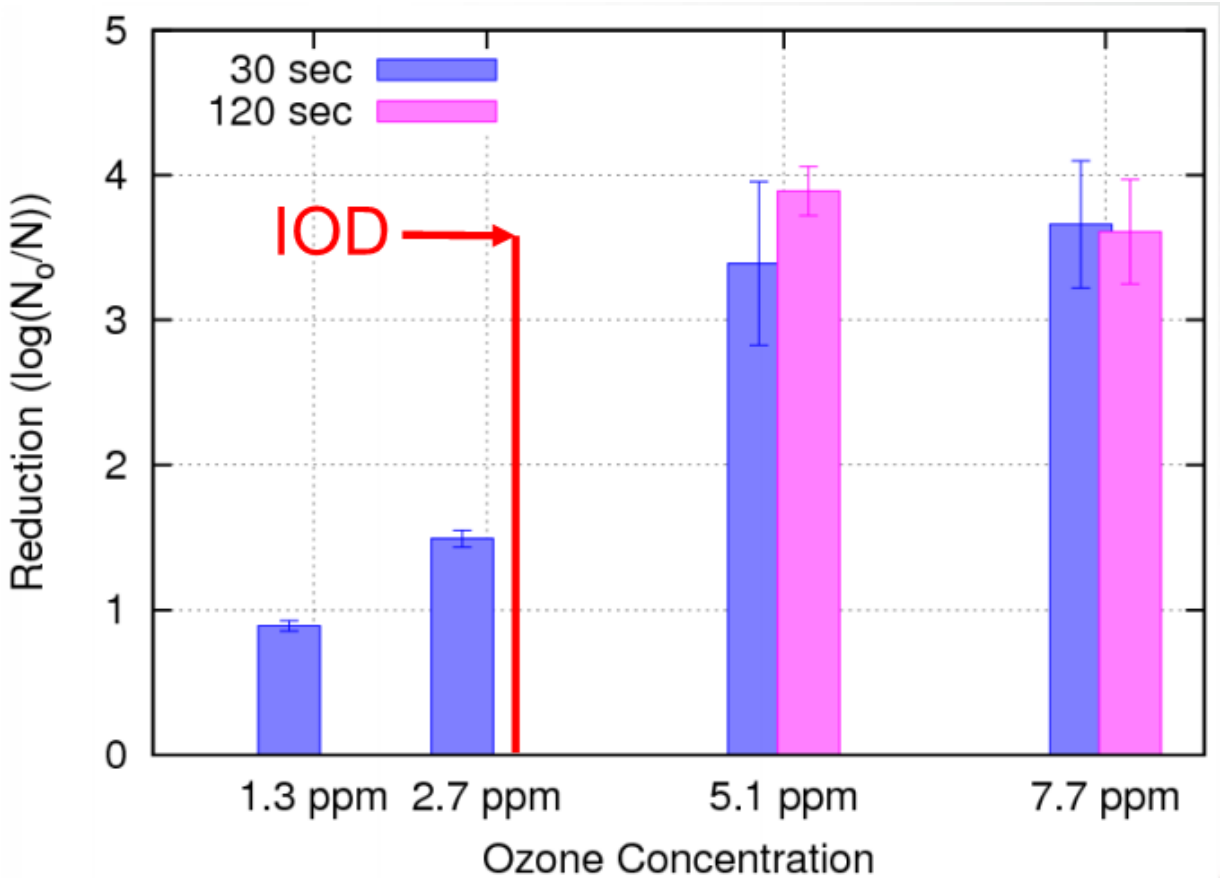


OZONE CAN REDUCE OVERALL TOXICITY OF TREATED WATERS



OZONE IS ALSO A RAPID WASTEWATER DISINFECTANT

Total Coliform



SUMMARY

WATER SUPPLY

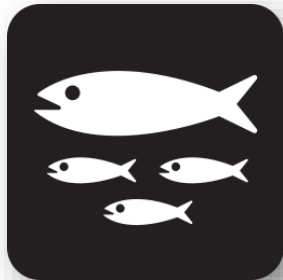
- Wastewater is a viable option
- Characterization of constituents is important

PPCPs

- Estrogenics and SSRIs are of documented concern

WWTP Treatment

- Tertiary treatment presents best removal
- Small package options exist



QUESTIONS?

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