Achieving Optimal Removal of Trace Organic Compounds and Nutrients (WERF Project U3R11)

2015 Water Reuse Conference

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Acknowledgements

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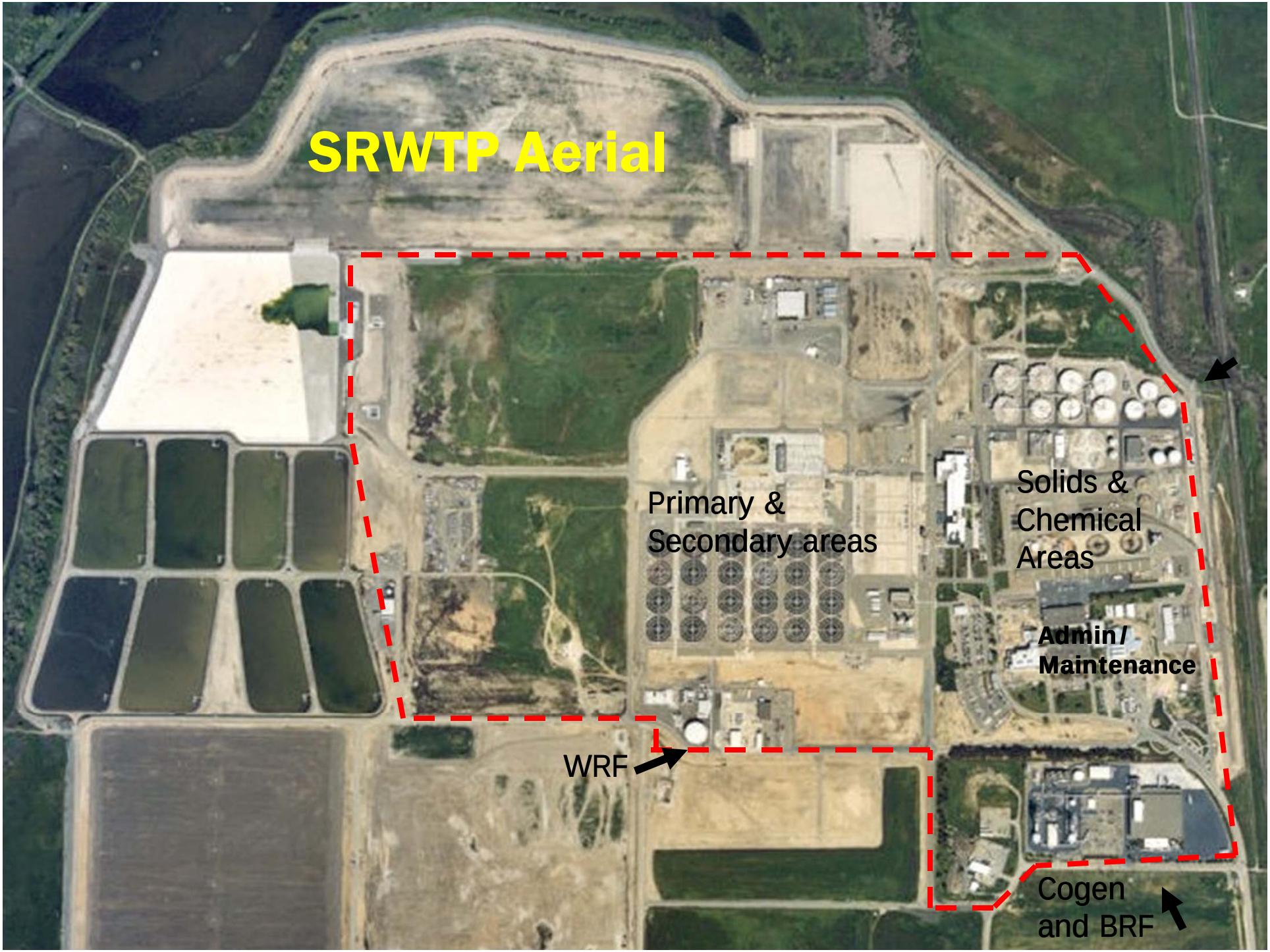
Outline

- Overview of SRWTP
- New NPDES permit
- Pilot Testing Technologies
- TOrC Results
- Conclusions

Overview of SRWTP

- The Sacramento Regional Wastewater Treatment Plant (SRWTP) currently provides secondary treatment and disinfection prior to discharge to the Sacramento River
- Service population = 1.3 million
- Wet weather capacity = 392 mgd
- Permitted ADWF = 181 mgd
- Current ADWF = 145 mgd
- Biological treatment: high purity oxygen activated sludge secondary treatment
- Disinfection: Chlorine gas (SO_2 dechlorination)


SRWTP Aerial
Primary &
Secondary areas
Solids &
Chemical
Areas
Admin/
Maintenance
WRF
Cogen
and BRF

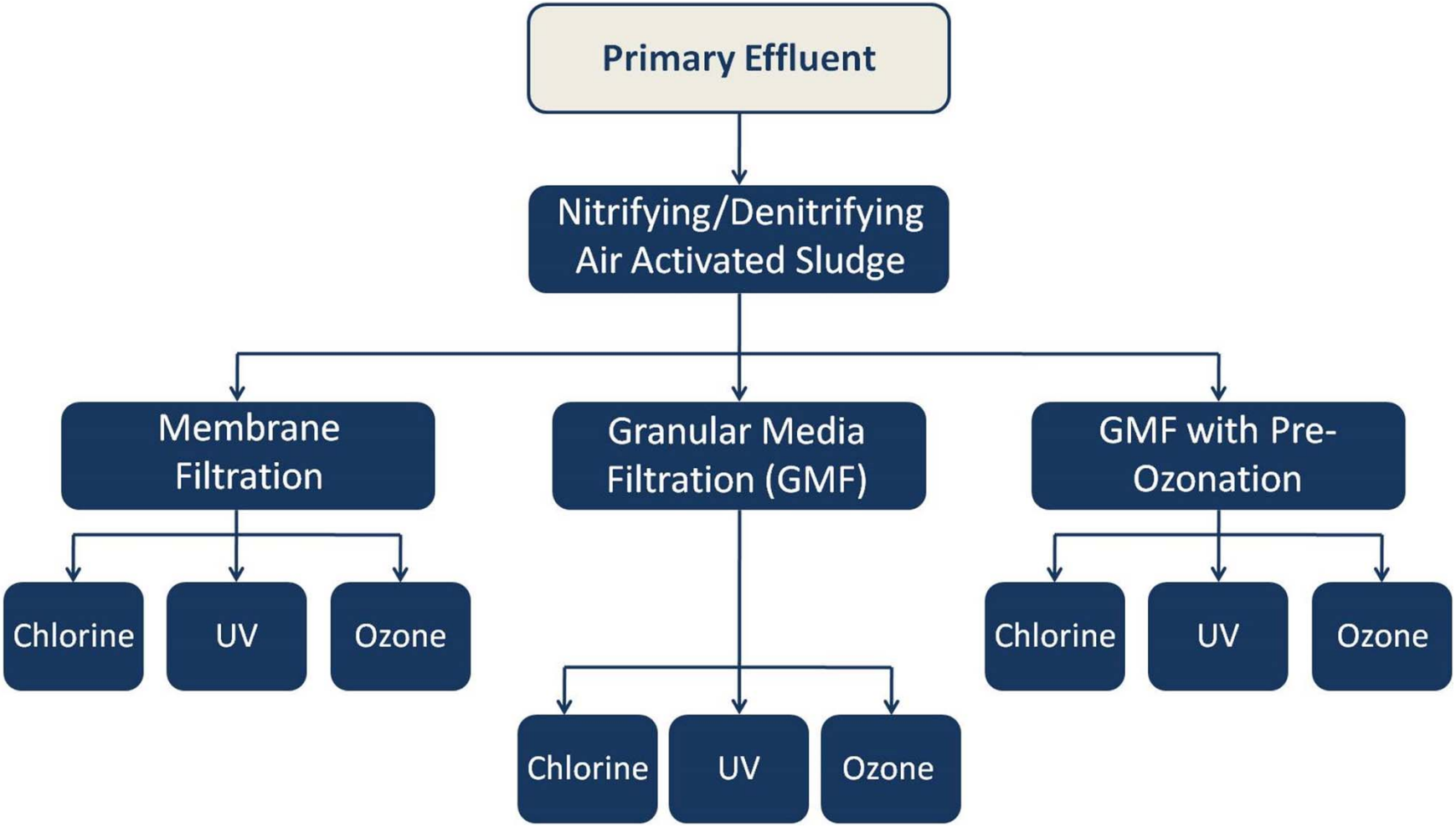
Regulatory Change

- December 9, 2010, the Regional Water Quality Control Board adopted a new NPDES Permit for the SRWTP
- The new permit includes nitrogen removal and Title 22 filtered, disinfected tertiary effluent requirements
- Compliance timeline = 10 years from permit adoption
- Estimated $1.7 billion

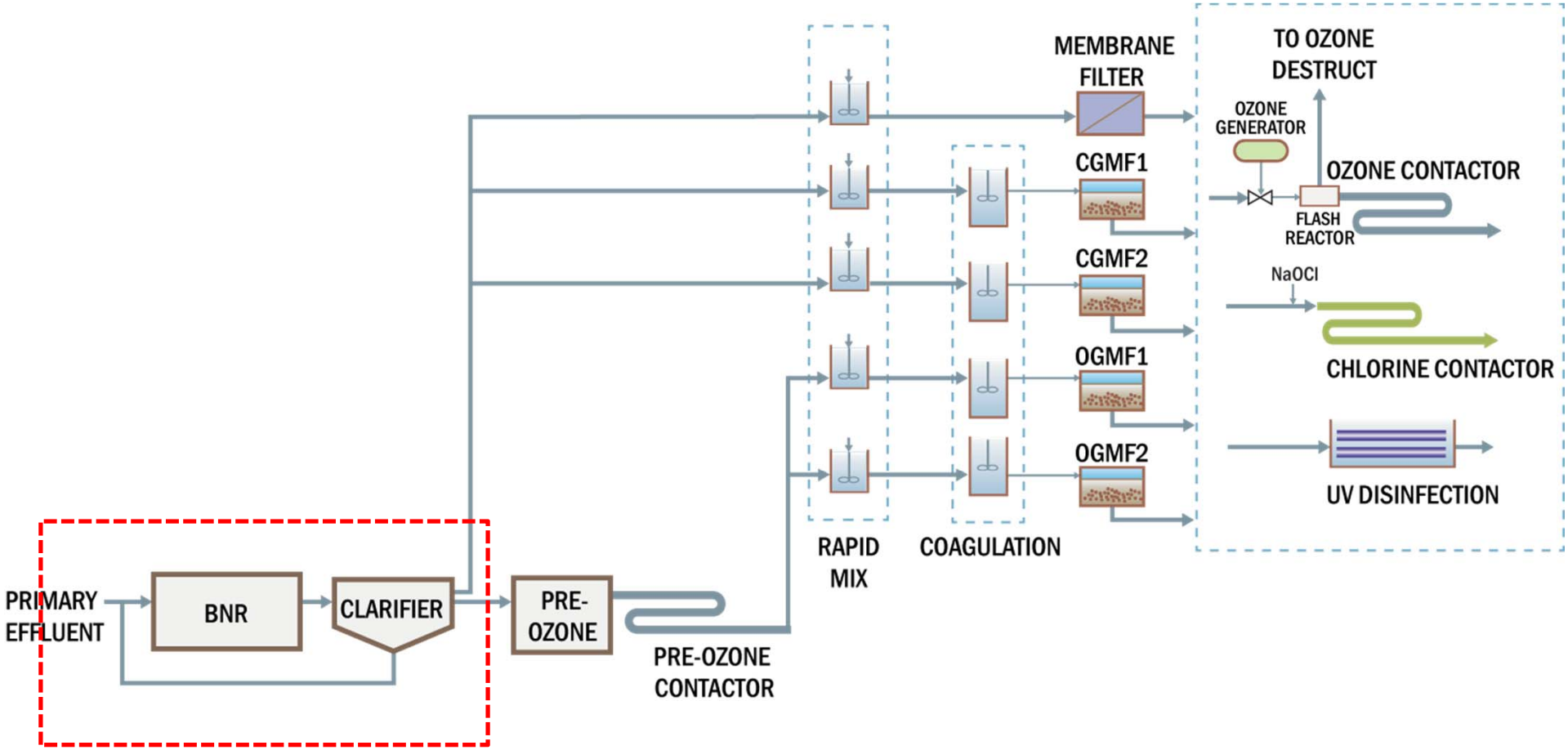
Overview of key permit requirements

CONSTITUENT	LIMIT
Ammonia (Apr-Oct)	1.5 mg-N/L (monthly average) 2.0 mg-N/L (max day)
Ammonia (Nov-Mar)	2.4 mg-N/L (monthly average) 3.3 mg-N/L (max day)
Nitrate	10 mg-N/L (monthly average)
Turbidity	<2 NTU (daily average)
Total coliform	2.2 MPN/100 mL (7-day median)
Title 22 equivalency	5-log virus inactivation (MS2)

ATTP Treatment Trains



Overview of BNR Process



Pilot Facility

Air Activated Sludge Process

Filtration Equipment

Disinfection Equipment

BNR Process

Preozonation system

Filtration Facilities

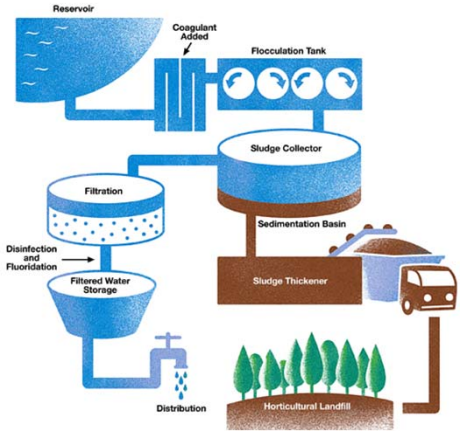
Disinfection Facilities

Motivations for the study

- Potential future regulatory limits on TOrCs

- SRCSD is making major investments in treatment infrastructure

- Increased understanding of TOrC treatment capabilities by candidate treatment technologies needed



Selected Indicator Compounds

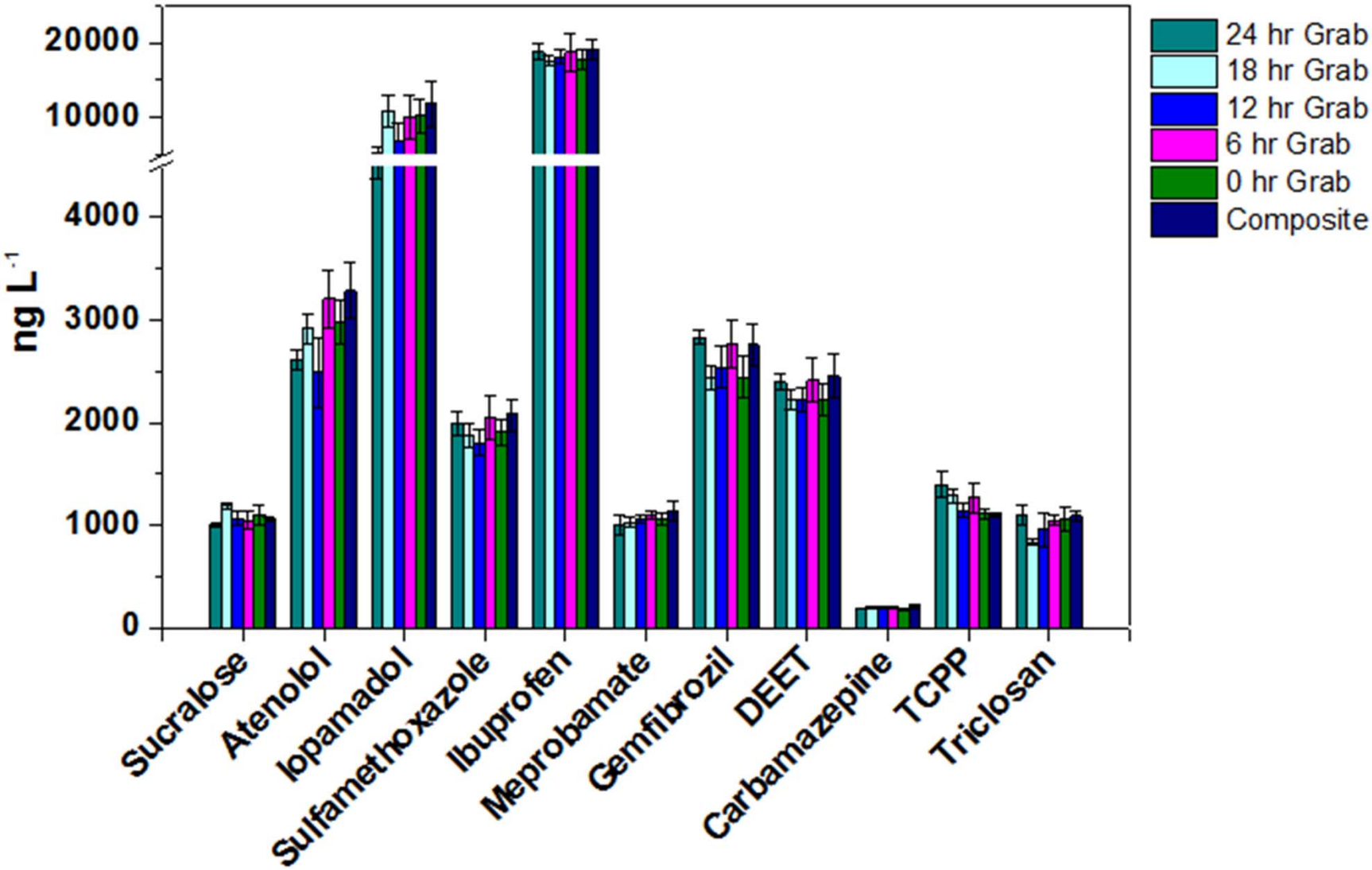
Compound	Use
Carbamazapine	*Anti-convulsant*
DEET	*Insect repellant*
Ibuprofen	*Anti-inflammatory*
NDMA	*Industrial byproduct*
Sucralose	*Artificial sweetener*
Sulfamethoxazole	*Antibiotic*

Compound	Use
Triclosan	*Anti-bacterial*
Atenolol	*Beta blocker*
Gemfibrozil	*Lipid regulator*
Iopamidol	*X-ray contrast agent*
Meprobamate	*Anti-anxiety*
TCPP	*Flame retardant*

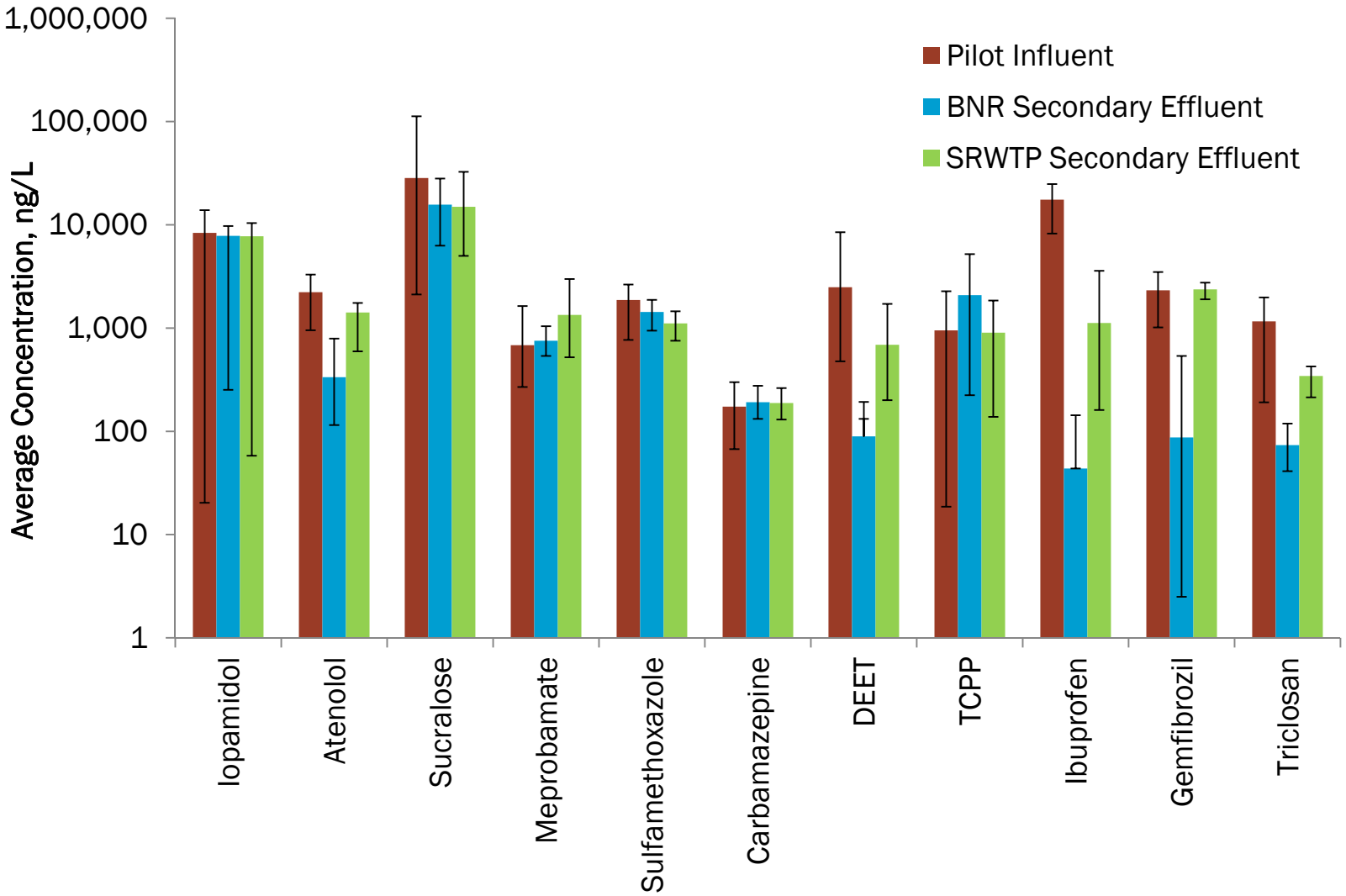
First – Check any impacts of sample preservative

- Composite samples more representative than grabs
- Composite samples require a chemical preservative to arrest biological activity
- Concern: does high sodium azide (NaN_3) preservative concentration at beginning of sample period affect sample?

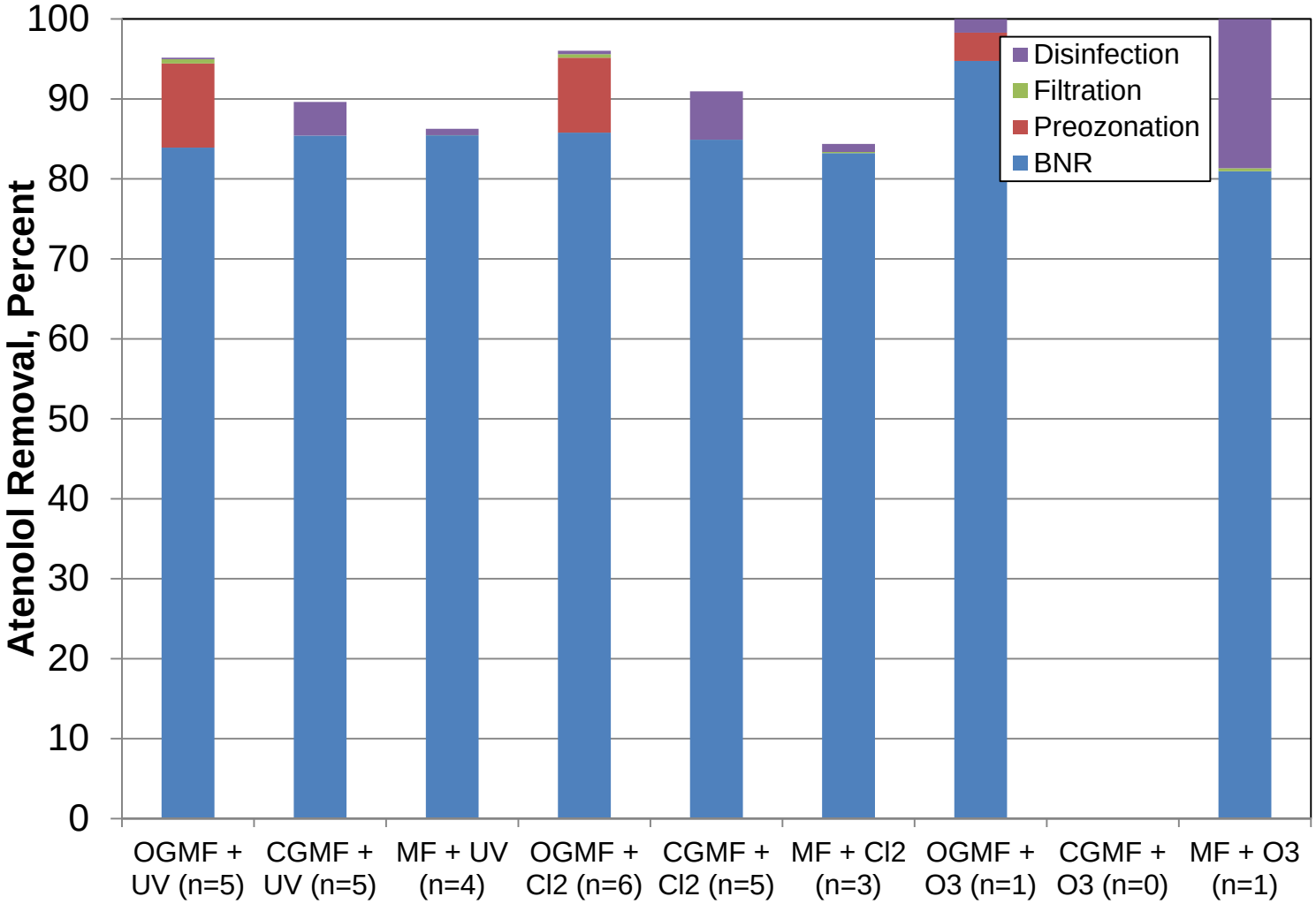
Grab vs. Composite Results



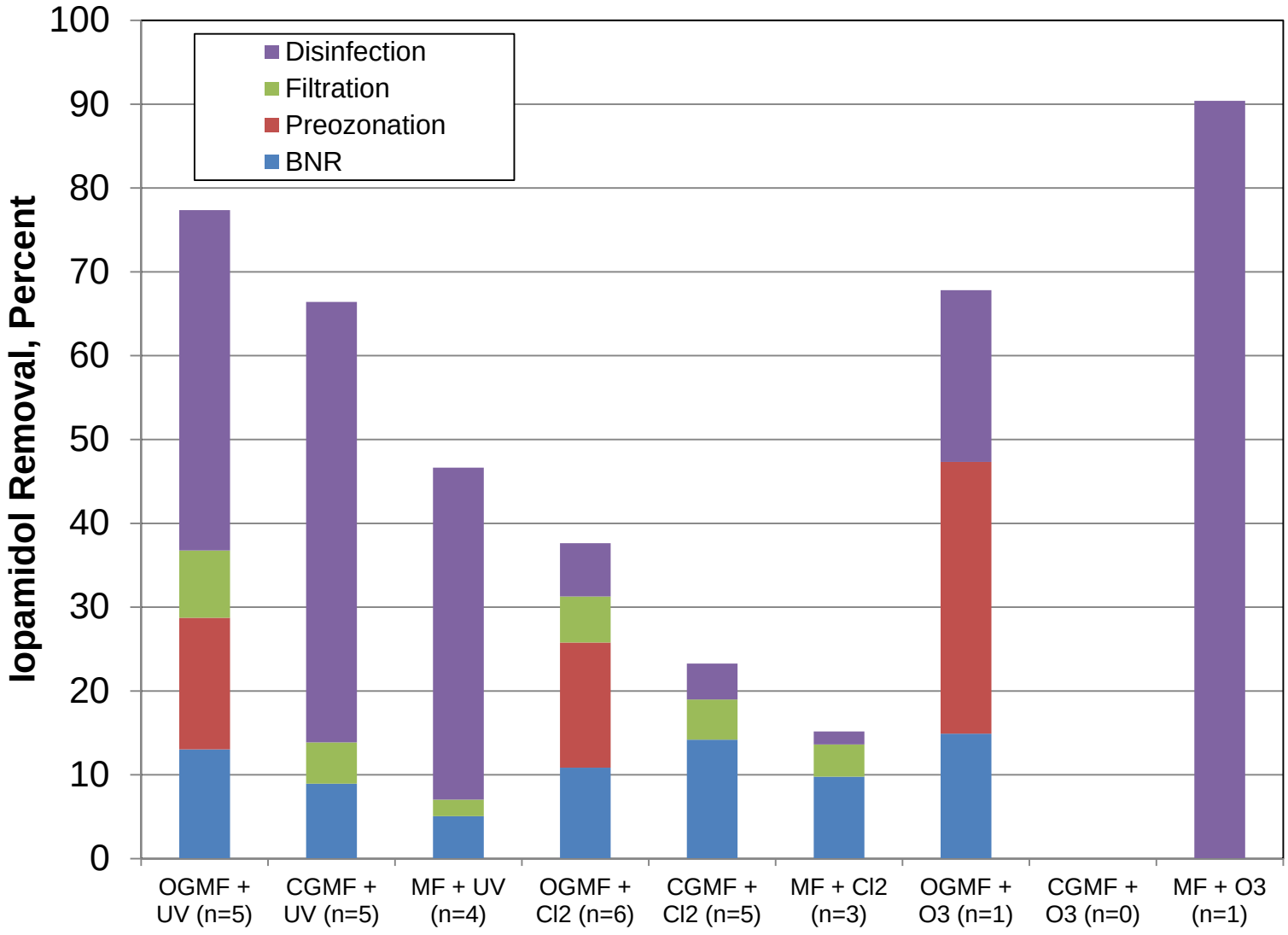
BNR Removal of TOrCs



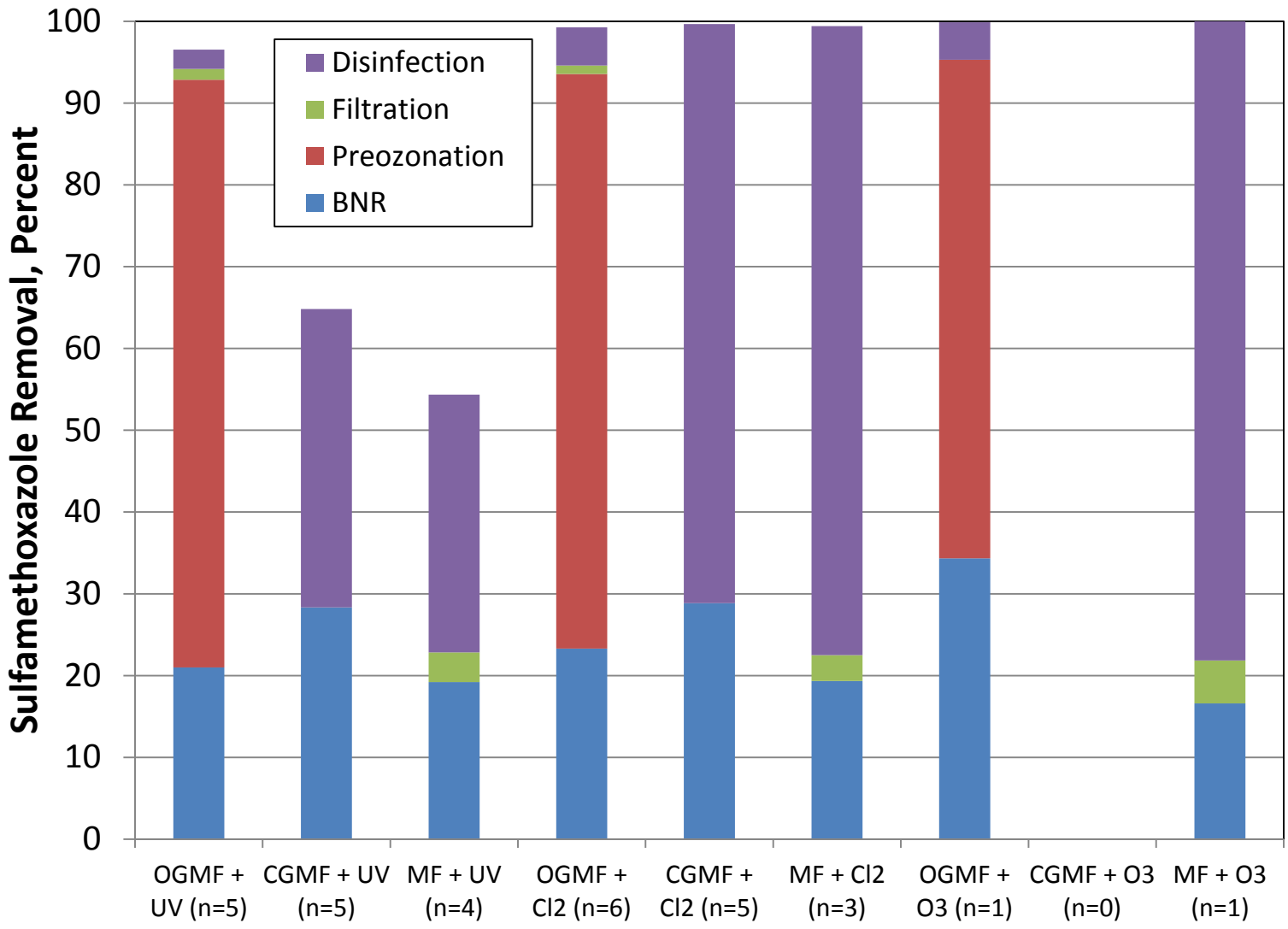
Overall TOrC Removals – Atenolol



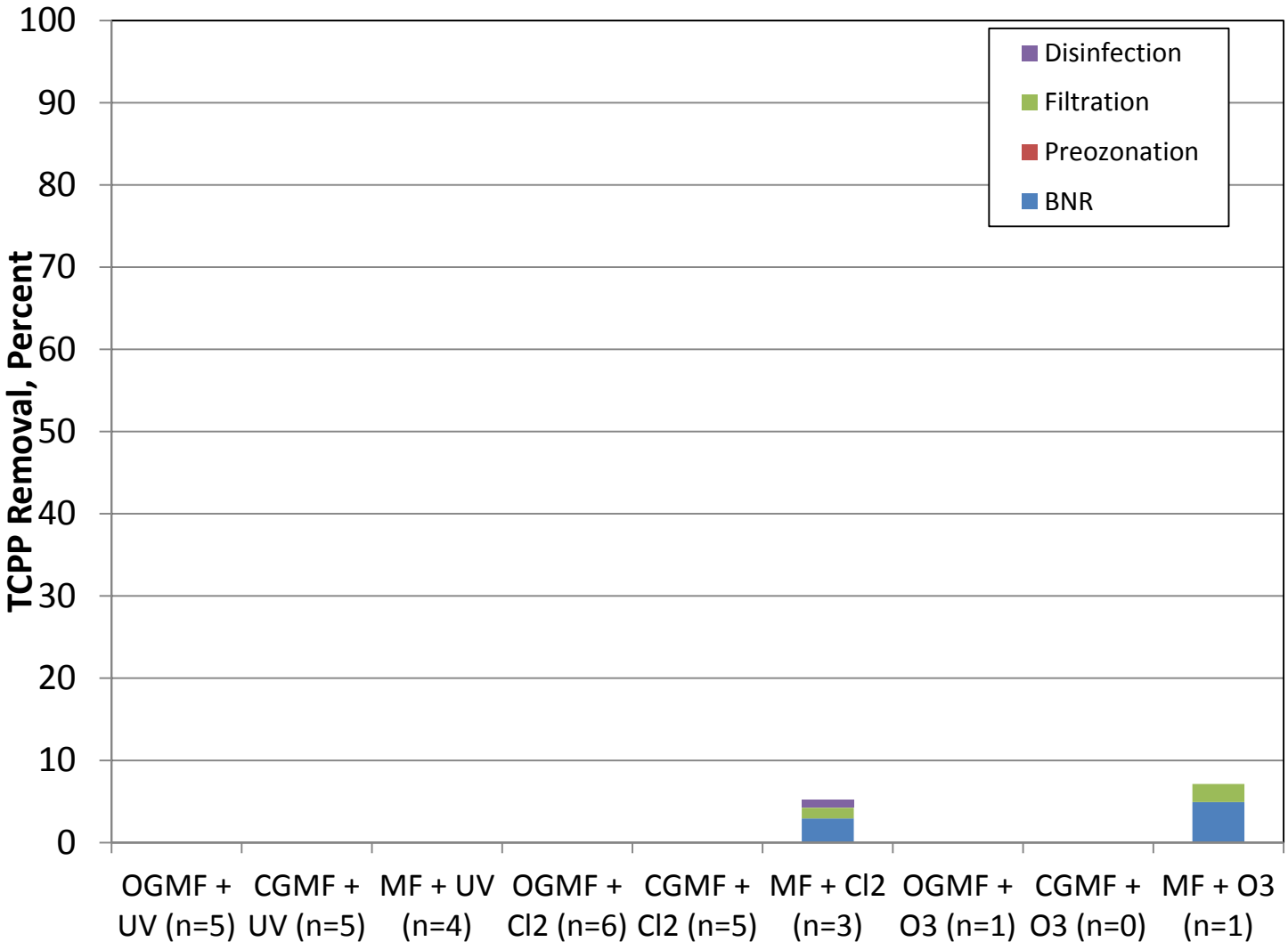
Overall TOrC Removals – Iopamidol



Overall TOrC Removals – Sulfamethoxazole



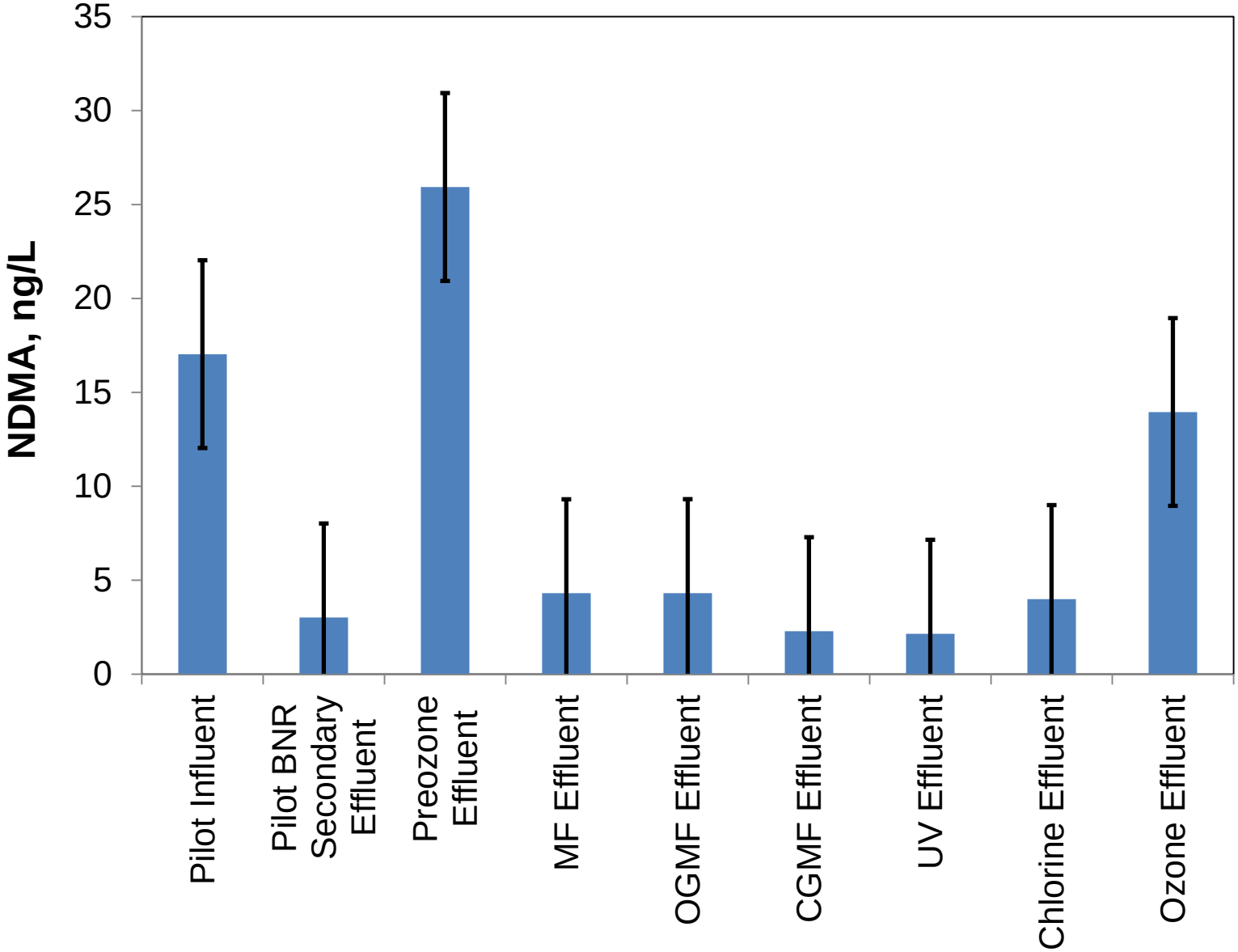
Overall TOrC Removals – TCPP



Impacts to Receiving Water

Constituent	Pilot Final Effluent BNR/GMF/Cl_2, ng/L	SRWTP Final Effluent HPO/Cl_2, ng/L	Background Sacramento River, ng/L	Projected Downstream Concentration	
				SRWTP, ng/L	Projected Downstream Concentration BNR+CGMF+Cl2, ng/L
Iopamidol	7299	6107	58	149	166
Atenolol	249	1415	0.30	22	4.0
Sucralose	11816	11793	93	269	269
Meprobamate	736	625	1.1	10	12
Sulfamethoxazole	7.1	1265	2.3	21	2.4
Carbamazepine	175	195	0.50	3.4	3.1
DEET	88	728	6.7	18	7.9
TCPP	2399	809	33	45	68
Ibuprofen	198	1239	2.8	21	5.7
Gemfibrozil	1.9	2223	0.30	34	0.32
Triclosan	2.1	82	1.1	2.3	1.1
NDMA	3.1	12	0.80	0.97	0.84

Overall NDMA Removals



Surrogates Results

Compound	UV_{280}	SM FI	FA FI	HA FI
Atenolol	**0.68**	**0.77**	0.48	0.52
Carbamazepine	0.18	0.19	0.51	0.54
DEET	0.4	0.44	0.16	0.16
Gemfibrozil	0.47	0.54	0.42	0.42
Ibuprofen	**0.76**	**0.83**	0.23	0.27
Iopamidol	0.17	0.17	0.21	0.23
Meprobamate	0.04	0.05	0.21	0.2
Sucralose	0.1	0.13	0.07	0.12
Sulfamethoxazole	0.44	0.53	**0.58**	**0.67**
TCPP	0.02	0.05	0.01	0.02
Triclosan	**0.64**	**0.73**	0.26	0.34

UV_{280}: Absorbance at 280 nm
SM FI: Soluble microbial byproduct-like fluorescence index
FA FI: Fulvic acid-like fluorescence index
HA FI: Humic acid-like fluorescence index

Conclusions

- Longer SRTs associated with BNR increase the removal of several TOrCs
- Many TOrCs are removed by ozone
- TOrCs respond differently to biological, filtration, and disinfection processes
- NDMA is reduced by biological treatment and is formed by ozone

Questions ?

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Brown AND Caldwell