Ozone for Multiple Benefits

Joint Water Commission

PNW AWWA

May 6, 2011

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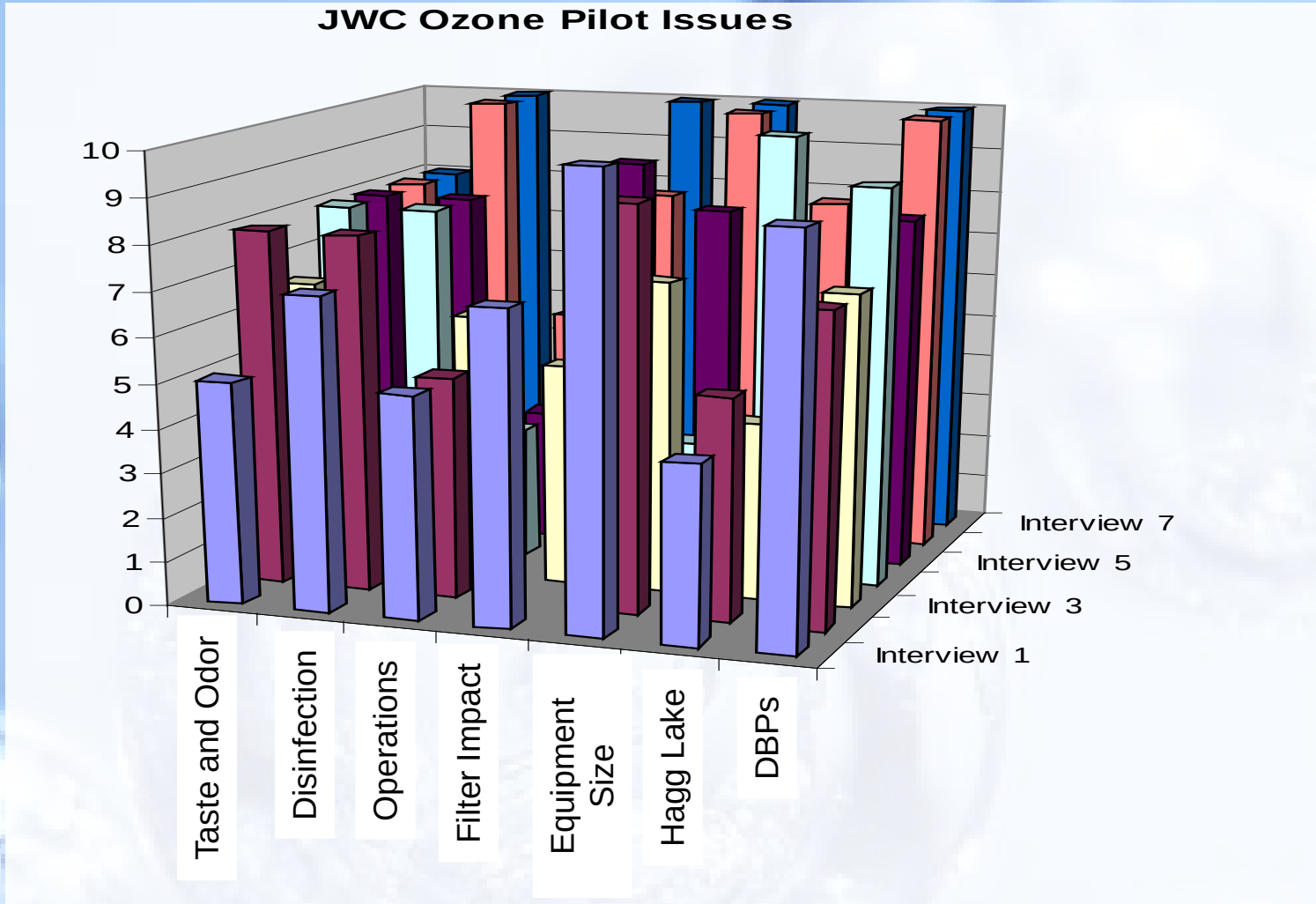
JWC Partners Had a Variety of Goals for the Pilot Study



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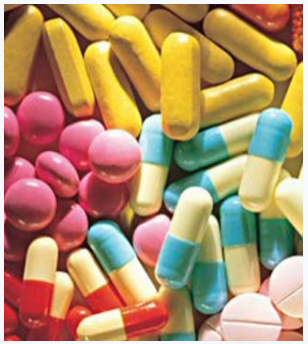
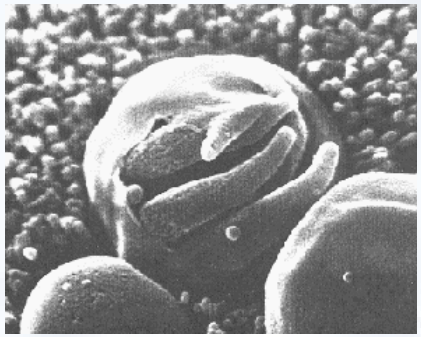
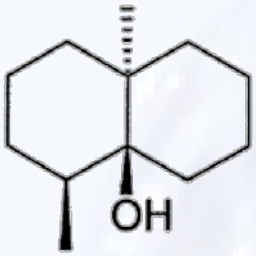
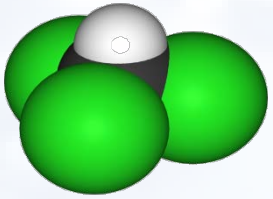
Ozone has many impacts on water quality



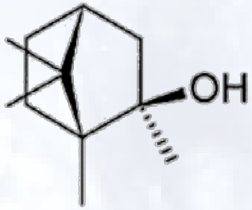




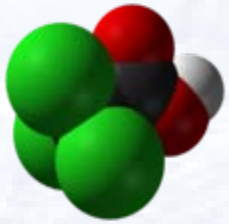
Geosmin



Chloroform



2-Methylisoborneol



Trichloracetic Acid

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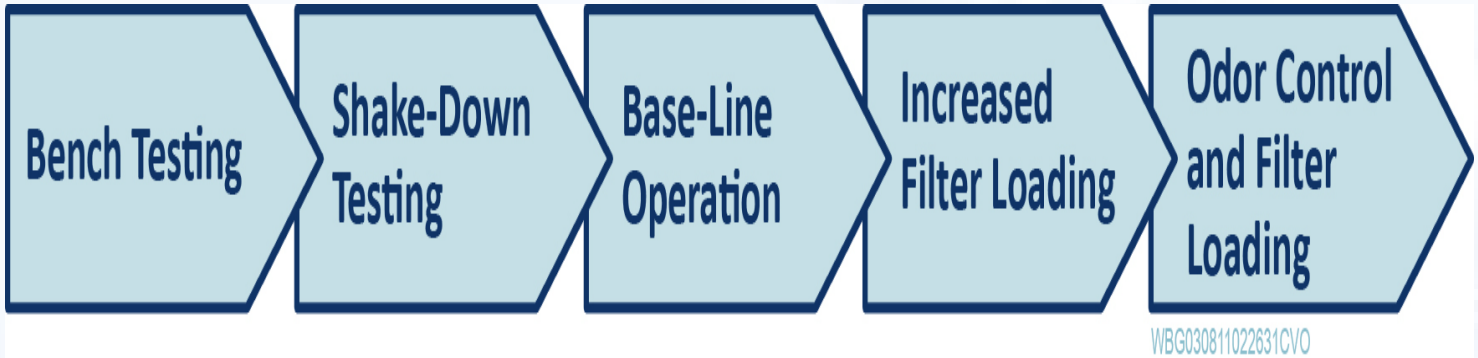
Systematic Approach Addressed Multiple Issues



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Complicated Watershed

- Tualatin River
- Gales Creek
- Wapato Creek (Lake)
- Scoggins Creek
- Hagg Lake
- Barney Reservoir

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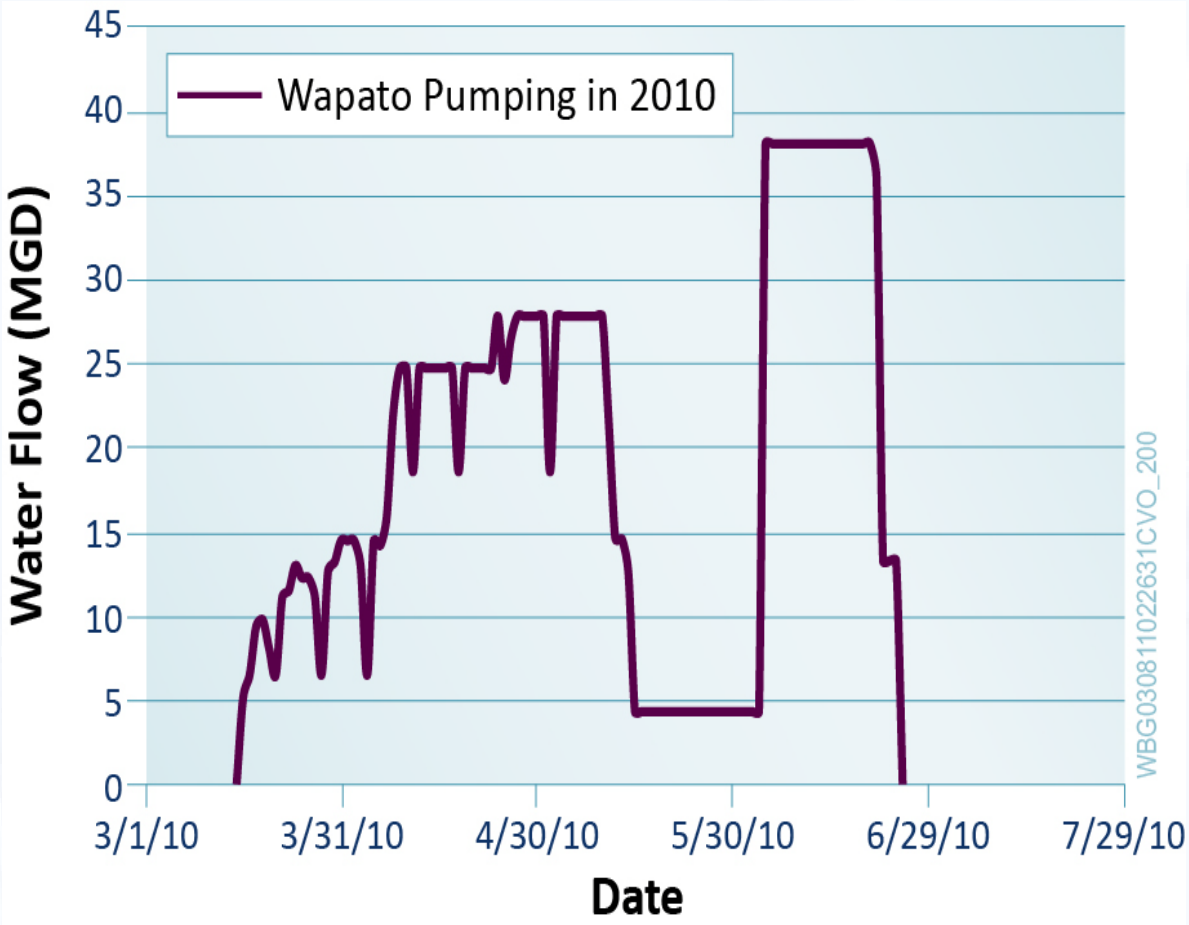
Contribution of Wapato



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Geosmin and MIB During Worst Event in Their History

	Geosmin			2-Methylisoborneol (MIB)		
Site Name	Ave (ng/L)	Range (ng/L)	No.	Ave (ng/L)	Range (ng/L)	No.
Tualatin River Intake	3.9	ND to 16	8	0.18	ND to 1.1	8
Finished water	4.4	ND to 13	8	ND	All ND	8
Distribution System	4.3	ND to 12	9	ND	All ND	9

Based on this information– Targeting 80% Gesomin Removal

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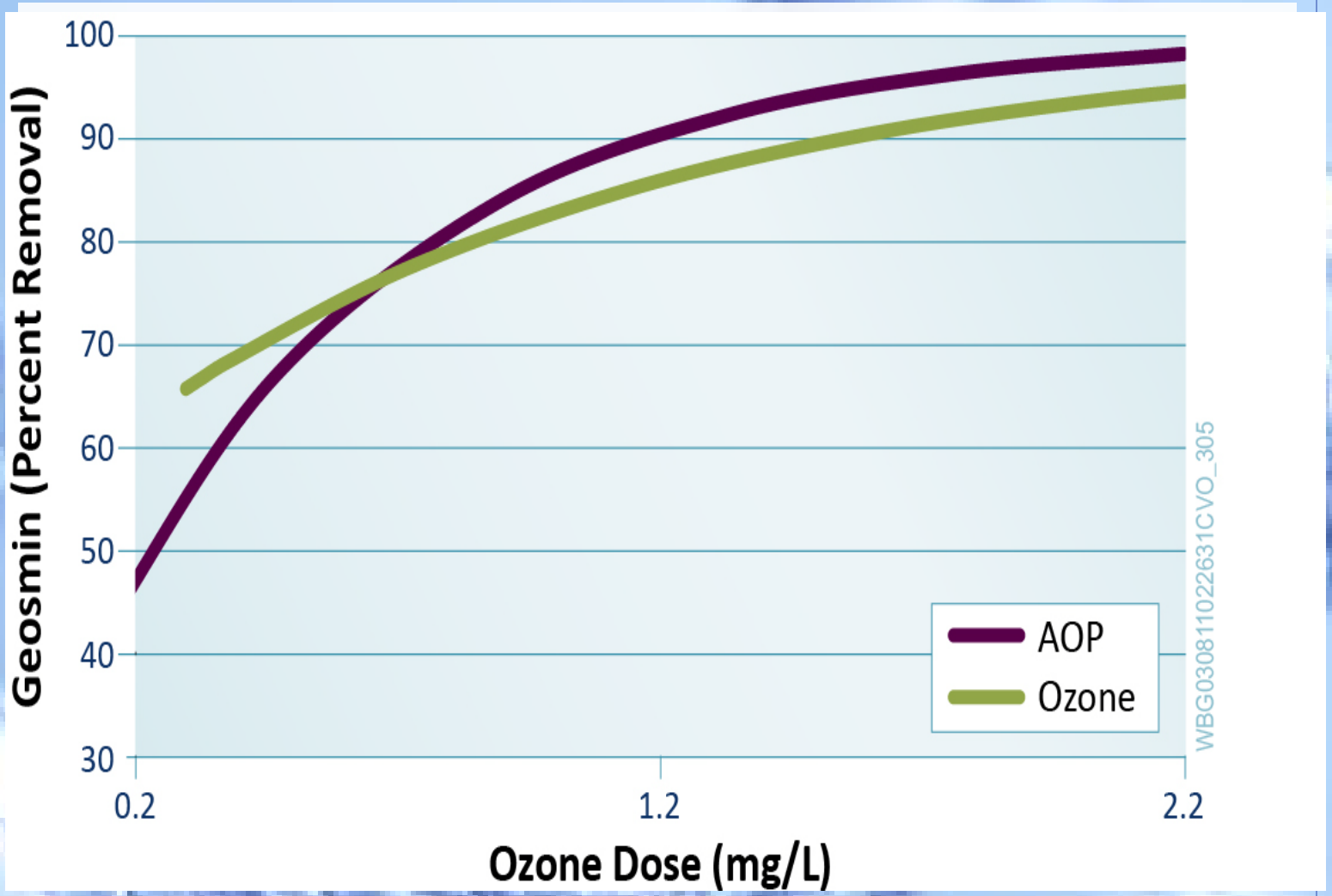
Results of Bench-Testing: Ozone vs. AOP



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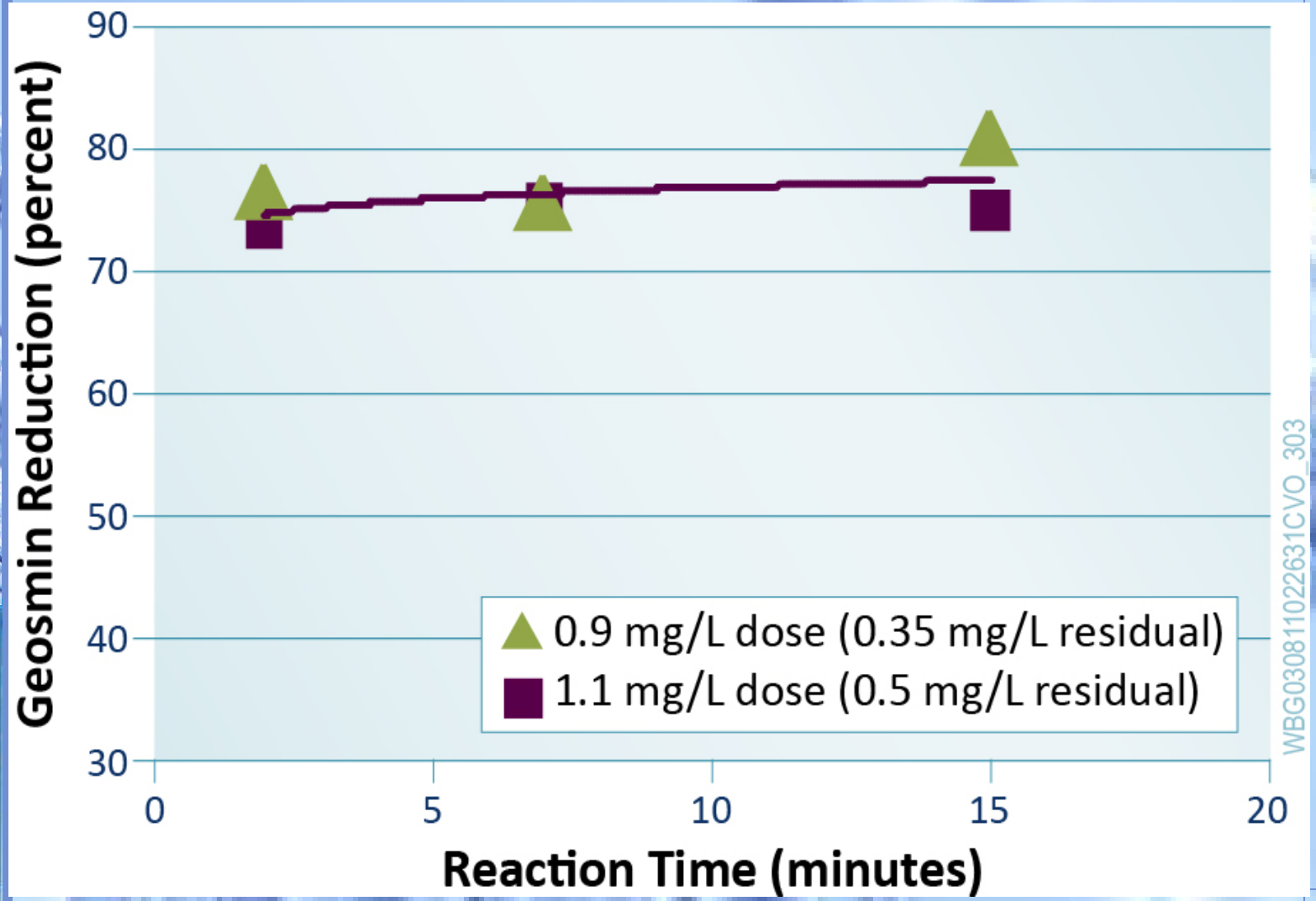
Results of Bench-Testing: Contact Time



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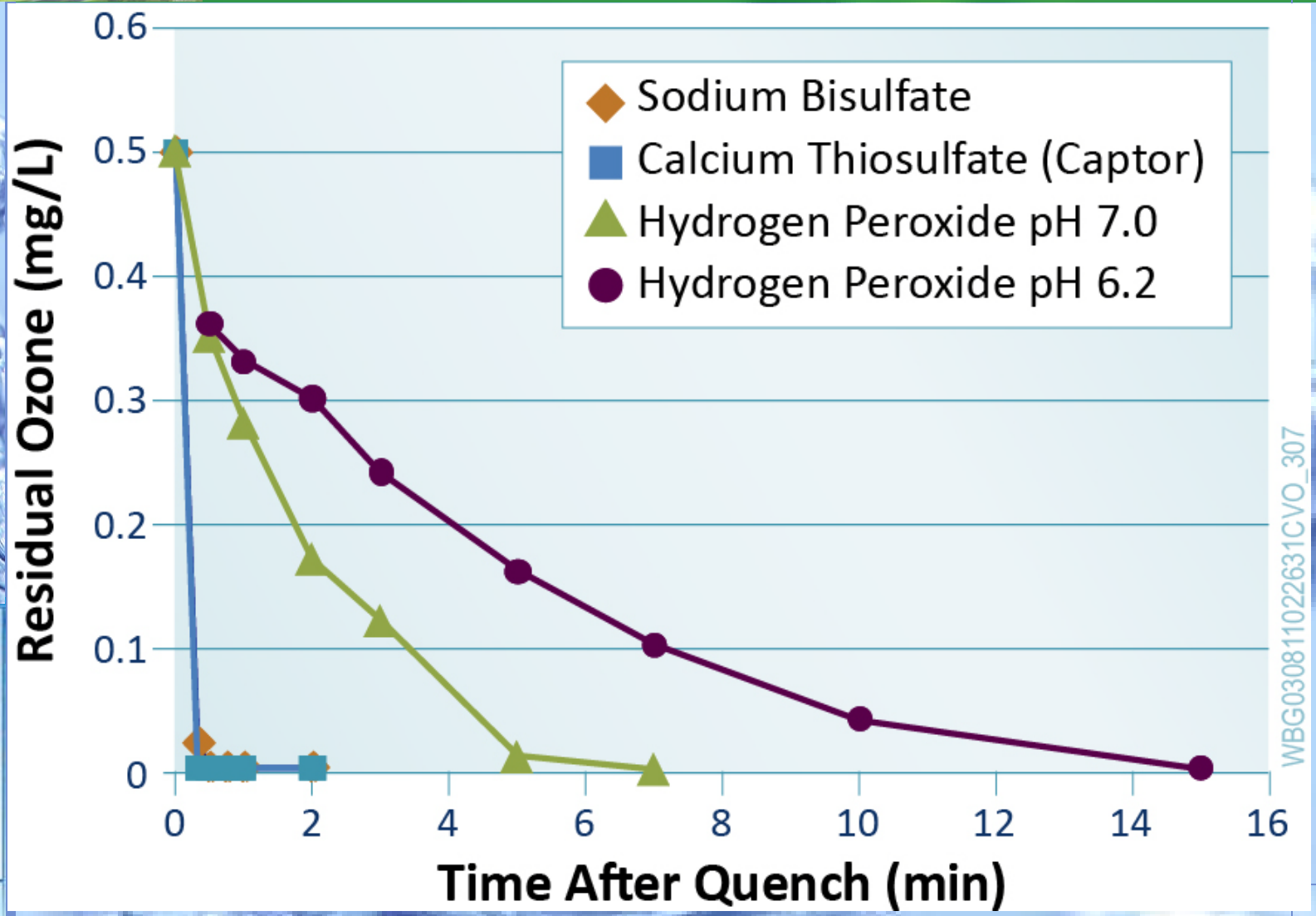
Results of Bench-Testing: Quench Agents and Time



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Pilot Scale Testing

- Targeted 0.1 to 0.2 mg/L residual for 1-log *Geosmin* inactivation
- Targeted 0.5 mg/L residual for taste and odor control
- Evaluated intermediate ozonation (settled water)
- Four Pilot Filters:
  - Existing Media/No ozone
  - Existing Media/Ozone
  - Deep Bed/Ozone
  - Biologically Activated Carbon (ozone/BAC)

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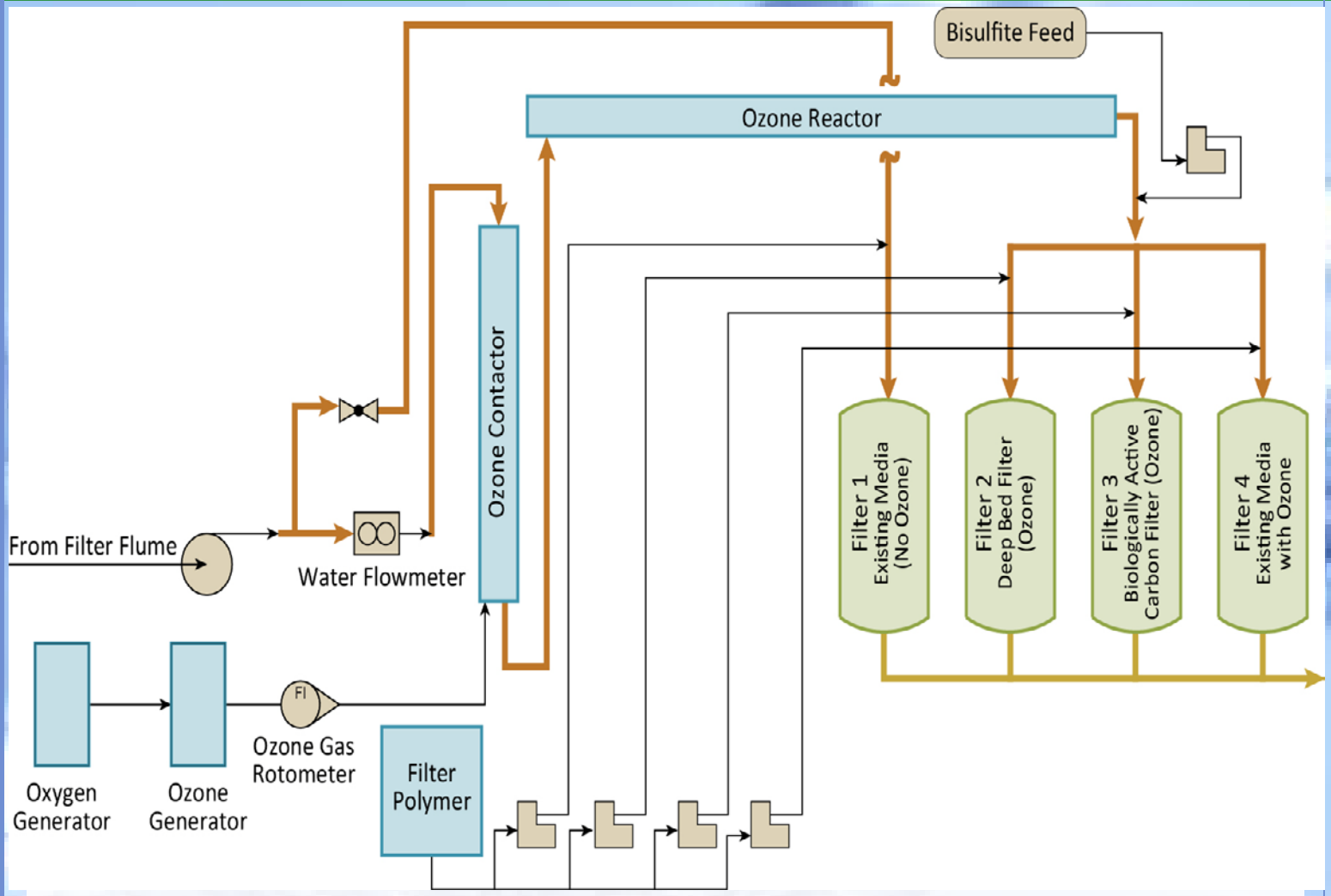
Pilot Plant Schematic



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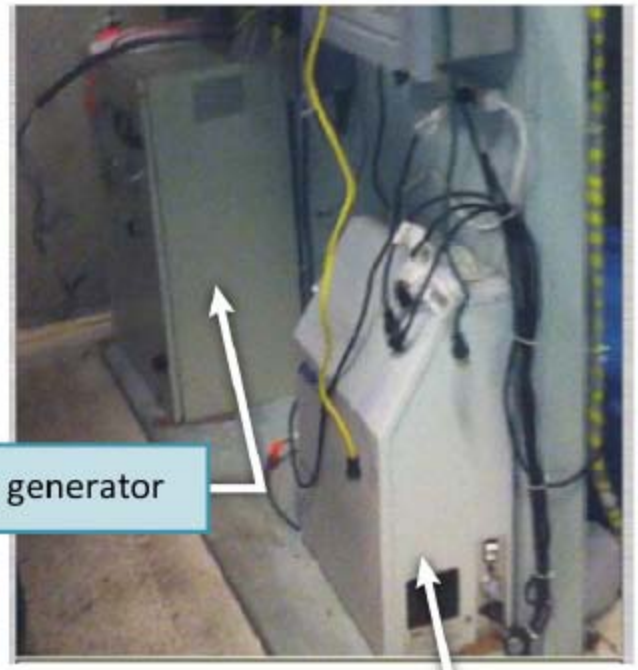
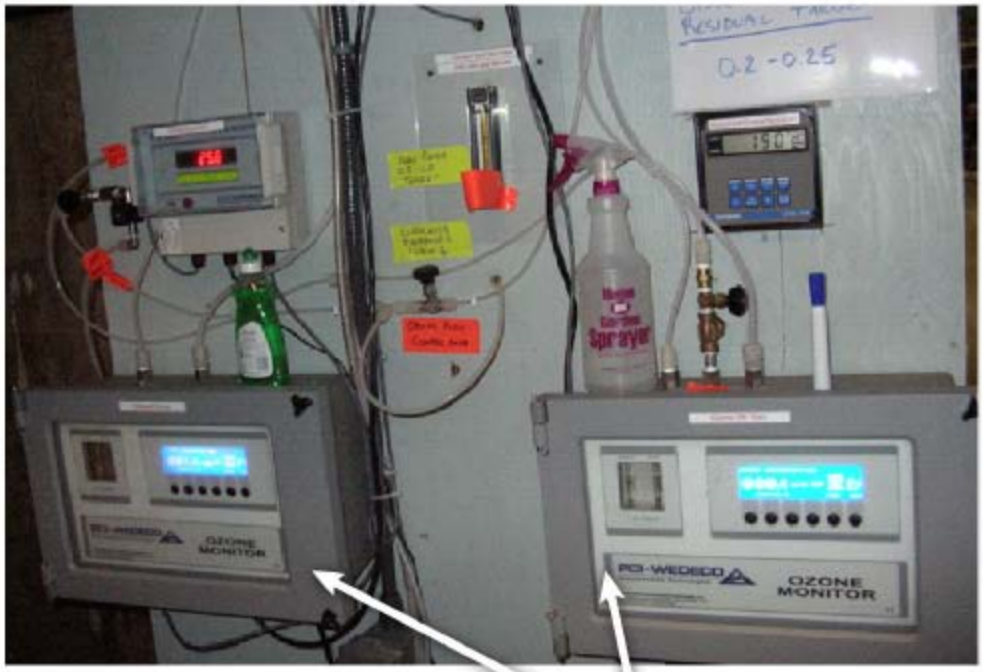
Four pilot filters and adjustable speed peristaltic pumps

Ozone contactor

Ozone Generator and Monitors



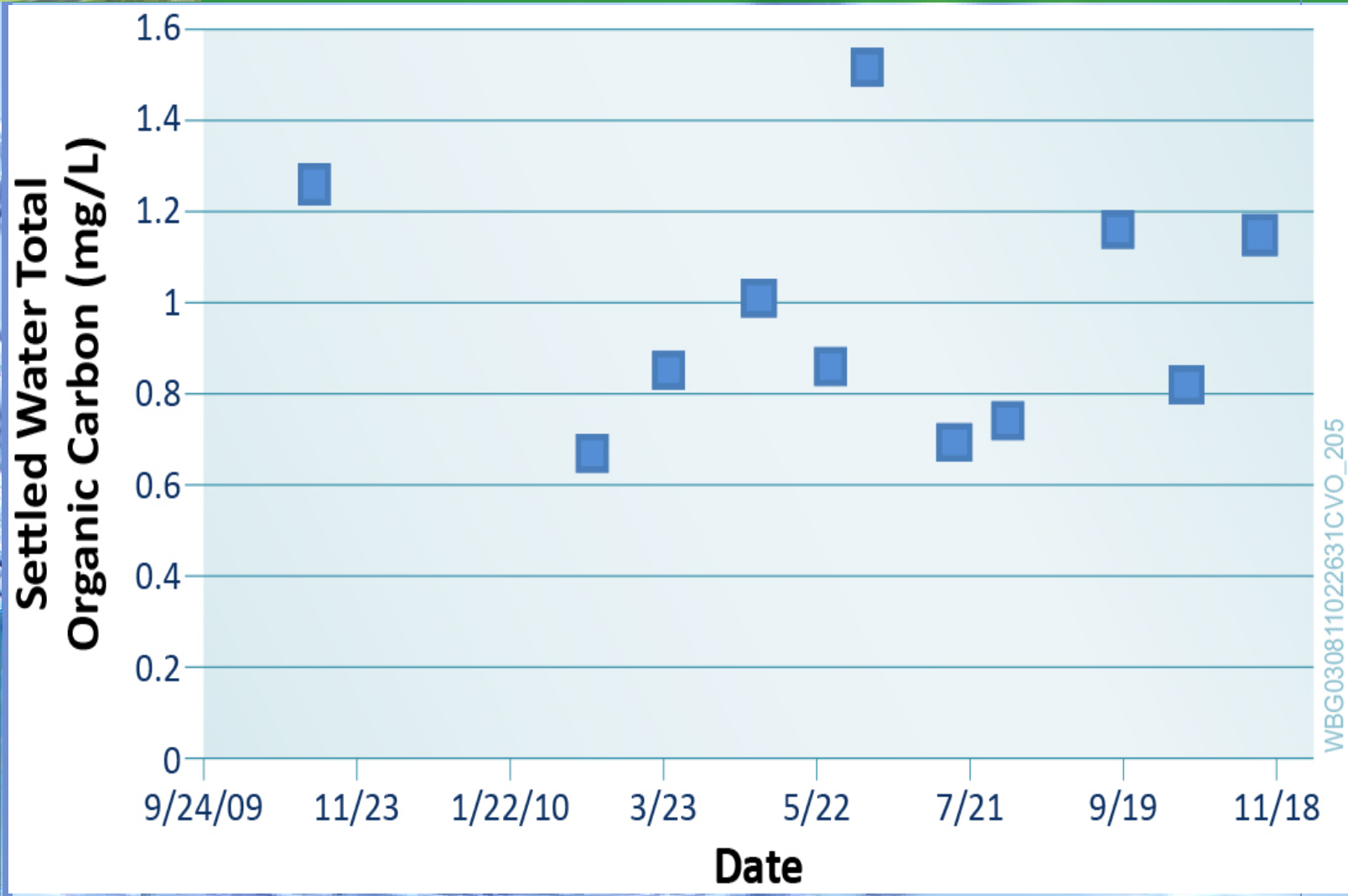


Ozone generator

Oxygen generator

Ozone monitors

Settled Water TOC



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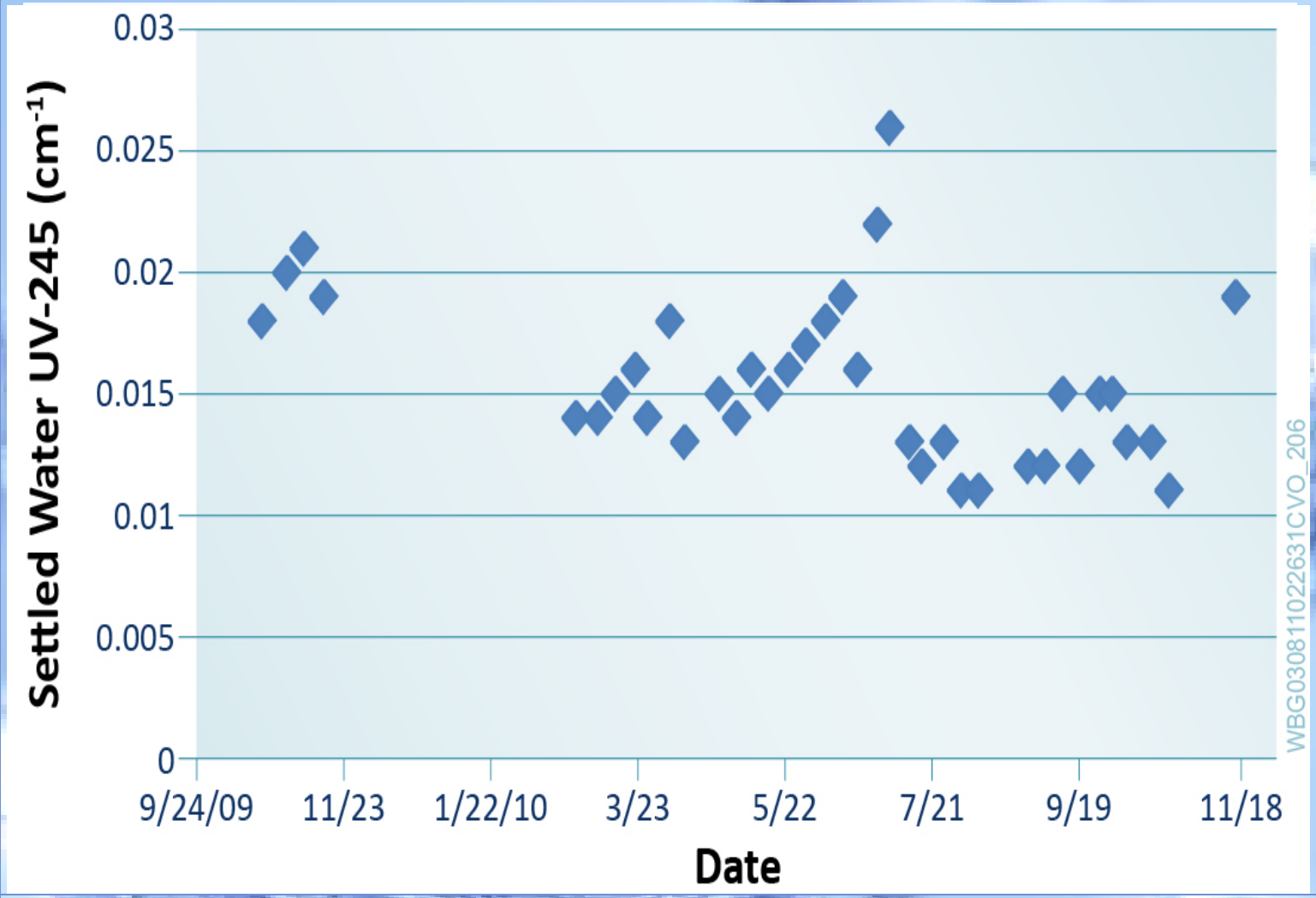
WBG0308110226 31CVO_205

Settled Water UV-254



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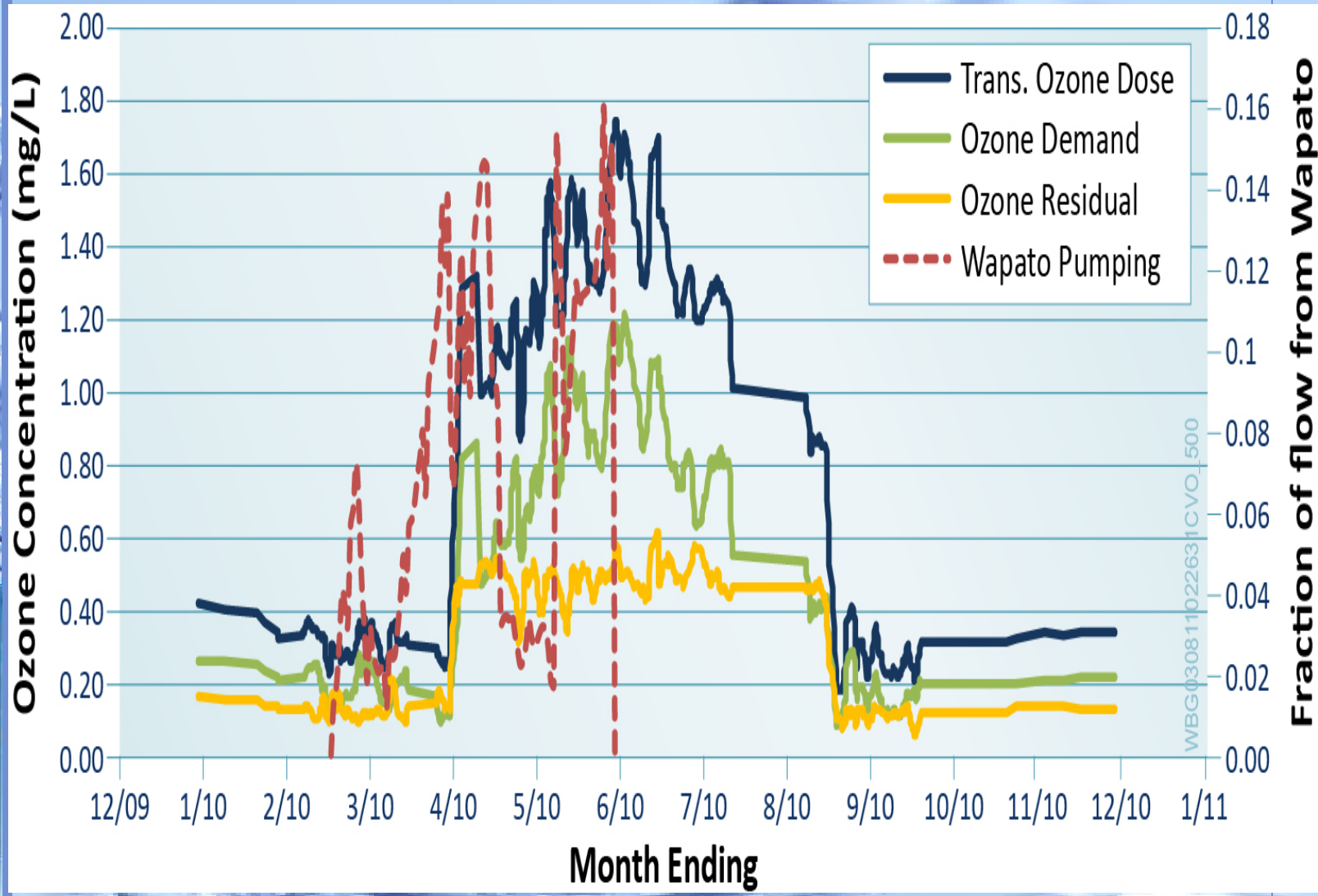
Ozone Dose, Residual and Demand



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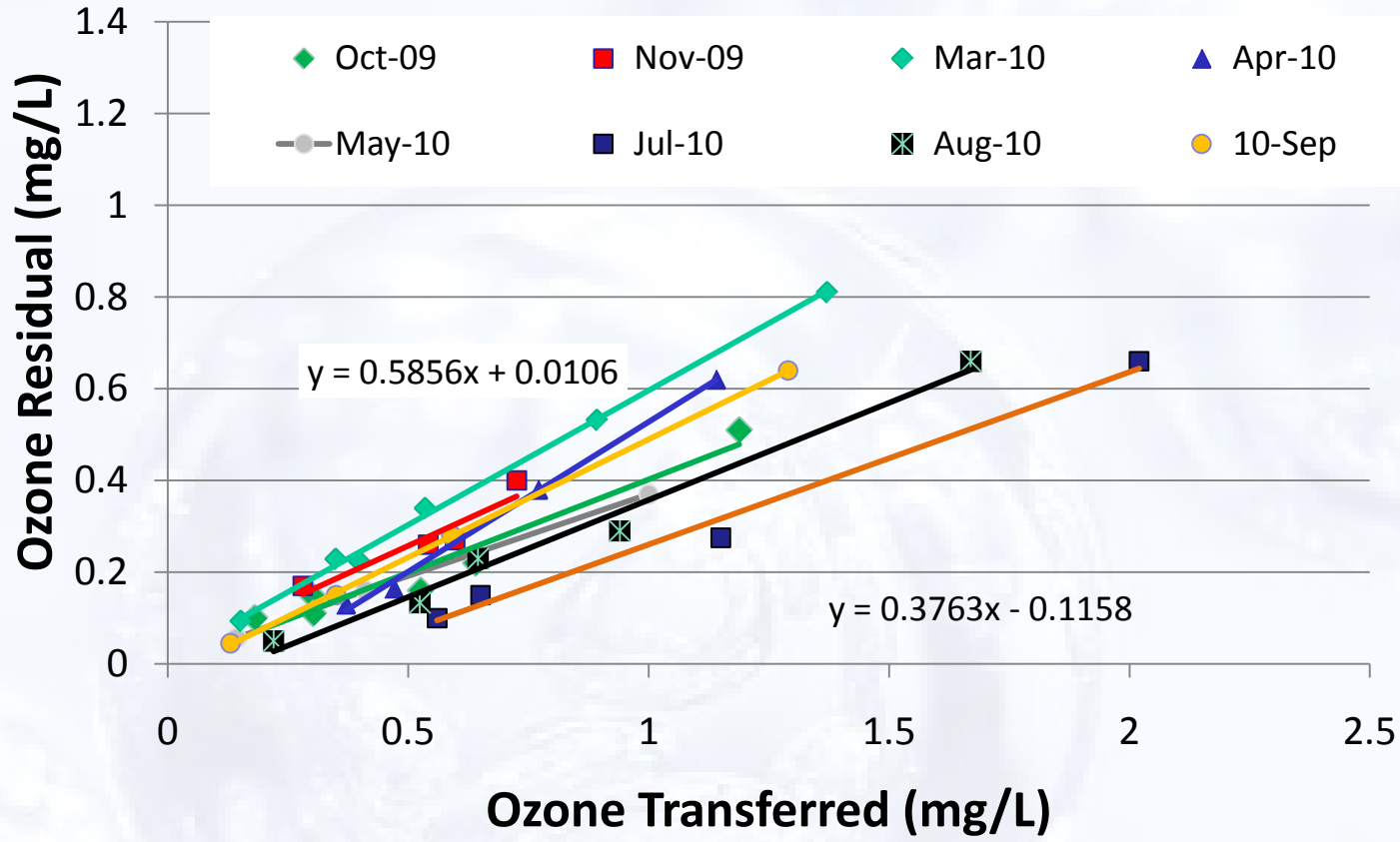
Ozone Demand



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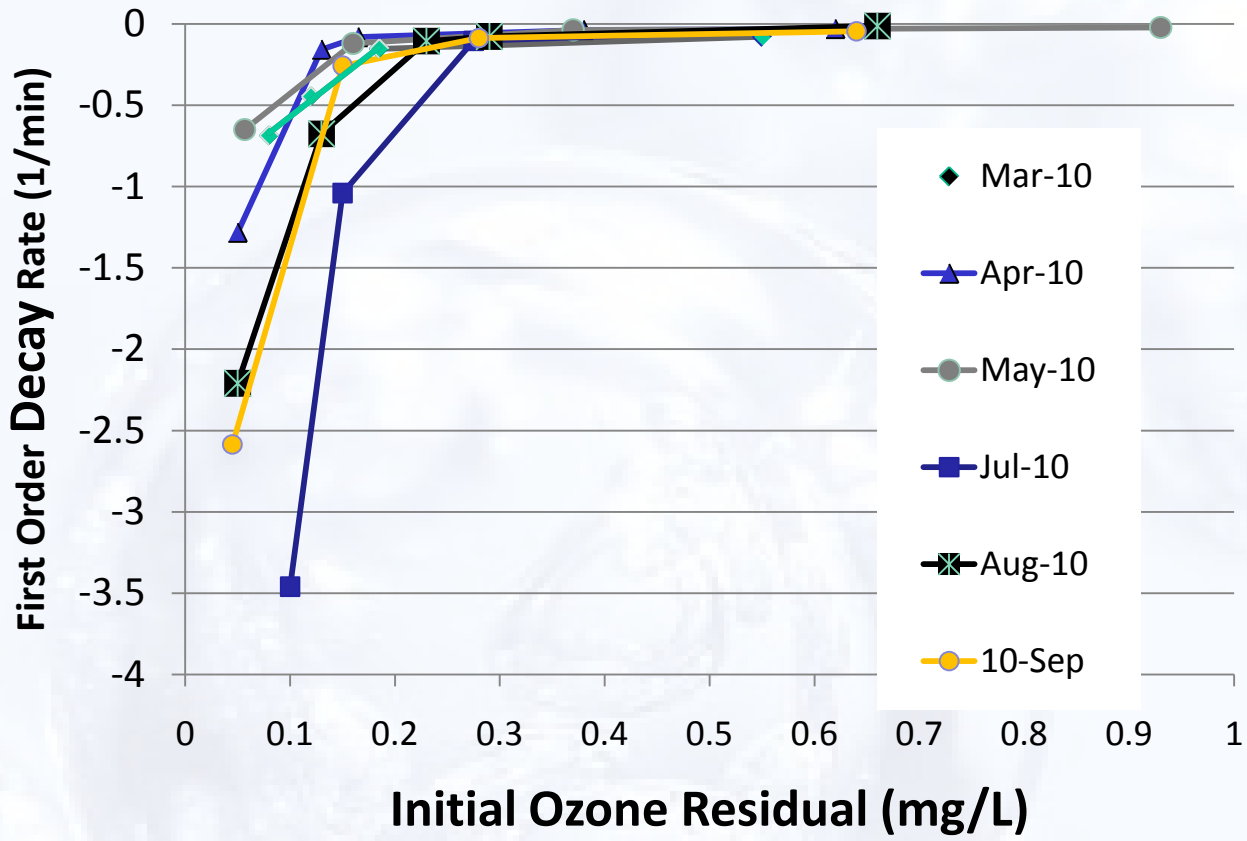
Ozone Decay



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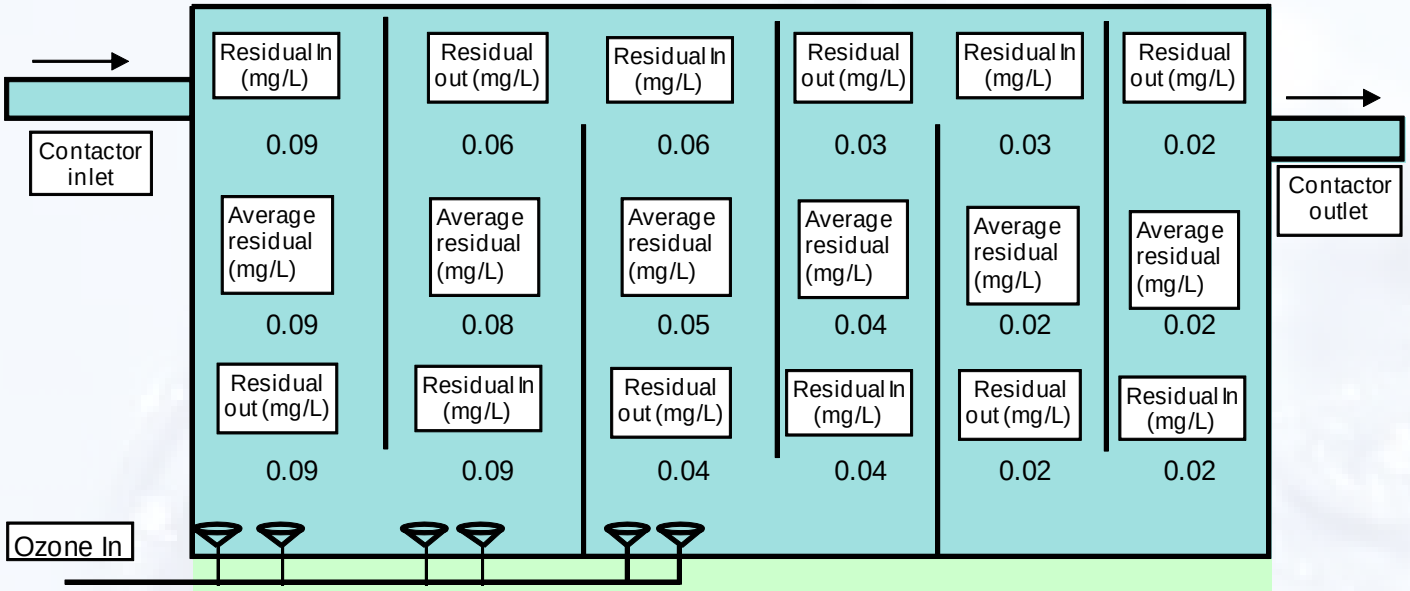
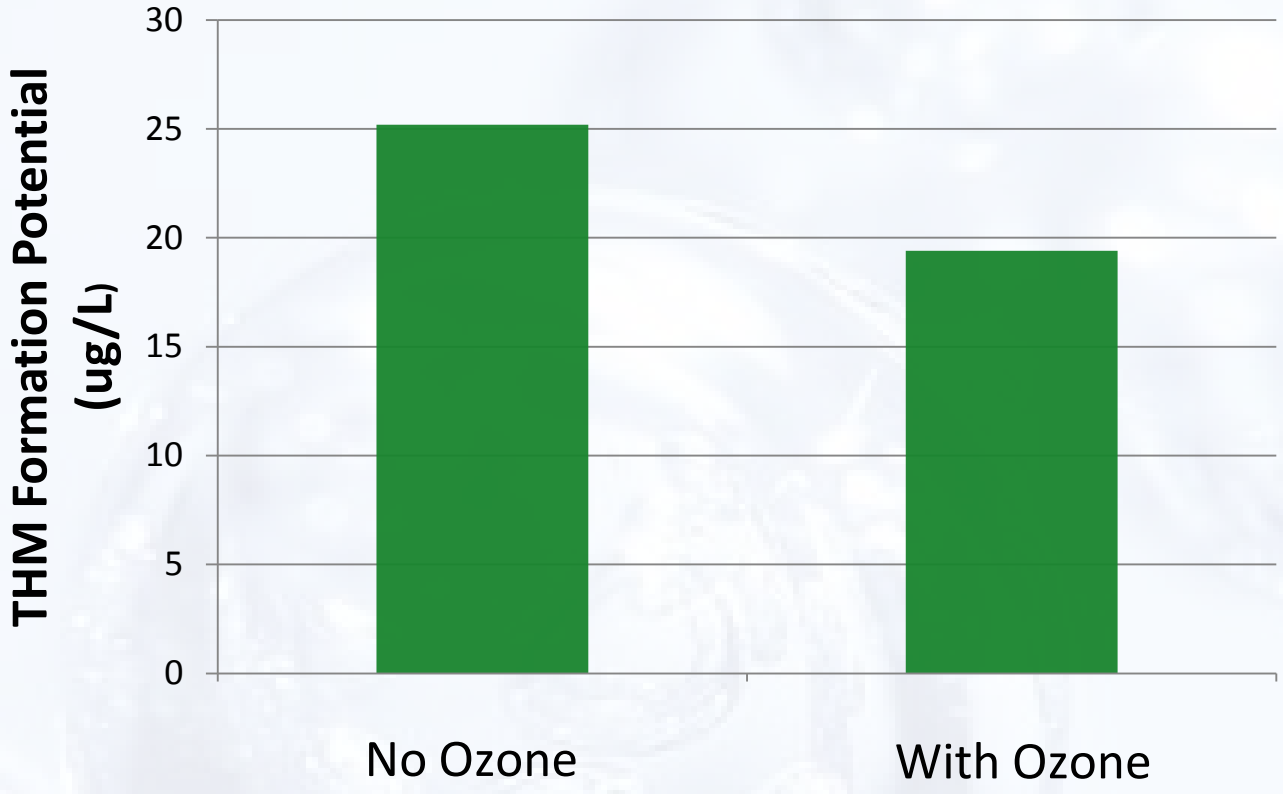
Ozone Disinfection Model



	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
CT (mg/L*min)	0.16	0.14	0.09	0.06	0.04	0.00
HRT (min)	3	3	3	3	3	0.001
T10 (min)	1.8	1.8	1.8	1.8	1.8	0.0006

Trihalomethane Formation Potential



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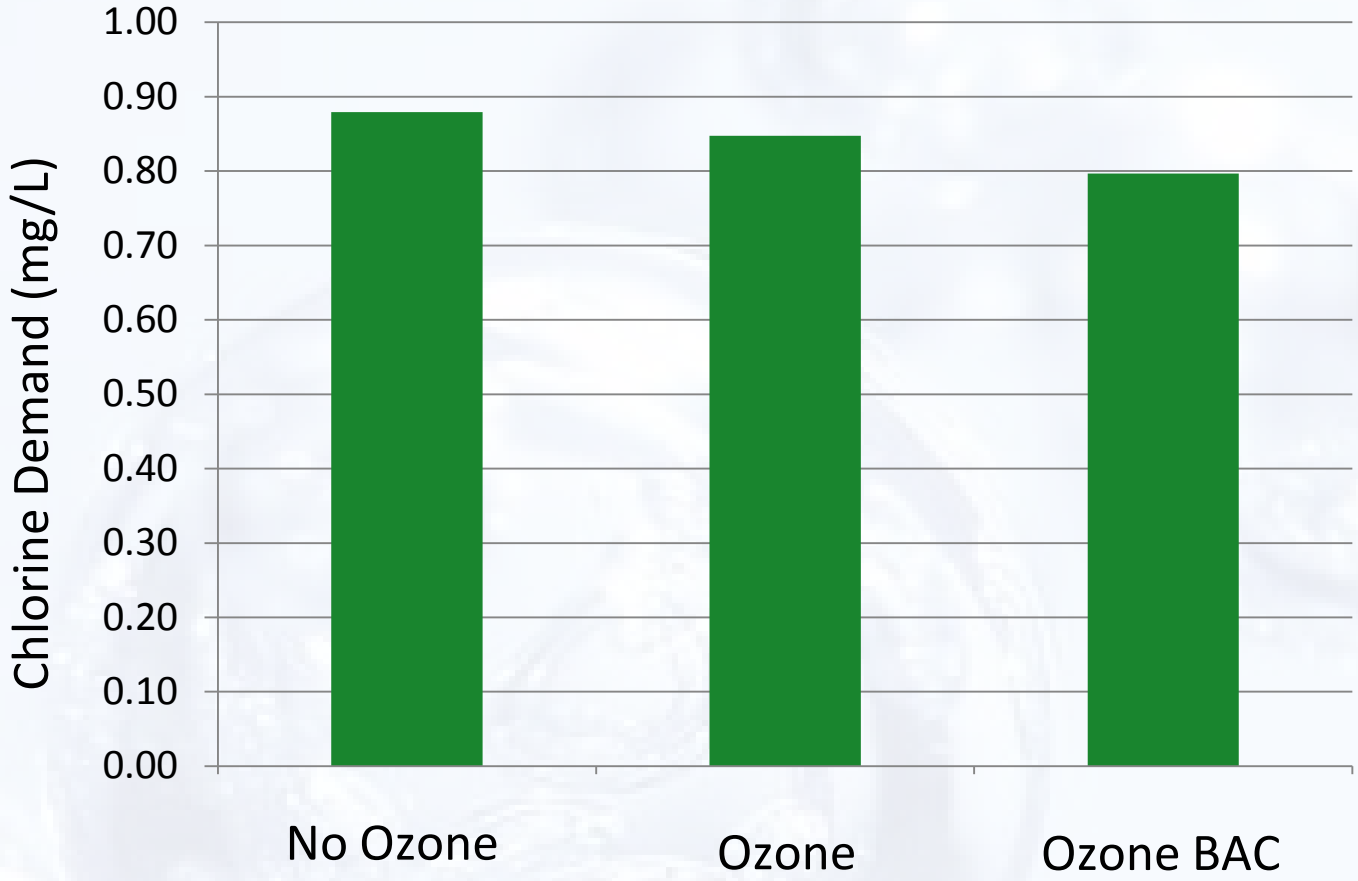
Chorine Demand



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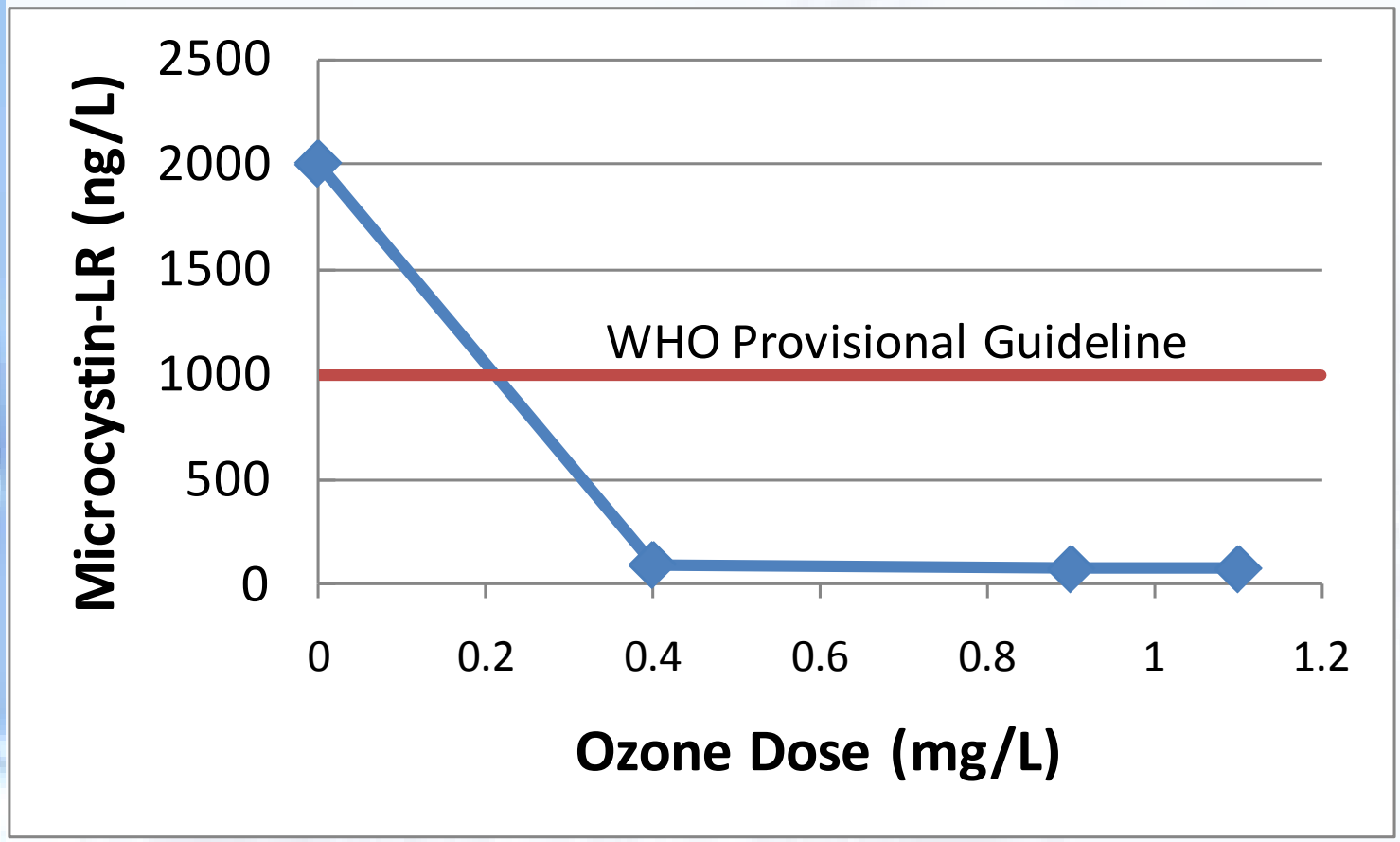
Microcystin-LR



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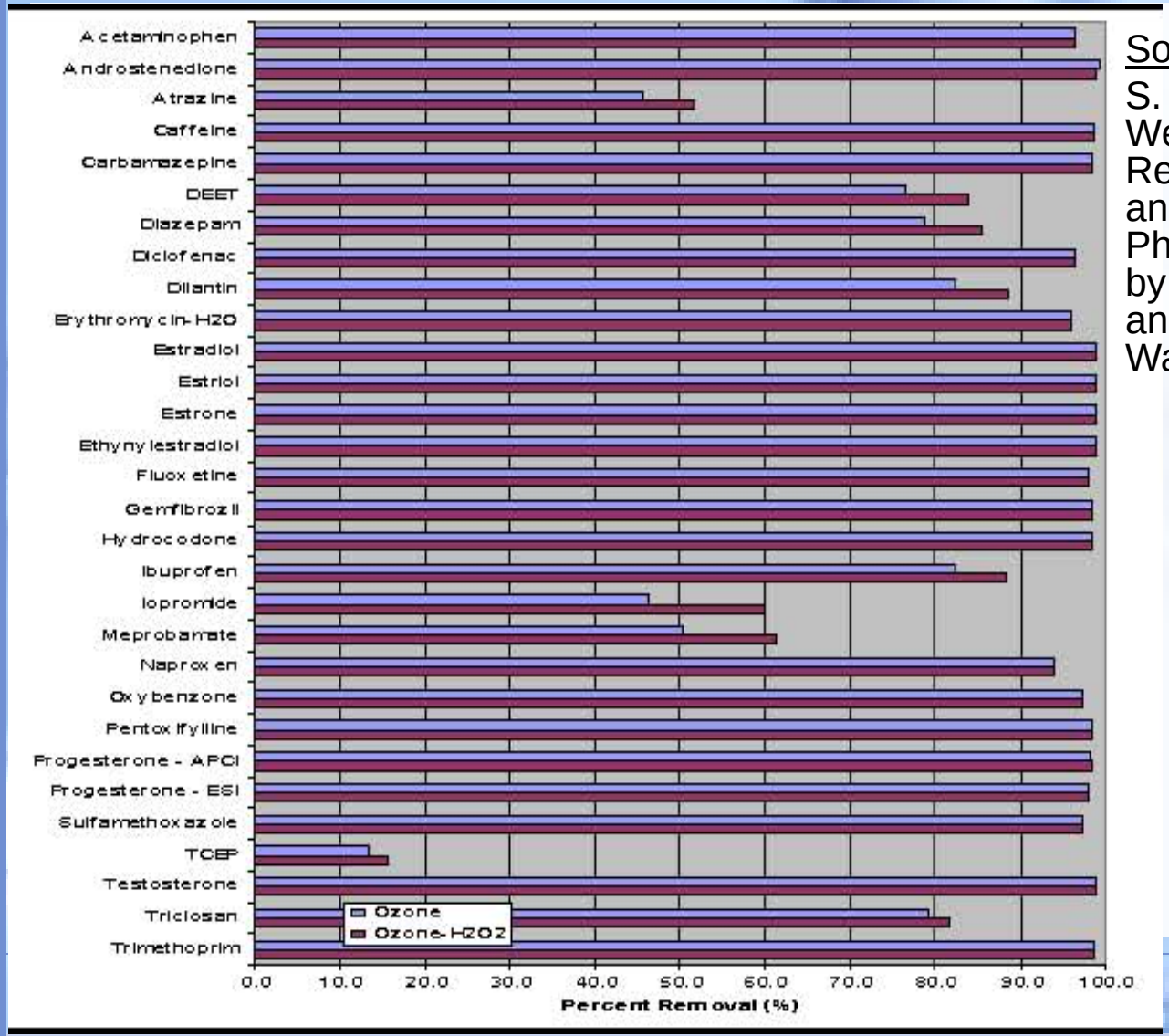
Pharmaceuticals and Personal Care Products (0.1-0.3 mg/L ozone residual)



Source:

S. Snyder, and P. Westerhoff. Removal of EDCs and Pharmaceuticals by Conventional and Advanced Water Treatment

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Ozone Byproducts

Formaldehyde (µg/L)

Filtered Water (no Ozone)	Filtered Water (ave 0.8 mg/L O_3)	BAC Filtered Water ave 0.8 mg/L O_3)
<5.0	7.0 (5.5 to 10)	<5.0

No MCL; 2,600,000 ug/L "tolerable limit" by Intern'l Pgm on Chem Safety

Bromate (10 µg/L MCL)

Ozone Dose (mg/L)	Bromate (µg/L)
0.3	<5.0
0.9	<5.0
1.1	<5.0

(Note Bromide <0.02 mg/L in source)

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Ozone Byproducts

Formaldehyde (µg/L)

Filtered Water (no Ozone)	Filtered Water (ave 0.8 mg/L O_3)	BAC Filtered Water ave 0.8 mg/L O_3)
<5.0	7.0 (5.5 to 10)	<5.0

Bromate (10 µg/L MCL)

Ozone Dose (mg/L)	Bromate (µg/L)
0.3	<5.0
0.9	<5.0
1.1	<5.0

(Note Bromide <0.02 mg/L in source)

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Filtration Performance Measures

- Turbidity to 0.1 NTU
- Headloss to 12-ft
- Unit filter run volume

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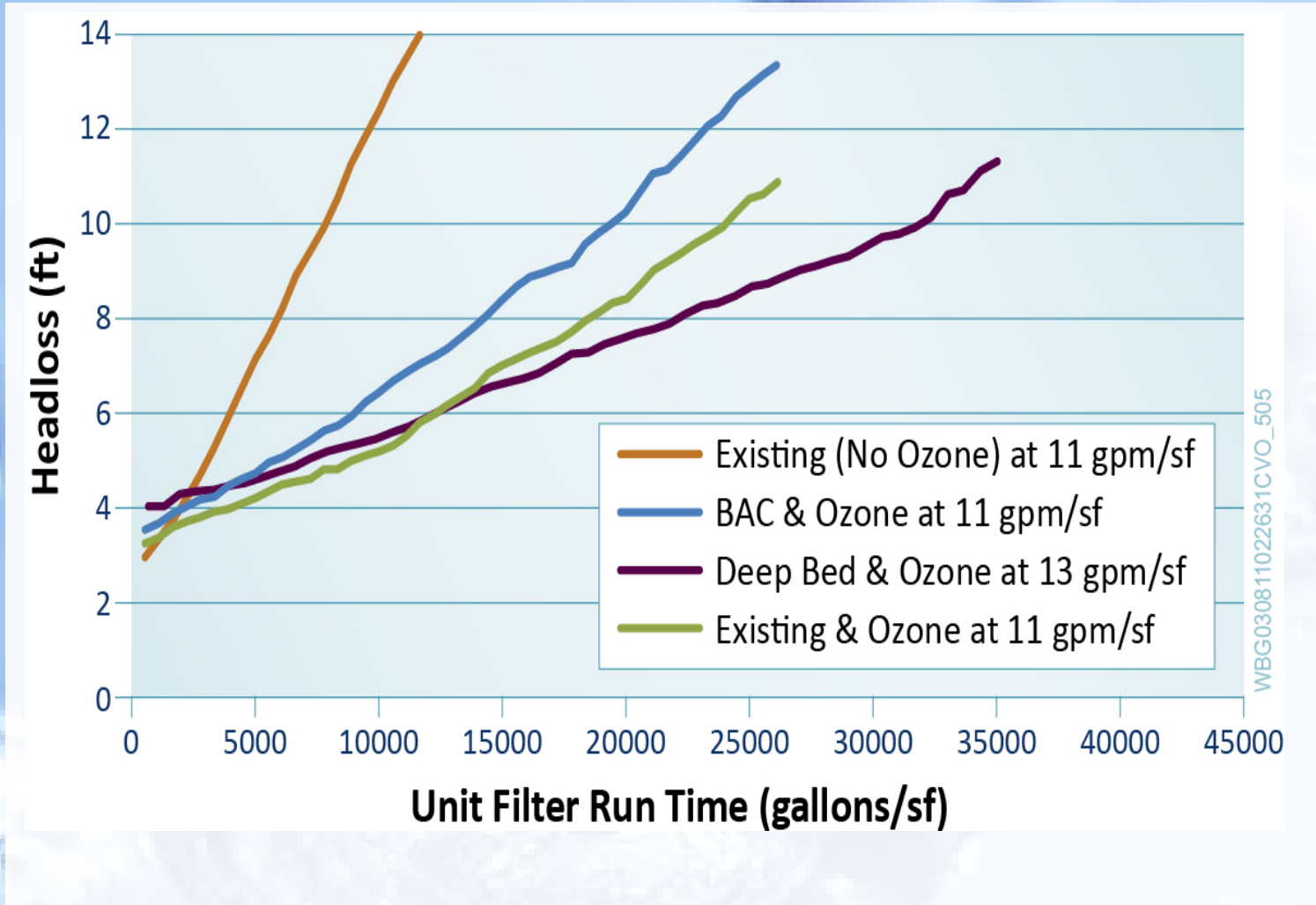
Typical Results



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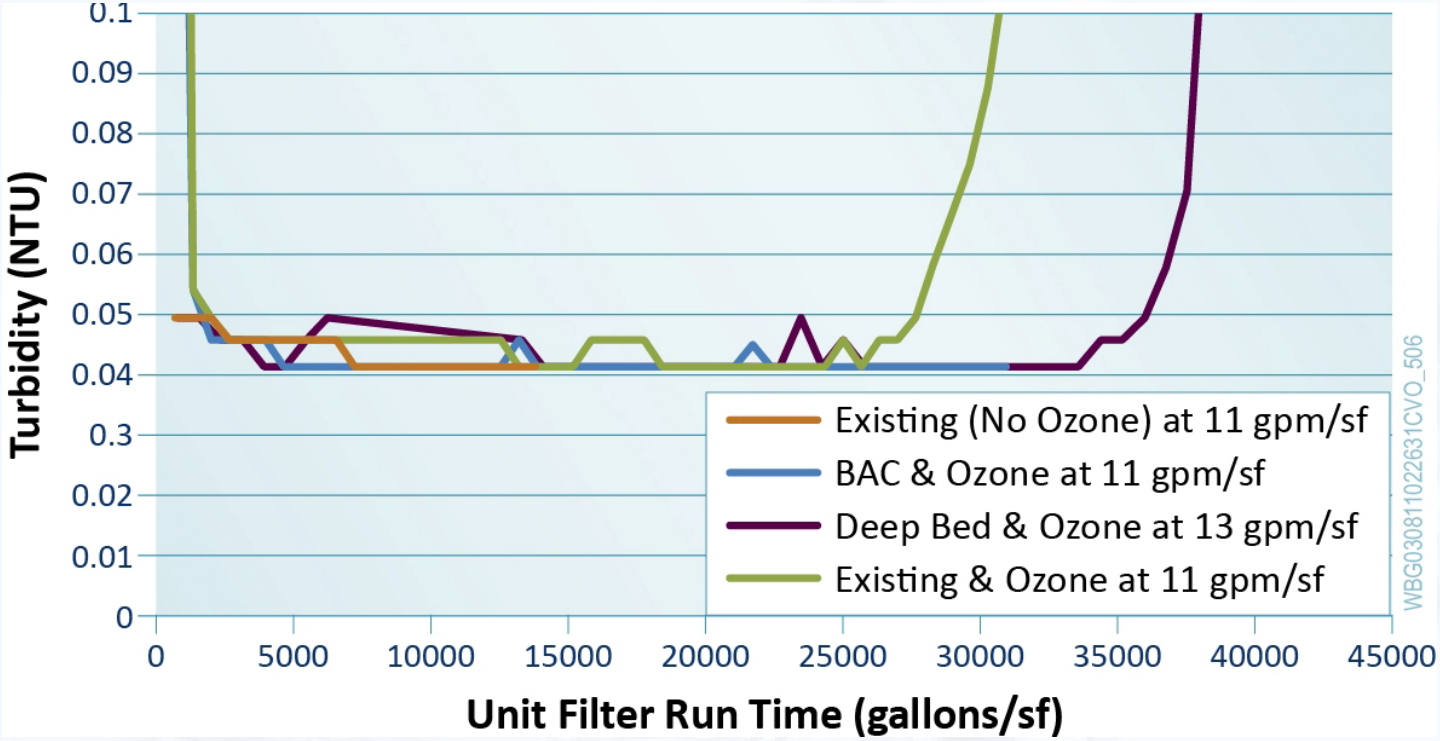
Typical Results



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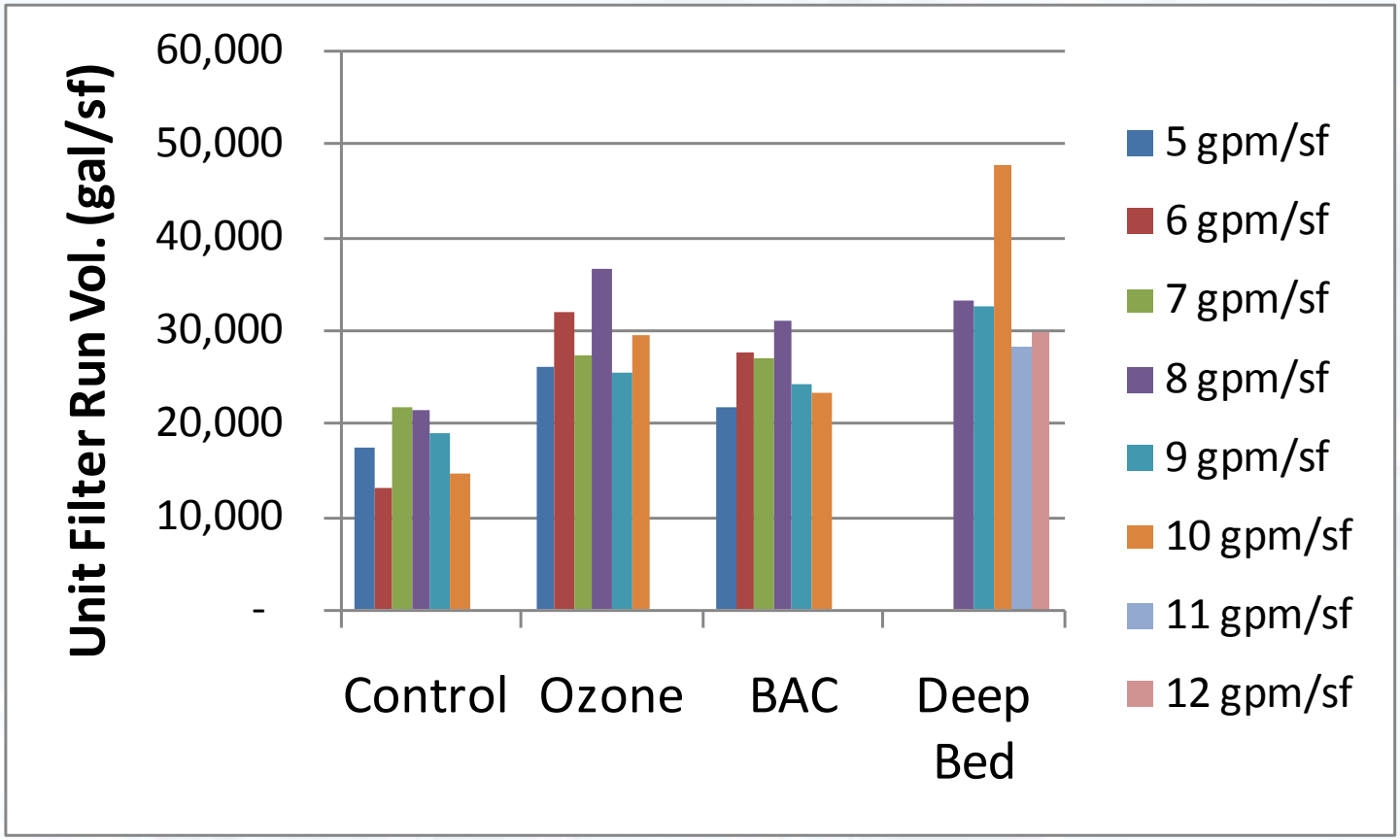
Ozone Improved Filter Performance



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Summary of Results

Issue	Result
Disinfection	1.2 mg/L
Tastes and Odors	1.8 mg/L
Algal Byproducts	>0.4 mg/L removes all MCLR
THMs	20 percent reduction
Chlorine Demand	4 to 10 percent reduction
Contact Time	5-min sufficient
Quench	Sodium Bisulfite for 1-min
Filtration	25% increase in Loading Rate 50% increase in productivity

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Incorporation of Ozone

Elev.

205

200

Ozone Generation Building

195

190

Settled Water

Ozone Contact Pipeline

185

180

Sed Basin and Outlet Flume

175

Ozone Injection

170

Ozone Contact Chamber

Note: Elevations are approximate and provided for general reference.

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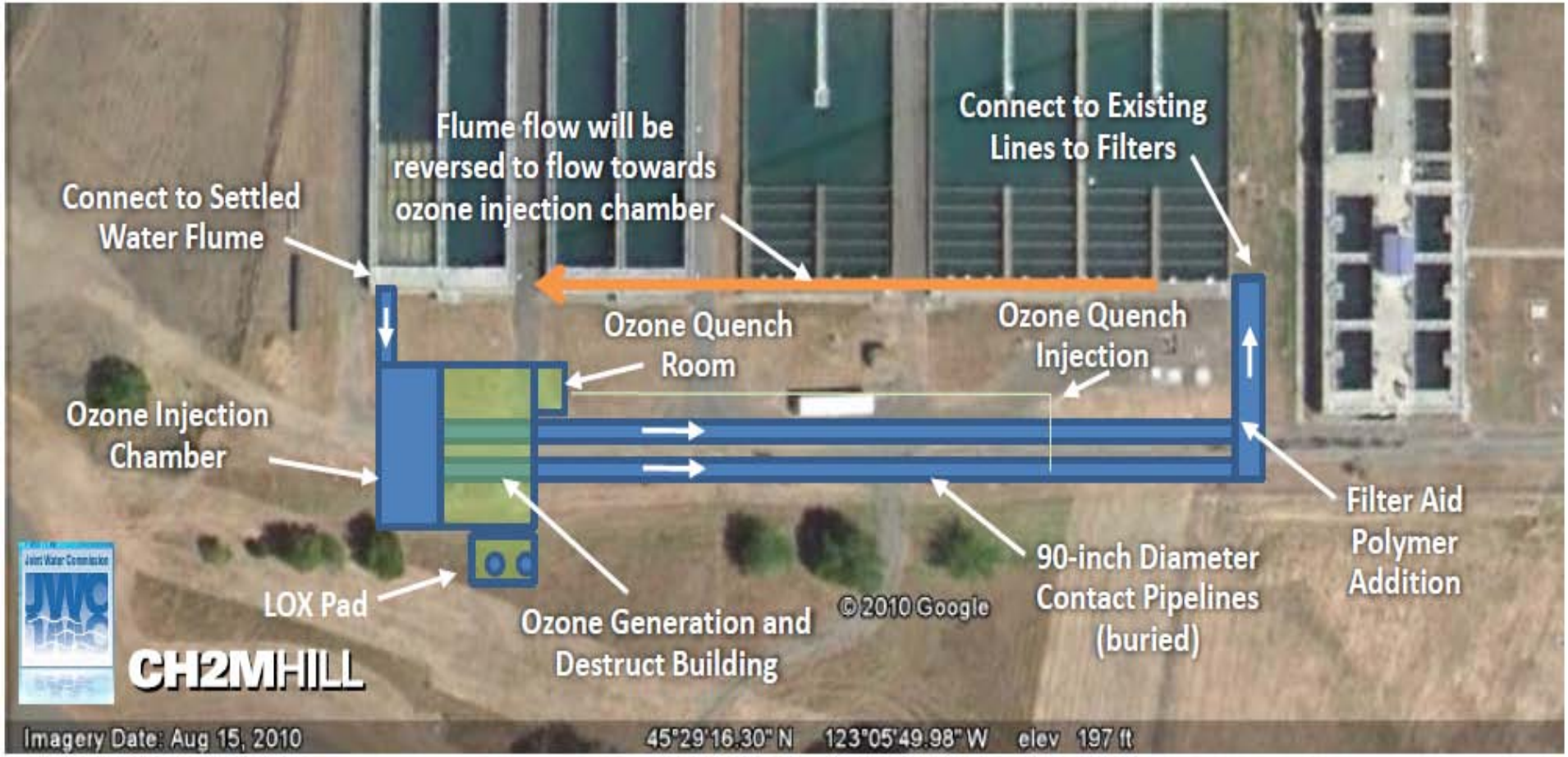
Incorporation in Existing Facility



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