

# Integrated Ozone Enhanced Biofiltration for Water Reuse

**Abigail Antolovich** 

WateReuse AZ Conference 2016 Flagstaff, AZ



### Potable Reuse Overview

### Advanced Treatment for Water Reuse

### Performance Data





## The Evolution of Potable Reuse



# Potable Reuse Benefits and Challenges

### **Benefits**

- Relieves Water Stress
- Less Energy Compared to Desalination
- Lower Capital Cost than Non-Potable Reuse
- Drought-Resistant
- Point of Waste = Point of Use
- Smarter Resource Management

#### Challenges

- Trace Organic Contaminants (TOrCs)
- Pathogens
- Public Perception
- Lack of Regulations
- Capital Cost of Advanced
  Treatment











Advanced Treatment is Needed to Address Water Quality Challenges

# **Ozone for Potable Reuse Applications**

### ✓Trace Organics Contaminants (TOrCs)

- Ozone is considered best available technology for destroying many emerging contaminants
- Ozone addresses both regulatory uncertainty and public perception of TOrCs



# Benefits of Ozone for Reuse

#### ✓ Improves aesthetics



#### ✓Ozone or ozone + biologically active filtration (BAF) may eliminate/minimize need for downstream reverse osmosis (RO)

- reduces membrane fouling
- enhances biologically active filtration
- increases UVT



## **Treatment Process Evaluation**



### Oxelia<sup>™</sup> is Greater Than The Sum of Its Parts...

#### Ozone Oxidation

- Disinfects (i.e. virus inactivation)
- Removes color and odor
- Reduces trace organic contaminants
- Increases biodegradability of recalcitrant organic carbon
- Supersaturates water with dissolved oxygen

### Ozone-BAF

- "Free" biology
- Destroys recalcitrant
  organic carbon
- Generates biologically stable effluent
- Eliminates toxicity
- Increases UVT
- Provides multiple-barrier

#### BAF Fixed-Film Biological Reactor

- Removes ammonia
- Removes TSS
- Reduces trace organic contaminants including NDMA
- Reduces oxidation byproducts



# **Treatment Goals**

Microbial Criteria	
--------------------	--

•

#### **Chemical Criteria**

- 12-log virus removal E
- 10-log Cryptosporidium removal
- 9-log total coliform removal
- Drinking water regulations Trace organic chemicals
- Disinfection byproducts

Unit Process	Pilot Evaluation Criteria				
Secondary Biological Treatment (CAS)	N/A				
Ultrafiltration (UF)	Total coliform				
Microfiltration (MF)	Total coliform				
Ozone (O <sub>3</sub> )	TOrCs, bromate, NDMA, MS2, total coliform				
Biologically Active Filtration (BAF)	TOrCs, bromate, NDMA				
Reverse Osmosis (RO)	TOrCs, bromate, NDMA				
Ultraviolet Photolysis (UV)	TOrCs, NDMA, MS2				
Advanced Oxidation Process (AOP) $(UV/H_2O_2)$	TOrCs, NDMA, MS2				
Free Chlorine (Cl <sub>2</sub> )	Chlorate, THM, HAA, MS2				

## **TOC Removal Results**

Avg. Transferred  $O_3$  Dose = 5.1 mg/L Avg.  $O_3$ :TOC Ratio = 0.88 Avg. EBCT = 15.2 min



- TOC removal ~40% after 4-6 weeks of operation
- Utilized exhausted GAC for study to eliminate adsorption impacts
- Increased UV Transmittance (UVT) from ~76% to ~89%

# **CEC Removal Results**



	Analyte	Units O	<b>)zone Effluen</b>	t BAC Effluent	% Removal
With 0./BAC 28/31 (90%) of CECs	TCEP	ng/L	170	15	91.2%
removed to below MRI	TCPP	ng/L	800	<100	>87.5%
Average removal of $272\%$ (2.0 E log) based	TDCPP	ng/L	280	<100	>64.3%
an MDLs	Iohexal	ng/L	760	480	36.8%
OTIMRLS	Sucralose	ng/L	5800	4000	31.0%

# **NDMA** Mitigation



NDMA formed by Ozone is removed by BAF

Ref: WRRF 11-02 Pilot Project

## **Bromate Minimization**



## Downstream Efficiency Improvement



Ref: Trussell Technologies IOA-PAG Dallas 2015

## Downstream Efficiency Improvement



- O3-BAF reduces organic fouling of membranes
- ~ 3x reduction in Transmembrane Pressure (TMP) Drop
- Reduces energy costs, cleaning and replacement frequency, and improves overall performance

Ref: WRRF 11-02 Pilot Project

# **Ozone/BAF Integrated Solution**





Integrated on-line monitoring / controlling system to achieve optimized operation at an economic cost

Consistent organics removal, optimized ozone dose and energy consumption

# Oxelia<sup>TM</sup> System Ozone Optimization

The Oxelia system can partially reduce the effluent TOC fluctuation and achieves lower effluent TOC value



## Conclusions

### O<sub>3</sub>/BAF Demonstrated the Following:

- Consistently achieved **40% removal of TOC**
- Mitigated the formation of NDMA by incorporating BAF downstream of O<sub>3</sub>
- **Decreased the potential for bromate formation** via targeted ozone dosing based on influent TOC levels
- Reduced TMP across downstream membrane process by approximately three-fold
- Improved overall efficiency of downstream treatment processes
- Reduced toxicity of RO brine discharge stream
- Integrated system results in optimized ozone dose and improved energy efficiency

# Acknowledgements

- •Keel Robinson (Xylem)
- Tony Zhang (Xylem)
- Aleks Pisarenko (Trussell Technologies)
- City of San Diego
- Fred Gerringer (Trussell Technologies)
- WateReuse Research Foundation
- Los Angeles County Sanitation District
- Andy Salveson (Carollo Engineers)

## Thank You



**Questions?** 

