AWWA Water Quality Technology Conference & Exposition (WQTC) 2022
November 13-: Cincinnati, Ohio

Session Descriptions & Objectives

Session Code	Session Title	Details	Session Date
AEESP	AEESEP - AEESP Emerging Investigator Lecture	Advancing Science and Engineering for Lead-Free Water: highlights of the joys and tribulations of a research career inevitably shaped by a pervasive old foe. It will unravel the chemistry that affects water lead contamination. It will then identify water sampling and lead quantification strategies to assess human exposure. By challenging outdated paradigms, this contribution will hopefully make the case for lead-free water. Speakers: Simoni Triantafyllidou	11/14/2022
MON01	MON01 - Screening, Monitoring, and Analysis	See description in subsessions below:	11/14/2022
MON01-01	A Framework for Prioritizing CEC Monitoring in Potable Reuse Treatment Trains	Attendees will learn about an approach used to screen for treatability of over 500 chemicals in advanced potable reuse, to identify priority chemicals for study, focusing on identifying chemicals that may be prone to breakthrough. This very broad screening study checked treatability of chemicals from the following lists: Federal Primary and Secondary Drinking Water Standards; USEPA Health Advisories; all UCM and UCMR Lists; California's DPR Regs, Candidate Contaminant Lists; Priority Pollutants; Eurofins PPCP list; in the SCCWRP 2018 CEC Report, and all the chemicals in WRF 4769 (Predicting Reverse Osmosis Removal of Unique Organics). Tools utilized included USEPA's EPISUITE Software and Emily Marron's Advanced Oxidation degradation model.	11/14/2022
MON01-02	Preparing for UCMR 5: A Laboratory Perspective	This presentation will review the challenges that we faced during preparing for UCMR 5 and provide an estimate of PFAS detection in UCMR 5.	11/14/2022
MON01-03	Analysis of Part per Trillion 1,4 Dioxane in Drinking Water by HSTrap/GC/MS	The accurate measurement of 1,4-dioxane is extremely important for this target is identified by the US Environmental Protection Agency (EPA) as a possible carcinogen. Very sensitive and accurate methods are imperative to protect public health. The analysis is challenging due to its high water-solubility, low vapour pressure and required reporting limits. Several methods have been employed including US EPA Methods 8260, 8270 and 522. The regulatory minimum reporting limit (MRL) can vary from 50 ppb to 0.3 ppb depending upon region. This presentation will focus on the methods to enable part per trillion detection of 1,4 Dioxane in drinking water and will include low level chromatograms, calibration curves and repeatability data.	11/14/2022
MON02	MON02 - Advanced Treatment for "One Water"	See description in subsessions below:	11/14/2022
MON02-01	Development and Application of an Accessible Method for the Quantification of 40 Emerging Halogenated DBPs in Wastewater for Reuse	An accessible method for detection of 40 emerging DBPs of health concern (e.g., haloacetonitriles, haloacetamides, haloacetaldehydes) in reuse water was developed and applied. Matrix method detection limits (9 ng/L to 0.7 µg/L for 33 species) were achieved using low sample volume (100 mL), one extraction (solid phase extraction), and detection with a single-quad GC/MS in a 30 min run. Quantification of Cl and Br analogues enables speciation evaluation. Insights into DBP occurrence in reuse-chlorinated wastewater effluent, using results from a survey of emerging DBP precursors in different wastewaters and a kinetic study of DBP formation and decay under different chlorination conditions, will also be presented.	11/14/2022
MON02-02	Implementation and Operations: Bioassays in Water Reuse	In the water reuse industry, determining compliant water criteria and developing the associated framework to ensure those standards are constantly met is a major challenge. This presentation will review the current application of bioassays for water reuse and discuss the challenges going forward.	11/14/2022
MON02-03	COVID-19 Containment on a College Campus via Wastewater-based Epidemiology, Targeted Clinical Testing and Intervention	A case study outlining application of WBE to test for and contain COVID-19 on a college campus	11/14/2022
MON03	MON03 - Algal Treatment in Reservoirs	See description in subsessions below:	11/14/2022

MON03-01	Ultrasonic Treatment of Harmful Algal Blooms	The increasing prevalence of harmful algal blooms throughout the world's freshwater sources threatens the efficiency of successive treatment processes necessary to produce good water quality and protect public health. As a result, the City of Newark, NJ Water Dept deployed LG Sonic MPC-Buoys in an NJDEP-funded project with the goal of preventing and controlling algal populations within the Echo Lake Reservoir by using ultrasonic technology to mitigate the buoyancy of cyanobacteria, consequently limiting their photosynthetic processes. This study evaluates the effectiveness of the LG Sonic MPC Buoys, summarizes the challenges associated with the treatment process, and outlines the cooperative efforts performed to reduce the algal population.	11/14/2022
MON03-02	Persistence of Ozone by Nanobubble Technology Deployed at a Reservoir Impacted by a Cyanobacterial Harmful Algal Bloom	Ozone nanobubbles are an emerging technology with potential to treat source waters impacted by harmful algal blooms (HABs). With bubble sizes < 1 µm, ozone nanobubbles have been reported to persist in water for weeks to months and enhance ozone lifetime compared to conventional ozonation. An 18-week field trial was conducted to evaluate the efficacy of ozone nanobubbles to treat a 42-acre reservoir impacted by HABs. Water samples were collected to quantify the cumulative ozone dose transferring from bubbles to solution over time. Ozone persisted up to 10 days after initial sampling. This work also studied the zone of influence of ozone nanobubbles within the reservoir as well as the gas utilization efficiency of the nanobubble unit.	11/14/2022
MON03-03	Success of Hydrogen Peroxide for Algal Management Across Three Regions of the United States	Hydrogen peroxide as a cyanobacterial bloom inhibitor has been successfully trialed at three utilities (OH, TN, CO). Each utility has experienced continued success, both financially, through lower chemical costs associated with toxin mitigation and algaecide costs in reservoir, and environmentally, with bloom frequency reduction or complete prevention. Ohio utility has experienced three years without a major bloom, Tennessee utility has seen major reductions in TOC entering the plant and Colorado utility has increased treatability and eliminated recreational closures. If used as a preventative tool, it is highly effective at mitigating HABs in drinking water reservoirs.	11/14/2022
MON04	MON04 - M/DBP Rule Revision Process: Overview and Data-Focused Analysis of Potential Revisions (STS)	This Special Topics Session will provide an overview of EPA's M/DBP rule revision process and key topics of interest. The session will summarize research findings for the two key topics for which data are available to support detailed analyses: (1) the potential implementation of a numeric minimum disinfectant residual and (2) the potential implementation of a HAA9 MCL.	11/14/2022
MON04-01	Overview of the M/DBP Rule Revision Process	Overview of the M/DBP Rule Revision Process	11/14/2022
MON04-02	DBP Aspects of the M/DBP Rule Revision	DBP Aspects of the M/DBP Rule Revision Process	11/14/2022
MON04-03	Disinfectant Residual Aspects of the M/DBP Rule Revision Process	Disinfectant Residual Aspects of the M/DBP Rule Revision Process	11/14/2022
MON05	MON05 - Protecting Our Local Drinking Water Sources through Watershed Monitoring (STS)	Hazardous material spills and harmful algal blooms are two key issues affecting drinking water sources in Ohio & surrounding states. Presentations will showcase the design and implementation of water quality monitoring programs to identify contaminants and provide early warning to treatment plant operators. They will also discuss important lessons learned over multiple years of implementation.	11/14/2022
MON05-01	Value of an Early Warning Spill Detection Water Quality Monitoring Network to Protect Drinking Water	The Ohio River Valley Water Sanitation Commission (ORSANCO) established the Organics Detection System to serve as an early warning monitoring network to detect unreported releases of VOCs and to track the location and magnitude of spills.	11/14/2022
MON05-02	Ohio's Experience with HABs: Drinking Water Treatment to Source Water Protection	The Ohio EPA developed HAB monitoring and notification protocols for public water systems following a 2014 cyanotoxin detection in Toledo's water supply. They recently filed the first revision of the rules and will share lessons learned.	11/14/2022
MON05-03	Proactive Strategies for Mitigating Harmful Algal Blooms (HABs) in Akron, Ohio	The presentation will focus on Akron's strategic response to HABs using source water protection strategies, applied research, routine monitoring, and proactive lake management to successfully mitigate HABs in a 107-year-old drinking water reservoir.	11/14/2022
MON06	MON06 - LCR, LCRR, LCRI – Lessons Learned on Road to Compliance (STS)	Compliance with the Lead and Copper Rule Revisions requires action now to prepare lead service line inventories, prepare for changes in monitoring, and importantly evaluation of corrosion control practice.	11/14/2022
MON06-01	Finding Lead Service Lines – Tools and Techniques – What Works?	The only 100% accurate way to identify service line materials is excavation – but this is not really practical. The presentation will describe recent developments in lead service line identification and verification approaches.	11/14/2022

MON06-02	GRR -- Utility Experience Identifying and Replacing Galvanized Pipe Requiring Replacement	We analyzed a robust dataset to illustrate how recent experience illustrates the degree to which the definition of GRR lines can impact the number of service lines presented as GRR in LCRR inventories and the resulting implementation burden.	11/14/2022
MON06-03	What Do You Mean My Monitoring Plan Is Changing? Lessons Learned From Early Implementation	The Lead and Copper Rule Revisions (LCRR) included significant changes in compliance monitoring. The presentation will illustrate the impact of LCRR implications based on the MWRA's and its members efforts to prepare with the Revisions.	11/14/2022
MON06-04	What Does It Take? – Corrosion Control Studies Consistent With LCRR	Producing water with low corrosivity is an important tool for meeting the water quality provisions of the LCRR. Performing Corrosion Control Evaluations (CCEs) are central to the selection of CCT and compliance with LCRR requirements.	11/14/2022
MON06-05	Filters – Do They Really Work? – Data From Three Communities With Lead Action Level	POU filter lead reduction claims have been questioned by some resulting in the carrying out of several large scale filter performance demonstration studies including two performed by the EPA.	11/14/2022
MON07	MON07 - WRF 5082: Investigation of Alternative Management Strategies to Prevent PFAS from Entering Drinking Water Supplies and Wastewater (STS)	This session showcases results from a Water Research Foundation project about identifying and preventing PFAS sources to water. It will feature: •An interactive PFAS survey •GAC PFAS removal in secondary effluent to protect the Great Lakes •A thorough investigation of PFAS sources within an urban watershed •Biosolids application impacts on groundwater •A One Water Q&A Panel	11/14/2022
MON07-01	Evaluation of the Efficacy of GAC PFAS Treatment in Secondary Effluent	RSSCTs revealed that GAC can remove PFOS and PFOA from municipal wastewater, but PFHxS and PFHxA are less effectively treated. Estimated costs and effectiveness are presented using several case studies.	11/14/2022
MON07-02	Impacts of Biosolids Land Application on	Data from multiple studies will be presented on PFAS in groundwater near biosolids application sites.	11/14/2022
MON07-03	PFAS Sources in an Arid, Urban, Wastewater-Dominated Watershed	PFAS sources were investigated and quantified in an arid, urban watershed including wastewater treatment facilities, an airport, and a military site.	11/14/2022
MON08	MON08 - Metals Mitigation	See description in subsessions below:	11/14/2022
MON08-01	Strategies to Implement Ion Exchange to Meet the Proposed Hexavalent Chromium (CR(VI)) Regulation in California	In March 2022, the State of California proposed a maximum contaminant level (MCL) for hexavalent chromium (Cr(VI)) of 10 µg/L. Strong base anion exchange is a proposed best available technology (BAT), but the economics are largely dependent on the cost of regeneration and waste brine disposal. This presentation compares three strategies to decrease treatment costs, including single use resins, direct brine reuse, and brine treatment followed by reuse.	11/14/2022
MON08-02	Challenges Involved in Lithium Treatment; Findings of the Inorganic Committee's Lithium Workgroup	Inclusion of lithium in UCMR5 indicates the EPA's interest in potentially regulating lithium in drinking water. In this presentation members of the Inorganic Contaminants Committee Lithium Workgroup will review its assessment of the issues the drinking water industry will face if the treatment of lithium is required.	11/14/2022
MON08-03	Is the Current Manganese SMCL Irrelevant?	This presentation will review the justification for the existing manganese Secondary Maximum Contaminant Level (SMCL) of 0.050 mg/L and evaluate, in light of recent research, if the existing SMCL is justifiable or even relevant.	11/14/2022
MON08-04	Applied Operations Experience with Second Stage Contactors for Manganese Removal	Manganese occurrence in drinking water has caused aesthetic water quality issues for consumers above 0.02 mg/l and although there is no regulated maximum contaminant level, EPA advises that infants do not consume water above 0.3 mg/l. The removal of trace amounts of manganese from surface water can prove challenging when balancing other treatment objectives. This presentation focuses on application of second stage contactors as part of a new 12 MGD DAF/GAC facility. Design considerations including media type, media depth, loading rates and media conditioning process to generate an oxide coating for manganese removal as part of this $50 million water treatment plant upgrade will be discussed.	11/14/2022
MON09	MON09 - UV-AOP, Where Do We Go From	See description in subsessions below:	11/14/2022
MON09-01	Optimizing Radical Yield by the Spectral Diversity of UV Light Emitting Diodes	This research analyzes the advantages of UV light emitting diodes in increasing the rate of photon absorption for the conversion of a radical promoter into free radicals. In comparison with conventional UV sources, LEDs can be engineered to emit at wavelengths of choice and thus can increase photon utilization in an AOP, especially in high photon-scavenging waters, improving contaminant degradation and system electrical efficiency.	11/14/2022

MON09-02	Influence of Wavelength on Production of Chlorine Reactive Species and Treatability of Degradation By-Products	The UV/HOCl advanced oxidation process (AOP) is considered a new means for the removal of micropollutants when compared with the conventional UV/H2O2 process. One of its appealing features is it can be operated with ultraviolet light emitting diodes (UV-LEDs) which allow for flexibility of operation, reactor design and the potential to operate the UV/HOCl process at targeted wavelengths. Existing UV/HOCl studies do not account for the impact of wavelength of irradiation on radical generation and micropollutant degradation. This work investigates the influence of the wavelength of irradiation on production of radical species in the UV-LED/HOCl process and, in turn, the degradation of pesticides and the treatability of transformation products	11/14/2022
MON09-03	Maximizing Your Return on UV AOP for Potable Reuse	With potable reuse, UV systems treating RO permeate are used to achieve 6 log adenovirus inactivation, NDMA photolysis, and 0.5 log 1,4-dioxane reduction. With this work, CFD-based UV dose models were used to evaluate the impact of inlet piping on UV dose delivery by two UV systems, and develop UV dose algorithms that account for the UVT increase that occurs through reactors because UV reduces chloramines, the main UV absorber in RO permeate. While poor UV system inlet piping can reduce UV dose delivery by 60 percent, perforated baffle plates or UVDGM compliant piping can counter these impacts. Algorithms that account for increasing UVT provided 50 percent benefits in terms of dose delivery compared to algorithms that use only inlet UVT.	11/14/2022
MON09-04	A New Way to Measure ·OH Scavenging Capacity and Applications for Advanced Oxidation Processes in Drinking Water	Hydroxyl radical (·OH) scavenging capacity is an important parameter for advanced oxidation processes as it affects the target contaminant treatment rate. The ·OH scavenging capacity has historically been difficult to measure, but a recently reported simpler method now allows more accessible measurement. A case study employs the new method to explore potential spatial and temporal variations in scavenging capacity across six drinking water treatment plants over 1 year that use or may be considering future AOP treatment. The study demonstrated that the scavenging potential may change across treatment and with time. It is recommended to routinely collect the scavenging capacity data to better design/operate the AOP system.	11/14/2022
MON10	MON10 - Monitoring and Tracking of Algae	See description in subsessions below:	11/14/2022
MON10-01	Columbia River 2022 Cyanotoxin Investigation Project	The neurotoxin anatoxin-a was detected in water samples collected in September 2021 along the banks of the Columbia River in Washington State following the deaths of several dogs. The toxin was detected in 5 different drinking water intakes and in 3 public water system entry point water sample locations. Anatoxin-a is an unregulated emerging contaminant produced by cyanobacteria. This two-month long event on the fourth largest river in North America was the first cyanotoxin occurrence on a free-flowing river source in the State. This presentation will share the findings of the resultant 2022 surveillance project and the experiences and lessons learned from organizing a health district and four cities to work together to face a common threat	11/14/2022
MON10-02	Detroit River Phytoplankton From Water Treatment Plant Data	Historical phytoplankton biodiversity from the Detroit River was compared to more recent data recorded at a Detroit-area drinking water treatment plant. Counts at the genus level were recorded for the following groups: diatoms, cyanophyta, chlorophyta, flagellates and protozoa. Diversity analysis comparison was completed using the historical and present-day data. The preliminary results show temporal changes in the community with Navicula being the most common diatom in the river presently when compared to data over 50 years ago. As lakes and rivers face more anthropogenic impacts these types of studies might reveal trends that could help shape future behavioral changes when it comes to our surface water resources. The application also pro	11/14/2022
MON10-03	Microbial Biomarker-Based Early Warning of CyanoHABs: an Implication towards Safe Drinking Water Production and Water Security	Repeated incidence of cyanobacterial harmful algal blooms (CyanoHABs) in freshwater lakes has caused challenges for safe drinking water production. The situation becomes even more challenging when a sudden increase in toxin level occurs. This necessitates the development of early warning tools to predict the occurrence of CyanoHABs. We performed 16S rDNA sequencing and quantitative real-time PCR analysis coupled with physicochemical measurements to identify microbial signatures as early warning biomarkers based on our monitoring of 2021 blooms in two Ohio Lakes. These early warning biomarkers will help water treatment plants take appropriate measures to produce safe drinking water and confirm water security during CyanoHAB events.	11/14/2022

MON10-04	The Effect of Local Physical Lake Conditions on the Vertical Heterogeneity of Cyanobacteria and Microcystin in Stratified Eutrophi	Using easily measurable local physical lake conditions to predict and forecast HAB and cyanotoxins in source water. This presentation will also help inform HAB management and response plans by outlining "Where, When and How many" samples are necessary to understanding cyanobacteria and cyanotoxins.	11/14/2022
MON11	MON11 - Tackling Chloramination and Nitrification Challenges	See description in subsessions below:	11/14/2022
MON11-01	Using Oxidation Reduction Potential To Monitor Chloramine Levels in Drinking Water in Washington, D.C.	DC Water has chloramine for a secondary disinfectant and some areas in Washington, D.C. experience low disinfectant residuals. DC Water is investigating methods to monitor chlorine residuals real-time at several locations susceptible to low residuals. While chlorine sensors can be expensive and require regular maintenance, oxidation reduction potential (ORP) sensors which have been used to monitor chlorine in pools are cheaper and easier to maintain. The use of ORP sensors to monitor chloramine in the DC distribution was investigated through a field study on the relationship between chloramine concentration and ORP of water sampled from hydrants and a pilot study on ORP sensors installed in a DC neighborhood.	11/14/2022
MON11-02	Multivariate- and Molar Absorptivity-Based Chemometric Models for Quantifying Nitrite and Nitrate in Chloramine Systems	NO2- and NO3- chemometric models (CMs) have been formulated using ultraviolet absorbance spectra, however their generalizability and accuracy under conditions in chloraminated drinking water distribution systems (CDWDSs) is unknown. We demonstrated that the second derivative of molar absorptivity (E'') was circa zero for natural organic matter, in contrast to the E'' spectra for NO2-, NO3-, Br-, and NH2Cl. An E''-based CM formulated from spectral deconvolution had root-mean square errors of 0.042- and 0.046 mg/L-N for NO2- and NO3-, respectively, among thirteen cycles of nitrification stimulation and arrest with four feed waters (n=651). The E''-based CM could be used to accurately track NO2- and NO3- under conditions relevant to CDWDSs.	11/14/2022
MON11-03	Assessment of Chloramine Decay and Nitrification Potential Following Orthophosphate Addition in a Full-Scale Distribution System	This study examines the effects of orthophosphate addition on chloramine decay in a full-scale chloraminated DWDS located in Ontario, Canada. This was obtained through a batch study on water samples collected from four different sites in this DWDS after years of continuous orthophosphate addition. The results were then compared to data collected from the same sites prior to orthophosphate addition (a previous study) to elucidate orthophosphate impacts on chloramine decay. This study offers novel insights on the under-explored topic of orthophosphate addition at the full-scale DWDS level. It also shows how this approach can be used to better understand operational change impacts on chloramine decay and nitrification.	11/14/2022
MON11-04	Chloramine Concentrations within Distribution Systems and Their Relationship on Heterotrophic Bacteria and NTM	EPA conducted a research study to understand how maintaining various drinking water distribution system disinfectant residual concentrations (affected by water age or operational practice) corresponded to the microbial communities (heterotrophic bacteria and Mycobacteria) found in the water, and the formation of disinfection byproducts (trihalomethanes (THMs) and haloacetic acids (HAAs)).	11/14/2022
MON12	MON12 - Taste & Odor - Source to Treatment	See description in subsessions below:	11/14/2022
MON12-01	Dealing with Taste & Odor Issues from Watershed to Tap for Maryville, MO	The City of Maryville, MO is currently experiencing issues with harmful algal blooms (HAB) in Mozingo Lake, their surface water supply, resulting in taste and odor (T&O) events within the distribution system. Long-term solutions will look at major rehabilitation work at the existing plant, or construction of a new WTP designed for treating surface water with T&O. HDR assisted the City with several short-term mitigation measures to reduce T&O while the ultimate long-term solution is developed, including implementing an algaecide application program for control of HABs, and installation of a granular activated carbon (GAC) contactor at the existing WTP for removal of T&O.	11/14/2022
MON12-02	Unprecedented Earthy/Musty T&O Episodes in the Bow River, Calgary: Investigating Causes and Maintaining Consumer Trust	When drinking water is perceived by consumers as aesthetically unpleasing as a result of off taste, odour or appearance, it erodes public trust in their water utility. The unprecedented 2020 and 2021 geosmin events in Calgary's source water will be described, along with the on-going work aimed at understanding why these odour events are occurring and the incorporation of aesthetics into Calgary’s drinking water Customer Levels of Service will be briefly discussed.	11/14/2022

MON12-03	Key Findings from the Saint Paul Regional Water Services Pilot Study	This presentation will provide an overview of the results from the 12 month pilot study conducted for the Saint Paul Regional Water Services. The pilot plant encompassed the entire water treatment process of lime softening/recarb, ozone/BAC, disinfection, and pipe corrosion loops and consisted of 4 parallel treatment trains. This presentation will provide an overview of the key findings from the study including those with full-scale design and operational implications as well as those with industry wide research value.	11/14/2022
MON12-04	Better With Age: Ozone's History and Path Forward at the Mannheim Water Treatment Plant	Ozone has been an integral treatment process at the Region of Waterloo's Mannheim Water Treatment Plant since commissioning in 1992. In 2018 an ozone system review was conducted to identify potential risks to the long-term operation of this essential system. Following the review, upgrades including replacement of fine-bubble diffusers with side stream ozone injection, calcium thiosulphate quenching system upgrades, and other modifications have been completed. Significant water quality improvements were observed following commissioning of side stream injection as demonstrated by improved ozone transfer efficiency as well as reduced chlorine costs. Upgrades to the calcium thiosulphate system have reduced ambient ozone gas alarm frequency.	11/14/2022
MON13	MON13 - Lead Corrosion Control Case Studies	See description in subsessions below:	11/14/2022
MON13-01	How Do I Know if a Corrosion Control Treatment Change Is Working? Portland's In-Home Lead Monitoring Through a Major CCT Change	Regulatory LCR sampling is too infrequent to inform operational decision making during a corrosion control treatment (CCT) change. The Portland Water Bureau recently upgraded its CCT system to further increase pH and begin to purposely control alkalinity. Four supplemental lead and water quality monitoring programs were enacted to inform operations of the new treatment facility and ensure it was having the desired effects on lead in water. These programs are compared for their ability to provide frequent results, consistent customer participation, and paired water quality data. Utility insights will be shared useful for implementing any CCT change, especially in systems where premise plumbing is a key component of lead exposure.	11/14/2022
MON13-02	Managing a Lead Service Line Replacement Program: Trenton Water Works Case Study	Trenton Water Works has conducted over 9,000 full lead service line (LSL) replacements since 2020 with $50 million in contracts. TWW has approximately 20,000 more LSL replacements to complete under the state of NJ's mandate to replace all LSLs by 2031. With the revised federal Lead and Copper Rule becoming effective in October 2024, water utilities should start their inventories and replacement planning immediately. The Trenton Water Works case study can provide valuable insight into best practices.	11/14/2022
MON13-03	Considerations and Blending Strategies for Drinking Water System Integration with Alternative Water Supplies	Introduction of alternative water sources, such as direct potable reuse and desalination, into existing drinking water distribution systems offers resiliency in water supply but holds the potential for corrosion and biological growth impacts. Distribution system and premise plumbing scale and microbiology are complex, with many variables potentially impacting water quality. Pipe loop testing will be presented that evaluated impacts of gradual introduction of advanced treated wastewater (ATW) on cast iron pipe with iron and manganese tuberculation, copper pipe with lead solder, and brass materials. This presentation will provide strategies to mitigate adverse impacts on introducing a new water supply.	11/14/2022
MON13-04	30 months of Progress on Denver Water's Lead Reduction Program	Lessons learned and successful outcomes after 30 months of operation under the Denver Water Lead Reduction Program.	11/14/2022
MON14	MON14 - Performance and Cost of PFAS Control	Performance and cost modeling of PFAS treatment will be evaluated for various technologies provide insight on the most cost effective approaches to control PFAS in an uncertain regulatory world.	11/14/2022
MON14-01	Investigation of Treatment Alternatives for Short-Chain PFAS – an Executive Summary	Presentation Description: This presentation will summarize results from The Water Research Foundation Project 4913 that investigated (1) the occurrence of short-chain PFAS in drinking water sources including groundwater, surface water, and treated wastewater and (2) the effectiveness of treatment options for their removal.	11/14/2022
MON14-02	Pilot-Scale Evaluation of GAC and IX for Removal of PFAS from Groundwater: Results and Conclusions from a Dual Media Approach	As Phase I of a PFAS removal evaluation, a collaborative pilot-scale study of two granular activated carbons (GACs), bituminous and sub-bituminous, was conducted to compare GAC PFAS removal performance to two ion exchange (IX) medias, macro-type and gel-type. For all medias, it was demonstrated that selectively of the linear PFAS isomers was higher than that of the branched. Additionally, removal of short-chain PFAS, e.g. PFBA & PFPeA, was greatest with GAC medias. As Phase II of the work, an attempt was made to leverage the strong points of each media in a lead-lag IX-GAC configuration, though comparing lead-lag performance was confounded by the separation of linear and branched isomers across the treatment train.	11/14/2022

MON14-03	PFAS Removal by GAC: Impacts of Water Matrices, PFAS and GAC Properties and Treatment Goals	Per- and polyfluoroalkyl substances are ubiquitous in the aquatic environments, raising increasing public and regulatory attention. Granular activated carbon (GAC) adsorption is commonly used in water treatment for PFAS removal. Despite its widespread application, important information about the performance of GAC in a wide range of treatment scenarios is lacking. For example, the impact of different factors on GAC performance remains unclear, such as dissolved organic matter (DOM) type and concentration, major ion type and concentration, non-fluorinated constituents of aqueous film-foaming foam (AFFF), GAC characteristics, and empty bed contact time (EBCT). The objectives of this research are to fill important data gaps by conducting rapid	11/14/2022
MON14-04	Development of PFAS Treatment Cost Curves to Inform PFAS Treatment Feasibility in Adsorption and Membrane Applications	Treatment cost remains a critical driver in PFAS treatment selection, yet there is a dearth of information related to cost estimation for PFAS removal technologies. Using EPA WBS cost models and experimental data gathered as part of Water Research Foundation project 4913, PFAS treatment cost curves were developed for GAC, IX, and high-pressure membranes applications. These cost curves were used analyze the impact of operating conditions, disposal alternatives, process selection, and treatment goals on the overall PFAS treatment cost. The feasibility of PFAS treatment alternatives were calculated using affordability ratios to estimate the influence of PFAS treatment installations on monthly water bills in the United States.	11/14/2022
OGS	OGS - Opening General Session	Join us Monday at 8:30 a.m. in Junior Ballroom C & D for the Opening General Session with Robert Bilott, a partner in the Cincinnati and Northern Kentucky offices of the law firm, Taft Stettinius & Hollister LLP, where he has practiced in the Environmental and Litigation Practice Groups for over 31 years. Robert Bilott will provide an overview of the scientific, legal, and regulatory history of our discovery of worldwide PFAS “forever chemical” contamination and the efforts undertaken over the last several decades to hold those who caused the problem responsible.	11/14/2022
ST30012610	The Conundrum of the PFOA Human Half-life: Findings from an International Collaboration	The developing consensus position from this international collaboration is that the likely PFOA half-life in humans lies in the general range of 0.5 to 1.5 years, based studies that do not have significant problems with unmonitored PFOA exposures and unmeasured branched chain isomers.	11/14/2022
ST30012729	The A to Zs of Pipe Rig Studies: Fit-for-Purpose Guidance	Water systems need to be prepared for the CCT requirements under the LCRR. As part of WRF 5081, a “fit-for-purpose” guidance document is being developed which will greatly advance industry understanding of how to conduct pipe rig studies, resulting in improved public health outcomes through selection and implementation of optimized CCT, and by facilitating primacy agency acceptance of results.	11/14/2022
ST30012735	Developing OCCT Through Coupon and Pipe Loop Studies: Utility Success Stories	This session will present case studies highlighting coupon and pipe-loop studies used to develop OCCTs. Industry experts have collaborated with water utilities to conceptualize, design, and operate these studies. Evaluation of corrosion from lead, copper and brass fixtures, as well as comparative results from pH/ alkalinity adjustment and application of corrosion inhibitors will be discussed.	11/14/2022
ST30012861	Destructive technologies for PFAS in water treatment residuals during water and wastewater treatment	This session will feature the destructive PFAS technologies: advanced reductive processes, electrooxidation, and thermal treatment of granular activated carbon. Additionally, these studies have additional emphasis on real water treatment residuals such as ion exchange regenerant, membrane brines, and activated carbon.	11/14/2022
T1 - Technical F	Richard Miller Treatment Plant & Triple Steam Pumps	A tour of the Greater Cincinnati Water Works will include a history of the utility and 200 years of progress in both water distribution and treatment. The tour will take place in a 100-year-old pump station at the Richard Miller Treatment Plant containing four large triple-expansion steam engines and will include a visit to the pump floor where you will stand six feet beneath the floor of the Ohio River.	17-Nov
TUE01	TUE01 - Current Perspectives on Risk Assessment	This session will focus on the occurrence of unregulated contaminants, approaches to risk characterization for unregulated contaminants and contaminant mixtures, and the effectiveness of biofiltration and granular activated carbon adsorption for risk management. The session will conclude with a panel discussion to explore implications on policy, source water quality management, and treatment.	11/15/2022
TUE01-01	Assessing Shifts in DBP Occurrence, Speciation, and Corresponding Risk Reduction Since Stage 2 DBPR	This talk will assess shifts in disinfection byproduct (DBP) occurrence and speciation since the Stage 2 DBP Rule. Shifts in DBP speciation will be conveyed in context with health risk reference values and opportunities for risk reduction.	11/15/2022

TUE01-02	Risk-based Water Quality Monitoring: Integration of High-throughput BioAssays and Data Science	This talk will describe a novel, feasible and cost-effective quantitative toxicogenomics-based toxicity assessment platform for high-throughput and effective chemical hazardous identification and environmental toxicity monitoring.	11/15/2022
TUE01-03	Protocols to Evaluate the Bulk Toxicity of Waters Attributable to Disinfection Byproducts	The talk will discuss ways to compare disinfection byproduct-associated toxicity between disinfected waters, including toxic potency-weighting calculations and in vitro toxicity assays.	11/15/2022
TUE01-04	Risk Management using Biofiltration and Granular Activated Carbon Adsorption in Water	The talk will focus on biofiltration and GAC treatment effects on controlling toxicity associated with preformed DBPs, DBP precursors and other contaminants including PFAS.	11/15/2022
TUE01-05	Risk Management Using Biofiltration and Granular Activated Carbon Adsorption in Water	Discussion of paper: Summation of Disinfection By-product CHO Cell Relative Toxicity Indices: Sampling Bias, Uncertainty, and a Path Forward	11/15/2022
TUE02	TUE02 - Recognizing Successes in Biological Treatment Advanced Operations	See description in subsessions below:	11/15/2022
TUE02-01	Improving Water Treatment Resilience and Sustainability with Biological Treatment	This presentation will focus on similarities and differences between the different forms of biological treatment and how biological treatment can be beneficial across a variety of water supply applications, including surface water, groundwater, and reuse treatment. Speakers, from the Biological Drinking Water Treatment Committee, will share how implementation and operation of biological treatment has evolved in response to regulations, climate change, and emerging contaminants. Attendees are expected to leave with a greater understanding of the range of treatment benefits that biological processes can provide within drinking water and reuse treatment facilities.	11/15/2022
TUE02-02	Evaluation of Ozone and Biofiltration as Barriers for Pathogen Removal in Water Reuse and Wastewater Treatment	This study will demonstrate the usefulness of ozone and biofiltration as barriers for pathogen removal/inactivation in both carbon-based water reuse applications and wastewater treatment. The approach taken in this case study will provide important guidance and insight for utilities that may implement ozone for water reuse in the future.	11/15/2022
TUE02-03	A Comprehensive Comparison of the Microbial and Elemental Properties Across Six Biological Inorganic Treatment Contactors	This study investigated elemental surface coatings, multiple biofilm parameters, and microbial community structure and function across the depth of six pilot-scale aerated contactors treating groundwaters containing ammonia (NH3), iron (Fe), manganese (Mn), and arsenic (As). The biofilm parameters investigated were morphology, ATP, extracellular polymeric substances (EPS), extracellular enzyme activity, community composition, and functional genetic potential via qPCR and metagenomics. The contactors removed 60-95% of the NH3 and 20-50% of the Fe, Mn, and As. Some biofilm parameters, like ATP and EPS, tended to be similar over depth, but the surface coatings and functional genes were stratified.	11/15/2022
TUE02-04	Water Treatment Metrics	Water treatment metrics or benchmarks are valuable for designing new facilities, optimizing operation and documenting performance. Although several metrics such as hydraulic loading rate and empty bed contact time are in use, the full potential of metrics remains untapped. For this presentation, thousands of data points from 25 full-scale waterworks in Denmark using biofiltration have been collected and organized. A set of 10 metrics with accompanying reference values are defined and numerous graphs exhibiting the data will be presented. The value of using water treatment metrics to encourage collaborative learning, enthusiastic borrowing and learning organizations in a community of practice among utilities will be discussed.	11/15/2022
TUE02-05	N2-Sparged Denitrification Reactor Promising for Small Systems	An innovative N2-sparged heterotrophic denitrification reactor was developed in the lab to select the optimal packing media and compare its treatment and operation performance to a fixed-bed filter. N2 sparging lowers the dissolved oxygen concentration, resulting in a lower acetic acid dose and less biomass. Additionally, it flushes out bubbles produced during denitrification. This results in less biofouling, more consistent flow, and longer filter run times. An empty bed, a packed gravel bed, and a bed packed with 1” PVC sections were compared, and both gravel and PVC sections were found to be inexpensive, suitable media. The innovative N2-sparged nitrate reduction system shows great promise for small systems.	11/15/2022

TUE02-06	Who are the Worker Bees in Biofiltration? Using Bioinformatics for Operational Adjustment	This presentation will share results from a one-year biofilter benchmarking study that goes beyond traditional biofiltration monitoring to understand biological and physical performance to enhance operation. The benchmarking focuses on characterizing biofiltration efficacy for several advanced techniques like next generation sequencing, ATP coupons, and surrogate water quality monitoring at different loading rates (up to 6 gpm/sf) and ozone doses. The results of the study will demonstrate how to use NGS/bioinformatics to inform operational adjustments to ozone-biofiltration systems.	11/15/2022
TUE03	TUE03 - Fecal Pollution Tracking and	See description in subsessions below:	11/15/2022
TUE03-01	Tracking the Primary Sources of Fecal Pollution in a Karst Aquifer Using Microbial Source Tracking Assays and Land Use Information	The Edwards Aquifer serves as a primary source of drinking water to more than 2 million people in south-central Texas. As a karst aquifer, it is vulnerable to human and animal fecal contamination, posing a severe risk to human and environmental health. A one-year study was conducted to determine the primary sources of fecal pollution along the contributing and recharge zones in Bexar County, Texas, within the Edwards Aquifer using general (E. coli, enterococci, and universal Bacteriodales), human-associated (HF183 and BacHum), and animal-associated (dog, cow and chicken/duck-associated Bacteriodales) microbial source tracking (MST) assays.	11/15/2022
TUE03-02	Tracking Fecal Pollution and Anthropogenic Antibiotic Resistance Genes in a Mixed-Use Watershed: Application of Molecular Biology	Antibiotic resistance has been identified by the United States Centers for Disease Control and Prevention (U.S. CDC) as a critical concern for human health, causing over 2.8 million infections in the U.S. annually. The role of waterbodies contaminated by municipal wastewater and agricultural runoff has been identified as a potential mechanism for the spread of antibiotic resistance in the environment. However, fecal indicator bacteria do not accurately inform the sources of antibiotic resistance genes originating from fecal pollution. This research focuses on tracking fecal contamination and anthropogenic antibiotic resistance sources using molecular methods in freshwater.	11/15/2022
TUE03-03	Benchmarking Quantitative Metagenomics Techniques for Comprehensive Wastewater-Based Epidemiological Surveillance of Wastewater	Metagenomic-based surveillance of wastewater systems are plagued with uncertainty in methodological reproducibility and high detection limits. The implementation of process controls, including spiked-in exogenous whole cells and synthetic DNA oligonucleotide reference standards, have the potential to dramatically increase the certainty of target detection and adequate characterization of infectious diseases and antibiotic resistance genes at low abundances. This presentation demonstrates the usefulness of such process controls in a benchmarking experiment utilizing deep Illumina sequencing and extensive sample replication. Finally, it suggests a path towards universal application of such controls for scaled up surveillance systems.	11/15/2022
TUE04	TUE04 - Assessing DBP Toxicity and Control	See description in subsessions below:	11/15/2022
TUE04-01	National Occurrence of HAA Groups: What can be learned from UCMR4?	Recently, USEPA completed the Fourth Unregulated Contaminant Monitoring Rule (UCMR4), which requires public water systems to monitor and report three groups of haloacetic acids (HAAs as disinfectant by-products, DBPs) in their distribution systems - HAA6Br, HAA9, and HAA5. In addition, the UCMR4 requires water systems to monitor for DBP precursors in source water, and to provide information on treatment processes and disinfectants used. This presentation provides an overview of what can be learned from the UCMR4 dataset about national occurrence of HAAs after the Stage 2 DBP rule was implemented. The collected information will also be evaluated to inform HAA formation. The results will be grouped by different categories.	11/15/2022
TUE04-02	Toxicity-Weighted Risks of Unregulated DBPs: HAAs and Beyond	Although unregulated DBPs are observed in lower concentrations than regulated DBPs, literature suggests that many unregulated groups have orders of magnitude higher toxicity with potential public health implications. The results from toxicity literature beg the question: does the current regulatory system for DBPs, which focuses on mass concentration of HAA5 and TTHM, mitigate toxicity-weighted exposure risk? Likewise, would a change from an HAA5 to an HAA9 regulation provide meaningfully improved protection of public health with respect to a broad range of potential DBPs? We will discuss a toxicity-weighted analysis to answer those questions and discussion opportunities and pitfalls for toxicity exposure reduction strategies.	11/15/2022

TUE04-03	Bromate Toxicology and Formation through Non-Ozonated Process: Implications for Bromate Standards	The current 10 µg/L bromate MCL is based on the practical quantification limit rather than a cancer risk standard. With improved analytical methods, lowering the bromate MCL could be considered as part of the Six Year Review, with implications for the use of ozonation. This study investigated the mode of action of bromate toxicity in rats. Our findings challenge the mechanisms assumed during regulatory development, and provide justification for a non-zero MCLG. We also investigated bromate formation in non-ozonated waters, including copper oxidation of bromide in ultrapure chlorinated waters and in UV-AOP. TOC had an inhibitory effect on bromate formation, and we investigated the impact of pH, bromide concentrations, and copper catalysis.	11/15/2022
TUE04-04	Impact of Pre-Chlorination and GAC Treatment on DBP Formation and Toxicity in Drinking Water	Changes to the Microbial and Disinfection By-Product (DBP) Rules could prompt more utilities to implement GAC treatment, which can reduce DBP formation overall, but shift the bromide to DOC ratio and result in increased formation of the more toxic brominated DBPs. A major research gap is whether strategies that reduce regulated DBP formation translate to an overall reduction in the toxicity of the drinking water. This paper presents results from pilot testing and full-scale sampling comparing GAC treatment to conversion to chloramines on DBP formation and measured toxicity, accounting for the contribution of unknown DBPs on the overall toxicity in drinking water.	11/15/2022
TUE04-05	Reduction of Disinfection By-Product Associated Toxicity by Adjustment of Distribution System pH	Nitrogenous disinfection by-products including haloacetonitriles (HANs) and haloacetamides (HAMs) have come under scrutiny in recent years due to their relatively high toxicity compared to the currently regulated carbonaceous disinfection by-products such as trihalomethanes (THMs) and haloacetic acids (HAAs). HAN and HAM hydrolysis kinetics have been demonstrated by others to be a function of pH and free chlorine residual. Thus, a possible mitigation strategy may be to distribute water at slightly increased pH to increase the rate of HAN and HAM hydrolysis to compounds of lower toxicity. Bench scale water treatment studies resulted in a decrease in DBP-associated toxicity of 77% and 45% between pH 6 and 9, and 7.5 and 9, respectively.	11/15/2022
TUE04-06	Bench Scale Evaluation of Treatment for HAA9 Control	USEPA is considering a change in the D/DBP rule which would expand the regulation of the five HAAs to nine species. There are questions and concerns that if the modifications to comply with the new rules will result in undesirable formation of other by-products, which may have higher toxicities than the regulated DBPs. This study under WRF project #5085 focused on the DBP precursor removal by different treatment processes. Treatment techniques including enhanced coagulation, ozonation, chlorine dioxide (ClO2) oxidation, GAC adsorption and ion exchange (IX) were tested in batch scale. A wide spectrum of DBP species were analyzed: THMs, HANs, HKs, HAAs, HALs, HAMs and HNMs.	11/15/2022
TUE05	TUE05 - Taking Real-time Water Quality Monitoring a Step Further: How to Derive Even More Benefits From Your Monitoring Network	This session is designed to show how water utilities can derive a wide range of benefits, both directly and indirectly, through the use of real-time water quality monitoring technologies in their source waters and distribution systems.	11/15/2022
TUE05-01	Using Non-traditional Approaches to Monitoring and Analyzing Real-time Water Quality Data in Source Water	An overview of a pilot study of online analyzers (turbidity, conductivity, pH, ORP, UV254, TOC, chlorophyll-a, tryptophan like fluorescence, ATP, etc.) and how to use machine learning to detect water quality events in source water.	11/15/2022
TUE05-02	Tightening Up: Balancing Water Quality and Non-revenue Water	A case study of how a water utility leveraged their AMI system, metered automatic flushers, and online DPD chlorine instruments to go from sporadic, manual flushing in their distribution system to data-driven, automatic flushing.	11/15/2022
TUE05-03	How to Monitor for Contamination Incidents in Drinking Water Distribution Systems	A description of how water utilities can monitor for the presence of contaminants in drinking water distribution systems, including an overview of parameters that can be monitored (with results from relevant studies) and approaches that can be used.	11/15/2022
TUE06	TUE06 - Lead Sampling and Testing Considerations	See description in subsessions below:	11/15/2022

TUE06-01	Sampling Every Tap in Every School in Quebec for Pb: What Did They Find, How Did They Measure and What Did They Do About It?	In 2019, the Ministry of Education requested that, by the end of 2021, all schools be screened for the presence of Pb in water. School boards proceeded to sample each tap used for water consumption/food preparation. Data from 39,146 water outlets located in 358 buildings was obtained. Samples were collected 250 mL after at least 6 hour of stagnation and after a 30 second flush at each outlet. This project presents a comprehensive analysis of factors influencing Pb concentration at the tap and can inform legislator, building owners or utilities on how to prioritize sampling for Pb in buildings. This study highlights how corrosion control treatment for distribution systems may not be optimized to control Pb at the tap in large buildings.	11/15/2022
TUE06-02	Lead Exposure, Service Line Identification, and Other Sampling; Comparison of Two Cities with Opposite Levels of Corrosion Control	Drinking water sampling is necessary to ascertain the state of lead (Pb) release. However, there are many other reasons to sample for Pb including regulatory compliance, evaluation of corrosion control effectiveness, Pb plumbing source identification, and human exposure assessment. This work compared results from different drinking water sampling approaches for lead assessment in two full-scale drinking water distribution systems (cities) with two distinct water qualities and opposing corrosion control effectiveness. The results were very different, and illustrated the importance of appropriate sampling approach when sampling for lead and the importance of effective corrosion control.	11/15/2022
TUE06-03	Pipe Loop Study Planning: Lessons Learned from Pipe Loop Case Studies	More utilities will need to perform pipe loop studies due to the revisions to the Lead and Copper Rule. Proper study design is needed to have easy to operate and maintain pipe loops with clear and actionable study results. This presentation will discuss pipe loop design customization based on case studies from multiple utilities around the US. Studies designs include water blending studies, re-optimizing phosphate corrosion inhibitors, changing water sources, and adding new treatment processes. Pipe loop design considerations will include test materials; pipe loop locations; flow pattern and sampling velocity; environmental conditions; sampling plan and replicates; and creating synthetic water.	11/15/2022
TUE06-04	Conducting a Representative Comprehensive Corrosion Control Study for a Complex System	GLWA is conducting a study to ensure corrosion control treatment is optimized and in compliance with recent state and federal regulatory changes. The study consists of placing pipe loop rigs throughout GLWA's distribution system that will test several treatment strategies on harvested and constructed materials. Testing conditions are based on historical water quality analysis, and pipe scale analysis. This presentation will discuss the study development and preliminary conditioning data to assist other utilities in adapting their own corrosion control treatment to meet updated regulations.	11/15/2022
TUE06-05	Filter Efficacy in Benton Harbor, Michigan	A POU and pitcher filter efficacy study was conducted in Benton Harbor, MI homes due to concerns about elevated Pb levels beginning in 2018 and limited similarities (i.e., phosphate treatment) to Newark, NJ where Pb-phosphate nanoparticles had been observed. All samples from properly certified (NSF/ANSI-53) and operated filters included in the study (199 locations) were found to reduce Pb to below the certification standard of 5 ppb. Concurrent particulate analysis from a smaller subset of homes did not find discrete Pb-phosphate nanoparticles as a result of the blended phosphate treatment. Field observations during this study highlighted the importance of public education surrounding filter installation, replacement, and use.	11/15/2022
TUE06-06	Assessing Three Field Analyzers for Lead Quantification in Drinking Water	Commercially available portable lead field analyzers can be used for lead quantification of non-regulatory drinking water samples. While there are currently numerous devices on the market with manufacturer-provided information on their lead quantification performance, there are limited third-party studies that have compared these field analyzers to established laboratory methods such as ICP-AES and ICP-MS. This study examined the effects of certain water quality parameters (temperature, chemical interference, and particulate lead) on the quantification of lead in water samples by three field analyzer types (electrochemistry, colorimetry and fluorescence).	11/15/2022
TUE07	TUE07 - Can you Measure PFAS at PPT? PPQ?	Modifications to existing EPA methods along with the latest in passive sampling approaches will be presented to improve analytical productivity and allow for unique experimental designs.	11/15/2022

TUE07-02	EPA 533 and 537.1: Solutions for Improving Sample Prep Efficiency & Productivity and Methods for Cost Saving on Isotopic Standards	This presentation focuses on Orange County Water District's (OCWD) solutions to improve the efficiency and productivity of sample preparations for PFAS analyses by EPA 533 and 537.1. Comparison of QA/QC data between the manual and the automated sample prep for both methods is provided. This presentation also demonstrates a practical approach for substantial cost savings with EPA 533 isotopic dilution analogue (IDA) and isotope performance standards (IPS).	11/15/2022
TUE07-03	Advancing the Diffusive Gradients in Thin-Films Passive Sampling Device for Monitoring PFAS in Drinking Water Systems	This presentation will focus on the development of a diffusive gradients in thin-films (DGT) passive sampling device (PSD) for 24 target PFAS, all of which are included in UCMR5. The DGT-PSD is intended to replace and/or augment grab sampling protocols and provide time-weighted average PFAS concentrations over deployment times ranging from a few days to several weeks. Measurements of PFAS diffusion coefficients in the diffusive gel layer will be discussed with an emphasis on the importance of the diffusive boundary layer in these measurements. Practical aspects of the DGT-PSDs will also be discussed, including the method detection limits and deployment times suitable for drinking water systems.	11/15/2022
TUE08	TUE08 - Quantification of Legionella by qPCR	See description in subsessions below:	11/15/2022
TUE08-01	The Importance of Rapid, Onsite qPCR for Waterborne Pathogen Detection	Every year, there are roughly 7.2 million infections, 120,000 hospitalizations and 7,000 deaths caused by waterborne pathogens in the United States. Effective January 1, 2022, the Joint Commission issued standard EC 02.05.02 which states that water management programs address Legionella and other multiple waterborne pathogens. Traditional culture-based methods are still considered the "Gold Standard" for waterborne pathogen testing; however, it is relatively labor intensive and time consuming. Onsite quantitative polymerase chain reaction (qPCR) can aid water management companies by flexibly surveilling multiple pathogens in buildings which can prevent outbreaks before they happen. Water management companies and public health can use onsite	11/15/2022
TUE08-02	Quantification of Legionella pneumophila by qPCR and Culture in Tap Water	Legionellosis prevalence is increasing in the United States. This disease is caused primarily by the bacterium Legionella pneumophila found in water and transmitted by the inhalation of aerosols. This pathogen has a slow growth rate and can "hide" in amoeba, making it difficult to monitor in water by the traditional method of culturing on selective media. Therefore, quantitative polymerase chain reaction (qPCR) and culture was used to monitor L. pneumophila in tap-water samples (n=358) from across the United States.	11/15/2022
TUE08-03	The Future of Legionella Testing is qPCR	When monitoring a system for the presence of Legionella spp., the cultural method (i.e., ISO 11731) is often purported to be the "Gold Standard". However, the cultural method has low accuracy, low sensitivity, low precision, and a very long time to result (7-14+ days), which puts the user in a constantly reactive position. We will present data outlining the case that modern, Quantitative Polymerase Chain Reaction (qPCR) technologies are currently available, and in many cases a better choice for assessing Legionella risk in building water systems, to proactively protect public health and safety.	11/15/2022
TUE09	TUE09 - Utility Research on Water Quality	See description in subsessions below:	11/15/2022
TUE09-01	The Dual Benefits of a Utility Research Program: Process Optimization and Workforce Development	This presentation will highlight the two main goals of the Great Lakes Water Authority (GLWA) pilot plant efforts: process optimization and workforce development. The process optimization program include the use of the pilot plants as predictive models of full-scale performance, providing calibration and validation in translating results from jar tests, through pilot scale, up to full scale implementation. As a tool for workforce development, the pilot facilities will serve as a training and educational tool for both current and future operators and technicians with outcomes including increased recruitment, retention, skills enhancement, and development of best practices.	11/15/2022
TUE09-02	Effective Prioritization of Applied Research to Balance Resources, Philadelphia's Program	The Philadelphia Water Department (PWD) continues to be committed to implementing various research initiatives to study how global and regional influences, as well as technology advances, may impact Philadelphia's drinking water and wastewater treatment/resource recovery facilities. Resources are always finite, therefore prioritizing PWD's research portfolio using a portfolio management plan creates a defensible list of their most immediate needs to effectively communicate to stakeholders. This presentation will describe how the portfolio management plan was developed, explain PWD's decision matrix and stage gate criteria, and discuss lessons learned during development and implementation of this plan.	11/15/2022

TUE09-03	State-of-the-Art Direct Filtration Pilot Plant Design and Application	SNWA's experience with replacing a 20-year old pilot plant with a state-of-the-art pilot plant will be discussed including the planning, design, construction, operation, and servicing of the equipment. The presentation will focus on the improvements made to pilot plant design including water supply flexibility, dual train operation, data acquisition software (SCADA), remote access capability, reserve power system, safety, effluent disposal alternatives, etc. Examples will also be provided regarding how the pilot plant system has been applied for process optimization and research purposes in the past, present, and future.	11/15/2022
TUE10	TUE10 - Primary Drinking Water Standards for PFAS: Anticipated Requirements, Occurrence, and Costs (STS)	EPA is preparing to set a national primary drinking water regulation for PFAS. The session will provide an overview of the regulatory framework expected for this rule, an updated analysis of PFAS occurrence using state data, and a projection of the national costs of the rule.	11/15/2022
TUE10-01	EPA's PFAS Drinking Water Regulations - What to Expect	This presentation will provide an overview of anticipated drinking water regulatory requirements including potential levels of standards and the monitoring framework.	11/15/2022
TUE10-02	Updating the National Occurrence Data with State Monitoring Programs	This presentation provides an updated national occurrence database that was developed by AWWA using UCMR 3 and state monitoring data. This presentation will discuss the approach and the insights on occurrence based on this updated information.	11/15/2022
TUE10-03	Estimating the National Cost of a PFAS Drinking Water Regulation	This presentation will discuss an effort to develop cost models for water systems to comply with the new drinking water regulation for PFAS and will provide a discussion of the approach and estimated national costs.	11/15/2022
TUE11	TUE11 - Machine Learning Applications across the One Water Spectrum (STS)	Many real-time water quality sensors have become available, generating vast quantities of data. With this data, machine learning (ML) and artificial intelligence (AI) can be applied for alert systems and real-time process control. This workshop will: (1) explain ML and AI concepts; (2) describe steps for implementation at scale; and (3) give case studies across the One Water spectrum.	11/15/2022
TUE11-01	Machine Learning Introduction	Brief introduction to machine learning concepts	11/15/2022
TUE11-02	ML project Life Cycle, Data Engineering for Full-Scale Implementation	The full life cycle of a ML project will be described in this presentation.	11/15/2022
TUE11-03	Machine Learning for Fault Detection and Process Control in Potable Reuse	This presentation will cover (1) an ML-based alert system for Hampton Roads Sanitation District's carbon-based potable reuse facility and (2) real-time ultrafiltration fouling forecasting at Las Virgenes Municipal Water District's Pure Water Demo.	11/15/2022
TUE11-04	Application of Multi-Agent Systems for Water Resources Management	This presentation will first introduce multi-agent systems as an artificial intelligence method, their capabilities, benefits, and challenges in capturing the complexities inherent in complex human-water systems.	11/15/2022
TUE11-05	Panel Discussion	See description in subsessions below:	11/15/2022
TUE12	TUE12 - Diversity in Ion Exchange Processes	See description in subsessions below:	11/15/2022
TUE12-01	Biological Ion Exchange: New Insights on the Contribution of Biodegradation vs. Ion Exchange Mechanisms	Biological Ion Exchange (BIEX) is a robust, efficient and operator-friendly water treatment strategy for small and large communities. BIEX combines high DOC removal efficiency with low maintenance operations and can remove 50% of DOC for two years without regeneration. Recently, we established that biodegradation is less significant than previously hypothesized, but instead the primary and secondary ion exchange mechanisms dominate DOC removal. This discussion presents new findings on biodegradation and its impact on treatment kinetics in the context of a unified understanding of the three DOC removal mechanisms during BIEX: 1) biodegradation, 2) primary IEX and 3) secondary IEX.	11/15/2022
TUE12-02	The Impacts of Suspended Ion Exchange (SIX®) On the Quality of Surface Waters	The Suspended Ion eXchange (SIX®) is a novel process developed by PWNT in the Netherlands for the removal of natural organic matter (NOM) as an early step in the production scheme of drinking water from surface waters. The SIX® employs a strong basis anion exchange resin in suspension to target the charged humic fractions of NOM and improve the efficiency of downstream treatment. Along with the NOM, the resin also adsorbs inorganic anions and micropollutants depending on initial surface water quality. Based on the continuous operation of two full scale plant and four long term pilot studies, this abstract identifies the multiple impacts of the SIX® treatment on the quality of various surface waters.	11/15/2022

TUE12-03	Impact of Reduced Regeneration Frequency on the Ion Exchange Equilibrium for Removal of Organic Matter and Inorganic Ions	Suspended ion exchange (IEX) is an efficient process for natural organic matter (NOM) removal. However, the use of chloride as a regenerant causes an increase in the treated water corrosivity and generates high volumes of brine and waste. To reduce these challenges, the impact of reduced regeneration frequency on the IEX equilibrium has been evaluated using chloride or bicarbonate as regenerants. A theoretical multicomponent model has been developed which enables the prediction of IEX equilibria when the resin loading increases due to reuse. The model suggested that both electrostatic interactions and admicelle formation occur for NOM removal and that reusing the bicarbonate-form resin every 5 cycles can achieve the most sustainable option.	11/15/2022
TUE12-04	Effect of Grinding Method Selection on Physical and Chemical Characteristics of Granular Activated Carbon and Ion Exchange Resin	This presentation will cover USEPA research on the effects of grinding methods on granular activated carbon (GAC) and ion exchange resin (IX) physical and chemical properties, investigated through various characterization processes. GAC and IX are two adsorbents used to treat organic and emerging contaminants in water. Grinding is commonly adopted during GAC and IX adsorption isotherm and rapid small-scale column tests, assuming that ground GAC and IX have the same characteristics as the bulk size material. This presentation summarizes the results of the characterizations and provides guidance for grinding method selection.	11/15/2022
TUE12-05	Ion Exchange vs Granular Activated Carbon: An Approach to Enhancing Delivered Water Quality in the Tampa Bay Region	Tampa Bay Water is performing a regional water quality study to evaluate and implement solutions to achieve enhanced water quality, focused on reducing total organic carbon (TOC). A lower treated TOC target (1 to 2 mg/L) at the points of connection in the regional system is being evaluated for treatment feasibility and cost implications. This presentation will discuss the results from bench and pilot scale work on two selected technologies, Granular Activated Carbon and Fixed Bed Ion Exchange, for TOC removal in Tampa Bay Water's groundwater and surface water sources.	11/15/2022
TUE12-06	Segmented Regeneration of Ion Exchange Resins Used for Natural Organic Matter Removal	Ion exchange using synthetic resins is an efficient approach for removing natural organic matter from drinking water. However, conventional regeneration of resins produces a concentrated brine that is difficult to be managed. This study aims to investigate the feasibility of segmented regeneration for ion exchange resins used for natural organic matter removal. Results demonstrated that segmented regeneration had similar performance compared to conventional regeneration in terms of the recovery of sulfate and NOM combined, and segmented regeneration could reduce salt usage and facilitate brine management.	11/15/2022
TUE13	TUE13 - Occurrence of Legionella in Drinking Water Systems	See description in subsessions below:	11/15/2022
TUE13-01	Occurrence of Legionella pneumophila in Drinking Water Distribution Systems	This presentation will provide an overview of the first year of monitoring for WRF project 5156 on the on the occurrence of Legionella pneumophila in drinking water distribution systems. The project objectives are to determine the relationship between secondary disinfectant concentration and other system features and the occurrence and concentration of L. pneumophila.	11/15/2022
TUE13-02	Characterization of Reported United States Legionellosis Outbreaks (2001-2017)	Legionella occur naturally in the environment and can be introduced into drinking water from water entering the distribution system or through distribution system breaches. The overall study goal was to evaluate public water system characteristics that could impact the incidence of legionellosis outbreaks, a mild to severe illness caused by Legionella bacteria. Legionellosis outbreaks were characterized by source water type, drinking water disinfectant type, settings of exposure, geographical distribution, and PWS size (population served). This national, systematic assessment of reported legionellosis outbreaks from drinking water exposures provides new insights on PWS characteristics that may influence building water quality.	11/15/2022
TUE13-03	Role of Temperature, Materials, and Stagnation on Microbial Density and Prevalence of L. Pneumophila in Drinking Water and Biofilm	Premise plumbing biofilms are recognized as reservoirs of opportunistic pathogens such as L. pneumophila (Lp) which is still a major public health concern as it is responsible of many community-acquired and nosocomial infections in North America. A 12 CDC reactors pilot study was conducted for 17 months to assess the impact of materials, stagnation, and temperature on the density of suspended and biofilm associated bacteria. Lp persisted in water and biofilms of a PP reactor let at room temperature and was detected again after a 6-month stagnation in previously negative reactors. Materials and temperature were the key factors defining water quality (metals), abundance of biofilm and suspended bacteria and the persistence of Lp.	11/15/2022

TUE14	TUE14 - Distribution System Operational Impacts on Water Quality	See description in subsessions below:	11/15/2022
TUE14-01	Tightening Up: Balancing Water Quality and Non-Revenue Water	Water quality and water loss are both important facets of water distribution systems, but for many systems they can be in conflict. When systems are oversized or large consumers leave, long residence times can lead to poor water quality. Flushing is often employed to mitigate water age but at the expense of increasing Non-Revenue Water. Like many others, Gainesville sought to “tighten-up”. To achieve this, Gainesville leveraged their AMI system, metered automatic flushers, and online DPD chlorine measurements to go from sporadic manual flushing to data-driven automatic flushing. Through this progression, Gainesville was able to better balance their water loss and water quality efforts.	11/15/2022
TUE14-02	Reconciling Water Conservation and Water Quality in Distribution Networks: Is It Possible?	Water conservation measures are increasing in response to regulatory requirements adressing the need for lower environmental footprint, response to water scarcity and lowering costs. These measures can cause water quality degradation. Preserving water quality in networks should be considered when prompting the adoption of water demand management programs. This work focuses on evaluating the hydraulic and water quality performance criteria of a network under various future demand conditions using a water quality model. Findings show the challenges of maintaining water quality in existing infrastructure after successful water conservation. The proposed robustness criteria provide a basis to plan operational measures to maintain water quality.	11/15/2022
TUE14-03	Aluminum and Iron as Possible Metal Sinks? Examining the Co-Occurrence of Aluminum and Iron with Regulated Metals During UDF	It has been hypothesized that aluminum and iron can act as sinks for regulated metals in drinking water systems. This study investigates unidirectional flushing (UDF) trials and shows the co-occurrence of aluminum and iron (as possible metal sinks) with other regulated metals such as arsenic and manganese. This research will assist municipalities in managing the occurrence of metals in their distribution systems.	11/15/2022
TUE14-04	Direct in Pipe, Low Maintenance Multiparameter Chlorine Sensor for Water Distribution Networks	A new amperometric multiparameter chlorine sensor technology requires no waste stream. This means water savings up to 65,000 gallons per year per sensor. The technology developed, in part, under an Office of Naval Research contract led to a flow independent sensor with an integrated self-cleaning system designed for long intervals between calibration and maintenance (125 days). The sensor is used under high biofouling conditions. It measures chlorine, pH, conductivity, temperature and ORP. It has application in “Direct in Pipe” measurements for drinking water distribution systems and reclaimed water in waste treatment plants. Experience with remote monitoring using a battery, solar panel, and cellular modem will be presented.	11/15/2022
TUE14-05	Challenges of Studying Water Storage Tanks in Distribution Systems: A Field- And Pilot-Scale Approach to Understand the Ecosystem	Finished water storage facilities are tanks or reservoirs used to store water that will undergo no further treatment to reduce microbial pathogens. Storage tanks are vulnerable to contamination, and excess water retention time may cause depletion of disinfectant residual which creates an environment favorable for microbial contamination. Sediment accumulation causes water quality degradation, including nitrification and enhanced biological growth, which harbored a highly structured water microbiome with a diverse assemblage of virulence and antimicrobial mechanisms. It is important to understand the spatial and temporal characteristics of these systems which amplify the potential public health risk relative to the distribution system.	11/15/2022
TUE14-06	Can Water Utilities Rely on Contamination Warning Systems to Detect and Respond to Contaminations?	WDSs are vulnerable infrastructures to contamination. Real time monitoring programs can be an effectual response for reducing the risk from potential contamination events on public health. However, factors to consider are multiple and complex and most utilities struggle to determine which type of CWS is most effective. In this study, a conceptual framework will be proposed to establish a data analysis method and improve the technologies to assist decision maker on how and when turn up the monitored data into an actionable measure as quickly as possible. Moreover, cases studies detailing different intrusion events will be presented to show the importance and limitations of real time monitoring for detection and response to contamination.	11/15/2022
TUE15	TUE15 - Optimizing Conventional Treatment	See description in subsessions below:	11/15/2022

TUE15-01	Can I Trust a Black Box? - Predicting Floc Sed Chemical Doses vs. TOC and Turbidity Removal Using Machine Learning	This presentation shares a success story of applying machine learning techniques to improve digital-twin water treatment plant operation model. This innovation greatly enhanced the accuracy of predicting flocculation sedimentation effluent turbidity and TOC versus dosages of coagulation / flocculation chemicals (e.g., Alum, ACH, Coagulant Aid and Floc Aid, etc.). Historical data showed poor correlation (R2 < 0.3 - 0.4) between chemical dosages and turbidity or TOC removal. Plant staff relied heavily on daily jar testing to determine the removal rate of turbidity and TOC. When four years of full-scale data and jar test data were used for machine learning, the R2 of model prediction was improved to above 0.9. This experience helps utilities	11/15/2022
TUE15-02	An Investigation of the Impact of Zeta Potential on the Removal of Turbidity and Organics	The recent advancements in online zeta potential technology have sparked a renewed interest in its application as a performance metric for coagulation optimization. While this technology can be integrated into existing systems for automatic dosing control, the user must still manually select a zeta potential setpoint. This presentation will explore the correlation between optimal turbidity and organics removals and post coagulation zeta potential with respect to coagulation conditions (i.e., dose and pH) and raw water quality. The results presented here can help guide operators and engineers in effectively using this tool to optimize the efficiency of their coagulation stage while also reducing chemical costs.	11/15/2022
TUE15-03	Quickly Switching From Ferric Based Coagulants to Aluminum Based Coagulants in Response to Chemical Supply Shortages	In early 2021, many utilities across the western portion of the United States received a Force Majeure letter from chemical suppliers and vendors indicating that there was a shortage of treatment chemicals, especially chlorine and iron based coagulants. By summer of 2021, many utilities started to feel the impact, including several municipal utilities operated by Jacobs Engineering. Rather than rely on the uncertainty of ferric coagulant deliveries, Jacobs decided to switch to aluminum-based coagulants which were much more available. This presentation will discuss a few case-studies of what the utilities did to transition, how the seamless transition occurred, and post monitoring to ensure compliance and cost comparisons.	11/15/2022
TUE15-04	Making Conventional Treatment Cutting Edge Technology – Process Optimization Using	This presentation will describe the smart utility tools Portland Water Bureau is building into their new water treatment plant to inform real time decision making during operations.	11/15/2022
TUE15-05	Deep-Bed Filters: State of the Art and Lessons Learned	This presentation discusses the state of the art for deep-bed filter designs from both a theoretical and practical basis, highlighting the characteristics of successful full-scale designs.	11/15/2022
TUE15-06	Modeling Air Entrainment from Full-Scale Filter Data Analysis	As existing media filters worldwide approach the end of their design life, rehabilitation presents an opportunity to extend their operational lifetime and improve performance. The Metropolitan Water District (MWD) Robert B. Diemer WTP has dual media filters arranged in two banks with different submergence, and filter air binding has been a periodic problem. In this study, a full-scale dataset served as a controlled experiment to characterize the phenomenon of air entrainment and the associated inflection point in headloss accumulation, which was observed at a pressure head around 90 cm within the media bed. Describing this phenomenon with full-scale data and capturing it in a model provide useful insights to guide design and operation.	11/15/2022
TUE16	TUE16 - Corosion Control Assessment Tools	See description in subsessions below:	11/15/2022
TUE16-01	Blending Polyphosphates and Silicates With Orthophosphate to Manage Lead, Iron, and Manganese in Drinking Water	The objective of this research is to compare the effectiveness of blended phosphates and silicates against zinc-orthophosphate alone using Pb coupons. In Phase 1, all coupons were conditioned with a target zinc-orthophosphate dose of 2 mg PO4/L. After 10 weeks, the median Pb concentrations were 231 ?g/L and 10 ?g/L in total and filtered (0.2 ?m) samples, respectively. Phase 2 introduces blends and different water parameters (pH, Mn/Fe) using a factorial design. We expect this presentation will be relevant to water suppliers and will advance our understanding of Pb, Fe, and Mn management in drinking water distribution systems.	11/15/2022
TUE16-02	Orthophosphate May Not Sufficiently Control Severe Lead Solder Corrosion in the Presence of High Nitrate	A switch from a groundwater to a surface water triggered a spike in 90th percentile lead levels to 131 ppb in a water deemed non-corrosive according to EPA criteria. When using surface water 90th percentile lead levels were correlated with nitrate levels (r2=0.79) which ranged from 0.3 up to 7.2 mg/L NO3-N during winter-spring runoff events. Bench-scale studies using new lead solder coupons and harvested pipes with aged solder verified that nitrate affected water lead and caused the release of solder particles. Even with orthophosphate inhibitor, every 1 mg/L increase in nitrate caused lead to increase 42 ppb for new solder and 6500 ppb for aged solder. This effect on lead solder is alarming as nitrate is increasing in many source waters.	11/15/2022

TUE16-03	Decades of Reactions, How Pipe Scale Analyses Can Help to Answer Questions	While a priority has been placed on removing all existing lead service lines (LSLs) in the US, LSLs will likely continue to serve drinking water and expose consumers for many decades. Therefore, understanding the scales present on LSLs is a critical piece of information that will help water systems limit consumer exposure to lead. Scale analysis is one of several tools that can be used to create a comprehensive understanding of lead release to drinking water. This presentation will focus on potential questions a drinking water utility may have about pipe scales and the different analyses that would be needed. A particular focus will be paid to what questions may be left unanswered given various analyses for a particular question.	11/15/2022
TUE16-04	Quantifying Polyphosphate-Lead Complexation and its Impact on Lead Levels in Drinking Water	Many drinking water utilities in the U.S. add polyphosphates to manage discoloration from iron and manganese and inhibit calcium carbonate scale formation. However, polyphosphates can form soluble complexes with lead from pipes, possibly increasing lead exposure at the tap. To date, the effects of polyphosphates on leaded solder and brass fixtures in consumer homes are not well understood. Furthermore, there has not previously been a practically useful method to quantify polyphosphate-lead complexation. We worked with two utilities to study the impact of their polyphosphate products on leaded solder and brass by conducting bench scale tests. We then developed the first practical method to quantify the complexation of lead by polyphosphates.	11/15/2022
TUE16-05	Lower Demand Will Increase Lead Release From Lead Service Lines: Can Corrosion Control Limit Exposure at the Tap?	Water conservation is an adoptative strategy to water scarcity and drought stress conditions. Lowering water consumptions can increase stagnation in buildings, which can increase lead release from lead service lines (LSL). Results indicate that the addition orthophosphate can be considered as a remediation measure for lowering lead contamination. However, 1mg/L of Ortho-P is not sufficient to meet new regulations (5 µg/L) during certain periods of use depending on the severity of demand reduction, showing the need for enhanced corrosion control. Hydraulic models can predict spatial-temporal variations in lead levels and assist utility managers to plan for short- and long-term remediation measures.	11/15/2022
TUE16-06	Orthophosphate-Silicate: An Alternative to Ortho-Polyphosphates for Reducing Aesthetic Issues Without Impacting Lead Solubility	Polyphosphate—typically added to drinking water as a blend with orthophosphate—may increase lead solubility. Owing to their effectiveness as sequestrants and minimal impact on lead solubility, sodium silicates are a potential alternative in these blends. Blends with sodium silicate had minimal impact on lead solubility and reduced iron corrosion. With the exception of trimetaphosphate, polyphosphates were not effective for iron or lead corrosion control. This study has important implications in addressing the often conflicting goals of sequestration and lead release control and can be used for the development of corrosion inhibitor formulations that are effective sequestrant without negatively impacting lead solubility.	11/15/2022
TUE17	TUE17 - Out of this World Approaches for PFAS Control	Novel technologies will be covered for the control of PFAS in various hard-to-treat matrices along with how muliple technologies can be combined to take advantage of the pretreatment needs and synergistic properties.	11/15/2022
TUE17-01	The Impact of Natural Organic Matter on Electrooxidation and Peroxi-Electrocoagulation for PFAS Mitigation	This work evaluated two electrochemical water treatment processes for PFAS mitigation. Additionally, the impact of different natural organic matter sources and characteristics was assessed to understand how natural organic matter can shift and promote PFAS treatment pathways during electrochemical water treatment. The proposed talk can be advantageous for the Water Quality Technology Conference program because the work focuses on applying novel treatment technology for PFAS mitigation through the lens of how water quality parameters such as natural organic matter can present challenges that drinking water engineers are responsible for when implementing PFAS treatment strategies.	11/15/2022
TUE17-02	Photo-Oxidative/Reductive Decomposition of PFOA and Its Common Alternatives (PFBA and GenX) Using Vacuum-UV Irradiation	Photochemical processes serving as adjustable tools to generate oxidative/reductive environments are promising options for decomposition of toxic per- and poly-fluoroalkyl substances (PFAS). However, studies on the efficacy of combining mediators with wavelengths other than 254 nm, the role of active agents, and impact of structural differences in PFAS are scarce. In this study, we investigated the degradability of PFOA and its common alternatives (i.e., PFBA and GenX) using well-controlled experiments involving UV and VUV radiations. Role of strong reductive/oxidative agents in sulfite and persulfate mediated photolysis, fluorine recovery, decomposition pathways, and efficacy of these processes in real and synthetic waters were determined.	11/15/2022

TUE17-03	Evaluating Source Water Impact on the UV-Advanced Reduction Process Treatment of PFAS	Ultraviolet advanced reduction processes (UV-ARP) water treatment can destroy recalcitrant polyfluoroalkyl substances (PFAS) within hours. The extent of degradation, however, is highly dependent on the hydrated electron scavenging capacity of a source water. This paper presentation explores a novel approach to evaluate the impact of background water matrix scavenging conditions on PFAS destruction. We demonstrate that the ultimate extent of perfluorooctane sulfonate (PFOS) degradation achievable in UV-ARP is not determined by the water's initial hydrated electron scavenging capacity. Instead, our results indicate that long term PFOS degradation is impacted by bicarbonate, a key finding influencing the treatment of PFAS in natural waters.	11/15/2022
TUE17-04	Mechanisms of Ultrasonic Defluorination of Fluorotelomer Sulfonates	Water treatment technologies that degrade a wide range of per- and polyfluoroalkyl substances (PFAS) into less harmful by-products are highly desired. Ultrasound can successfully degrade legacy PFAS (e.g., PFOS), however little work has assessed ultrasonic treatment of polyfluoroalkyl substances. Considering polyfluoroalkyl substances comprise a large portion of AFFF, this work investigated ultrasonic treatment of fluorotelomer sulfonates with varying fluoroalkyl chain lengths. Near complete fluoride and sulfate release were observed for 4:2 and 6:2 fluorotelomer sulfonate. Results indicate ultrasound directly defluorinates C-F bonds in the fluoroalkyl chain, making ultrasound a compelling option for treating PFAS contaminated water.	11/15/2022
TUE17-05	Fate of Perfluorooctanesulfonic Acid (PFOS) In Concentrated Waste: Aggregation or Degradation?	PFAS, which are known as "forever chemicals", are of growing concern all over the world. Although IEX has been recognized as one of the most effective techniques for their removal from water sources, taking a strategic approach for management of the produced IEX regeneration waste is urgently needed. This work will emphasize on the destruction of PFOS in the regeneration waste utilizing UV/S technique as a promising process in PFAS decomposition. Outcome of this research, enhances the current knowledge on PFAS behavior and fate under high ionic condition of concentrated wastes, affecting the performance of UV/S remediation, and open new insights into combination of removal and degradation techniques for PFAS treatment.	11/15/2022
TUE17-06	Evaluation of Ozone-based Pretreatment on the Breakthrough of Perfluoroalkyl Acids during GAC Treatment of Wastewater Effluent	Per- and polyfluoroalkyl substances (PFASs) represent a large group of recalcitrant anthropogenic compounds that pose a substantial risk to the wastewater sector with respect to treatment, reuse, and environmental discharge. Municipal wastewater treatment plants (WWTPs) serve as one of the main vectors for PFASs contamination into the aquatic environment as they receive PFASs from residential, commercial, and industrial sources. As O3-BAF-GAC treatment trains predominantly rely on GAC as its main sorption-based treatment barrier, there is limited understanding of the effectiveness and robustness of GAC for PFAS removal and possible strategies to improve its performance.	11/15/2022
TUE18	TUE18 - Monitoring and Analytical Methods for Legionella	See description in subsessions below:	11/15/2022
TUE18-01	The Case for Monitoring for Legionella pneumophila	As water utilities and building water managers start to conduct more monitoring for Legionella in water systems an important question to ask is "what should be the target of my monitoring program? A hybrid approach is proposed, using L. pneumophila as a target in non-health care facilities (buildings, distribution sytems, etc.) and measurement of "all" Legionella species in hospitals and locations with immunocompromised patients	11/15/2022
TUE18-02	Use of Legiolert for Epidemiological Studies: Isolation of Legionella Pneumophila and Long-Term Storage Method	Legionella pneumophila (Lp) is bacteria that can cause severe pneumonia when contaminated aerosols, as generated by cooling towers, are inhaled by humans. Culturing on selective media has long been the gold standard for Lp detection, quantification and risk assessment, however it can take weeks to complete. Legiolert is a rapid culture-based enzymatic method with comparable sensitivity and selectivity to standard culture. By typing 99 isolates from various buildings in Quebec, we found it could detect 6 STs, one of which was of subspp. fraseri. We also found that Legiolert media can be easily preserved long-term by adding 10% glycerol and storing at -80 °C, and proposed a procedure to allow isolates to be conserved for later characterizatio	11/15/2022
TUE18-03	A Comparison of Six L. Pneumophila Detection Methods: Implication for Effective Monitoring of Risks in Water Systems	As cases of Legionnaires' disease continue to increase, precise and rapid methods are needed to ensure optimal treatment to maintain low levels of L. pneumophila (Lp) in cooling towers. Six selected commercially available culture-based and qPCR-methods including an online device for process control, were compared for their ability to quantify reproducibly suspended Lp. Application of these methods to monitor Lp across industrial CTs revealed significant spatial-temporal fluctuations on Lp concentrations across circuits and time showing that monthly compliance sampling may not be indicative of periodical non-compliance.	11/15/2022

WED01	WED01 - The Microplastics Maelstrom	See description in subsessions below:	11/16/2022
WED01-01	It's Not That Simple: Microplastic Sampling Strategies for Drinking Water Systems	The presence of microplastics in both source and treated drinking water has been observed around the globe. However, no standardized sampling or analysis methods have been adopted, limiting the comparability of reported data. Of particular importance are methods for sample collection, as studies have employed volumes ranging from 1 L to >1000 L. This presentation compares available methods including: i) collection of samples for subsequent microplastic separation in-lab, ii) a sieve-based ASTM method, and iii) on-site sampling and separation. Selection of an appropriate method should be largely based on the objectives of a specific study. When considering treated water volumes >1000 L, on-site separation is typically the most appropriate.	11/16/2022
WED01-02	How Will Disinfection By-Products Interact With Microplastics in Drinking Water?	There is a growing concern about microplastics and chemicals that may become sorbed to them in drinking water. The adsorption of disinfection by-products (DBPs) onto microplastics should not be ignored since microplastics that remain in treated water may concentrate toxic DBPs and deliver the contaminants to the human body, thus posing a health risk. However, information about the interactions between DBPs and microplastics is extremely limited. Therefore, this study investigates the adsorption behavior of various DBPs onto microplastics in drinking water. Work continues regarding the impact of microplastic weathering and source water quality.	11/16/2022
WED01-03	From Bad to Worse: Interaction of Per- and Polyfluoroalkyl Substances (PFAS) and Microplastics in Drinking Water	Microplastics and per- and polyfluoroalkyl substances (PFAS) are both persistent environmental contaminants that have been associated with human health risks. Recent concerns have emerged regarding the ability of microplastics to adsorb various types of organic contaminants, including PFAS. This study examined the adsorption of two long-chain PFAS and two short-chain PFAS compounds by both virgin and weathered microplastics in freshwater. Adsorption trials for individual compounds were used to evaluate 5 different types of microplastics with sizes representing those of concern in drinking waters. This study is particularly important since it considers short-chain PFAS and weathered microplastics, which have largely been overlooked to-date.	11/16/2022
WED01-04	Developing Strategic Consumer Messaging for Microplastics in Drinking Water	With the state of California mandating microplastics sampling in drinking water supplies over the next four years and third-party sampling efforts being conducted across the country, publicly available microplastics occurrence data is poised to proliferate rapidly. The disclosure of these data, coupled with recent high-profile media reports about the detection of microplastics in human blood and fecal matter, will inevitably prompt consumer inquiries. Water Research Foundation project 5155 represents an unprecedented proactive effort to develop appropriate consumer messaging resources for utilities in advance of these inquiries, while simultaneously building water industry institutional knowledge about microplastics.	11/16/2022
WED01-05	Toxic Additives in Microplastics Desorb into Drinking Water Matrices	Microplastics consist of synthetic polymers as well as chemical "additives" that may constitute up to 75% of the total plastic mass. Additives may include hundreds of individual chemicals. As such chemical hazards associated with ingestion of microplastics or leaching of additives into drinking water are challenging to predict. In this study, the toxicity of the extracts from five common polymer types was assessed using in vitro assays. PVC pellets and PVC pipe materials exhibited greater toxicity when compared to other common polymer types. Non-targeted analyses were conducted to identify the specific additives driving toxicity. Subsequent trials were conducted to assess the potential for these additives to leach into drinking water.	11/16/2022
WED01-06	Microplastics Removal in a Dynamic Coagulation-Flocculation-Sedimentation System	To-date, the removal of microplastics during conventional treatment has been poorly characterized. Of the limited studies available, most have incorporated jar tests to represent coagulation-flocculation-sedimentation processes when considering the removal of microplastics. Typical jar tests cannot appropriately represent dynamic performance at full scale as they often employ conditions that do not address hydraulic residence times, mixing intensities, and/or coagulation/flocculation mechanisms. In this study, removal of microplastics of varying types and sizes was assessed using a dynamic bench-scale CFS system for a range of operating conditions and source waters.	11/16/2022
WED02	WED02 - Pilot Testing for Advanced Water	See description in subsessions below:	11/16/2022

WED02-01	Biological Filtration to Improve the Finished Water Quality in Cold Climate Zone: Pilot studies and Full Implementation	Authors performed three comprehensive pilot studies in the last decade to investigate the biological filtration to improve the finished water quality at three surface water treatment plants in the cold climate zone: the City of St. Cloud (MN) 24 million gallons per day (MGD) lime-softening Water Treatment Facility, Minnesota in 2015-2016, the Moorhead Public Service 10 MGD Water Treatment Plant (MPSWTP), Minnesota in 2017- 2018, and the City of Fargo 30 MGD Lime Softening Water Treatment Plant (FLSWTP), ND from 2021 to 2022. The treatment processes in three plants all include coagulation/flocculation/sedimentation, lime softening, ozone contactors/recarbonation, filtration, chlorine/chloramine disinfection, and fluoridation.	11/16/2022
WED02-02	Pilot Testing to Optimize TOC Removal Through Coagulation, Biofiltration, and GAC Adsorption for Stage 2 DBPR	The Town of Gilbert, AZ is replacing their 60 MGD surface water treatment plant. The need for the new plant is exacerbated by failing infrastructure, water supply, water quality and regulatory drivers, specifically the Stage 2 BDP Rule. In July 2021 a 14 month pilot effort commenced to explore the synergies of the selected processes; which include ballasted flocculation, ozonation, biofiltration and GAC adsorption. Key to this effort was to understand the efficacy of biofiltration and how different peroxidation strategies can reduce GAC replacement frequencies. This presentation will provide utility's insight on how operational strategies can be leveraged to reduce operational costs while maintaining operational flexibility.	11/16/2022
WED02-03	Blending Advanced Treated Water with Surface Water Upstream of a Surface Water Treatment Plant can be Advantageous for DPR	This presentation will discuss bench- and pilot-scale tests conducted to evaluate effects of blending advanced treated water (ATW) with surface water sources on water quality and process performance at a surface water treatment plant (SWTP). The results showed site- specific effects of ATW blending on water quality, which can be controlled through zeta-assisted coagulant does optimization. ATW blending did not affect TOC and turbidity removal, while hydraulic performance and pathogen log removal improved with increasing ATW blending ratio. Increasing ATW blending ratio also resulted in decreasing DBP formation potential in the treated water.	11/16/2022
WED03	WED03 - The Current Dtate of Quantitative Microbial Risk Assessment for Drinking Water (STS)	It is intended that this STS will highlight some important considerations and advance the understanding for both those involved in designing and those wishing to implement QMRA. The presenters in the session have extensive experience in QMRA and its successful implementation in the drinking water industry.	11/16/2022
WED03-01	Uses and Practices for Better and More Consistent Application of QMRA	This presentation will provide an introduction to QMRA for potential new users and a refresher of the basic principles for others.	11/16/2022
WED03-02	Microbial Techniques for Assessing/Estimating Pathogen Concentrations	This presentation will focus on the suitable methods and approaches used for the collection of high quality pathogen concentration data.	11/16/2022
WED03-03	Making QMRA More Quantitative: Important Concepts in Interpreting Microbial Data	Will focus on the following themes: Microbes are not chemicals, concentrations are estimates, censored data, analytical recovery, uncertainty and variability	11/16/2022
WED03-04	Modeling Real World Contamination to Exposure Dynamics for Health Risk Modeling	The presentation will focus on demonstrating a greater connection to realistic exposures and sources of contamination as well as greater specificity and realism in the developing exposure models.	11/16/2022
WED03-05	QMRA and Probabilistic Assessment of Treatment Train Performance (PATTP) for	This presentation will provide specific examples of how users could identify valid inputs for the tool to develop their own QMRA scenarios.	11/16/2022
WED04	WED04 - Wildfire Impacts on Water Quality	See description in subsessions below:	11/16/2022
WED04-01	Changes in Water Quality after the Marshall Fire at the Wildland-Urban Interface (WUI)	The 2021 Marshall Fire in Boulder County Colorado was the most destructive fire in the Colorado history. Changes in water quality from initial snowmelt to summer rain precipitation events in 2022 will presented, including trends in suspended solids, carbon, nutrients, trace elements (copper, lead, zinc, lithium), regulated volatile organic compounds (VOCs), and unregulated aromatic polycarboxylic acids.	11/16/2022
WED04-02	Identifying and Addressing VOC and SVOC Concerns After the Marshall Fire	On December 30, 2021, the Marshall Fire became the most destructive fire in Colorado's history. The City of Louisville, CO was particularly impacted with more than 600 destroyed or damaged properties – nearly 10% of their water services connections. This talk will provide an overview of the Marshall Fire, water systems response and recovery, specific details of the City's VOC and SVOC sampling and results, and propose recommendations for other communities.	11/16/2022

WED04-03	Addressing Fire-Related Taste & Odor Issues for Unidentified Target Organic Compounds	The Marshall Fire in Boulder County, Colorado, deposited significant amounts of fire-related debris in and around the Town of Superior (Superior) terminal drinking water reservoir. Wind-blown smoke was also in contact with the reservoir water surface for hours during the fire. As a result, a smoky taste and odor (T&O) was imparted on Superior's drinking water supply and is expected to be present for the foreseeable future as long as the reservoir is used to supply raw water to the drinking water treatment plant (WTP). This presentation will detail the Town's technical efforts to address the smoky T&O issues with activated carbon on an accelerated timeframe.	11/16/2022
WED04-04	Uptake and Release of Benzene from Stagnant Drinking Water Pipes	Recently, benzene contamination has been discovered in drinking water systems affected by wildfires in California. Benzene in a drinking water distribution system can permeate certain plastic water system components, including polyethylene service connections. Once permeated, plastic system components can act as reservoirs for benzene which complicate decontamination and sampling strategies. This presentation provides experimental data and numerical modeling for benzene in pipes from different manufacturers, pipes of different sizes and densities, and pipes taken from wildfire-impacted areas. Results from this study will aid water utilities and decision-makers in optimizing decontamination and sampling plans.	11/16/2022
WED04-05	Effects of Wildfire on the Formation of Haloacetonitriles, Haloacetamides, and Regulated Disinfection By-products	Changes to the formation of DBPs after the Caldor Fire will be presented. DBP formation was strongly linked to precipitation events and did not return to pre-fire concentrations for at least 6 months after fire, which may present regulatory compliance issues for utilities with source waters that originate in forested catchments.	11/16/2022
WED04-06	The Legacy of Wildfire in Fort McMurray, Canada: Elevated Organic Carbon, Cyanobacteria Blooms, and Treatment Upgrades	Five years worth of source water quality and treatment impacts data will be presented to described the costly impacts of the 2016 wildfire in Fort McMurray, Canada. Dissolved organic carbon concentration and characterization (including fractionation) will be linked to increased coagulation challenges and costs. Reservoir characterization will demonstrated that post-fire increases in phosphorus have promoted annual algae blooms. Strategies for making these operations linkages from watershed and performance monitoring will be presented and approaches for increasing preparedness and treatment resilience will be discussed.	11/16/2022
WED05	WED05 - Water Quality Analysis	See description in subsessions below:	11/16/2022
WED05-01	Monitoring the Right Parameters for the Enhanced Treatment of Natural Organic Matter Laden Water Sources	The current approaches for optimising coagulant doses for water sources dominated by natural organic matter (NOM) are based on monitoring of UV absorbance of water and jar testing methods. These approaches are not able to detect subtle changes in water quality or are not carried out at the frequency needed to keep up with rapid changes in water quality. This talk will consider how effective characterisation of NOM using molecular weight, charge density and fluorescence can be used to better understand and determine the treatability of water sources containing NOM. The work will consider how these characteristics can be linked to signals from online sensors to enable effective process control systems to be developed at water treatment works.	11/16/2022
WED05-02	Advanced Water Quality Modeling at Greater Cincinnati Water Works	Greater Cincinnati Water Works (GCWW) recently developed an advanced water quality model to help predict the complex and unique phenomena that influence finished water within their distribution system, which provides water service to approximately 1.1 million people via 3,200 miles of pipe. Maintaining water quality in water distribution systems is often critical but challenging, so advanced water quality models can be utilized to help predict constituent concentrations. The multi-species extension (MSX) is a powerful tool for evaluating water quality throughout a distribution system, and GCWW developed and evaluated multiple methodologies to simulate water quality concentrations like free chlorine, THM, and bromoform.	11/16/2022
WED05-03	Augmentation of Field Fluorescence Measurements to Improve in Situ Detection of Contaminants in Surface Waters	Recent events such the undetected fuel contamination of Iqaluit's drinking water, showed that the rapid detection of toxic contaminants in natural surface waters is needed to protect public health and the aquatic environment. This research presents a new method that leverages optical sensors coupled with machine learning algorithms to quantify in situ specific contaminants in surface waters. The method is also applicable to other field measurements such organic matter monitoring. The method was applied to quantify naphthenic acids, phenol, pyrene and fluoranthene. Results suggest that the method can accurately predict these toxic components of oil sands process water and fuels in surface waters at environmentally relevant concentrations.	11/16/2022

WED05-04	FlowCam Analysis of Particle Concentrations to Monitor Water Quality in Pre and Post Treated Drinking Water	In drinking water treatment plants, knowledge of particle size distribution and concentration at various points in the treatment process helps operators determine filter performance and optimize treatment efficiency while protecting public health. Sampling at pre-determined points in the plant, in conjunction with knowledge of historical particle distribution at each of these points, helps to create a picture of overall water quality. By creating a particle count baseline, operators are able to immediately identify increased counts that might signify a problem in the treatment system. The City of Wichita Falls Cypress Environmental Laboratory uses their FlowCam to monitor and react to particle concentration changes in their treatment plant	11/16/2022
WED05-05	Temperature Dependence of Indophenol Method Color Development: Monochloramine, Free Chlorine, or Free Ammonia Concentration Impact	A commercial indophenol monochloramine (NH2Cl) method has been available for several years. This method is not an EPA-approved method and cannot be used for regulatory monitoring. As a result, EPA built on this existing method and published EPA Method 127, a new analytical method for determining NH2Cl residual in drinking water. During EPA's method development, the impact of sample temperature on reagent reaction development was investigated. At < 20°C, reaction times were greater than reported in the commercial method (~ 3X greater at 5°C). Based on these results, new reaction times were determined. These revised reaction times may also apply to the free ammonia and free chlorine indophenol commercial methods that use the same reagent.	11/16/2022
WED05-06	EPA's Water Laboratory Alliance Program: Supporting Water Sector Resiliency	The Environmental Protection Agency's (EPA's) Water Laboratory Alliance (WLA) offers a variety of tools and resources to assist the Water Sector in preparing for and quickly responding to chemical, biological, and radiological water contamination incidents. Resources include free online templates, preparedness guides, and year-round webinar trainings, as well as a platform to access a national network of water testing laboratories.	11/16/2022
WED06	WED06 - Using the Latest Research to Prepare for the Revised Lead and Copper Rule (STS)	This session will present information from industry leading researchers on projects that are designed to increase understanding on topics related to the Revised Lead and Copper Rule (LCRR) and provide solutions to help utilities with upcoming LCRR compliance challenges.	11/16/2022
WED06-01	Identifying Service Line Materials without Excavation: Distinguishing LSLs from Non-LSLs	The effectiveness of novel no-dig technologies and currently used industry techniques at identifying the service line material will be explored through blind trials and testing at six water systems.	11/16/2022
WED06-02	Evaluating Key Factors that Affect the Accumulation and Release of Lead from	This presentation is intended to increase the understanding of several concerns related to galvanized iron lead problems in drinking water.	11/16/2022
WED06-03	When and How to Evaluate Corrosion Control Treatment When Conditions Change	A framework for reimagining corrosion control treatment for lead and copper corrosion through focusing on the impact of the change on finished water quality will be examined.	11/16/2022
WED06-04	Towards Renewed Guidance on Phosphate-Based Corrosion Inhibitors for Lead and Copper	Corrosion control inhibitor and sequestrant guidance will be provided for a wide range of circumstances while considering holistic treatment objectives.	11/16/2022
WED06-05	Development of a Community-Based Lead Risk and Mitigation Model	A web-based model to assist utilities and individuals in prioritizing lead reduction locations and mitigation measures will be presented. The model also includes a module to convert water lead levels to IQ decrements.	11/16/2022
WED07	WED07 - PFAS Occurrence-Modeling, Research, and Treatment Data Analysis and Modeling – An EPA Research Overview (STS)	Within the EPA PFAS Strategic Roadmap, ORD, OW, and other partners are working more closely together than ever before to reach common goals. The overall objective of this session is to share some of the breadth and depth of ongoing work. With Cincinnati as home of ORD's primary drinking water treatment research laboratory, this is a perfect time to showcase the research being conducted.	11/16/2022
WED07-01	A Bayesian Hierarchical Model for Estimating National PFAS Drinking Water Occurrence	A national model for four per- and polyfluoroalkyl substances (PFAS) was developed and informed by national and state datasets. Model development, model structure, and the current estimates of national occurrence will be discussed.	11/16/2022
WED07-02	Factors Affecting Granular Activated Carbon (GAC) Adsorption of Per-and-Polyfluoroalkyl Substances (PFAS) from Drinking Water	USEPA research to systematically evaluate GAC adsorption kinetics and capacity of PFAS at various drinking water relevant conditions, providing the basis for customizing and optimizing GAC treatment units for specific conditions and treatment goals.	11/16/2022
WED07-03	Anion exchange for PFAS Removal & Inorganic Anion Impacts: Batch & Column Experiments to Validate a New Ion Exchange Column Model	USEPA research investigated anion exchange for PFAS removal and inorganic anion impacts, including kinetics, isotherms, and columns (with and without NOM) and leading to validation and application of a newly developed ion exchange column model.	11/16/2022
WED07-04	Rapid Small-Scale Column Tests and Scale-up Approaches for Predicting PFAS Removal by GAC Adsorption and Anion Exchange Processes	PFAS breakthrough data were collected with rapid small-scale column tests and compared to pilot-scale data to develop validated scale-up approaches. Factors controlling GAC and anion exchange use rates will be presented based on scaled up RSSCT data.	11/16/2022

WED07-05	A Review and Analysis of Field Performance of Granular Activated Carbon Adsorption and Anion Exchange Treatment of PFAS	The impact of influent (TOC, PFAS and other compounds concentrations and pH), effluent and operating (EBCT, lead lag, media type) conditions on the full- and pilot-scale removal (> 50 breakthrough curves) of several PFASs will be summarized.	11/16/2022
WED07-06	Modeling Adsorption of PFAS in Full and Pilot-Scale GAC and Ion Exchange Systems	Media capacity estimates were developed based on breakthrough data from more than fifty full and pilot-scale systems. Opportunities and challenges of using models to predict performance based on system configuration and water quality are discussed.	11/16/2022
WED08	WED08 - Evaluating Treatment Performance, Pathogen Removal and LRV Credit Approaches for Potable Reuse (STS)	This session will focus on ongoing research in the field of potable reuse, specifically related to pathogen removal rates in membrane bioreactors (MBR), measuring treatment performance at advanced water reuse facilities using viral indicators, and reviewing alternative disinfection monitoring and pathogen log reduction value (LRV) approaches.	11/16/2022
WED08-02	Putting Membrane Bioreactors (MBRs) to the Test: Demonstrating Pathogen Removal for Potable Reuse	This presentation will cover research conducted to demonstrate reduction of Cryptosporidium, Giardia and viral indicators in primary and secondary effluents to establish a pathway for qualifying MBR-RO treatment for LRV credits.	11/16/2022
WED08-03	Alternative Disinfection Monitoring and Pathogen LRV Credit Approaches used in	This presentation will highlight differences in reuse pathogen monitoring from conventional drinking water approaches and obtaining LRV credits for advanced treatment processes.	11/16/2022
WED09	WED09 - Control of CECs	See description in subsessions below:	11/16/2022
WED09-01	Granular Activated Carbon Use for the Control Of PFAS, PPCP and Regulated and Unregulated DBPs: the Role of EBCT and Influent TOC	A systematic study of the GAC adsorption of a range of organic contaminants (DBP precursors, PFAS and PPCPs) was carried out at the pilot-scale for 16 months and with multiple RSSCTs for a river water treated by bank filtration, softening and UV-AOP. TOC, UVA and sucralose were evaluated as surrogates. Organic compound analysis for 52 DBPs, 32 PPCPs and seven PFAS were run. The impact of EBCT and influent TOC was evaluated. In general TOC, UVA and DBP precursor breakthrough occurred first, followed by PFAS and PPCPs.	11/16/2022
WED09-02	Electron Beam Treatment for the Removal of 1,4-dioxane and PFAS	Electron beam treatment uses accelerated electrons to generate powerful oxidizing and reducing radicals in a combined advanced oxidation-reduction process. Electron beam treatment was evaluated for 1,4-dioxane removal and shown to be a comparable alternative to more established treatment processes and showed promising results for PFAS removal.	11/16/2022
WED09-03	Photodegradation of 1,4-dioxane by Vacuum-UV Advanced Oxidation Process in Potable Reuse Trains	Climate change and population growth have impacted the availability of water to communities. Wastewater recycling for augmenting drinking water supplies offers a sustainable response to this crisis. In water reuse trains, advanced oxidation processes (AOPs) are an important step for ensuring the safety of the treated water. UV radiation with a chemical oxidant is a common AOP that generates reactive agents for degradation of micropollutants. Vacuum-UV (VUV), an alternative AOP, reduces the need for chemical oxidants by producing radicals directly from water molecules and improves degradation of micropollutants. This research investigated VUV performance under AOP feed water conditions in potable reuse trains to better develop the VUV AOP.	11/16/2022
WED09-04	Optimization and Validation of Cyanotoxin Degrading Bacteria with Algaecide Treatment: Sustainable Bio-Treatment Approach	HABs can release abundant cyanotoxin after treating with algaecide on source water reservoir. Biological treatment is the efficient method for toxin removal. Algaecide has an impact on cyanobacteria as well as to the toxin degrading bacteria. This study evaluated the the MIC of algaeicide that can be applied for sustainable treatment of water allowing efficient toxin removal by toxin degrading bacteria. This would help establishing guideline for source water treatment in the reservoirs of drinking water treatment plants	11/16/2022
WED09-05	Destruction of Saxitoxin and Other Cyanotoxins With Permanganate and Chlorine	This study compared the destruction of five cyanotoxins, including Saxitoxin, with permanganate compared to that with chlorine in a surface water supply. The test conditions were designed to simulate the addition of permanganate and chlorine at a conventional treatment plant that also practices enhanced coagulation for maximizing TOC removal. Permanganate doses ranged from 0.5 to 2.5 mg/L, while chlorine doses ranged from 2 to 6 mg/L. The starting concentration of each toxin was between 10 and 20 ug/L. The results show large differences between the two oxidants when it comes to their destruction of several cyanotoxins.	11/16/2022

WED09-06	Degradation of Cyanobacteria Cells by Peracetic Acid and Microcystins by Ultraviolet/PAA Advanced Oxidation	Peracetic acid (PAA) is a non-halogenated disinfectant that is used in the wastewater industry and is gaining interest in the drinking water industry. However, its ability to degrade organic contaminants is not well known. In particular, no studies have reported the degradation of cyanobacterial toxins by PAA with or without ultraviolet (UV) light for advanced oxidation. This study investigates the ability of PAA and UV/PAA to degrade cyanobacteria cells and two microcystins in comparison to UV/H2O2.	11/16/2022
WED10	WED10 - Advancing Treatment Opportunities in Reuse	See description in subsessions below:	11/16/2022
WED10-01	Bromate Mitigation Strategies for Ozone in Potable Reuse: Investigation of Sidestream Contact Times and Chemical Addition.	Recent decades have seen an increase in utilities employing ozonation, more specifically via sidestream injection (SSI), for reasons such as lower capital and operational costs and improved ozone transfer efficiency among other operational benefits. In this presentation, we will provide an evaluation of different treatment strategies for minimizing bromate formation during sidestream ozonation in potable reuse. Particularly, the impact of changing sidestream ozone contact times and addition of chemicals such as peroxide or chloramines prior to ozonation on the net bromate formation will be summarized.	11/16/2022
WED10-02	Innovation in Florida Water Reuse: Palm Beach County's Green Cay Project	Palm Beach County is building on the success of its popular Green Cay Phase 1 wetlands water reuse park. Green Cay Phase 2 will use advanced treatment technologies to supply constructed lakes with pure water, creating new recreational opportunities for the public, reminiscent of Florida's world-famous natural springs.	11/16/2022
WED10-03	Our wAAter Program: Implementing Indirect Potable Reuse in Maryland	To improve long-term water supply resiliency and water quality in the Chesapeake Bay, the Anne Arundel County, Maryland Our wAAter Program is evaluating different management strategies to reduce nutrients and provide augmented water supply options to the region. This presentation will highlight the County's approach to implementing managed aquifer recharge as part of indirect potable reuse. The presentation will provide results from characterization of WRF effluent and steps taken for implementing a non-membrane-based pilot treatment train.	11/16/2022
WED11	WED11 - The Water Research Foundation's latest Opportunistic Pathogens Research Update (STS)	WRF has supported opportunistic pathogens (OPs) research to fill the knowledge gaps to advance understanding of OPs in distribution and plumbing systems. This session will highlight key research results from three WRF projects funded by the WRF Research Priority Program to address the public health challenge posed by OPs and develop improved monitoring and control strategies in systems.	11/16/2022
WED11-01	WRF 4721 – Methods to Quantify Drinking Water Opportunistic Pathogens and Determine Efficacy of Control and Treatment Technologies	Culture-independent drinking water opportunistic pathogen quantification methods were evaluated. The selected qPCR methods were then used in laboratory experiments evaluating the efficacy of OP mitigation strategies in building plumbing.	11/16/2022
WED11-02	WRF 4911- Legionella monitoring strategies for drinking water systems	OPs present a significant public health threat. Guidance on monitoring in drinking water systems are needed. Usefulness of large volume sampling, advanced detection methods and innovative sampling strategies are being explored and will be discussed.	11/16/2022
WED11-03	Effectiveness of Flushing for Reducing Legionellae Levels in Premise Plumbing Systems	The effectiveness of flushing for reducing Legionellae levels was evaluated in a pilot premise plumbing system. The effect of several operating conditions provide novel data for the development of evidence-based guidance.	11/16/2022
WED12	WED12 - Water Quality Challenges in Premise	See description in subsessions below:	11/16/2022
WED12-01	Chlorine Conversion Impact on Pathogen Occurrence, Residual Level, and DBP Formation in a Distribution System and Premise Plumbing	This presentation will describe a USEPA study to understand drinking water quality before, during, and after a free chlorine conversion (FCC) in a chloraminated drinking water system. The transient results for Legionella, Pseudomonas, non-tuberculous mycobacteria, heterotrophic bacteria, free-living amoebae (Naegleria fowleri, Acanthamoeba, and Vermamoeba vermiformis), disinfectant residual, trihalomethanes, and haloacetic acids will be summarized. This information aids in the understanding of FCC so drinking water quality is effectively managed by limiting occurrence and growth of waterborne pathogens, minimizing disinfection byproduct formation, and ensuring disinfection residuals are within recommended operating ranges.	11/16/2022

WED12-02	Can Chlorine Residuals Really Be Maintained in Building Water Systems to Prevent Growth of Opportunistic Pathogens?	Building water systems can harbor opportunistic pathogens (OPs), including Legionella pneumophila, Pseudomonas aeruginosa and nontuberculous mycobacteria. Secondary disinfection is widely used to prevent regrowth of OPs from the treatment facility to the consumer's tap. Most regulations recommend maintaining a minimum free chlorine residual across the main distribution system. However, maintaining supplied residuals across the plumbing of large buildings is a significant challenge, even more so in hot water systems. The distribution of chlorine concentrations in a range of large buildings was analyzed to show the limitations of relying on incoming residuals for its maintenance in cold and hot water systems.	11/16/2022
WED12-03	A Leap Forward: New Tools and Knowledge for Predicting, Finding, and Resolving Building Water System Contamination	A 6 year study lead by Purdue University, Michigan State University, Manhattan College was completed in March 2022 and provides 25 studies worth of new knowledge about water safety in buildings. Knowledge pertains to commercial, institutional, and residential building water safety. Two free online water quality prediction tools were also developed. An overview of the discoveries, how results can be applied, and the tools will be demonstrated.	11/16/2022
WED12-04	Evaluating microbial water quality changes in response to residential activities in a model home	This work showed that the culturable L. pneumophila, L. pneumophila gene markers, and heterotrophic plate count in hot water immediately increased following a simulated resident vacation (i.e., 10 days of no water use) and gradually returned to baseline levels at most taps with continued normal water use. Partial water plumbing drawdown (i.e., water lines completely drained but heater not drained) did not affect most taps while completely draining water heater decreased culturable L. pneumophila in some hot taps. Opening shower for 3-4 mins lowered microbial growth significantly. The results are informative for occupants to take measures to minimize risks associated with exposure to opportunistic pathogens such as Legionella in hot water.	11/16/2022
WED12-05	Characterization of Microbial Water and Treatment Performance in a Building Plumbing System Using Molecular Technology	Potable water is delivered to buildings via water treatment and distribution systems. To ensure water quality in building, water management plans are sometimes developed and often employ low-cost easy treatments such as heat treatment, flushing protocols, and water drainage. In this study, we aimed at monitoring the occurrence of three major OPPPs and phagocytic amoebae using molecular assays and investigated the efficacy of different treatment options on the microbial population of a simulated home plumbing system (HPS) located in an EPA lab in Cincinnati, OH. The results suggest that additional research is needed to optimize distribution system treatment options that can reduce the risks of pathogens in drinking water.	11/16/2022
WED12-06	Shock Disinfection of Building Water Systems: Making Sense of the Wild West of Guidance	Building water system shock disinfection is prescribed in some guidance either as a preventative procedure during commissioning or as a corrective action in the case of a confirmed/suspected contamination. There is no consensus on when and how a shock disinfection should be conducted. The objective of this study was to review current practices of shock disinfection for different system sizes and types (small to large distribution systems; premise plumbing systems). Based on this review, a guidance was developed on how and when to flush and disinfect buildings located in remote areas, with the objective of protecting public health, preventing damage to premise plumbing and minimizing the impact of discarded water.	11/16/2022
WED13	WED13 - Source Water Protection	See description in subsessions below:	11/16/2022
WED13-01	Water Contaminant Information Tool (WCIT): A Tool for Water Contamination Incident Preparedness and Response	The Water Contaminant Information Tool (WCIT) is a secure, online database that contains information on chemical, biological, and radiochemical contaminants of concern to the Water Sector. WCIT was created in response to the Water Sector's needs for a quick and effective response to intentional, unintentional, or natural water contamination events. It is designed to be a tool to aid the Water Sector in their emergency response and preparedness efforts. This presentation will review the main features of the tool and provide real-world examples of how WCIT has been integrated utilities' work and the lesson learned from these experiences.	11/16/2022
WED13-02	A Comprehensive Inventory and Characterization of Source Water Contamination Threats: A Ten State Study	The Water Security Division of the EPA's Office of Water completed a state-level source water contamination threat inventory in ten states to understand the occurrence of sites that could contaminate the surface water or groundwater supplies for community water systems, identify the prevalence of contaminant classes in source water protection areas, and understand the relationship between the density of threats and reported releases. The water sector can use the results to guide source water contamination threat inventory development in other states, help prioritize and develop risk management strategies for the most common acute contamination threats identified, and prioritize source water protection and spill response planning efforts.	11/16/2022

WED13-03	Leveraging Water Quality Management Strategies for Navigating Future Uncertainty	The presentation will focus on proactive source water monitoring and management to better understand baseline water quality conditions and establish strategies to reinforce ecosystem resiliency. Implementation of dynamic source water plans will better prepare utilities for future challenges including climate change impacts, eutrophication, wildfire impacts.	11/16/2022
WED13-04	Challenges of Monitoring Contamination from Kirtland AFB Near Albuquerque (ABCWUA) Supply Wells Under Aquifer Recovery Conditions	The Albuquerque Bernalillo County Water Utility Authority (ABCWUA) serves more than 650,000 users. Since discovery of the Kirtland Air Force Base Bulk Fuel Facility jet fuel and ethylene dibromide (EDB) plume in 1999, ABCWUA has proactively engaged in monitoring clean-up efforts to ensure public water supplies are protected. Water levels in the aquifer have rebounded several tens of feet since 2008 as ABCWUA has diversified its water supply portfolio and reaped benefits of conservation and aquifer storage and recovery (ASR) projects. Vadose zone contaminants are entrained in groundwater as the water table rises. Monitoring data reveal complexities of monitoring contaminant migration in three dimensions under such conditions.	11/16/2022
WED13-05	Groundwater Salinization; Implications for Drinking Water Utilities and the Benefits of Source Water Monitoring	The Greater Cincinnati Water Works and the Hamilton to New Baltimore Groundwater Consortium conduct routine source water monitoring in the Great Miami Buried Valley Aquifer in Butler County, Ohio. Long-term chemical trends indicate salinity is increasing at many locations throughout the region likely due, at least in part, to road salt application. The presentation will include an overview of the aquifer setting and the monitoring network, a summary of long-term concentration trends for sodium and chloride, the statistical methods used to evaluate the increasing trends, and source evaluation. It will also highlight the benefits of long-term groundwater monitoring data for wellfield operations and will touch on possible mitigation solutions.	11/16/2022
WED13-06	Fluorescence Excitation Emission Matrix (FEEM) Signatures for Source Water Monitoring in Response to a Freshwater Oil Spill	Incidents of oil spills in freshwater sources are on the rise and need research attention. When the freshwater source is also a drinking water source, such incidents will have direct adverse human health impacts. Therefore, it is important for utilities to monitor the water quality near the intake, so required treatment changes can be implemented in case oil hydrocarbons are detected. In this study, we demonstrate the changes expected in Fluorescence Excitation Emission Matrix (FEEM) signatures using laboratory-generated solutions of commercial standards for natural organic matter (NOM), NOM-type molecules and petroleum hydrocarbons, as well as raw water samples and commercial crude oil.	11/16/2022
WED14	WED14 - Testing, LSL Inventories, and other LCRR Considerations	See description in subsessions below:	11/16/2022
WED14-01	Best Practices for Lead Service Line Replacement Plans	The USEPA Lead and Copper Rule Revisions (LCRR) require water systems to submit a lead service line inventory and a lead service line replacement (LSLR) plan by October 16, 2024. While service line inventories have received much of the attention around LCRR compliance, the LSLR plan is due at the same time and has many detailed components that water systems must include. This session will focus on the required aspects of the LSLR plan and draw upon the experience of utilities across the country to highlight best practices in developing and implementing replacement plans. This session will provide an overview of each component of the LSLR plans and showcase resources and case studies that utilities can draw upon when drafting their plans.	11/16/2022
WED14-02	Lead Testing – from Bubblers in Schools to Triple-Deckers in Boston - the MWRA Experience	The Massachusetts Water Resources Authority, the wholesale supplier of water to the metro Boston area, has been working to increase testing of lead in tap water in locations that could impact children. In cooperation with MA DEP's school testing program for lead, MWRA offered its communities free lead analysis for their schools. MWRA is also working in partnership with the MA Department of Public Health to sample for lead in the tap water at homes where a child has an elevated lead level in their blood, and to identify if there is a lead service line. This presentation will provide an overview of the results of both of these sampling, and future actions that MWRA is taking to help reduce possible lead exposure at the tap.	11/16/2022

WED14-03	Utility and Residential Guidance to Address Elevated Levels of Copper in Potable Water	Gaps in the EPA Lead and Copper rule leave residents with public water and private wells vulnerable to elevated copper in drinking water. We examined how water quality criteria and citizen science can help utilities and residents address issues with cuprosolvency. A decision-making framework was developed utilizing water quality (pH, alkalinity, and orthophosphate) to demarcate waters unlikely to be corrosive to copper. However, the influence of other water quality parameters may need to be considered. Citizen science field testing and companion laboratory studies demonstrate the use of this framework for guiding and empowering residents and utilities in addressing copper concerns.	11/16/2022
WED14-04	Building and Using Your Lead Inventory to Address Health Inequity in the Water System: Three Real World Examples	This presentation discusses an innovative approach to apply the principles of health equity and environmental justice to prioritize the implementation of multi-year lead service line replacement programs. Case studies are used to compare approaches with and without machine learning to develop the inventory.	11/16/2022
WED14-06	Evaluating an Initial Lead Service Line Inventory to Remove Unknowns Ahead of the October 2024 LCRR Due Date	The purpose of this paper is to present strategies for water system on how to reduce the unknowns in a utility's lead inventory through the strategic and statistically relevant use of various service line investigation techniques. Utilities need to prepare for compliance in the transition from the Lead and Copper Rule (LCR) to the Lead and Copper Rule Revisions (LCRR). In October 2024, the Environmental Protection Agency (EPA) will require an initial lead service line inventory, where, under the LCRR, all service lines with unknown materials are considered to be lead in the event that replacement is mandated.	11/16/2022
WED15	WED15 - Managing PFAS at Utilities: Pilot- and Full-scale Results	PFAS treatment management approaches will be covered for various water utilities along with what information and data were determined to be of greatest value to the design team.	11/16/2022
WED15-01	Managing the Unknown Unknowns in PFAS Treatment: Implications of Pilot Scale Results on Full Scale Design	The City of Greensboro has been operating a year-long pilot study to evaluate GAC, ion exchange, and nanofiltration membranes to treat PFAS. This presentation will cover PFAS results from the study along with key findings that impact full scale design. Additional focus areas include managing bioaccumulation when treating PFAS in surface waters, how PFAS treatment techniques aid in the removal or mitigation of other emerging contaminants, and managing the impact of waste streams.	11/16/2022
WED15-02	Pilot-Scale Evaluation of PFAS Removal From Surface Water Using GAC, Ion-Exchange Resin, and a Specialty Adsorbent	This 9-month pilot study evaluated how PFAS treatment processes can be incorporated into a conventional filtration plant treating a high-TOC surface water supply. The study evaluated two GACs, as well as one ion-exchange resin and one clay-based specialty adsorbent. The surface water supply contained eight PFAS with varying adsorbability on all three adsorbents. The study tracked the impact of seasonal changes in water quality on the performance of the unit processes, and estimated the projected adsorbent replacement frequency at the full-scale plant. Through special testing, the study also determined that no PFAS is removed from any of the adsorbents during backwashing.	11/16/2022
WED15-03	Treatment Alternatives for PFAS Removal in Surface Water: A Case Study at the City of Ann Arbor Water Treatment Plant	The City of Ann Arbor has conducted full-scale and pilot-scale studies to test the performance of various granular activated carbon types, anion exchange resins, and the impacts of several operational parameters for the removal of PFAS. This research was designed to provide guidance for full-scale treatment of PFAS for the City of Ann Arbor and other surface water systems.	11/16/2022
WED15-04	Expand Your Toolbox – What to Gain from Performing Both RSSCT Bench-Scale and Field-Scale Pilot Studies to Evaluate PFAS Treatment	(This presentation was on the program for WQTC 2021 but had to be withdrawn due to the presenter having caught Covid-19 just before the conference) Middlesex Water Company used both bench-scale and field-scale pilot testing to evaluate alternatives and operational parameters for PFAS treatment. Each method contributed to the basis of design for the treatment process in different and significant ways. This presentation will provide the types of information that utilities can expect to obtain from each type and discuss factors to consider when implementing a rapid small-scale column test and/or a field-scale pilot test for evaluating PFAS treatment.	11/16/2022
WED15-05	PFAS Treatment on a Postage Stamp Site: Aqua NJ's Lawrenceville Well Station	The state of New Jersey was one of the first to adopt a Maximum Contaminant Level (MCL) for PFAS compounds in drinking water. Aqua NJ intends to meet this new regulatory requirement utilizing Anion Exchange treatment at their Lawrenceville Well Facility. This project involved treating multiple groundwater sources, including two wells under direct influence of surface water. The presentation will describe obstacles encountered during the selection of a treatment technology as well as other operational considerations which were taken into account during the design phase.	11/16/2022

WED15-06	Tucson Water's PFAS Management Strategy	Tucson Water has been operating the Tucson Airport Remediation Project (TARP) remediation system to remove TCE since 1994. In 2002, 1,4-dioxane (DX) was detected in TARP groundwater, and in 2014, the utility added an UV light-hydrogen peroxide advanced oxidation process (UV AOP) to destroy DX along with TCE. The utility faces its third water quality challenge at TARP due to the presence of PFAS above EPA's 2016 Drinking Water Health Advisory. Beyond TARP, water quality monitoring indicated the presence of PFAS in approximately 30 production wells and Tucson's recycled water supplies. This presentation reviews Tucson Water's PFAS management strategy and innovative solutions, including both short-term and long-term mitigation efforts.	11/16/2022
WED16	WED16 - Membrane Treatment Impacts on Water Quality and Pathogen Removal	See description in subsessions below:	11/16/2022
WED16-01	Putting Membrane Bioreactors (MBRs) to the Test: Demonstrating Pathogen Removal for Potable Reuse	Removal of Cryptosporidium, Giardia, and enteric viruses by membrane bioreactors (MBRs) is being assessed in a 0.5 million gallons per day (MGD) demonstration-scale advanced water reuse plant. The demo-plant supports a regional reuse program that could potentially provide up to 150 MGD of purified water for Southern California. Recently completed testing utilized non-disinfected secondary wastewater as the feed water for the MBR. MBR performance was assessed under baseline conditions and challenge testing conditions with intentionally compromised membranes (cut and removed MBR fibers). This presentation will present pathogen and indicator microbe results for secondary wastewater and large volume (3,000 to 10,000 L) MBR filtrate samples.	11/16/2022
WED16-02	RO and NF Log Removal Credit Validation through Long-Term Pilot Operation with Challenge Testing	Reverse osmosis (RO) and nanofiltration (NF) are widely applied and trusted membrane treatment technologies for water and wastewater treatment due to their ability to effectively remove dissolved compounds, bacteria, and viruses. However, in potable water reuse applications, RO is given an LRV credit of 0.5–2, even though research has proven RO to achieve log removal values (LRVs) of up to 6 for viruses. Therefore, the goal of this project was to close the gap in RO and NF performance and the given LRV credit through long term pilot testing along with challenge tests with native wastewater compounds and MS2.	11/16/2022
WED16-03	From slow sand filtration to ceramic membrane filtration - a pilot evaluation of its application and water quality impacts	This presentation will provide a summary of an 18-month pilot study into the application and performance of suspended ion exchange (SIX®), in-line coagulation including ozone pre-treatment for ceramic membrane microfiltration and how this compared to an existing slow sand filters (SSFs) full scale water plant in the southwest of England. The study evaluated DOC removal and UV transmission improvements from trials with and without SIX® and ozone pre-treatment on ceramic membrane filtered water quality and its effect on membrane performance. Membrane performance was also assessed using different coagulants and different cleaning regimes which resulted in varying rates of fouling of the membrane.	11/16/2022
WED17	WED17 - Design Considerations and Response to Legionella Detection	See description in subsessions below:	11/16/2022
WED17-01	Development of Response Protocols to the Detection of Legionella pneumophila in Drinking Water Distribution Systems	This presentation will provide an update on a workshop held in the spring of 2022 with EPA, CDC, health agencies, and academics on developing response protocols for detection of L. pneumophila in water systems. The workshop is part of WRF project 5156 on the on the occurrence of Legionella pneumophila in drinking water distribution systems.	11/16/2022
WED17-02	Design and Operational Considerations in Response to Legionella Occurrence in Las Vegas Valley Groundwater	The Southern Nevada Water Authority (SNWA) has been proactively monitoring for Legionella across various raw and treated surface water and groundwater supplies for several years. This presentation will provide an overview of the occurrence monitoring results and focus on detections found in non-treated groundwater supplies, impact of well operation, and efficacy of chlorination. SNWA's response plan will also be discussed with respect to working with local and state health officials, removing wells from service, and evaluating a multi-barrier treatment approach at select groundwater wells.	11/16/2022

WED17-03	Impact of Oversized vs Right-Sized Plumbing Design on Chlorine Disinfectant Efficacy to Control Opportunistic Pathogens	Opportunistic pathogens (OPs) that naturally colonize building plumbing are the leading cause of disease associated with potable water in the U.S. and many other countries. While secondary disinfectant is added to water prior to distribution, the remaining residual that crosses the property line is often insufficient to suppress OPs growth or will be further diminished in building plumbing. This study uses a novel pilot-scale premise plumbing rig to investigate the optimum concentration of disinfectant needed at the building point-of-entry to control OP growth in properly maintained “right-sized” pipes and identify the extent to which poorly designed hydraulics can undermine the effectiveness of secondary disinfectant to control OPs.	11/16/2022

Technical Posters Sessions

Technical Post	**PST01 - Monday Poster Session (AM)**	**All sessions below are posters in the Monday Morning poster session:**	11/14/2022
PST01-01	Getting the Most Out of Coagulation – Enhancing the Process Through the Addition of Adsorbents, Photocatalysts And UV light	This presentation will consider how we can enhance the coagulation process through incorporation of active particles into the structure of flocs formed during coagulation and flocculation. The objective of such an approach is to enhance the ability of these upfront treatment processes to provide additional removal of contaminants from water. Traditionally, we rely on coagulation processes to provide bulk removal of dissolved organic carbon and turbidity. However, if we are able to activate the coagulation process through the addition of sorbents and photo-active media, we can provide opportunities for removal of compounds that are not typically removed by coagulation, namely micropollutants, and negate the need for downstream investment.	11/14/2022
PST01-02	Evaluation of Ozone Dissolution Systems and Their Effects on Bromate Formation in Water Treatment and Wastewater Reuse	Sidestream injection and fine bubble diffusion were evaluated for bromate formation in both natural water and wastewater to compare the mechanistic differences in bromate formation and control in these systems. The implications of chemical bromate control strategies on these systems and the tradeoffs between ozone treatment objectives and bromate formation were also evaluated.	11/14/2022
PST01-03	Precursors, Formation Pathways, and Mitigation of Halonitromethanes in Drinking Water and Recycled Wastewater	This presentation will focus on the precursors and transformation pathways leading to halonitromethane disinfection byproduct formation during water treatment and wastewater reuse, particularly in systems using ozone for primary disinfection. Halonitromethanes are genotoxic, three of them, including chloropicrin, are on EPA’s Candidate Contaminant List 5, and they have been widely reported as contaminants in drinking water and recycled wastewater. This talk will cover how molecular insights into halonitromethane formation can inform control strategies, particularly in systems using ozone.	11/14/2022
PST01-04	Effects of Dissolved Oxygen and Dimethylamine on Dichloramine Decomposition Products and NDMA Formation Pathways	This presentation will focus on the kinetics and yields of dichloramine decomposition products at pH 9 under ambient and low dissolved oxygen conditions and include nitrogen and oxygen mass balances on monochloramine, free ammonia, nitrogen gas, nitrite, nitrate, and nitrous oxide. These measurements formed the basis to revise the dichloramine decomposition reactions in the Unified Model of Chloramine Chemistry and update a numerical model to quantify reactive nitrogen species formed, which included nitroxyl and peroxynitrite. These findings help resolve the dichloramine decomposition pathway and its role in NDMA formation in chloramine systems.	11/14/2022
PST01-05	Accumulation and Release of Arsenic From an Old Cast Iron Drinking Water Main	Arsenic (As) is naturally present in many groundwaters and can gradually adsorb to and accumulate in iron pipe scale. Iron pipes are widely present in water distribution and there are increasing concerns over undetected release and mobilization of As from iron pipe scale into drinking water. This work showed that iron scale could constantly accumulate As from water and concentrate As in iron pipe scale, which could later leach into water at concerning levels. Short-term addition of orthophosphate to drinking water and/or changes in source water As levels promoted As release from iron scale; long-term addition gradually reduced As release. This work has important health implications for water systems with orthophosphate treatment.	11/14/2022

PST01-06	Developing a Set of Formation Conditions to Assess Precursors of Haloacetonitriles (HANs) In Source Waters	Haloacetonitriles (HANs) are unregulated disinfection byproducts (DBPs) that are formed during free chlorine or chloramine disinfection of water. HANs are detected frequently and exhibit higher cytotoxicity and genotoxicity compared to their regulated counterparts. Since the stability and formation of HANs vary with different formation conditions such as pH, chlor(am)ine dose, reaction time, and chlorine residual, it is not suitable to use the existing formation potential (FP) test conditions to assess the HAN precursors in source water. A new set of FP test conditions was established for three different application techniques for two source waters and was utilized to assess HAN precursors in various source waters along the Colorado River.	11/14/2022
PST01-07	Examining the Spatial and Temporal Variation and Correlations Between Water quality and Regulated Metals in a Canadian DWDS	With the growing interest in accumulation and release of inorganic contaminants in distribution systems, it is important to understand how they influence the bulk water quality. In this study, a historical water quality dataset spanning 2016-2019 developed from 26 distribution system monitoring sites and from the effluent of 2 water treatment plants was used to examine the effect of seasonality and hydraulic distance from source treatment on the water quality and concentration of regulated metals (Al, Mn, Fe, As, Cr, Cl). This research will help to advance our understanding of the role residual coagulant concentration play in the accumulation of metals in a DWDS as well as predict accumulation risks with potential sinks within the network	11/14/2022
PST01-08	Evaluation of Hydraulic Retention Time and Temperature Impact on Biodegradation of Disinfection Byproduct in Biological Activated	Drinking water disinfection is essential to protecting public health from waterborne diseases. However, disinfectants can react with natural organic matters form carcinogenic disinfection byproducts (DBPs). It is essential to control both regulated and unknown DBPs in drinking water to protect public health. As a green technology, biological filtration has not been carefully evaluated for the removal of unknown DBPs. The objective of this study is to evaluate the impact of hydraulic retention time and temperature on the biodegradation of disinfection byproducts using biological activated carbon filters. This study provides guidance regarding the application of biofiltration technology for the removal of different DBPs in drinking water.	11/14/2022
PST01-09	Evaluation of Contribution of Extracellular Polymeric Substances of Pseudomonas aeruginosa in Disinfectant By-Products Formation	The quality of treated drinking water deteriorates in drinking water distribution systems (DWDS). The microbial community and the extracellular matrix of biofilms formed in the inner surface of the distribution system are driving forces in the degradation of water quality. Extracellular polymeric substances (EPS) present in the biofilms react with disinfectants resulting in the formation of disinfectant by-products. The research described in this abstract focuses on the investigation of the contribution and compositional characteristics of EPS that are responsible for the formation of disinfectant by-products.	11/14/2022
PST01-10	Evaluating Significance of DBP Formation Factors and Developing DBP Models for a 240-mgd Surface Water Plant	The Richard Miller Treatment Plant of the Greater Cincinnati Water Works (GCWW) is a 240 mgd surface water treatment plant. The facility may need to increase chlorine residual and pH as responses to EPA's new LCRR and M/DBP regulations. A factor significance analysis using an orthogonal array design was conducted, and the results allow GCWW to adjust the chlorine dosage and pH while maintaining DBP at the current level. Three THM models were compared, and the pros and cons of each model were discussed.	11/14/2022
PST01-11	Approaches to Modeling Water Quality across Four Ohio Distribution Systems	This presentation describes the approaches and benefits of distribution system water quality modeling recently completed by four Ohio cities: Cincinnati, Columbus, Toledo, and Canton. Water quality modeling performed by these cities included disinfectants and disinfection byproducts, source traces, and water age. Calibration of these water quality models ranged from using typical water quality sampling already performed by the city, to complex tracer studies of chlorine concentrations and extensive temporary water quality sampling. These four case studies exhibit a range of water quality modeling applications and allowed these utilities to better understand their distribution system.	11/14/2022
PST01-12	Phosphate Chemical Use for Sequestration, Scale Inhibition and Corrosion Control: A 3-Dimensional Challenge	Phosphates are widely used by water utilities for three objectives: to control iron and manganese (Fe/Mn), inhibit calcium scale, and address corrosion. Polyphosphate dosing is relatively cheap compared to centralized removal of hardness or Fe/Mn, but it may cause issues with lead and copper dissolution and scale destabilization. Orthophosphate is superior for corrosion control and inferior for the other objectives. Due to gaps in understanding, utilities often select a phosphate type and dose for their most important issue with the hope the other dimensions will not be negatively affected. This work describes approaches for the use of phosphates in order to achieve multiple objectives while minimizing unintended consequences.	11/14/2022

PST01-13	Factors Influencing Lead and Copper Contamination in Massachusetts Schools and Childcare Facilities	The Massachusetts Assistance Program for Lead in School Drinking Water began in 2016 to encourage schools and early childhood centers to test their drinking water for lead and copper contamination. There are also many facilities that were not a part of the statewide program but did their own independent lead and copper testing. Results from all these tests, over 180,000 since 2016, are made public in an Executive Office of Energy and Environmental Affairs database. This study uses that data to analyze the factors associated with increased lead levels using three different types of data 1) building infrastructure characteristics 2) water treatment techniques and water quality information and 3) school demographics.	11/14/2022
PST02	**PST02 - Monday Poster Session (PM)**	**All posters below are part of the Monday Afternoon Poster Session:**	11/15/2022
PST02-01	The Promise of Biofiltration for Treatment of Wildfire-ash Impacted Water	Drinking water treatment can be challenged by wildland fire because of elevated and more variable turbidity, increased levels and shifts in character of natural organic matter, and release of other contaminants. These can challenge treatment plants beyond design or operational capacities. The impact of relatively rapid fluctuations in dissolved organic carbon (DOC) can be especially challenging for ensuring adequate coagulation, clarification, and filtration, thereby leading to potentially increased disinfection by-product formation. DOC removal by biofiltration of wildfire ash-impacted source water was investigated at bench-scale and found to be promising for treatment of post-fire DOC-associated water quality changes.	11/15/2022
PST02-02	Upscaling Small-Scale Post-Wildfire Hydrologic and Water Quality Effects to the Catchment-Scale	Wildfires can drive significant changes in water quality and supply, presenting challenges for water treatment plants and freshwater systems. This research explores the potential to upscale small-scale (~300 cm3) observations of wildfire effects on runoff, sediment, nutrients, and dissolved organic matter loads to the basin scale using spatially-distributed physical models. The goal is to provide insight into key processes driving water quality and hydrologic response in post-fire environments, allowing for a characterization of basin vulnerability to wildfire effects based on geophysical and climatic variables. Utilities may use these predictions to conduct a priori wildfire impact assessments, informing future infrastructure upgrades.	11/15/2022
PST02-03	Biological Oxygen-Dosed Activated Carbon (BODAC) Filtration: A Promising Technology for Fouling Prevention in RO Membranes	Biological oxygen dosing activated carbon (BODAC) filters were installed at the Ultrapure Water Plant (UWP) (Nieuw-Amsterdam, the Netherlands) to prevent biofouling in the downstream reverse osmosis (RO) system. The BODAC filters effectively removed fouling precursors, resulting in the extended lifespan of the RO membranes. The present work aims to investigate those removal mechanisms through a mass balance approach.	11/15/2022
PST02-04	Application of Cyanophages as a Biological Control Agent for Harmful Cyanobacterial Blooms	Cyanobacteria are incredibly abundant in aquatic ecosystems around the world and can grow rapidly in blooms, referred to as harmful algal blooms (HABs). Cyanotoxins are produced in consequence of the HABs and cause stress on the drinking water treatment facilities. Current treatment methods include chemical algaecides and the need for a biological alternative is necessary. Cyanophage are known to be bioregulators of cyanobacterial populations and were isolated from water collected from Lake Erie during the HAB of 2019. Cyanophage were used to determine the feasibility in the inhibition of cyanobacterial growth.	11/15/2022
PST02-05	Early Warning System for Detecting Cyanobacterial Lysis and Toxin Release	This presentation shows the early warning system for detecting cyanobacterial lysis and toxin release, which could be a valuable tool for drinking water treatment managers.	11/15/2022
PST02-06	Evaluation of Microcystin Extraction Methods from Drinking Water Treatment Residuals for LC-MS/MS Analysis	Increased eutrophication has led to growing instances of cyanobacterial blooms in freshwater bodies. Drinking Water Treatment Residuals (DWTRs) generated from the treatment of algal bloom water contain high concentrations of cyanotoxins. DWTRs recycled for land applications can lead to potential cyanotoxin bioaccumulation in the food chain. Cyanotoxin quantification from DWTR has proven challenging due to the presence of chelating ions like alum and matrix interference, which hinder toxin recovery and quantification. Herein, controlled experiments were conducted for microcystin and nodularin recovery from DWTR matrices collected from three different water treatment plants in Ohio, USA affected by Harmful Algal Blooms.	11/15/2022

PST02-07	Legionella Bacteria in Premise Plumbing Supplied by Aging Potable Water Infrastructure Impacted by Prolonged Stagnation	The COVID-19 building shutdowns created unintended consequences in premise plumbing water quality, particularly in buildings supplied by aging potable water infrastructure. The prolonged building shutdown created the ideal environment (low chlorine residual) for the growth and spread of Legionella bacteria. This study quantified Legionella bacteria in potable water over a period of two years in a residential building impacted by the COVID-19 building shutdown. The results illustrate that heat shock and chlorine shock treatments were effective only short-term, and that Legionella is highly variable by sample location and by season. Improved treatment and water management plans are required to manage Legionella in building potable water.	11/15/2022
PST02-08	The Impact of Commercial Algaecides on Cyanobacterial Control and Water Quality	The occurrence of cyanobacterial harmful algal blooms (cHABs) is a growing concern for public drinking water system to produce safe water as several species of cyanobacteria produce toxins that are known to cause severe illnesses in animals and humans. Algaecide application is one of the common methods to inhibit cHABs, but excess application has shown to damage the cells and release intracellular organic matter (IOM) and toxins. In this study, four different commercial algaecides were evaluated, and the optimum dosage and treatment time for each were examined. Cyanobacterial heath and the release of IOM and toxin were monitored.	11/15/2022
PST02-09	Adsorption Perfluorooctanoic Acid (PFOA) Onto Polyethyleneimine Modified Graphene Oxide (GO-PEI)	The widespread existence, long-term environmental persistence, and potential human health threats of PFOA in water systems have greatly attracted the attention in removing PFOA from water bodies. Adsorption is a most commonly used technique in pollutants removal. An efficient adsorbent for PFOA removal should be considered and applied in remove PFOA from water.	11/15/2022
PST02-10	A Unique Cost Optimization and Breakthrough Forecasting Tool for PFAS Adsorption with GAC	The presentation showcases a unique operating cost optimization tool for PFAS treatment with GAC. The tool combines a cost model for organics removal via convention treatment (coagulation/flocculation/sedimentation/filtration) and an adsorption model that predicts breakthrough curves for PFAS compounds based on carbon type, influent TOC and PFAS concentration, and operational setpoints. The combination of these approaches results in an optimization tool for the whole plant to maximize carbon life and minimize life cycle costs. This is applied to two case studies, Greensboro, NC and Cape Fear Public Utility Authority, to demonstrate that it can be used broadly by utilities across the US to save significantly on GAC costs.	11/15/2022
PST02-11	Regeneration and Reuse of PFAS-Specific Resins: Impact of Resin Microstructure, Substrate Augmentation and Regenerant Selection	Treatment technologies such as ion exchange (IX) process exhibit promising potentials for the removal of per- and poly-fluoroalkyl substances (PFAS) from natural waters. In recent years, industries have started manufacturing PFAS-specific resins which are typically operated in a single load-and-dispose mode until exhaustion. However, this strategy increases the resin demand and the consequent operational cost of IX. In this study, we compared the performance of multiple PFAS-specific resins with conventional organic scavenger resins. The removal of multiple long- and short-chained carboxylic, sulfonic, precursor and emerging PFAS from natural waters was examined with a particular focus on the applicability of resin reuse and regeneration.	11/15/2022
PST02-12	Machine Learning Models to Predict PFAS Removal by Granular Activated Carbon	The presentation would be divided into the following two components-- the development of predictive machine learning (ML) models for predicting PFAS breakthrough in GAC and case studies of the ML model application. First, we will go through the development of a GAC breakthrough database which serves as the basis for the machine learning model development and validation. Subsequently, we will provide an analysis of the model inputs which are constituted of water quality parameters, chemical properties and GAC characteristics. Finally, we will present two projects in which the machine learning models were deployed for the purpose of cost estimation and bench-scale test planning.	11/15/2022
PST02-13	Investigating the Interactions Between Ciprofloxacin and Drinking Water Biofilms Using a Novel Bench-Top Bioreactor	The persistence of contaminants of emerging concern (CEC) in drinking water distribution systems (DWDSs) has been a recent topic gaining attention from public health and municipal management. A CEC of growing interest is the antibiotic ciprofloxacin, which has been found to persist from source to tap. In this study, a novel bench-top scale bioreactor was designed and built to examine the interactions between trace levels of ciprofloxacin and premise plumping biofilms. This research will help in further understanding the interactions of CECs in DWDSs and their associated risks.	11/15/2022
PST03	**PST03 - Tuesday Poster Session**	**All posters below are part of the Tuesday Poster Session:**	11/15/2022

PST03-01	Microbubble Ozonation –a Matter of Mass Transfer	Ozonation is widely applied as a drinking water treatment process. Conventional ozonation is limited by low ozone gas generation efficiency and mass transfer into water. The development of microbubbles technology (1 - 100 µm) is emerging as a revolutionary step to improve the process. Microbubbles have the potential to enhance ozone mass transfer, gas utilisation and micropollutant removal rates. This is due to the higher interfacial area of microbubbles in comparison to conventional bubbles (2 – 6 mm), which can improve ozone transfer into water. This research explores and quantifies the differences in mass transfer and pesticide removal efficiency between conventional and microbubble ozonation for drinking water.	11/15/2022
PST03-02	UV-LED Disinfection No Longer a Myth in the Public Water Supply and Municipal Wastewater Treatment Industries	This collaborative research between Korea Water Partnership and U.S. Environmental Protection Agency aims to apply multiple wavelength ultraviolet (UV) light emitting diodes (LEDs) for the disinfection of municipal wastewater effluent. Our challenge was to achieve comparable (even greater) reliability for compliance with bio-stability goals, especially by replacing conventional UV lamps with mercury free UV-LEDs. This research demonstrated the technical feasibility of using UV-LED water treatment systems for the disinfection of municipal wastewater effluent. The results with practical applications provide information that will be useful to the water and wastewater industries and for practitioners in UV disinfection science and engineering.	11/15/2022
PST03-03	Bromate Mitigation Strategies for Ozone in Potable Reuse: Investigation of Sidestream Contact Times and Chemical Addition.	Recent decades have seen an increase in utilities employing ozonation, more specifically via sidestream injection (SSI), for reasons such as lower capital and operational costs and improved ozone transfer efficiency among other operational benefits. In this poster we will provide an evaluation of different treatment strategies for minimizing bromate formation during sidestream ozonation in potable reuse. Particularly, the impact of changing sidestream ozone contact times and addition of chemicals such as peroxide or chloramines prior to ozonation on the net bromate formation will be summarized.	11/15/2022
PST03-04	DRINCS: A GIS-based model that allows analysis of Defacto Reuse, Nutrient Recovery and PFAS Risk Analyses	Assessing the potential for increasing water availability in the United States through reuse of municipal wastewater is ranked as the top research need in the National Research Council's 2011 report. Due to outdated information regarding the contribution of municipal wastewater effluent to potable water supply, it is difficult to assess the significance and health impacts of de facto water reuse. By developing a model that estimates the amount of wastewater effluent inside drinking water treatment plants, the overall goal is to quantify how much de facto reuse has occurred and using it to assess public health risk from drinking water contamination (pathogen, PFAS, etc.) and building a national Phosphorous inventory for food sustainability,	11/15/2022
PST03-05	Treatment of Algal Toxins and DBP Precursors at The City of Toledo Collins Park Water Treatment Plant	The CPWTP draws its source water from the western basin of Lake Erie, which is subject to seasonal HABs that can produce algal toxins, specifically MC. Several rounds of bench-scale tests were completed to select the long-term MC treatment strategy (ozone), validate its efficacy in achieving the required MC removal, and to demonstrate the impact ozone and BAF would have on chlorinated DBPs in the distribution system. In this presentation, the various studies that were conducted to prepare COT for future HAB events, the implementation of the new ozone and BAF treatment facilities, and results of bench-scale tests for MC and DBP reduction as compared to full-scale operating conditions now that these systems are online will be discussed.	11/15/2022
PST03-07	Coagulant/Polymer 101: Fundamentals of Clarification and Dewatering	Various topics regarding coagulation and flocculation are discussed about its mechanism, available chemicals, preparation before application, injection methods, and typical dosages for wide range of processes. Effect of dilution water on polymer solution quality is presented, followed by implementation of two-stage mixing, two-step dilution and sufficient residence time into polymer system design. Case studies at municipal treatment plants demonstrated that well-designed polymer systems can significantly improve the performance of dewatering process.	11/15/2022
PST03-08	Brownification: Causes and Implications of Changing Source Water Quality on Drinking Water Treatment	In recent decades, water utilities have seen DOC levels in their surface water increase. Concomitant increases in Fe concentration have also been observed. Since the efficacy of treatment processes is dependent on NOM, browning is expected to have a profound impact on water treatment practices. We will present 1) the extent of brownification in several large Atlantic Canadian surface drinking water supplies in terms of both NOM concentration as well as changes in quality, 2) the influence of browning on the mobilization of trace metals in water supplies, and 3) the treatment challenges and operational considerations for browning water supplies.	11/15/2022

PST03-09	Selection of Ferric Coagulants	Theoretically, the same mass of Fe (III) should result in the same coagulation performance, but utilities have found that the conversion to ferric sulfate often leads to a reduction in coagulation performance. The choice of counterion affects the surface charge and settleability of the resultant flocs, leading to differing removals of turbidity and organic compounds. We will present our recent findings from coagulation/flocculation/sedimentation studies on ferric coagulants with recommendations for ferric coagulant selection and dosing.	11/15/2022
PST03-10	Comparing the Triple Bottom Line of Centralized Improvements to Point-Of-Use or Point-Of-Entry (POU/POE) for SDWA Compliance	Our study examines strategies for achieving SDWA compliance in existing small water systems using a triple bottom line approach. Our study compared the human health, environmental and economic impacts associated with either a centralized treatment improvement or the installation of POU/POE devices in 4 case study communities across the US to determine which alternative provided the best triple bottom line in each community.	11/15/2022
PST03-11	Wastewater Pathogen Surveillance Using Digital PCR and Quantitative PCR	Wastewater-based epidemiology (WBE) is a method of systematically sampling and analyzing wastewater influent to detect specific pathogens and measure early warning signs for disease outbreak and spread. The importance of WBE surveillance systems gained significant attention with the emergence of SARS-CoV-2. WBE enables early detection of SARS-CoV-2, monitors community-level trends, evaluates the efficiency of public health measures, and identifies potential viral outbreaks to limit transmission. Here we will show both absolute and relative detection of pathogens - viral and bacterial - from waste water samples for use in surveillance monitoring.	11/15/2022
PST03-12	Microbial Source Tracking of Stormwater Basins Overlying the Edwards Aquifer Recharge Zone	Pathogens enter hydrologic systems via failing on-site sewage facilities (OSSFs), wastewater treatment plant effluent, and discharge from livestock waste facilities, among other sources. The effectiveness of best management practices (BMPs) in protecting water quality is questionable due to issues such as 1) lack of standardization in monitoring their efficacy, 2) their inability to handle overall pollutant loads, and 3) inadequate location and selection of BMPs for specific purposes. Accurate and efficient fecal source identification is thus paramount to the implementation of BMPs that can cost-effectively prevent, control, and remediate pollution events and preserve water quality.	11/15/2022
PST03-13	Optimization of Coagulation-Flocculation Process for Effective Removal of Algal Organic Matter in Drinking Water Treatment Plants	Cyanobacteria harmful algal blooms presence in freshwater sources poses major problems to the supply of drinking and industrial water. Algal cell lysis during water treatment process releases algal organic matter (AOM). Coagulation-flocculation is one of the most widely applied techniques in drinking water treatment plants. AOM removal by this process is not well understood yet. In this study, the performance of four different coagulants was tested for algal cell and AOM removal using the jar test.Microcystis aeruginosa and Planktothrix argardhii were used to evaluate the removal of AOM. The results of this study will help DWTPs to optimize their water treatment process during the HAB event.	11/15/2022