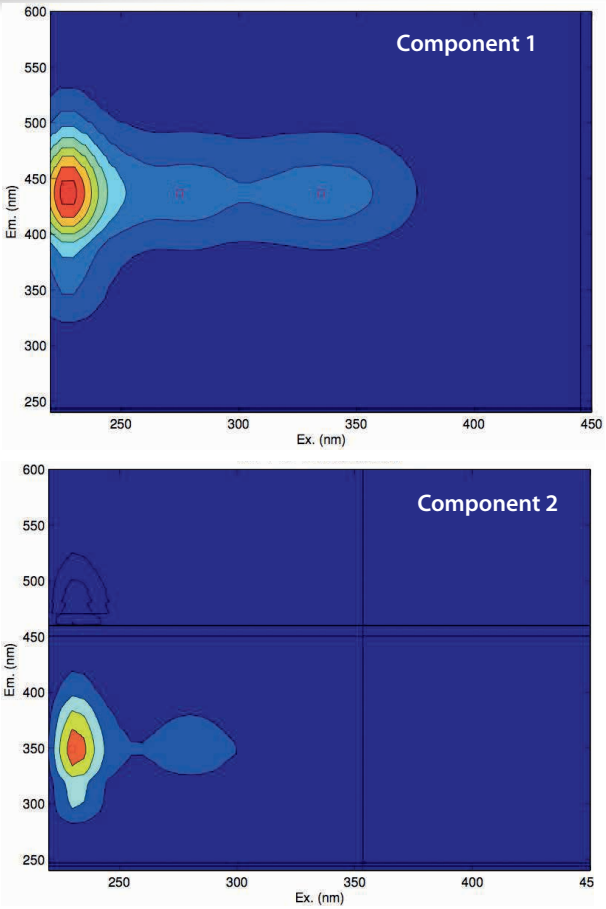
Executive Summary

WERF

Advanced oxidation processes could be part of a strategy for recalcitrant organic nutrient removal

Impact of Advanced Oxidation Processes on the Composition and Biodegradability of Soluble Organic Nutrients in Wastewater Effluents (NUTR5R14e)



Representative EEM contours of the two different fluorescent components identified with the dataset of effluents using PARAFAC model analysis.

The Central Issue

To meet lower total phosphorus (TP) and total nitrogen (TN) limits for effluent, water resource recovery facilities (WRRFs) use advanced nutrient removal technologies. Secondary biological nutrient removal (BNR) and advanced tertiary nutrient removal processes could nearly eliminate the inorganic forms of nutrients (soluble reactive phosphorus, ammonia, nitrate, and nitrite); but soluble organic phosphorus (SOP) and soluble organic nitrogen (SON) concentrations persist and represent a major fraction of the effluent TP and TN concentrations. Design engineers and utilities are challenged with the ability to predict and meet stringent effluent nutrient concentration goals, given that SON and SOP concentrations may vary widely for different WRRFs.

Context and Background

Advanced oxidation processes (AOPs) have shown capability for reducing the concentrations of soluble organic nutrients. They can convert specific nutrient-containing organic compounds into simpler forms. This research investigates the impact of AOP treatments on the speciation and composition of soluble nutrients, and consequently, the biodegradability of SON in wastewater effluents.

The project team collected effluent from three WRRFs and each was treated with three different AOPs: low-pressure ultraviolet (UV) irradiation, hydrogen peroxide (H_2O_2), and a combination of UV and H_2O_2. A comprehensive analysis for wastewater characterization, nitrogen and phosphorus speciation analysis, and SON biodegradability assays were performed on both untreated and AOP-treated effluents.

Findings and Conclusions

The research findings provide insight into an initial understanding of how AOPs may potentially transform wastewater effluent-derived organic nutrients and their biodegradability. The AOP processes applied did not lead to significant changes in the SON concentrations of the wastewater effluents examined. Effluent SOP composition varied depending on the effluents. However,

Wastewater Plants Selected for This Study

Plant	Location	Secondary Processes	Tertiary Processes
North Attleborough WTF	North Attleborough, MA	Anaerobic/Anoxic/Aerobic	Cloth-Media Filters
Truckee Meadows WRF	Reno, NV	Anaerobic/Aerobic; Nitrifying Trickling Filters	Denitrification Fluidized Bed; Dual-Media Granular Filters
Upper Blackstone WPAF	Millbury, MA	Anaerobic/Anoxic/Aerobic	N/A

Impact of Advanced Oxidation Processes on the Composition and Biodegradability of Soluble Organic Nutrients in Wastewater Effluents

change in the dissolved organic matter pool composition was observed, suggesting that there may be changes in organic nutrients composition.

The impact of AOP treatments on biodegradable SON (BSON) varied depending on the effluent and the AOP treatment. Comparison of the results among the three different AOPs indicated that the combined UV/H_2O_2 treatment was more effective at oxidizing some of the organic or organically bound nutrients, in particular phosphorus compounds which oxidized into a more readily removable form.

Management and Policy Implications

This research illustrates the potential efficacy of AOPs for enhancing the downstream biological degradation for advanced SON removal. The findings provide a preliminary scientific basis for the feasibility of applying various AOPs to achieve recalcitrant organic nutrients removal.

Related WERF Research

Project Title	Research Focus
Phosphorus Fractionation and Removal in Wastewater Treatment – Implications for Minimizing Effluent Phosphorus (NUTR1R06l)	Investigates several wastewater treatment configurations to determine the various phosphorus fractions and their fate and susceptibility to a range of different phosphorus removal processes in order to gain better insight into the removal efficiency and mechanism of different phosphorus fractions through various treatment technologies.
Bioavailability and Characteristics of Dissolved Organic Nutrients in Wastewater Effluents (NUTR1R06o)	Investigates the bioavailability and characteristics of various phosphorus fractions, particularly dissolved organic phosphorus (DOP) fraction, from effluents in advanced tertiary treatment processes targeting for extremely low effluent total phosphorus concentrations.
Demonstrating Advanced Oxidation Coupled with Biodegradation for Removal of Carbamazepine (INFR6SG09)	The basis for the U2R11 research project below, this effort focuses on carbamazepine (a frequently found and recalcitrant PPCP in conventional wastewater treatment) that was removed to a lesser extent in the root zone during irrigation with recycled water. However, UV light in combination with hydrogen peroxide produced breakdown products that could then be completely biodegraded. This advanced treatment holds promise for other ring-bearing compounds.
Demonstrating Advanced Oxidation/Biofiltration for Pharmaceutical Removal in Wastewater (U2R11)	Develops and demonstrates design criteria for UV/H_2O_2 advanced oxidation followed by downstream biofilm-based treatment to remove biologically recalcitrant pharmaceuticals from wastewater effluents.

Principal Investigators:

April Z. Gu, Ph.D.
Nicholas Tooker
Northeastern University

Technical Reviewer:

Fernando L. Rosario-Ortiz, D. Env.
University of Colorado – Boulder

To Order

Contact WERF at 571-384-2100 or visit www.werf.org and click on Search Research Publications & Tools.
WERF Subscribers: Download unlimited free PDFs. Non-Subscribers: Charges apply to some products.

Refer to Stock No. **NUTR5R14e**
For more information, contact
Christine Radke at **cradke@werf.org**