

WATER ENVIRONMENT FEDERATION 2019

# NUTRIENT REMOVAL AND RECOVERY SYMPOSIUM

JULY 23–25, 2019  
MINNEAPOLIS, MN

## CONFERENCE PROGRAM

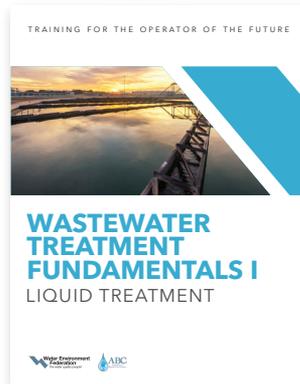


This conference is held by the Water Environment Federation in cooperation with the Central States Water Environment Association and The Water Research Foundation.



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**WEF**  
**Nutrient Removal and Recovery**  
**Symposium 2019**  
**21st Century Vision**

July 23-25, 2019

Renaissance Minneapolis Hotel, The Depot  
Minneapolis, Minnesota, USA



This symposium is held by the Water Environment Federation in cooperation with the Central States Water Environment Association and The Water Research Foundation.

July 23, 2019

Dear Colleagues,

Welcome to Minneapolis, Minnesota! The Water Environment Federation, the Central States Water Environment Association and the Water Research Foundation are honored to have you join us for the Nutrient Removal and Recovery Symposium 2019. On their behalf, we invite you to fully participate in this exceptional opportunity for education and collaboration!

WEF is committed to providing continuing learning and information transfer opportunities for our design, operations, and research communities. This symposium focuses on the current state of the art and best practices for nutrient removal and recovery in greater detail than can be covered at WEF's annual conference, WEFTEC. This symposium therefore presents a unique opportunity to share ideas which is critical for continued advancement, acceptance, and implementation of sustainable nutrient strategies into practice, and identification of knowledge gaps and future needs in this crucial field.

This year, the steering committee wanted to have a grand theme for the opening general session. Presentations in this session will broadly highlight the nutrient journey we are on, beginning with where we have come from, and extending to where we are going and how we think we are going to get there. The following moderated technical sessions of the program have speakers from a wide variety of backgrounds including regulatory, research, design, implementation, and utility operations. These sessions are composed of 15-20-minute presentations, short technical briefings, and interactive facilitated discussions.

Session topics include:

- Carbon Management for Nutrient Removal;
- Granular Sludge;
- Phosphorus Recovery;
- Biological Phosphorus Removal - Mainstream and Sidestream;
- Membrane Aerated Biofilm;
- Mainstream Shortcut Nitrogen;
- Planning and Decision Making;
- Compliance Strategies; and
- Case Studies and Optimization

Many of the sessions have associated poster presentations which we encourage you to visit.

We are also offering two great workshops: *Removal and Recovery of Phosphorus: What Does the Future Hold?*; and *Fundamentals of Nutrient Removal and Recovery: Theory, Technologies, Operation Troubleshooting using Process Simulators*. The symposium workshops are always popular and well attended, offering fantastic opportunities for meeting your peers and hearing current ideas for tackling the issues we are all working on.

While you network with other attendees and presenters, make a point to share your experiences. It's always great to hear what others are doing, learn about new areas of research and practice, and maybe get an idea for a different approach that you hadn't thought of before.

We hope you enjoy this informative event and have many productive interactions.

Sincerely,



Paul Wood  
Lockwood, Andrews & Newnam, Inc.  
Symposium Chair



George Wells  
Northwestern University  
Symposium Vice Chair

## TABLE OF CONTENTS

<b>Symposium Steering and Program Committee.....</b>	<b>1</b>
<b>Registration .....</b>	<b>4</b>
<b>Presenter and Moderator Information .....</b>	<b>4</b>
<b>Reception and Meal Functions .....</b>	<b>5</b>
<b>Continuing Education .....</b>	<b>6</b>
<b>Online Proceedings .....</b>	<b>8</b>
<b>Technical Publications .....</b>	<b>8</b>
<b>Sponsors .....</b>	<b>9</b>
<b>WEF Policies &amp; Positions .....</b>	<b>10</b>
<b>WEF Social Media Policy .....</b>	<b>10</b>
<b>Conference Safety and Security .....</b>	<b>11</b>
<b>Pre-Conference Workshops .....</b>	<b>12</b>
<b>Opening General Session .....</b>	<b>15</b>
<b>Technical Program .....</b>	<b>16</b>
<b>Presentations-at-a-Glance .....</b>	<b>35</b>
<b>Sessions-at-a-Glance .....</b>	<b>41</b>
<b>Presenter and Moderator Directory .....</b>	<b>42</b>
<b>Conference Schedule-at-a-Glance .....</b>	<b>45</b>
<b>Green Initiatives at WEF Nutrients 2019 .....</b>	<b>46</b>
<b>Nearby Dining Options .....</b>	<b>47</b>
<b>Upcoming Education and Training Events .....</b>	<b>48</b>

# NUTRIENT REMOVAL AND RECOVERY SYMPOSIUM COMMITTEE

## Symposium Chairs



**Paul Wood**  
Lockwood, Andrews & Newnam, Inc.  
*Symposium Chair*



**George Wells**  
Northwestern University  
*Symposium Vice Chair*

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<b>NUTRIENT REMOVAL &amp; RECOVERY SYMPOSIUM COMMITTEE</b>
--

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COMMITTEE**

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Melody White  
*Hach Company*

Qingzhong Zu

Nerea Uri Carreño  
*VCS Denmark*

Renee Willette  
*Stantec*

## REGISTRATION

**All events are held in the Renaissance Minneapolis Hotel, The Depot.**

The Registration Desk is located in Great Northern – A Lobby and will be open at the following times:

**Hours:**

Tuesday, July 23	7:30 AM – 5:00 PM
Wednesday, July 24	7:30 AM – 5:15 PM
Thursday, July 25	8:00 AM – 5:15 PM

## PRESENTER AND MODERATOR INFORMATION

**All presenters, technical briefs, posters, and moderators should sign in at the conference Registration Desk and attend their assigned briefing.**

Presenters, technical briefs, poster presenters, and session moderators, participating Wednesday and Thursday should attend their assigned briefing. Please attend only once unless speaking on multiple days. The Speaker Briefing and room schedule is as follows:

Wednesday, July 24 — The Great Northern- B *Sessions 1 through 4	7:30 AM – 8:15 AM
Thursday, July 25 — The Great Northern- B *Sessions 5 through 13	7:30 AM – 8:15 AM

## RECEPTION AND MEAL FUNCTIONS

### **Join the Steering Committee to Kickoff the 2019 Symposium!      Hotel Bar**

Come join us at the Hotel Bar to get to know each other as the symposium gets underway. Connect with colleagues and friends old and new before heading out for the evening. Drinks are at your own cost.

#### **Tuesday, July 23**

Starting at 5:00 PM

Food/Drinks at own Cost

### **Networking Reception**

### **The Conservatory**

Come grab a beer while they last! Join us in the exhibit area to mingle with your fellow attendees while you view the exhibits, renew acquaintances, and make new contacts. Light hors d'oeuvres and refreshments will be served. Beer will be available first come, first served with a cash bar to follow. Don't miss out!

#### **Wednesday, July 24**

5:15 PM – 6:45 PM

Sponsored by: World Water Works

### **Wednesday Luncheon**

### **The Conservatory**

Lunch will be provided for all full conference, daily registrants, and students only on Wednesday. Please advise staff as soon as possible if you have any special dietary requirements. The luncheon will be held in the Conservatory.

#### **Wednesday, July 24**

12:15 PM – 1:30 PM

**Important Note:** Step outside for some fresh air between morning and afternoon sessions. **Lunch is on your own Thursday, July 25.** There is a list of nearby dining options on page 47 for your convenience.

### **Networking Breaks**

#### **Tuesday, July 23**

The Conservatory

10:00 AM – 10:30 AM and 3:00 PM – 3:30 PM

#### **Wednesday, July 24**

The Conservatory

10:00 AM – 10:45 AM and 3:00 PM – 3:45 PM

#### **Thursday, July 25**

The Conservatory

10:00 AM – 10:45 AM and 3:00 PM – 3:45 PM

## CONTINUING EDUCATION

### **How Do I Receive Credit For this Conference?**

To receive credit for all technical sessions and pre-Symposium workshop, please fill out a Continuing Education Request Form and be sure to have a room monitor initial for verification.

Attendees will have to submit their CE Request Form to the Registration Desk at the end of the Symposium. Please request a continuing education form when you check-in and ask WEF staff at the Registration Desk if you have further questions.

### **Pre-Conference Workshops:**

WEF offers Continuing Education Units (CEUs) for participation in workshops. **One CEU is the equivalent to 10 hours** of training or formal instruction. These are distributed for structured, relevant professional training above and beyond that of initial certification or employment in a particular field.

### **Technical Sessions:**

WEF offers Professional Development Hours (PDHs) for participation in technical sessions. **A PDH is defined as one hour** spent engaged in an activity that contributes to the advancement or enhancement of professional skills or scientific knowledge of a professional engineer or operator.

### **When Will I Receive Credits For this Conference?**

Certificates and transcripts for this event will be mailed within 8 weeks of the Symposium.

Please keep in mind that although WEF does provide these files, most states will require the individual licensee to report continuing education credits.

Note: Educational Credits will not be recorded and documentation will not be distributed unless the attendee is a confirmed registrant of this event and the proper steps are completed as indicated in the directions provided.

## CONTINUING EDUCATION

### Are WEF Continuing Education Credits Approved in My State?

WEF applies for approval in many states and will be happy to work with individuals and Member Associations for additional state or agency approvals upon request. In addition, WEF has been approved as a Training Provider through the following:

The Florida Board of Professional Engineers, the New York State Department of Education, and the Ohio EPA. Several states typically accept WEF PDH and CEU credits without issue. For example: California (CWEA), Florida and New Jersey.

### What Else Do I Need to Know?

WEF follows the International Association of Continuing Education and Training (IACET) guidelines along with state-specific regulations to achieve strict policies and procedures regarding its Continuing Education Program. WEF calculates education credits following a standardized method that is the most widely accepted by certification and licensing agencies. However, many states differ in the type and/or number of credits they will approve for educational events. Because of this, participants are responsible for exploring their state requirements and for ensuring that WEF conference credits are accepted.

### Service and Support...

In keeping with IACET guidelines, WEF maintains a database of all continuing education files for a minimum of 7 years. You may contact WEF's Customer Service Team between the hours of 8:30am and 5:00pm EST, Monday through Friday to request these files. Please call 1-800-666-0206 or submit an email request to [csc@wef.org](mailto:csc@wef.org).

### State Credit Calculations:

\*Some state licensing boards will accept CEUs for session under 3 hours in length. Some use different acronyms for training credits. In most instances the credits issued by WEF can be converted to meet state specific requirements that vary from the system used by WEF. This is usually managed at the state level using the following conversion:

**1.0 CEU = 10 Hours** of session time

**1.0 PDH = 1 Hour** of session time

**1.0 Contact Hour = 1 Hour** of session time

For example: **1.7 CEU Credits = 17.0 PDH** depending on individual state regulations.

*\*CEU & PDH credits are available for Workshops to Professional Engineers licensed in the state of New York (NYSED).*

**For more information regarding WEF's Continuing Education Program, please visit [www.wef.org/Nutrients](http://www.wef.org/Nutrients)**

## ONLINE PROCEEDINGS

Conference proceedings, consisting of manuscripts for each presentation, have been made available through an online portal. Advance registrants within Full Conference, Daily, and Student categories will receive access to the Nutrients 2019 online proceedings on the day prior to the conference. Onsite registrants will receive an access link following the event's conclusion.

Copies of proceedings may be ordered after the conference at the member rate of \$100 USD/nonmember rate of \$150 USD. All orders will be processed after conclusion of the conference. You may call 1-800-666-0206 or visit [www.wef.org/ShopWEF](http://www.wef.org/ShopWEF) and ask for Stock Number – CPNR1904

## TECHNICAL PUBLICATIONS



### **Activated Sludge and Nutrient Removal**

Member: \$95.22

List: \$120.23

This extensively revised third edition of Activated Sludge and Nutrient Removal, MOP OM-9 reflects industry best practices and the latest advances. It is the primary reference for the operation of the activated sludge process. Expanded content includes an updated process control section with step-by-step examples for calculations, a new laboratory chapter with detailed directions for common process control tests, and an introduction to using modeling for process control.



### **Wastewater Treatment Fundamentals I, Liquid Treatment**

Member: \$95.22

List: \$133.70

Wastewater Treatment Fundamentals I: Liquid Treatment covers all aspects of liquid treatment processes and helps operators prepare for the first three levels of certification examinations. In addition to learning the basics of liquid treatment, operators will gain a thorough understanding of critical aspects of biological treatment, nutrient removal, and disinfection.

*\*\*\* Both Titles Include 10% off and MN State Sales Tax.*

## SPONSORS

We would like to thank the following sponsoring companies for their contributions to the conference and program.

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Opening General Session



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Networking Reception

## WEF POLICIES & POSITIONS

### **WEF's Vision**

A community of empowered professionals creating a healthy global water environment.

### **Core Values**

Leadership, Passion, Scholarship, and Collaboration, and Service

### **WEF Policies**

WEF respects and takes the broadest view of human diversity and inclusion and is committed to providing a professional, safe, and welcoming environment at its events for all water professionals and their guests. WEF expects all sponsors, speakers, attendees, media, exhibitors and other participants to uphold our commitment to diversity and inclusion by helping us provide a positive conference environment for everyone.

For more information, please see WEF's Diversity and Inclusivity Policy, as well as WEF's Non-Discrimination and Harassment Policy at [www.wef.org/about/about-wef](http://www.wef.org/about/about-wef).

### **Reporting Concerns**

If you have any concerns during this conference, please stop by the conference registration desk in Luce Line Prefunction at the Renaissance Marriot Hotel, The Depot, or you may email the WEF Executive Director Dr. Eileen O'Neill at [oneill@wef.org](mailto:oneill@wef.org).

## WEF SOCIAL MEDIA POLICY

WEF strongly encourages the use of social media to share your experiences at our event. This includes sharing interesting quotes or information, taking pictures with colleagues, and using the event hashtag. However, to protect intellectual property, videotaping, filming, or live-streaming of any workshop or technical session presentation, or exhibit booth is prohibited. Any participant violating this policy must relinquish the media and may be removed from the conference. Also, promotional or commercial use of photographs taken at WEFTEC and other WEF conferences is strictly prohibited. If you are interested in content, materials, or products, please consider talking to the speaker or exhibitor, who may provide the information or grant permission.

## CONFERENCE SAFETY AND SECURITY

### **Renaissance Marriot Hotel, The Depot**

225 3rd Avenue South, Minneapolis, Minnesota 55401

Phone: 612-375-1700

In an Emergency situation, we ask that (when possible) dial 911 or the hotel operator by dialing (o) 24/7.

In a Non-Emergency situation, we ask that (when possible) notify the hotel operator by dialing (o) 24/7.

## PRE- CONFERENCE WORKSHOPS

**Workshop A: Removal and Recovery of Phosphorus: What Does the Future Hold?**

**Tuesday, July 23**

**8:30 AM – 5:00 PM**

*(Separate registration fees apply)*

**8:30 AM Welcome and Overview**

**8:35 AM Topic 1: Advances in Biological Phosphorus Removal**

**Future Directions of Biological Phosphorus Removal;  
Perspectives from the WEF Barnard Forum 2019**

Chris deBarbadillo, DC Water

**Integrating Shortcut Nitrogen Removal with Biological  
Phosphorus Removal for Resource-Efficient Wastewater  
Treatment**

George Wells, Northwestern University

**Considerations of Carbon Storage and Competition of  
dPAO/GAO in Mainstream and Sidestream EBPR Systems**

Ali Gagnon, Stephanie Klaus, Hampton Roads Sanitation  
District

**Importance of Microbial Ecology in Optimizing EBPR  
Systems**

Varun Srinivasan, Brown and Caldwell

**Panel Discussion**

**10:00 AM Networking Break**

**10:30 AM Topic 2: New Trends in Phosphorus Recovery**

**Whole Plant Consideration When Performing Phosphorus  
Recovery at WRRFs**

Wendell Khunjar, Hazen

**Case for Phosphorus Recovery – A Full-Plant Evaluation**

Liam Cavanaugh, Metro Wastewater Reclamation District;  
Chris Wilson, Hampton Roads Sanitation District

**Global Trends and Experiences for Phosphorus Recovery**

Chris deBarbadillo, DC Water, Sudhir Murthy, Newhub

**Panel Discussion**

**12:00 PM Networking Lunch**

*Workshop A Agenda continues on next page*

## PRE- CONFERENCE WORKSHOPS

*Workshop A Agenda continues from previous page*

**1:30 PM**                    **Topic 3: How Low Can We Go? Tale of Low Phosphorus Limits**

**Leveraging our Knowledge Base in EBPR to Gain its Rightful Benefits**

Art Umble, Stantec

**A Case for Algae-Based Tertiary Phosphorus Recovery**

Dal D. Wayment, South Davis Sewer District; Jordan Lind, Clearas

**Lessons Learned in Phosphorus Recovery in Citronelle, AL; Process Validation for Discharge Complying with < 0.022 mg/L TP**

CJ Strain, Nexom

**Panel Discussion**

**3:00 PM**                    **Networking Break**

**3:30 PM**                    **Final Panel Discussion: What Needs Rethinking?**

Belinda Sturm, Jose Jimenez

**5:00 PM**                    **Workshop Adjourns**

*Join the symposium steering committee at the hotel bar at 5:00 PM before heading out to dinner. More information on page 5.*

## PRE- CONFERENCE WORKSHOPS

**Workshop B: Fundamentals of Nutrients Removal and Recovery:  
Theory, Technologies, Operation Troubleshooting using  
Simulators**

**Tuesday, July 23**

**8:30 AM – 5:00 PM**

*(Separate registration fees apply)*

**Presenters:** Paul Dombrowski, Woodard & Curran  
Art Umble, Stantec  
Jeanette Brown, Manhattan College

**8:30 AM Welcome and Introductions**

**8:45 AM Activated Sludge Overview**

**9:30 AM Simulator Description and Overview**

**10:00 AM Networking Break**

**10:30 AM Nitrification**

**12:00 PM Networking Lunch**

**1:30 PM Denitrification and Total Nitrogen Removal**

**2:15 PM Biological Phosphorus Removal**

**3:00 PM Networking Break**

**3:30 PM Chemical Phosphorus Removal**

**4:00 PM Simulator Demonstrations of Combined Nitrogen and  
Phosphorus Removal Systems and Practice Problems**

**4:30 PM Operations Challenge Process Control Simulator Event**

**5:00 PM Workshop Adjourns**

*Join the symposium steering committee at the hotel bar at 5:00 PM before heading out to dinner. More information on page 5.*

## OPENING GENERAL SESSION

Wednesday, July 24

8:30 AM – 12:15 PM

Room: The Great Northern - A

- 8:30 AM**            **Welcome to the 2019 Symposium!**  
Paul Wood, *Lockwood, Andrews & Newnam, Inc.*, 2019 Chair  
George Wells, *Northwestern University*, 2019 Vice-Chair
- 8:40 AM**            **Welcome**  
Lynn Broaddus from WEF, *Broadview Collaborative*, WEF  
*Board of Trustees*
- 8:45 AM**            **Welcome from CSWEA**  
Patrick Haney, *HDR*
- 8:50 AM**            **Grand Theme in the Nutrient Journey**  
Cindy Wallis-Lage, *Black & Veatch*
- 9:25 AM**            **Where Have We Come From?**  
Peter Dold, *EnviroSim Associates Ltd.*
- 10:00 AM**           **Networking Break**
- 10:45 AM**           **Where Are We going? And the Search for Cheaper, Faster, Better...**  
Belinda Sturm, *University of Kansas*
- 11:00 AM**           **Where Are We Going? From Treatment and Disposal to Processing and Recovery Through Source Separation**  
Bilsen Beler Baykail, *Istanbul Technical University*
- 11:20 AM**           **How Are We Going to Get There?**  
Lori Schectel, *Central Contra Costa Sanitary District*; Sandeep Sathyamoorthy, *Black & Veatch*; Michael Falk, *HDR*
- 11:45 AM**           **How Are We Going to Get There? LIFT**  
John Norton, *Great Lakes Water Authority*
- 12:05 PM**           **Panel and Q&A**
- 12:15 PM**           **Session Adjourns for Networking Luncheon**

## TECHNICAL PROGRAM

### Session 01: Granular Sludge

Wednesday, July 24

1:30 PM – 5:15 PM

Room: The Great Northern - A

**Moderators:** Bruce Johnson, Jacobs; Paul Wood, Lockwood, Andrews & Newnam, Inc

- 1:30 PM**            **Full Scale Performance of Aerobic Granular Sludge Technology in North America**  
Manuel De Los Santos, Terry Reid, Brian Bates, Aaron Glauch, Aqua-Aerobic Systems Inc
- 1:50 PM**            **Operation and Performance of Sidestream Aerobic Granular Sludge Nitrifying Reactor**  
Maxwell Armenta, H. David Stensel, University of Washington; Bob Bucher, Pardi Sukapanpotharam, King County West Point; Bao Nguyen-Quoc, Mari Winkler, University of Washington
- 2:10 PM**            **Utilizing Metabolic Selectors to Facilitate the Path to Densification of Activated Sludge**  
Wendell Khunjar, Hazen and Sawyer
- 2:30 PM**            **Technical Brief: Extracellular Polymeric Substance Composition as Bridge Between Process and Clarifier Models**  
Khoa Nam Ngo, Catholic University of America and DC Water; Tim Van Winckel, DC Water; Arash Massoudieh, Catholic University of America; Imre Takacs, Dynamita; Bernhard Wett, ARA Consult GmbH; Charles Bott, Hampton Roads Sanitation District; Ahmed Al-Omari, DC Water; Sudhir Murthy, NEWhub Corp. and Columbia University; Haydee De Clippeleir, DC Water
- 2:35 PM**            **Facilitated Panel Discussion**
- 3:00 PM**            **Networking Break**
- 3:45 PM**            **Innovative Process for Granulation of Conventional Continuous Flow Activated Sludge - A Novel Cost Effective Infra-Stretching Concept to Treat More Flow and Remove/Recover More Nutrients Without Expanding Your Plant**  
Beverly Stinson, Giampiero Galvagno, Keith Sears, AECOM
- 4:05 PM**            **What Did We Learn from Three Full-Scale Hydrocyclone Implementations?**  
Pusker Regmi, Jose Jimenez, Brown And Caldwell; Sudhir Murthy; Bernhard Wett, ARA Consult

*Session 01 continues on next page*

## TECHNICAL PROGRAM

*Session 01 continues from previous page*

- 4:25 PM**            **Modeling Aerobic Granular Sludge Performance in Sequencing Batch Reactor**  
Rasha Faraj, Jacobs; Belinda Sturm, University of Kansas; Jose Jimenez, Brown And Caldwell; Tanush Wadhawan
- 4:45 PM**            **Technical Brief: Quantifying the Benefits of Densified Activated Sludge on Secondary Clarifier Capacity**  
Alonso Griborio, Hazen & Sawyer; Belinda Sturm, University of Kansas; Rasha Faraj, Jacobs; Nandita Ahuja; Wendell Khunjar, Hazen and Sawyer; Paul Pitt
- 4:50 PM**            **Facilitated Panel Discussion**
- 5:15 PM**            **Session Adjourns for Networking Reception**

## TECHNICAL PROGRAM

### Session 02: Carbon Management for Nutrient Removal

Wednesday, July 24

1:30 PM – 3:00 PM

Room: Zephyr

**Moderators:** Melody White, Hach Company; Joe Husband, Arcadis

- 1:30 PM**            **Onsite VFA Production to Support Simultaneous EBPR and Denitrification- Role of Novel PAOs**  
Ramesh Goel, Brendan Mackey, Sunayna Dasgupta, Aditi Podder, University of Utah
- 1:50 PM**            **Energy-Positive Wastewater Treatment Based on an Anaerobic Moving Bed Biofilm Reactor (AnMBBR) and Mainstream Anammox MBBR Process**  
Fernando Morgan-Sagastume, My Carlsson, Magnus Christensson, Henrique Sánchez, Anoxkaldnes-Veolia Water Technologies AB; Hong Zhao, Veolia Water Technologies/Kruger Inc
- 2:10 PM**            **Redirecting Methane for Biological Nitrogen Removal: Enrichment of Nitrifying-Denitrifying Methanotrophic Mixed Culture an a Sequential Batch Reactor**  
Ahmed Eldyasti, Danelle Bishoff, Ahmed Fergala, Ahmed Alsayed, York University
- 2:30 PM**            **Technical Brief: Primary Sludge Fermentation: Sustainable and Economic Process of Supplementing Carbon for Short Cut Nitrogen Removal**  
Priyanka Ali, George Washington University; Nadezhda Zalivina, University of South Florida; Tri Le, Rumana Riffat, George Washington University; Bernhard Wett, ARA Consut; Sudhir Murthy; Charles Bott, Hampton Roads Sanitation District; Sarina Ergas, University of South Florida; Salil Kharkar, Ryu Suzuki, Christine deBarbadillo, DC Water; Ahmed Al-Omari; Haydee De Clippeleir, DC Water
- 2:35 PM**            **Facilitated Panel Discussion**
- 3:00 PM**            **Session Adjourns for Networking Break**
- Poster**              **Piloting Mainstream Partial Nitritation-Anammox in a Two-Stage Configuration**  
Maciej Kowalski, University of Manitoba; Tanner Devlin, Nexom; Alessandro di Biase, Jan Oleszkiewicz, University of Manitoba

## TECHNICAL PROGRAM

### Session 03: Phosphorus Recovery

Wednesday, July 24

1:30 PM - 5:15 PM

Room: Southern Pacific

Moderators: Patrick Haney, HDR; Thor Young, GHD

- 1:30 PM**            **Realizing The Promise of Nutrient Recovery**  
Ron Latimer, Bryan Atieh, Wendell Khunjar, Hazen & Sawyer;  
Kristen Wisdom, MWRD; Gayathri Ram Mohan, Gwinnett  
County - Department of Water Resources
- 1:50 PM**            **Building upon Practice and Experience from Early  
Adopters of Sidestream Phosphorus Recovery**  
Bryan Coday, Tanja Rauch-Williams, Carollo Engineers
- 2:10 PM**            **High Efficiency Calcium Phosphate Recovery Technology  
at The Madison Metropolitan Sewerage District: Stability  
Metrics, Design Optimization, and Performance**  
Menachem Tabanpour, Centrisys-CNP; Phillip Barak, Mauricio  
Avila, Nutrient Recovery & Upcycling; Zhongtian Li,  
Centrisys/CNP; Hiroko Yoshida; Gerhard Forstner,  
Centrisys/CNP; Leon Downing, Black & Veatch; Wendell  
Khunjar, Hazen and Sawyer
- 2:30 PM**            **Technical Brief: Struvite Recovery through  
Electrochemical Phosphorus Precipitation in Side-stream.  
Industrial Scale Application of ePhos® at High  
Phosphorus Concentrations**  
Iosif Mariakakis, Siegfried Egner, Fraunhofer IGB
- 2:35 PM**            **Facilitated Panel Discussion**
- 3:00 PM**            **Networking Break**
- 3:45 PM**            **Finding the Right Solution for Phosphorus Harvesting: A  
Risk Based Approach to the Evaluation of Process  
Alternatives**  
Greg Knight, Black & Veatch; Bikram Sabherwal; Lucas  
Botero; Leon Downing, Eric Redmond, Black & Veatch
- 4:05 PM**            **Innovative Process for the Recovery of Magnesium  
Phosphate (Newberyite) and Ammonia from Digester  
Effluents**  
Matias Vanotti, USDA; Patrick Dube, Water Environment  
Federation

*Session 03 continues on next page*

## TECHNICAL PROGRAM

*Session 03 continues from previous page*

- 4:25 PM**            **Emergy Evaluation of Wastewater-Derived Struvite as an Alternative to Conventional Fertilizer for Crop Production**  
Ranjani Theregowda, Xin Ma, Jay Garland, U.S.Environmental Protection Agency
- 4:45 PM**            **Technical Brief: Determining the Dissolution Rate of Field Grown Struvite**  
Sam Aguiar, University of Illinois at Urbana Champaign; Adrian Romero, CH2M; Leon Downing, Black & Veatch; Rachel Lee, Ostara Nutrient Recovery Technologies, Inc.; Tom Johnson, CH2M; Roland Cusick, University of Illinois
- 4:50 PM**            **Facilitated Panel Discussion**
- 5:15 PM**            **Session Adjourns for Networking Reception**
- Poster**              **Beneficial Reuse of High Strength "Waste" to Achieve Stable EBPR at Gary Sanitary District**  
Anthony Giovannone, CDM Smith; Rhonda Anderson
- Poster**              **A Case Study of Using a Revolving Algal Biofilm (RAB) Treatment System to Treat Anaerobic Digester Effluent at Pilot Scale**  
Martin Gross; Xuefei Zhao, Zhiyou Wen, Max Gangestad, Gross-Wen Technologies

## TECHNICAL PROGRAM

### Session 04: Planning and Decision Making

Wednesday, July 24

3:45 PM - 5:15 PM

Room: Zephyr

**Moderators:** Rob Sharp, Manhattan College; Uma Vempati, ISG

- 3:45 PM**            **The Power of Principle: How One Danish Utility is Achieving Sustainable Development Goals in their Operations**  
Per Henrik Nielsen, Mads Leth, Troels Kærgaard Bjerre, VCS Denmark
- 4:05 PM**            **Embracing the Uncertain Allows NEW Water to Plan for their Upcoming Phosphorus TMDL**  
Colin Fitzgerald, Jacobs; Thomas Sigmund, Green Bay Metro Sewerage Dist; Nathan Qualls, Philip Mentink, New Water, Green Bay Metro Sewerage Dist; William Desing, Jacobs; Brent Brown, CH2M-Jacobs Engineering Group; Leon Downing, Black & Veatch; Glen Daigger, University of Michigan
- 4:25 PM**            **Tool for Estimation of Capital and Operating Costs of Nitrogen and Phosphorus Recovery from Wastewater and Agricultural Wastes**  
Ankit Pathak, Kelly Landry, Wendell Khunjar, Hazen and Sawyer; Christine Radke, The Water Research Foundation
- 4:45 PM**            **Facilitated Panel Discussion**
- 5:15 PM**            **Session Adjourns for Networking Reception**
- Poster**              **Comprehensive Modelling of Full-Scale Nitrifying and Post-Denitrifying Biofilters**  
Jialu Zhu, Université de Technologie de Compiègne; Jean Bernier, SIAAP, Direction Innovation et Environnement; Bernard Patry, Université Laval – modelEAU; Sam Azimi, SIAAP, Direction Innovation et Environnement; André Pauss, Université de Technologie de Compiègne; Vincent Rocher, SIAAP, Direction Innovation et Environnement; Peter Vanrolleghem, Université Laval – modelEAU

*Session 04 continues on next page*

## TECHNICAL PROGRAM

*Session 04 continues from previous page*

- Poster**            **Performance of Pilot-scale Anaerobic Ammonium Oxidation (Anammox) Reactors in Treating Ammonium Rich Wastewater for Pima County Wastewater Reclamation Facility (WRF)**  
Guangbin Li, University of Maryland; Jim Field, University of Arizona; Jeff Prevatt, Pima County Wastewater Management; Mallory McMurray, University of Arizona; Jacob Smutzer, Steve King, Pima County Regional Wastewater Reclamation Department; Joleen Shiroma, Reyes Sierra-Alvarez, University of Arizona
- Poster**            **Watershed Protection through Liquid Manure Valorisation – Turning a Problem into a Commodity**  
Iosif Mariakakis, Siegfried Egner, Fraunhofer IGB
- Poster**            **Simplification of Treatment Processes and Equipment Replacement Results in Energy Efficient Biological Nutrient Removal at the Bensenville, IL WWTF**  
Troy Stinson, Nick Bartolerio, Strand Associates
- Poster**            **Fast Scale-Up Strategies of Pilot-Scale Single-Stage Deammonification Seeded with Conventional BNR (Biological Nutrient Removal) Sludge**  
Daehee Choi, Hojin Shin, Dongeun Park, Sukhyun Cho, Jinyoung Jung, Yeungnam University

## TECHNICAL PROGRAM

### Session 05: Biological Phosphorus Removal: Main/Sidestream

Thursday, July 25

8:30 AM- 12:15 PM

Room: The Great Northern - A

**Moderators:** Brian Mitchell, WesTech Engineering; Kumar Upendrakumar, Veolia

**8:30 AM Meeting Stringent Phosphorus and Copper Limits in BNR Processes: Challenges, Success and Lessons Learned**  
Mehran Andalib, Stantec; Kristen Rolison, MWH; Christopher Andres, Art Umble, Stantec

**8:50 AM Integrating BioP and Shortcut Nitrogen Removal via RAS Fermentation and Partial Denitrification/Anammox**  
Stephanie Klaus, HRSD; Kathryn Printz, Water Environment Federation; Kester McCullough, HRSD; Varun Srinivasan, Brown and Caldwell; Dongqi Wang, Xi'an University of Technology; Peisheng He, Cornell University; Haydee De Clippeleir, DC Water; April Gu, Department of Civil and Env. Eng; Charles Bott, Hampton Roads Sanitation District

**9:10 AM Elucidating the Microbial Ecology of Side-stream Enhanced Biological Phosphorus Removal (S2EBPR)**  
Varun Srinivasan, Brown and Caldwell; Nicholas Tooker, Northeastern University; Dongqi Wang, Xi'an University of Technology; Guangyu Li, Annalisa Onnis-Hayden, Ameet Pinto, Northeastern University; April Gu, Department of Civil and Env. Eng

**9:30 AM Technical Brief: S2EBPR Case Study – Full Scale Experience at South Cary Water Reclamation Facility 20 Years of Sidestream EBPR Process Operation**  
Frederick Stroud, CDM Smith

**9:35 AM Facilitated Panel Discussion**

**10:00 AM Networking Break**

**10:45 AM Insights on Bio-P Optimization Using MLSS Fermentation at the Western Wake Regional WRF**  
David Wankmuller, Wendell Khunjar, Katya Bilyk, Joseph Rohrbacher, Ron Latimer, Hazen & Sawyer; Damon Forney

*Session 05 continues on next page*

## TECHNICAL PROGRAM

*Session 05 continues from previous page*

- 11:05 AM**      **Elucidating Factors for the Success or Failure of Biological Phosphorus Removal: A Comparison Between Two Lab-Scale and One Pilot/Full-Scale EBPR Processes**  
Paul Roots, Northwestern University; Fenghua Yang, Milwaukee Metropolitan Sewage District; Fabrizio Sabba; Alex Rosenthal; Joseph Kozak, Heng Zhang, MWRD of Greater Chicago At Cicero Stickney WTP; George Wells, Northwestern University
- 11:25 AM**      **The New Nutrient! Applications of Sulphur and Redox Modeling in Phosphorus Control**  
Bruce Johnson, Colin Fitzgerald, Heather Stewart, Jacobs
- 11:45 AM**      **Technical Brief: Organic Phosphorus Removal using an Integrated Advanced Oxidation/Ultrafiltration System and Implications for Phosphorus Recovery**  
Holly Gray, Tony Powell, Purifics Water Inc.; Scott Smith, Wilfrid Laurier University, Department of Chemistry; Wayne Parker, University of Waterloo
- 11:50 AM**      **Facilitated Panel Discussion**
- 12:15 PM**      **Session Adjourns**
- Poster**         **Going Green: Mankato WRRF Clearas ANBR Bench Scale Testing**  
Patrick Haney, HDR

## TECHNICAL PROGRAM

### Session 06: High Strength Wastewater Treatment

Thursday, July 25

8:30 AM- 10:00 AM

Room: Zephyr

**Moderators:** Zhongtian Li, Centrysis CNP; Nerea Uri Carreño, VCS Denmark

**8:30 AM**            **IFAS ANITA™ Mox Deammonification Process for Treating THP Reject Water: from Lab/Pilot Scale Development to Full Scale Implementation**

Hong Zhao, Meg Hollowed, Romain Lemaire, Laure Graveleau, Frederic Veuillet, Veolia Water Technologies; Magnus Christensson, AnoxKaldnes AB; Brandy Nussbaum, Veolia Water Technologies

**8:50 AM**            **Treatment of Gold Mine Wastewater with Aerobic Up-Flow Submerged Attached Growth Reactor**

Alessandro di Biase, Victor Wei, Maciej Kowalski, University of Manitoba; Michael Bratty, Golder; Martin Hildebrand, Nelson Environmental; Tanner Devlin, Nexom; Pouria Jabari; Jan Oleszkiewicz, University of Manitoba

**9:10 AM**            **Successful Upcycling of Residual Brewery Nutrients into an SCP Ingredient**

Seth Terry, Andy Logan, Jian Hua Song, iCell Sustainable Nutrition

**9:30 AM**            **Technical Brief: Single Stage Partial Nitritation/Anammox in Treatment of Complicated Urban Waste-streams Containing High Recalcitrant Organic Matter**

Aditi Podder, University of Utah; Debra Reinhart, University of Central Florida; Ramesh Goel, University of Utah

**9:35 AM**            **Facilitated Panel Discussion**

**10:00 AM**           **Session Adjourns for Networking Break**

## TECHNICAL PROGRAM

### Session 07: Operations Experience at Nutrient Removal Plants

Thursday, July 25

8:30 AM- 10:00 AM

Room: Southern Pacific

**Moderators:** Mark Miller, Brown and Caldwell; Mehran Andalib, MWH

- 8:30 AM**            **Record Rainfall and Sewer Flows Not Enough to Dampen New Denitrification Filter Startup**  
Thor Young, Scott Crosswell; Peng Chen, GHD; Stona Cosner, City Of Frederick Public Works
- 8:50 AM**            **Real-Time Process Controls to Meet Increasingly Stringent Effluent Limits and Improve Operational Sustainability: A Case Study of Three North Carolina Facilities**  
Victoria Boschmans, Katya Bilyk, Hazen and Sawyer; Erika Bailey, City of Raleigh; Nathan Howell; John Dodson, Charles Cocker, City Of Durham
- 9:10 AM**            **Full-Scale Optimization of a BNR Facility in Northwest Montana**  
Rickey Schultz, HDR
- 9:30 AM**            **Technical Brief: How Biological Filtration Was Used to Surpass Tough Nitrogen Limits for Long Island Sound**  
Matt Edds, Kruger; Glenn Thesing, Veolia Water Technologies; Anthony Della Valle, Westchester County Department of Environmental Facilities
- 9:35 AM**            **Facilitated Panel Discussion**
- 10:00 AM**           **Session Adjourns for Networking Break**

## TECHNICAL PROGRAM

### Session 08: Membrane Aerated Biofilm Reactors

Thursday, July 25

10:45 AM - 12:15 PM

Room: Zephyr

**Moderators:** Phil Ackman, Sanitation Districts of Los Angeles County; Patrick Haney, HDR

- 10:45 AM**      **BNR Process Intensification using Membrane Aerated Biofilm Reactors**  
Sandeep Sathyamoorthy, Yueyun Tse, Kelly Gordon, Black & Veatch; Dwight Houweling; Daniel Coutts, Suez Water
- 11:05 AM**      **A One Year Demonstration of Nutrient Removal with Membrane Aerated Biofilm Reactor (MABR)**  
Jose Bicudo, Associated Engineering; Barry Heffernan, OxyMem; Amber Klassen, Associated Engineering; Max Rao; John McConomy, Eoin Syron, OxyMem; Leigh McDermott, Region of Waterloo
- 11:25 AM**      **Going Bubbleless: Design and Start-Up of the Full-Scale MABR Demonstration at the Ejby Mølle WRRF**  
Tim Constantine, Jacobs; Nerea Uri, VCS Denmark; Julian Sandino; Adrienne Willoughby, Jacobs; Per Henrik Nielsen, VCS Denmark
- 11:45 AM**      **Technical Brief: Simultaneous Nitrification and Denitrification Throughout a Multi Stage Process Comprising Membrane Aerated Biofilm Reactors**  
Ronen Shechter, Yedidya Heffes, Fluence
- 11:50 AM**      **Facilitated Panel Discussion**
- 12:15 PM**      **Session Adjourns**

## TECHNICAL PROGRAM

### Session 09: Ultra-Low Nutrient Effluent and Reuse

Thursday, July 25

10:45 AM - 12:15 PM

Room: Southern Pacific

**Moderators:** Uma Vempati, ISG; Zhongtian Li, Centrysis CNP

- 10:45 AM**            **Maximizing TN Removal and Reliability for SWIFT Reuse with Upstream Controls**  
Heather Stewart, Bruce Johnson, Tyler Nading Jacobs;  
Charles Bott, Michael Parsons, Hampton Roads Sanitation District
- 11:05 AM**            **Exeno: Removal of Micropollutants in Municipal WWTP Effluents with Moving Bed Biofilm Reactors**  
Elena Torresi, Veolia Water Technologies-Anoxkaldnes;  
Magnus Christensson, AnoxKaldnes AB; Henrik Andersen, Kai Tang, DTU; Christina Sund, Heidi Andersen, Kruger; Hong Zhao, Veolia Water Technologies/Kruger Inc; Brandy Nussbaum, Veolia Water Technologies
- 11:25 AM**            **Meeting Ultra-Low Effluent Quality Standards in Lagoons and Mechanical Plants**  
Tanner Devlin, Nexom
- 11:45 AM**            **Facilitated Panel Discussion**
- 12:15 PM**            **Session Adjourns**
- Poster**                **Study of Three Enhanced Nutrient Removal (ENR) Facilities Meeting Stringent Nutrient Limits in the Chesapeake Bay Watershed**  
Ankit Pathak, Gregory Pace, Wendell Khunjar, Hazen and Sawyer
- Poster**                **Impact of Averaging Periods on Nutrient Discharge Load and WRRF Design**  
JB Neethling, Michael Falk, Samuel Bruce, David Clark, HDR
- Poster**                **Achieving Low Effluent Nutrient Concentrations with No Chemical Addition: Results of a BNR Optimization Study at the 2.54 MGD Louisville, Colorado WWTP**  
Patrick Radabaugh, Dewberry Engineers; Just Elkins, City of Louisville

## TECHNICAL PROGRAM

### Session 10: Reality Check: Mainstream Shortcut Nitrogen

Thursday, July 25

1:30 PM - 5:15 PM

Room: The Great Northern - A

**Moderators:** Pusker Regmi, Brown and Caldwell; Weihua Peter Peng, Suez

- 1:30 PM**            **AlexRenew's Experience with Aeration Controls for Shortcut Nitrogen Removal**  
Paula Sanjines, Jacobs; Hari Santha, Kacey King-Mcrae, Alexandria Renew Enterprise; Timothy Constantine, Adrienne Willoughby, Jacobs
- 1:50 PM**            **Concurrent Mainstream Deammonification and Phosphorus Removal Using the ANITA Mox Process: A Pilot-Scale Evaluation at the Joint Water Pollution Control Plant (JWPCP)**  
Eric Krikorian, Hana Chmielewski, Thomas Knapp, Michael Liu, Nikos Melitas, LA County Sanitation District; Hong Zhao, Veolia Water Technologies/Kruger Inc; Mitchell Johnson, Kruger
- 2:10 PM**            **Single-sludge Shortcut N and Biological P Removal for Sustainable Mainstream Wastewater Treatment in Temperate Climates**  
Paul Roots, Northwestern University; Fabrizio Sabba; Alex Rosenthal; Yubo Wang, Northwestern University; Quan Yuan; Fenghua Yang, Milwaukee Metropolitan Sewage District; Joseph Kozak, Heng Zhang, MWRD of Greater Chicago At Cicero Stickney WTP; George Wells, Northwestern University
- 2:30 PM**            **Technical Brief: Electron Competition as a Mechanism of Nitrite Accumulation in a Denitrating Culture**  
Matthew Baideme, Julian van der Made, Kartik Chandran, Columbia University
- 2:35 PM**            **Facilitated Panel Discussion**
- 3:00 PM**            **Networking Break**
- 3:45 PM**            **Exploring the Conversion of Tertiary Denitrification to Mainstream Deammonification: Pilot Scale Filter Results and Challenges**  
Eric Polli, North Carolina State University; Katya Bilyk, Wendell Khunjar, Hazen and Sawyer; Erika Bailey, City of Raleigh; Tarek Aziz, Francis De Los Reyes, North Carolina State University

*Session 10 continues on next page*

## TECHNICAL PROGRAM

*Session 10 continues from previous page*

- 4:05 PM**      **Pushing Process Intensification Limits for Biological Nitrogen Removal using Gel Entrapment Technology**  
Mehran Andalib, Carla Cherchi, Art Umble, Stantec Inc.; Jacangelo; Shu Tsuda, Hiroyuki Yoguchi, Hitachi, Ltd.; Kellogg Schwab, Johns Hopkins Bloomberg School of Public Health; Bradley Schmitz, Johns Hopkins University
- 4:25 PM**      **Nitrogen Removal from Water Resource Recovery Facilities Using Partial Nitrification, Denitrification-Anaerobic Ammonia Oxidation (PANDA)**  
Wendell Khunjar, Hazen and Sawyer
- 4:45 PM**      **Technical Brief: Lab-scale Results from a Partial Nitrification / Anammox Membrane Aerated Biofilm Reactor (MABR) for Mainstream Nitrogen Removal**  
Brett Wagner, Glen Daigger, University of Michigan; Nancy Love, Virginia Tech
- 4:50 PM**      **Facilitated Panel Discussion**
- 5:15 PM**      **Symposium Adjourns**
- Poster**        **Using Sensor-Mediated Control to Achieve Energy Efficient Mainstream Nitrogen Removal with Next Generation Treatment Systems: Long Term Stability and Operating Strategies**  
Zerihun Bekele, University of Michigan; Charles Bott, Hampton Roads Sanitation District; Nancy Love, Virginia Tech
- Poster**        **Stability of Partial Nitrification–Anammox Process Using Immobilized Gel Carriers For Mainstream Deammonification**  
Shoko Miyamae, Hitachi, Ltd.; Yuya Kimura; Shinichi YOSHIKAWA, Hitachi,Ltd

## TECHNICAL PROGRAM

### Session 11: Case Studies and Optimization

Thursday, July 25

1:30 PM - 5:15 PM

Room: Zephyr

**Moderators:** Clint Rogers, Stantec; Jeanette Brown, Manhattan College

**1:30 PM**                    **3 Million Pounds of Nitrogen Removed and Counting at the Fairfax County NCPCP**

Gregory Pace, Joseph Rohrbacher, Wendell Khunjar, Ronald Taylor, Janice Carroll, Hazen & Sawyer; Sarah Motsch; Mujahid Ali, Fairfax County Government

**1:50 PM**                    **Adapting to the Unexpected: Pre-digestion Waste Activated Sludge Phosphorus Release Process Design and Optimization at St. Cloud Nutrient, Energy & Water Recovery Facility**

Derek Lycke, Ostara Nutrient Recovery Technologies Inc.; Patrick Shea, Tracy Hodel, Emma Larson, City of St Cloud; Rachel Lee, Pavan Patel, Joshua Benoit, Ostara Nutrient Recovery Technologies Inc

**2:10 PM**                    **Achieving Nitrification and Nutrient Removal through Mainstream Bio-Augmentation from Parallel Plant**

Mario Benisch, Partick Young, HDR Engineering Inc; Andy Clements, City of St Joseph

**2:30 PM**                    **Facilitated Panel Discussion**

**3:00 PM**                    **Networking Break**

**3:45 PM**                    **Optimization Strategies at Four BNR Facilities to Reduce Nutrients and Operating Costs**

David Wankmuller, Katya Bilyk, Hazen and Sawyer; Eric Polli; Damon Forney; John Dodson, Charles Cocker, City Of Durham; Jeffery Mahagan

**4:05 PM**                    **Economic Analysis of Removing Orthophosphate and Improving Dewaterability of Digested Sludge by Struvite Precipitation in Digested Sludge**

Zhongtian Li, Gerhard Forstner, Menachem Tabanpour, Centrisys/CNP; Hiroko Yoshida

*Session 11 continues on next page*

## TECHNICAL PROGRAM

*Session 11 continues from previous page*

- 4:25 PM**      **Denitrifying PAOs for Low- Carbon and Low-Energy Nutrient Removal in Cold Weather Conditions: The Ejby Mølle Case Study**  
Nerea Uri, Per Henrik Nielsen, VCS Denmark; Timothy Constantine, Jacobs; Kartik Chandran, Catherine Hoar, Columbia University; Christine deBarbadillo, DC Water; George Wells, Northwestern University
- 4:45 PM**      **Technical Brief: An Energy Evaluation of Nitrogen Removal Methods: Is Fancy Nitrogen Removal Worth the Effort?**  
Bruce Johnson, Colin Fitzgerald, Jacobs
- 4:50 PM**      **Facilitated Panel Discussion**
- 5:15 PM**      **Symposium Adjourns**

## TECHNICAL PROGRAM

### Session 12: Microbial Ecology

Thursday, July 25

1:30 PM – 5:15 PM

Room: Southern Pacific

**Moderators:** George Wells, Northwestern University; Guangbin Li, University of Maryland, College Park

- 1:30 PM**            **Generous Orthodoxy: Understanding the Future of Dissolved Oxygen Setpoints While Acknowledging the Past**  
Leon Downing, Black & Veatch; Eric Redmond; Colin Fitzgerald, Jacobs
- 1:50 PM**            **Single-Cell Raman Spectroscopy-Based Phenotyping Revealed Metabolic Difference Between Side-Stream and Conventional Enhanced Biological Phosphorus Removal Systems**  
Dongqi Wang, Xi'an University of Technology; Nicholas Tooker, Guangyu Li, Northeastern University; Varun Srinivasan, Brown and Caldwell; Annalisa Onnis-Hayden, Northeastern University; April Gu, Department of Civil and Env. Eng; Peisheng He, Cornell University
- 2:10 PM**            **Glycerol-Driven Dissimilatory Nitrate Reduction to Ammonium (DNRA): Impact of Kinetic-Limitation on System Performance and Microbial Ecology**  
Matthew Baideme, Columbia University; Luke Plante, Michael Butkus, United States Military Academy; Kartik Chandran, Columbia University
- 2:30 PM**            **Facilitated Panel Discussion**
- 3:00 PM**            **Session Adjourns for Networking Break**

## TECHNICAL PROGRAM

### Session 13: General Nutrient Management

Thursday, July 25

3:45 PM - 5:15 PM

Room: Southern Pacific

**Moderators:** Patrick O'Donnell, INVENT Environmental Technologies, Inc.; Mark Halm, Deuchler Engineering Corp.

- 3:45 PM**            **Strategies, Tools, and a Case Study for Implementing Watershed Nutrient Management**  
Brent Brown, CH2M-Jacobs Engineering Group; Jeffrey Smudde, New Water, Green Bay Metro Sewerage Dist; Megan Bender, Jacobs
- 4:05 PM**            **Simultaneous Organic Matter Removal and Nitrification in a Highly Loaded Aerated Lagoon Enhanced with Biofilm**  
Bernard Patry, Paul Lessard, Peter Vanrolleghem, Université Laval - modelEAU
- 4:25 PM**            **Comparison of a Modified and Traditional Rapid Infiltration Basin for Control of Nitrate in Reclaimed Water**  
Jessica Cormier, Steven Duranceau, University of Central Florida
- 4:45 PM**            **Facilitated Panel Discussion**
- 5:15 PM**            **Symposium Adjourns**
- Poster**             **Coupled Anoxic Suspended Growth and Membrane Aerated Biofilm Reactor Process Options**  
Avery Carlson, Glen Daigger, University of Michigan

## PRESENTATIONS AT-A-GLANCE

*We encourage attendees to participate in presentations from among all sessions. To better plan your learning, see below and on the following pages a list of presentations offered during each time block.*

*Poster Presentations are listed in the previous pages within their associated sessions. They will be set up in the Conservatory on Wednesday, July 23 from 10:00 AM – 6:30 PM, and Thursday, July 24 from 10:00 AM – 3:45 PM.*

Wednesday, July 24			
Room	Great Northern - A	Zephyr	Southern Pacific
Session	Session 01: Granular Sludge	Session 02: Carbon Management for Nutrient Removal	Session 03: Phosphorus Recovery
1:30 PM	Full Scale Performance of Aerobic Granular Sludge Technology in North America	Onsite VFA Production to Support Simultaneous EBPR and Denitrification-Role of Novel PAOs	Realizing the Promise of Nutrient Recovery
1:50 PM	Operation and Performance of Sidestream Aerobic Granular Sludge Nitrifying Reactor	Energy-Positive Wastewater Treatment Based on an Anaerobic Moving Bed Biofilm Reactor (AnMBBR) and Mainstream Anammox MBBR Process	Building upon Practice and Experience from Early Adopters of Sidestream Phosphorus Recovery
2:10 PM	Utilizing Metabolic Selectors to Facilitate the Path to Densification of Activated Sludge	Redirecting Methane for Biological Nitrogen Removal: Enrichment of Nitrifying-Denitrifying Methanotrophic Mixed Culture in a Sequential Batch Reactor	High Efficiency Calcium Phosphate Recovery Technology at The Madison Metropolitan Sewerage District: Stability Metrics, Design Optimization, and Performance
2:30 PM	Technical Brief: Extracellular Polymeric Substance Composition as Bridge Between Process and Clarifier Models	Technical Brief: Primary Sludge Fermentation: Sustainable and Economic Process of Supplementing Carbon for Short Cut Nitrogen Removal	Technical Brief: Struvite Recovery through Electrochemical Phosphorus Precipitation in Sidestream. Industrial Scale Application of ePhos® at High Phosphorus Concentrations

## PRESENTATIONS AT-A-GLANCE

Wednesday, July 24 continued			
Room	Great Northern - A	Zephyr	Southern Pacific
Session	Session 01: Granular Sludge	Session 04: Planning and Decision Making	Session 03: Phosphorus Recovery
3:45 PM	Innovative Process for Granulation of Conventional Continuous Flow Activated Sludge - A Novel Cost Effective Infra-Stretching Concept to Treat More Flow and Remove/Recover More Nutrients Without Expanding Your Plant	The Power of Principle: How One Danish Utility is Achieving Sustainable Development Goals in their Operations	Finding the Right Solution for Phosphorus Harvesting: A Risk Based Approach to the Evaluation of Process Alternatives
4:05 PM	What Did We Learn from Three Full-Scale Hydrocyclone Implementations?	Embracing the Uncertain Allows NEW Water to Plan for their Upcoming Phosphorus TMDL	Innovative Process for the Recovery of Magnesium Phosphate (Newberyite) and Ammonia from Digester Effluents
4:25 PM	Modeling Aerobic Granular Sludge Performance in Sequencing Batch Reactor	Tool for Estimation of Capital and Operating Costs of Nitrogen and Phosphorus Recovery from Wastewater and Agricultural Wastes	Energy Evaluation of Wastewater-Derived Struvite as an Alternative to Conventional Fertilizer for Crop Production
4:45 PM	Technical Brief: Quantifying the Benefits of Densified Activated Sludge on Secondary Clarifier Capacity		Technical Brief: Determining the Dissolution Rate of Field Grown Struvite

## PRESENTATIONS AT-A-GLANCE

<b>Thursday, July 25, Morning</b>			
<b>Room</b>	<b>Great Northern - A</b>	<b>Zephyr</b>	<b>Southern Pacific</b>
<b>Session</b>	<b>Session 05: Biological Phosphorus Removal: Main/Sidestream</b>	<b>Session 06: High Strength Wastewater Treatment</b>	<b>Session 07: Operations Experience at Nutrient Removal Plants</b>
<b>8:30 AM</b>	Meeting Stringent Phosphorus and Copper Limits in BNR Processes: Challenges, Success and Lessons Learned	IFAS ANITA™ Mox Deammonification Process for Treating THP Reject Water: from Lab/Pilot Scale Development to Full Scale Implementation	Record Rainfall and Sewer Flows Not Enough to Dampen New Denitrification Filter Startup
<b>8:50 AM</b>	Integrating BioP and Shortcut Nitrogen Removal via RAS Fermentation and Partial Denitrification/Anammox	Treatment of Gold Mine Wastewater with Aerobic Up-Flow Submerged Attached Growth Reactor	Real-Time Process Controls to Meet Increasingly Stringent Effluent Limits and Improve Operational Sustainability: A Case Study of Three North Carolina Facilities
<b>9:10 AM</b>	Elucidating the Microbial Ecology of Side-stream Enhanced Biological Phosphorus Removal (S2EBPR)	Successful Upcycling of Residual Brewery Nutrients into an SCP Ingredient	Full-Scale Optimization of a BNR Facility in Northwest Montana
<b>9:30 AM</b>	Technical Brief: S2EBPR Case Study – Full Scale Experience at South Cary Water Reclamation Facility 20 Years of Sidestream EBPR Process Operation	Technical Brief: Single Stage Partial Nitritation/Anammox in Treatment of Complicated Urban Waste-streams Containing High Recalcitrant Organic Matter	Technical Brief: How Biological Filtration Was Used to Surpass Tough Nitrogen Limits for Long Island Sound

## PRESENTATIONS AT-A-GLANCE

Thursday, July 25, Morning continued			
Room	Great Northern - A	Zephyr	Southern Pacific
Session	Session 05: Biological Phosphorus Removal: Main/Sidestream	Session 08: Membrane Aerated Biofilm Reactors	Session 09: Ultra-Low Nutrient Effluent and Reuse
10:45 AM	Insights on Bio-P Optimization Using MLSS Fermentation at the Western Wake Regional WRF	BNR Process Intensification using Membrane Aerated Biofilm Reactors	Maximizing TN Removal and Reliability for SWIFT Reuse with Upstream Controls
11:05 AM	Elucidating Factors for the Success or Failure of Biological Phosphorus Removal: A Comparison Between Two Lab-Scale and One Pilot/Full-Scale EBPR Processes	A One Year Demonstration of Nutrient Removal with Membrane Aerated Biofilm Reactor (MABR)	Exeno: Removal of Micropollutants in Municipal WWTP Effluents with Moving Bed Biofilm Reactors
11:25 AM	The New Nutrient! Applications of Sulphur and Redox Modeling in Phosphorus Control	Going Bubbleless: Design and Start-Up of the Full-Scale MABR Demonstration at the Ejby Mølle WRRF	Meeting Ultra-Low Effluent Quality Standards in Lagoons and Mechanical Plants
11:45 AM	Technical Brief: Organic Phosphorus Removal using an Integrated Advanced Oxidation/Ultrafiltration System and Implications for Phosphorus Recovery	Technical Brief: Simultaneous Nitrification and Denitrification Throughout a Multi Stage Process Comprising Membrane Aerated Biofilm Reactors	

## PRESENTATIONS AT-A-GLANCE

Thursday, July 25, Afternoon			
Room	Great Northern - A	Zephyr	Southern Pacific
Session	Session 10: Reality Check: Mainstream Shortcut Nitrogen	Session 11: Case Studies and Optimization	Session 12: Microbial Ecology
1:30 PM	<p>AlexRenew's Experience with Aeration Controls for Shortcut Nitrogen Removal</p>	<p>3 Million Pounds of Nitrogen Removed and Counting at the Fairfax County NCPCP</p>	<p>Generous Orthodoxy: Understanding the Future of Dissolved Oxygen Setpoints While Acknowledging the Past</p>
1:50 PM	<p>Concurrent Mainstream Deammonification and Phosphorus Removal Using the ANITA Mox Process: A Pilot-Scale Evaluation at the Joint Water Pollution Control Plant (JWPCP)</p>	<p>Adapting to the Unexpected: Pre-digestion Waste Activated Sludge Phosphorus Release Process Design and Optimization at St. Cloud Nutrient, Energy &amp; Water Recovery Facility</p>	<p>Single-Cell Raman Spectroscopy-Based Phenotyping Revealed Metabolic Difference Between Side-Stream and Conventional Enhanced Biological Phosphorus Removal Systems</p>
2:10 PM	<p>Single-sludge Shortcut N and Biological P Removal for Sustainable Mainstream Wastewater Treatment in Temperate Climates</p>	<p>Achieving Nitrification and Nutrient Removal through Mainstream Bio-Augmentation from Parallel Plant</p>	<p>Glycerol-Driven Dissimilatory Nitrate Reduction to Ammonium (DNRA): Impact of Kinetic-Limitation on System Performance and Microbial Ecology</p>
2:30 PM	<p>Technical Brief: Electron Competition as a Mechanism of Nitrite Accumulation in a Denitrating Culture</p>		

## PRESENTATIONS AT-A-GLANCE

Thursday, July 25, Afternoon continued			
Room	Great Northern - A	Zephyr	Southern Pacific
Session	Session 10: Reality Check: Mainstream Shortcut Nitrogen	Session 11: Case Studies and Optimization	Session 13: General Nutrient Management
3:45 PM	Exploring the Conversion of Tertiary Denitrification to Mainstream Deammonification: Pilot Scale Filter Results and Challenges	Optimization Strategies at Four BNR Facilities to Reduce Nutrients and Operating Costs	Strategies, Tools, and a Case Study for Implementing Watershed Nutrient Management
4:05 PM	Pushing Process Intensification Limits for Biological Nitrogen Removal using Gel Entrapment Technology	Economic Analysis of Removing Orthophosphate and Improving Dewaterability of Digested Sludge by Struvite Precipitation in Digested Sludge	Simultaneous Organic Matter Removal and Nitrification in a Highly Loaded Aerated Lagoon Enhanced with Biofilm
4:25 PM	Nitrogen Removal from Water Resource Recovery Facilities Using Partial Nitrification, Denitrification-Anaerobic Ammonia Oxidation (PANDA)	Denitrifying PAOs for Low- Carbon and Low-Energy Nutrient Removal in Cold Weather Conditions: The Ejby Mølle Case Study	Comparison of a Modified and Traditional Rapid Infiltration Basin for Control of Nitrate in Reclaimed Water
4:45 PM	Technical Brief: Lab-scale Results from a Partial Nitritation / Anammox Membrane Aerated Biofilm Reactor (MABR) for Mainstream Nitrogen Removal	Technical Brief: An Energy Evaluation of Nitrogen Removal Methods: Is Fancy Nitrogen Removal Worth the Effort?	

## SESSIONS AT A GLANCE

Session Number	Session Title	Time	CE Credit Total/Type	Room
<b>Tuesday, July 23</b>				
<b>Workshop A</b>	Removal and Recovery of Phosphorus: What Does the Future Hold?	8:30am–5:00pm	<b>0.6 CEUs</b>	<b>Zephyr</b>
<b>Workshop B</b>	Fundamentals of Nutrient Removal and Recovery: Theory, Technologies, Operation Troubleshooting using Process Simulators	8:30am–5:00pm	<b>0.6 CEUs</b>	<b>Southern Pacific</b>
<b>Wednesday, July 24</b>				
<b>OGS</b>	Opening General Session	8:30am–12:15pm	<b>3.0 GCHs</b>	<b>The Great Northern - A</b>
<b>Session 1</b>	Granular Sludge	1:30pm–5:15pm	<b>3.0 PDHs</b>	<b>The Great Northern - A</b>
<b>Session 2</b>	Carbon Management for Nutrient Removal	1:30pm–3:00pm	<b>1.5 PDHs</b>	<b>Zephyr</b>
<b>Session 3</b>	Phosphorus Recovery	1:30pm–5:15pm	<b>3.0 PDHs</b>	<b>Southern Pacific</b>
<b>Session 4</b>	Planning and Decision Making	3:45pm–5:15pm	<b>1.5 PDHs</b>	<b>Zephyr</b>
<b>Thursday, July 25</b>				
<b>Session 5</b>	Biological Phosphorus Removal: Main/Sidestream	8:30am–12:15pm	<b>3.0 PDHs</b>	<b>The Great Northern - A</b>
<b>Session 6</b>	High Strength Wastewater Treatment	8:30am–10:00am	<b>1.5 PDHs</b>	<b>Zephyr</b>
<b>Session 7</b>	Operations Experience at Nutrient Removal Plants	8:30am–10:00am	<b>1.5 PDHs</b>	<b>Southern Pacific</b>
<b>Session 8</b>	Membrane Aerated Biofilm Reactors	10:45am–12:15pm	<b>1.5 PDHs</b>	<b>Zephyr</b>
<b>Session 9</b>	Ultra-Low Nutrient Effluent and Reuse	10:45am–12:15pm	<b>1.5 PDHs</b>	<b>Southern Pacific</b>
<b>Session 10</b>	Reality Check: Mainstream Shortcut Nitrogen	1:30pm–5:15pm	<b>3.0 PDHs</b>	<b>The Great Northern - A</b>
<b>Session 11</b>	Case Studies and Optimization	1:30pm–5:15pm	<b>3.0 PDHs</b>	<b>Zephyr</b>
<b>Session 12</b>	Microbial Ecology	1:30pm–3:00pm	<b>1.5 PDHs</b>	<b>Southern Pacific</b>
<b>Session 13</b>	General Nutrient Management	3:45pm–5:15pm	<b>1.5 PDHs</b>	<b>Southern Pacific</b>

## PRESENTER AND MODERATOR DIRECTORY

**Phil Ackman**  
Sanitation Districts of  
Los Angeles County  
**Moderator Session 08**

**Sam Aguiar** University  
of Illinois at Urbana  
Champaign **Speaker**  
**Session 03**

**Priyanka Ali** George  
Washington University  
**Speaker Session 02**

**Mehran Andalib**  
Stantec **Moderator**  
**Session 07 Speaker**  
**Session 10**

**Christopher Andres**  
Stantec **Speaker**  
**Session 05**

**Maxwell Armenta**  
University of  
Washington **Speaker**  
**Session 01**

**Matt Baideme**  
Columbia University  
**Speaker Session 10,**  
**12**

**Zerihun Bekele**  
University of Michigan  
**Speaker Session 10**

**Mario Benisch** HDR  
Engineering Inc  
**Speaker Session 11**

**Jose Bicudo**  
Associated  
Engineering **Speaker**  
**Session 08**

**Danelle Bishoff** York  
University **Speaker**  
**Session 02**

**Victoria Boschmans**  
Hazen and Sawyer  
**Speaker Session 07**

**Jeanette Brown**  
Manhattan College  
**Speaker WKSP B,**  
**Moderator Session 11**

**Brent Brown** CH2M-  
Jacobs Engineering  
Group **Speaker**  
**Session 13**

**Avery Carlson**  
University of Michigan  
**Speaker Session 13**

**Liam Cavanaugh** City  
of Longmont WWTP  
**Speaker WKSP A**

**Bryan Coday** Carollo  
Engineers **Speaker**  
**Session 03**

**Tim Constantine**  
Jacobs **Speaker**  
**Session 08**

**Jessica Cormier**  
University of Central  
Florida **Speaker**  
**Session 13**

**Sunayna Dasgupta**  
University of Utah  
**Speaker Session 02**

**Manuel De Los**  
**Santos** Aqua-Aerobic  
Systems Inc **Speaker**  
**Session 01**

**Christine**  
**deBarbadillo** DC  
Water **Speaker WKSP**  
**A**

**Tanner Devlin** Nexom  
**Speaker Session 09**

**Alessandro di Biase**  
University of Manitoba  
Civil Engineering  
**Speaker Session 06**

**Paul Dombrowski**  
Woodard & Curran  
**Coordinator WKSP B**

**Leon Downing** Black  
& Veatch **Speaker**  
**Session 12**

**Matt Edds** Kruger  
**Speaker Session 07**

**Colin Fitzgerald**  
Jacobs **Speaker**  
**Session 04**

**Alexandria Gagnon**  
HRSD **Speaker WKSP**  
**A**

**Max Gangestad**  
Gross-Wen  
Technologies **Speaker**  
**Session 03**

**Anthony Giovannone**  
CDM Smith **Speaker**  
**Session 03**

**Alonso Griborio**  
Hazen & Sawyer  
**Speaker Session 01**

**Martin Gross** Gross-  
Wen Technologies  
**Speaker Session 03**

**Mark Halm** Deuchler  
Engineering Corp.  
**Moderator Session 13**

**Patrick Haney** HDR  
**Moderator Session**  
**03, 08, Speaker**  
**Session 05**

**Joe Husband** Arcadis  
**Moderator Session 02**

**Jose Jimenez** Brown  
And Caldwell **Speaker**  
**WKSP A**

## PRESENTER AND MODERATOR DIRECTORY

**Bruce Johnson**  
Jacobs **Moderator**  
**Session 01, Speaker**  
**Session 05, 11**

**Jinyoung Jung**  
Yeungnam University  
**Speaker Session 04**

**Wendell Khunjar**  
Hazen and Sawyer  
**Speaker WKSP A,**  
**Session 01, 10**

**Maureen Kinyua UC**  
Davis **Moderator**  
**Session 09**

**Stephanie Klaus**  
HRSD **Speaker WKSP**  
**A, Session 05**

**Greg Knight** Black &  
Veatch **Speaker**  
**Session 03**

**Maciej Kowalski**  
University of Manitoba  
**Speaker Session 02**

**Eric Krikorian**  
Sanitation Districts of  
Los Angeles County  
**Speaker Session 10**

**Ron Latimer** Hazen &  
Sawyer **Speaker**  
**Session 03**

**Guangbin Li** University  
of Maryland **Moderator**  
**Session 12, Speaker**  
**Session 04**

**Zhongtian Li**  
Centrisys/CNP  
**Moderator Session**  
**06, Speaker Session**  
**11**

**Jordan Lind**  
CLEARAS Water  
Recovery **Speaker**  
**WKSP A**

**Derek Lycke** Ostara  
Nutrient Recovery  
Technologies Inc.  
**Speaker Session 11**

**Xin Ma** US EPA  
**Speaker Session 03**

**Iosif Mariakakis**  
Fraunhofer IGB  
**Speaker Session 03,**  
**04**

**Mark Miller** Brown and  
Caldwell **Moderator**  
**Session 07**

**Brian Mitchell**  
WesTech Engineering,  
Inc. **Moderator**  
**Session 05**

**Shoko Miyamae**  
Hitachi, Ltd. **Speaker**  
**Session 10**

**Fernando Morgan-**  
**Sagastume**  
Anoxkaldnes-Veolia  
Water Technologies  
AB **Speaker Session**  
**02**

**Sudhir Murthy**  
NEWhub Corp.  
**Speaker WKSP A**

**JB Neethling** HDR Inc  
**Speaker Session 09**

**Khoa Nam Ngo** DC  
Water **Speaker**  
**Session 01**

**Per Henrik Nielsen**  
VCS Denmark  
**Speaker Session 04**

**Brandy Nussbaum**  
Veolia Water  
Technologies **Speaker**  
**Session 09**

**Patrick O'Donnell**  
INVENT Environmental  
Technologies,  
Inc. **Moderator**  
**Session 13**

**Gregory Pace** Hazen  
and Sawyer **Speaker**  
**Session 11**

**Ankit Pathak** Hazen  
and Sawyer **Speaker**  
**Session 04, 09**

**Bernard Patry**  
Université Laval -  
modelEAU **Speaker**  
**Session 04, 13**

**Weihua Peng** Suez  
**Moderator Session 10**

**Aditi Podder**  
University of Utah  
**Speaker Session 02,**  
**06**

**Eric Polli** North  
Carolina State  
University **Speaker**  
**Session 10**

**Patrick Radabaugh**  
Dewberry Engineers  
**Speaker Session 09**

**Pusker Regmi** Brown  
and Caldwell  
**Coordinator WKSP A,**  
**Moderator Session**  
**10, Speaker Session**  
**01**

**Clint Rogers** Stantec  
**Moderator Session 11**

**Paul Roots**  
Northwestern  
University **Speaker**  
**Session 05, 10**

## PRESENTER AND MODERATOR DIRECTORY

**Paula Sanjines**  
Jacobs **Speaker**  
**Session 10**

**Sandeep**  
**Sathyamoorthy** Black  
& Veatch **Speaker**  
**Session 08**

**Rickey Schultz** HDR  
**Speaker Session 07**

**Rob Sharp** Manhattan  
College **Moderator**  
**Session 04**

**Ronen Shechter**  
Fluence **Speaker**  
**Session 08**

**Scott Smith** Wilfrid  
Laurier University,  
Department of  
Chemistry and  
Biochemistry **Speaker**  
**Session 05**

**Varun Srinivasan**  
Brown and Caldwell  
**Speaker WKSP A,**  
**Session 05, 12**

**Heather Stewart**  
Jacobs **Speaker**  
**Session 09**

**Beverly Stinson**  
AECOM **Speaker**  
**Session 01**

**Troy Stinson** Strand  
Associates **Speaker**  
**Session 04**  
**CJ Strain** Nexom  
**Speaker WKSP A**

**Frederick Stroud**  
CDM Smith **Speaker**  
**Session 05**

**Belinda Sturm**  
University of Kansas  
**Speaker WKSP A,**  
**Session 01**

**Menachem**  
**Tabanpour** Centrisys-  
CNP **Speaker Session**  
**03**

**Seth Terry** iCell  
Sustainable Nutrition  
**Speaker Session 06**

**Art Umble** Stantec Inc.  
**Speaker WKSP A, B**

**Kumar**  
**Upendrakumar** Veolia  
**Moderator Session 05**

**Nerea Uri** VCS  
Denmark **Moderator**  
**Session 06, Speaker**  
**Session 11**

**Matias Vanotti** USDA  
**Speaker Session 03**

**Uma Vempati** ISG  
**Moderator Sessions**  
**04, 09**

**Brett Wagner**  
University of Michigan  
**Speaker Session 10**

**David Wankmuller**  
Hazen and Sawyer  
**Speaker Session 05,**  
**11**

**Dal Wayment** South  
Davis Sewer District  
**Speaker WKSP A**

**George Wells**  
Northwestern  
University **Speaker**  
**WKSP A, Moderator**  
**Session 12**

**Melody White** Hach  
Company **Moderator**  
**Session 02**

**Christopher Wilson**  
Hampton Roads  
Sanitation District  
**Speaker WKSP A**

**Paul Wood** Lockwood,  
Andrews & Newnam,  
Inc. **Moderator**  
**Session 01**

**Thor Young** GHD  
**Moderator Session**  
**03, Speaker Session**  
**07**

**Hong Zhao** Veolia  
Water  
Technologies/Kruger  
Inc **Speaker Session**  
**06**

## CONFERENCE SCHEDULE AT-A-GLANCE

### **Tuesday, July 23**

7:30 AM – 5:00 PM  
8:30 AM – 5:00 PM

Registration  
Workshops A & B

### **Wednesday, July 24**

7:30 AM – 5:15 PM  
8:30 AM – 12:15 PM  
12:15 PM – 1:30 PM  
1:30 PM – 5:15 PM  
1:30 PM – 3:00 PM  
3:45 PM – 5:15 PM  
5:15 PM – 6:45 PM

Registration  
Opening General Session  
Networking Luncheon  
Technical Sessions 1, 3  
Technical Session 2  
Technical Session 4  
Networking Reception

### **Thursday, July 25**

8:00 AM – 5:15 PM  
8:30 AM – 12:15 PM  
8:30 AM – 10:00 AM  
10:45 AM – 12:15 PM  
12:15 PM – 1:30 PM  
1:30 PM – 5:15 PM  
1:30 PM – 3:00 PM  
3:45 PM – 5:15 PM

Registration  
Technical Session 5  
Technical Sessions 6, 7  
Technical Sessions 8, 9  
Lunch on Own  
Technical Sessions 10, 11  
Technical Session 12  
Technical Session 13

## GREEN INITIATIVES AT WEF NUTRIENTS 2019

### **Renaissance Minneapolis Hotel, The Depot**

Marriott International aspires to be the global leader that demonstrates how responsible hospitality management can be a positive force for the environment and create economic opportunities around the world, in the communities where we work and live!

#### **RENAISSANCE HOTELS**

Replaced light bulbs with energy-efficient bulbs, installed low-flow showerheads and toilets, introduced water/energy saving linen program, operates the most ENERGY STAR® certified properties in the industry and Involves its global workforce in eco-volunteerism.

#### **EVENTS & MEETINGS**

100% Recycled note paper, pens made from recycled materials, pitcher water service, in-meeting room recycling, on-line event menus, organic flowers (upon request), American's Second Harvest, where available, recyclable box lunch program and paperless billing.

#### **RENAISSANCE MINNEAPOLIS HOTEL, THE DEPOT**

Hotel-Wide Conservation Program encompassing guest rooms, events and internal work areas, office paper, plastic and glass is recycled, uses only post-consumer paper, water saving shower heads in all guest rooms, energy efficient lighting in all guest rooms, locally sourced botanicals, menu items incorporating local produce and ingredients, when available, participant in Marriott Rewards' "Your Choice" linen and water conservation program, serves locally roasted Dunn Brothers coffee in recyclable cups and electric vehicle charging stations on-site.

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## NEARBY DINING OPTIONS

### **American Food**

112 Eatery  
112 3<sup>rd</sup> St N  
612.343.7696

### Crave

825 Hennepin Ave  
South  
612.332.1133

### Crooked Pint Ale House

501 Washington Ave  
612.877.6900

### Eastside Eat & Drink

305 S. Washington Ave  
612.208.1638

### Union

731 Hennepin Ave  
612.455.6690

### Borough

730 N Washington Ave  
612.354.3135

### Smith & Porter

428 S 2nd St  
612.249.5503

### Red Rabbit

201 N Washington Ave  
612.767.8855

### Mercury

505 S Marquette Ave  
612.728.1111

### **French Inspired**

Spoon and Stable  
211 N 1<sup>st</sup> Street  
612.224.9850

### **Italian**

Bar la Grassa  
800 Washington Ave N  
612.333.3837

### Buca di Beppo

1204 Harmon Pl  
612.288.0138

### Zelo

831 Nicollet Mall  
612.333.7000

### **Asian**

#### Kindee

719 S 2<sup>nd</sup> St  
612.465.8303

#### Sawatdee

607 Washington Ave S  
612.338.6451

#### Seven Sushi

700 Hennepin Ave South  
612.238.7770

#### Zen Box

602 Washington Ave South  
612.332.3936

### **Organic & Locally Grown**

Spoonriver  
750 S 2<sup>nd</sup> St  
612.436.2236

### The Bachelor

Farmer  
50 N 2<sup>nd</sup> St  
612.206.3920

### Crisp & Green

428 N Washington Ave  
612.545.5120

### **Seafood**

McCormick's & Schmick's  
800 Nicolett Ave  
612.338.3300

### The Oceanaire

600 Nicollet Ave  
612.333.2277

### Sea Change

806 S 2<sup>nd</sup> St  
612.225.6499

### Smack Shack

603 Washington Ave North  
612.259.7288

### **Steak/Charcuterie**

Fogo De Chao  
645 Hennepin Ave South  
612.338.1344

### Manny's

825 Marquette Ave South  
612.339.9900

### The Butcher and the Boar

1121 Hennepin Ave South  
612-238-8888

## UPCOMING WEF EDUCATION AND TRAINING EVENTS

### **WEF/AWWA Transformative Issues Symposium 2019**

August 7-9, 2019  
Washington, D.C.  
*www.wef.org/TISWorkforce*

### **WEFTEC 2019**

September 21 – 25, 2019  
Chicago, Illinois  
*www.weftec.org*

### **WEF/AWWA The Utility Management Conference 2020**

February 25-28, 2020  
Anaheim, California  
*www.wef.org/UtilityManagement*

### **Odors and Air Pollutants Conference 2020**

March 15-18, 2020  
Cincinnati, Ohio  
*www.wef.org/OdorsAir*

### **Residuals and Biosolids Conference 2020**

Late March/Early April 2020  
Minneapolis, Minnesota  
*www.wef.org/ResidualsBiosolids*

### **Stormwater & Green Infrastructure Symposium 2020**

Late March/Early April 2020  
Minneapolis, Minnesota  
*www.wef.org/StormwaterGI*

### **Collection Systems Conference 2020**

Early June 2020  
El Paso, Texas  
*www.wef.org/CollectionSystems*

*For more information, visit individual event site or <https://www.wef.org/events/all-events/>.*

**NOTES**

**NOTES**

# ACTIVATED SLUDGE AND NUTRIENT REMOVAL <sup>3RD</sup> EDITION

## ACTIVATED SLUDGE AND NUTRIENT REMOVAL

THIRD EDITION

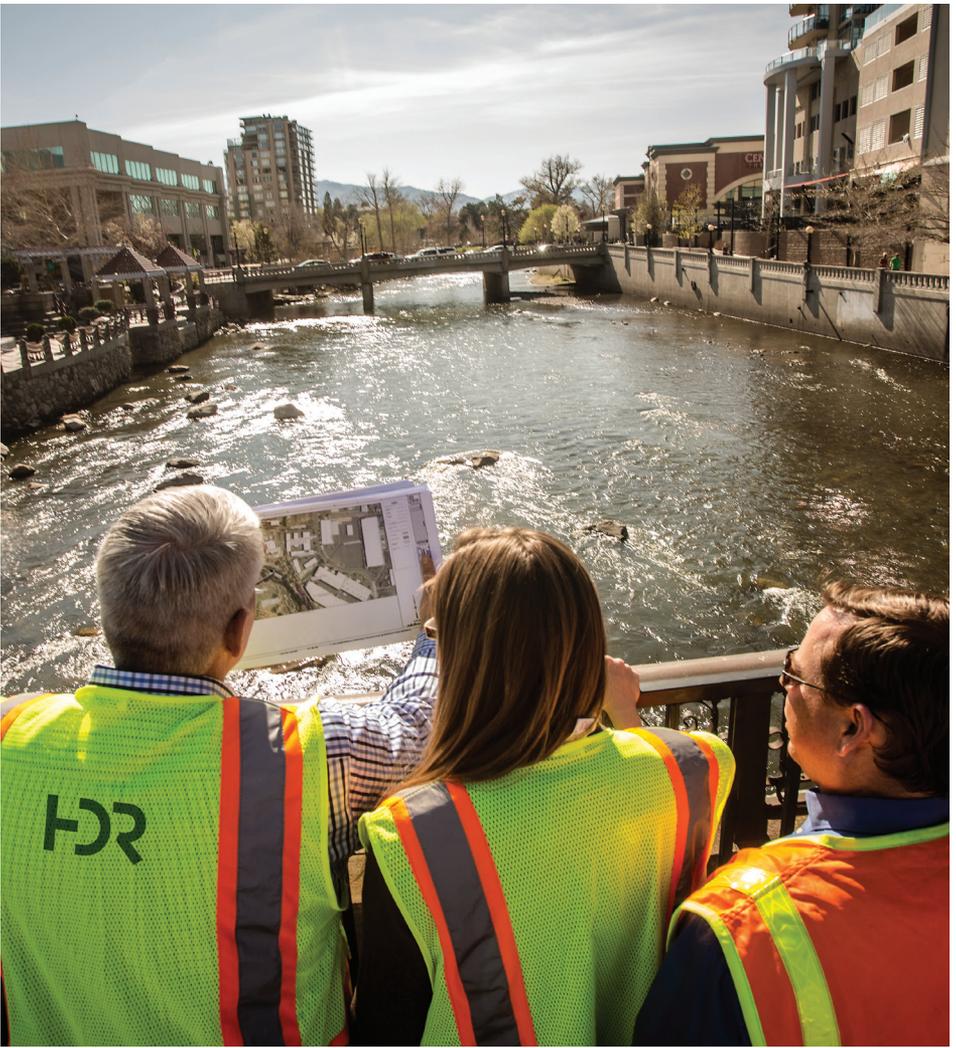
### **SPECIAL PRICING FOR ATTENDEES!**

Member: \$95.22

List: \$120.23

*Activated Sludge and Nutrient Removal, 3rd Edition, guides you through selecting an appropriate sludge age, calculating wasting rates, optimizing return activated sludge flow, managing clarifier blankets, and setting DO and ORP set points. Expanded content includes an updated process control section, a new laboratory chapter, an introduction to using modeling for process control, and practice questions at the end of each chapter. 2018*

 **Water Environment  
Federation**  
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