

THE Onsite Journal

NOWRA
National Onsite Wastewater Recycling Association

Spring 2026



★
2025 | Sandusky, OH
Onsite Wastewater
Mega-Conference
Clean Water Strategies
at the Heart of it All

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Nitrogen Transformations, Page 29



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Recycling Association**

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A NOTE FROM THE PRESIDENT

Konnichiwa!

This is my first update since the Mega-Conference in Ohio last October. Since then, I had the privilege of representing NOWRA, Minnesota, and Otter Tail County at the 13th International Workshop on Decentralized Wastewater Treatment in Asia, held in Tokyo, Japan, in November.

The workshop featured experts from across Asia—including Japan, Vietnam, China, Indonesia, and India—who focused extensively on a technology known as **Johkasou**, Asia’s leading solution for decentralized wastewater management. The term *Johkasou* translates from Japanese to English as “purification tank.” These systems are self-contained treatment units that perform primary, secondary, and tertiary treatment within a single device before discharging effluent to the environment, typically into a stream or drainage channel.

In contrast to systems in the United States, which primarily depend on soil for secondary treatment, Johkasou units are designed to internally manage components such as

BOD₅, TSS, and pathogenic microorganisms. Remarkably, this process is accomplished within a compact unit that is smaller than a Volkswagen microbus. A standard household Johkasou system processes approximately 1.0–2.0 cubic meters (264–528 gallons) of wastewater per day. Given the compact design, sludge removal must be performed more frequently compared to U.S. systems, and this task is carried out by licensed desludging vendors who are permitted by local municipalities.

After listening to the representatives from various countries, I, as the only westerner present, had the chance to present our decentralized wastewater management approach in the United States—**soil-based treatment**. Just as I found the Johkasou technology captivating, the Asian delegates were equally intrigued by our use of soil for wastewater treatment. For many participants, the concept of using soil for this purpose was entirely new, sparking genuine curiosity and thoughtful discussions during the field trip day.

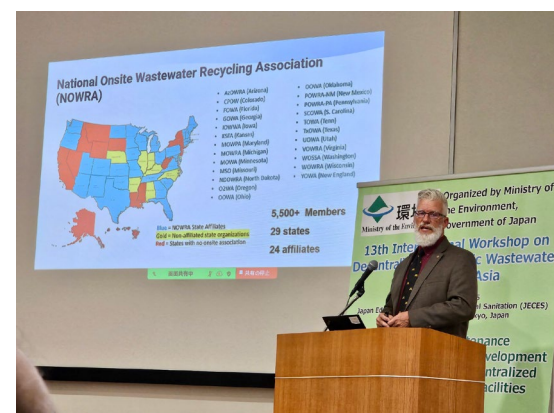
While embracing an Anthony Bourdain-inspired adventurous approach to trying exotic foods in Japan



(including eating four grilled baby octopus whole), a key takeaway I walked away with is that there are various methods to achieve our common goal: protecting our precious water resources. While the methods may vary, the goal remains the same. During my travels this winter speaking at various state onsite conferences, I’ve had numerous conversations with onsite professionals equally intrigued in Johkasou systems. Many of them face challenges with limited space for soil treatment, and Johkasou technology may offer a practical and effective solution.

Dr. Yurie Shirakawa of the Japan Education Center of Environmental Sanitation (JECES) is a leading expert on Johkasou systems. Dr. Shirakawa has accepted NOWRA’s invitation to be a keynote speaker at the Mega-Conference in Denver in October. If learning more about Johkasou is of interest to you, please consider coming to Denver!

— **Chris LeClair**





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MESSAGE FROM THE EXECUTIVE DIRECTOR



Welcome to the Winter/Spring issue of NOWRA's Onsite Journal. Depending on what part of the country you are living in, you have either had a milder than normal winter, or like us here in New England, a winter for the ages, especially if you are a ski enthusiast as I am.

This is our first issue of 2026, and we are really excited about what this year can bring to NOWRA and our members. In addition to our regular features of an advocacy report from Washington D.C., state affiliate news, etc., this issue features a technical article on Nitrogen removal, a wrap up of the 2025 Mega-Conference, and an overview of some of NOWRA's international dealings.

We are eagerly looking forward to our 2026 Onsite Wastewater Mega-Conference, our return to Colorado, and partnership with one of our strongest affiliates, the Colorado Professionals in Onsite Wastewater (CPOW). This year's Mega-Conference will be held in Westminster, Colorado, in late

October. The Call for Abstracts is currently open and looks to be one of our most successful conferences yet. Please make plans to join us.

This year promises to be a transformative year for NOWRA. Our online education has continued to grow as we just had a record setting year in 2025. NOWRA affiliates benefited as well through our revenue sharing. They also get key contacts for non-members who take our training. Believe it or not, 75% if not more of our online learning attendees are non-members. If they joined NOWRA not only would they save money, but they would help make NOWRA stronger with a larger membership. Look for several new courses to be rolled out in 2026.

In addition to our online learning growth, NOWRA has been busily involved with grants through sub-agreements with some of our national partners for the development of educational materials (see page 25), which will continue into 2028 through a new 3-year

agreement. We are also exploring opportunities to provide technical assistance to our state affiliates with communities in their states that are in need of reasonable, and sustainable, solutions to their wastewater issues.

Much of the great work that you will read about inside of the publication is due to the dedicated board members, committee chairs, and volunteers. This organization is only as strong as its volunteers. We recently welcomed two new members to the NOWRA Board in our 2025 election. You can learn more about our current Board of Directors on page 12.

As you read about NOWRA's activities, please consider joining a committee or task force, see page 18 for a list of current NOWRA committees. It's a great opportunity to expand your horizons, network with like professionals, feel good about yourself and the industry that we have chosen, and make life-long friends.

Thank you for allowing me to serve as the Executive Director of this organization! I can't believe it has been 5 years already. I am looking forward to many more.

— **Thomas Groves**



Interested in getting more involved with NOWRA?

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It's a great place to start!

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STATE AFFILIATE NEWS

CPOW (COLORADO) — The 2026 CPOW Annual Education Conference, held January 29 & 30 in Lakewood, Colorado educated, entertained, and enlightened. This year's CPOW Annual Education Conference welcomed two influential industry professionals as keynote speakers: Dr. Sara Heger and Ben Kele. Ten additional speakers, 152 attendees, and 16 exhibitors rounded out the event.

Two \$2,000 scholarships were awarded to well-deserving students entering the industry. CPOW presented Chuck Cousino with the Industry Leadership Award for his career-long leadership in Colorado. Ken Bortscheller was awarded the Industry Service Award for his commitment to the onsite industry. We raised \$1595 for CPOW's 2027 scholarship through a 50/50 raffle.

CPOW is excited to collaborate with NOWRA for the 2026 Mega-Conference, which will be October 25-28 in Westminster, Colorado. We hope to see you in Colorado in October!

NDOWRA (NORTH DAKOTA) — Exciting things happened at our convention on February 13! We had a strong turnout and truly appreciated the support from our great sponsors.

We are also pleased to welcome our newest board members, Zach Bowers and Chad Dietrich. Zach, who will be stepping in as our incoming Treasurer/Secretary and is already doing an outstanding job. Chad has also proven to be a tremendous asset to our organization, bringing many years of valuable knowledge in septic system installation. Both men are excellent additions to our team.

We were glad to have representatives from the ND Department of Environmental Quality (DEQ) join us and speak to our group about updates regarding the newly passed bill and the companies entering the industry. Local health departments also provided important insights and helpful points. Working together, we continue to build a stronger path forward.

With our newly established motto, "Partners in Progress," we look forward to working with everyone as we take on new opportunities and challenges.

Thank you again to all who attended and helped make our convention a success!

OOWA (OHIO) — Greetings from the Buckeye State! The 2025 Mega Conference in Sandusky in October was one for the books! We enjoyed hosting and we hope that all of you enjoyed your time in the Buckeye State!

We recently held our annual meeting and there will be some changes to the leadership positions in 2026. SCS Engineers' Dan Brennan is President, Zak Sherman of SICKEL'S Septic Tanks is Past President, Dominic Dowell of Jet Inc is Vice President, Drew Nickoli of Eljen will serve as Treasurer, and Tidy Tim's Zach Gossett will serve as Secretary. OOWA Board of Directors is excited for the upcoming year!

We are also excited to hold a field day this year. It will be taking place in June 17 in Kox County! More details will be available soon!



Representatives from the three OOWAs (Oklahoma, Ohio, and Ontario) attending the 2025 Mega-Conference!

WOWRA (WISCONSIN) — Wisconsin held a very successful conference in early February that included a full day of soils training and two additional days on design, installation, and maintenance. Two individuals were honored during the event: Mark Prevost, Retired Fluid Handling Technical Service Manager for First Supply, and E. Jerry Tyler, Emeritus Professor of Soil Science, University of Wisconsin Madison.

Prevost has been a fixture in the Onsite Wastewater industry in Wisconsin. He has developed and conducted countless training programs and has been a strong advocate for the industry. He has served the WOWRA Board of Directors on multiple occasions.

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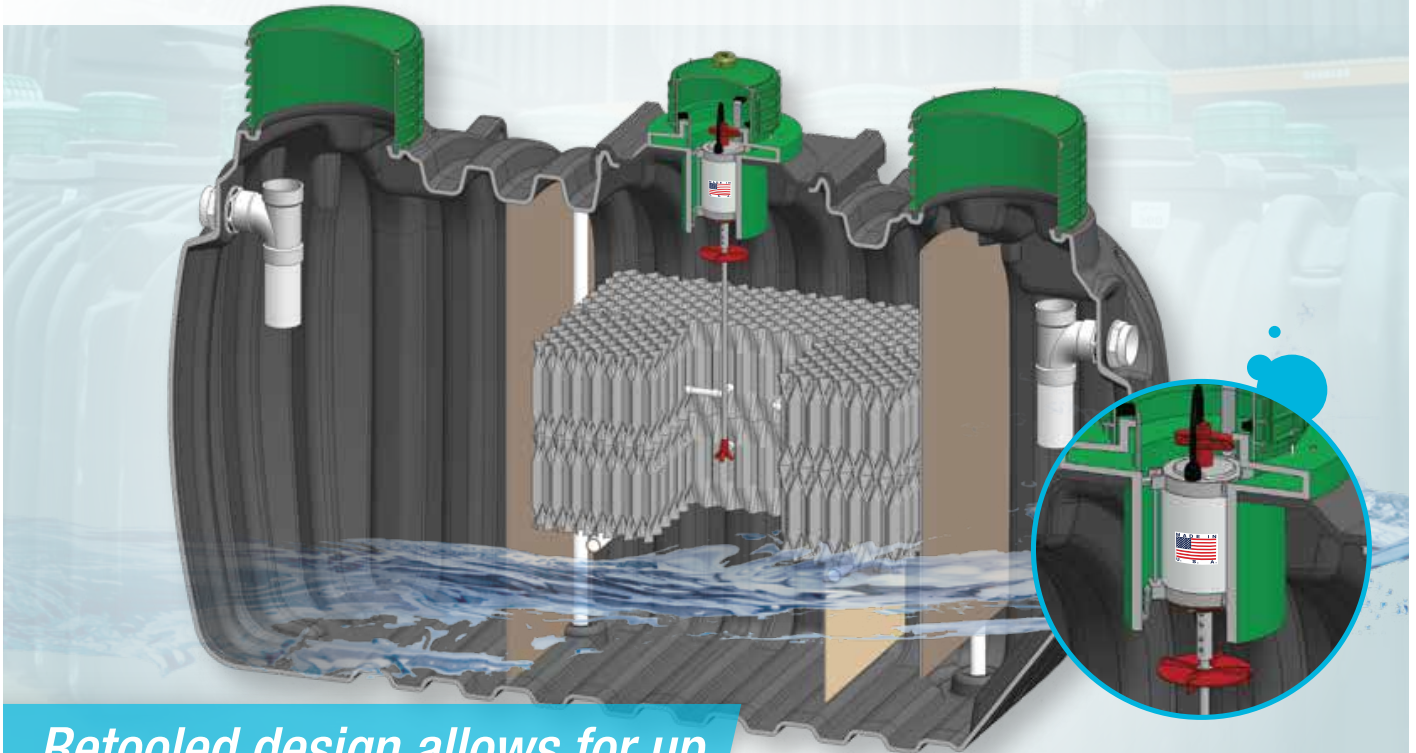
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STATE AFFILIATE NEWS (continued)

For more than 30 years, Tyler undertook research about the acceptance and treatment of onsite wastewater by soil. Notably, he worked on the development of the Wisconsin Mound and At-Grade systems and manuals. He has been an instructor, trainer, and a notable resource for the industry worldwide.

YOWA (NEW ENGLAND) — The Yankee Onsite Wastewater Association (YOWA) recently held their Board of Directors elections. Returning Board members and those serving unexpired terms include Dennis Healy, Michelle (Shelly) Jenkins, John McVeigh, Mike Moreau, Rebekah

Novak, Melissa Ranieri, Alyssa Rusiecki, and Jared Willey. Zach Gardner was the sole name on the ballot, seeking election for a three-year term on the Board. YOWA members also had the opportunity to write themselves in as a self-nomination on the ballot.

In addition to the members listed above, the following individuals will serve as 2026 Officers and be part of the Board: Lauren Usilton, President; Jim Healy, Vice President; and Rob Sarmanian, Treasurer. All terms begin on March 1, 2026.

[See full listing of NOWRA state affiliates.](#)

2026 National Backhoe Roe-D-Hoe Champion Crowned

It was a clean sweep for the state of Ohio in the top finishes of the 2026 NOWRA National Backhoe Roe-D-Hoe championships held recently in Indianapolis at the 2026 WWETT Show. Entrants tested their backhoe skills through the obstacle course of basketballs, bowling pins, and golf balls.



First place winner Cody Wheeler with Event Sponsor, Ron Naumann, NPCA

Five qualifying finalists, the reigning National Champion; Adrien Keiper, the Ohio state champion; Albert Breech competed for the top three prizes in the

finals. Congratulations to Cody Wheeler from Ohio for winning first place with an incredible total time of 47 seconds. He got to wear the Backhoe Roe-D-Hoe championship belt and walked away with \$1000 in cash and a commemorative belt buckle.

Congratulations also goes out to our other top finishers: 2nd place, Albert Breech, Ohio; 3rd place, Adrien Keiper, Ohio; honorable mention, Sean Bonifacio, CA; Dylan Ames, AL; AJ Bonifacio, CA; and Jared Wheeler, OH.

Check out more pictures and a video of the championship round on the NOWRA FaceBook page. Join us next year for the NOWRA National Backhoe Roe-D-Hoe championships at the WWETT Show in February 2027. We hope to have several state champions vying for the top prize and bragging rights.



2026 Backhoe Roe-D-Hoe winners.

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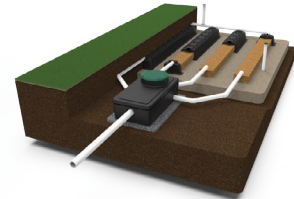
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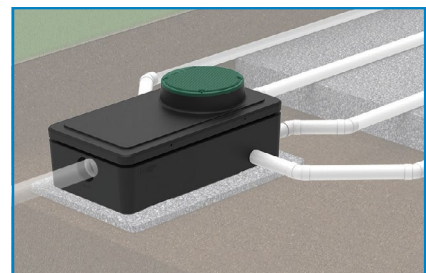
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2025-2026 NOWRA Board Members, Committee Chairs, and Executive Director.



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ZAK SHERMAN (Ohio)
Category: Service Provider

Zak started his wastewater career in North Carolina while working for the US Department of Interior: National Park Service as a heavy equipment operator. While working for the Park Service, he worked with Infiltrator Systems, Inc., using ISI products out on the islands. This relationship with ISI led to leaving the federal government and having a wonderful 17-year career at Infiltrator.

Currently, Zak runs Sickels Concrete Products, a small concrete precast plant in Athens, Ohio. Sickels is a 55-year-old company servicing 15 counties in Southeastern Ohio with the supply of tanks as well as a service business. Zak is also the current president of the Ohio Onsite Wastewater Association (OOWA).



BRIAN WAKEFIELD (Texas)
Category: Installer

Brian has dedicated over 25 years to the onsite wastewater industry, and has gained extensive knowledge and experience that is valuable to the national board. His background includes hands-on experience in various facets of the industry, including installation, maintenance, repairs, manufacturing, distribution, and sludge transport.

As the owner and operator of B & J Wakefield Services for over 25 years, he has managed a full-service company specializing in installation, maintenance, inspections, repairs, and sludge transport. In addition, his experience with Texas Septic Installations focuses on commercial septic and wastewater treatment installations and provides commercial consulting services. Brian currently serves as Treasurer and Board Member for the Texas Onsite Wastewater Association (TOWA).



More info and
enrollment



New Health Benefits Available for NOWRA Members

At NOWRA, we're committed to supporting the health and well-being of our members. That's why we're excited to announce a new partnership with Apollo Health Insurance.

As a NOWRA member, you now have access to a range of tailored health insurance plans designed to meet your unique needs.

Whether you're an installer, designer, pumper, service provider, or other small business owner in the onsite wastewater industry, Apollo offers flexible and affordable options with your lifestyle in mind.

Key Benefits:

- **Personalized Plans:** Apollo's experts will work with you to create a plan that fits your specific needs and budget.
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To explore your options and enroll, please visit [Apollo and NOWRA Enrollment](#) to schedule your call. For immediate assistance or to learn more, please contact Apollo at 816-282-1977.



LEGISLATIVE UPDATE

Policy Forecast: Federal Opportunities Ahead for Decentralized Wastewater Stakeholders

By Tim Perrin and Marisa Campbell, The Southern Group

Recent headlines surrounding the major sewage spill in Maryland into the Potomac River just a few miles from Washington, D.C. have thrust centralized wastewater infrastructure into the national spotlight. The incident, resulting in significant environmental impact and widespread public concern, has underscored certain realities: centralized wastewater infrastructure is aging, underfunded, and failures risk public health and damage the environment. High-profile failures like the one in Maryland draw attention not only to centralized sewer systems but to the broader wastewater ecosystem. At a time when Congress is actively considering water and wastewater policy vehicles, several opportunities for decentralized wastewater are emerging.

One major legislative vehicle on the horizon is the Water Resources Development Act (WRDA), which Congress typically considers on a bipartisan basis every two years. While WRDA primarily focuses on U.S. Army Corps of Engineers water infrastructure projects, including flood control, ecosystem restoration, and navigation, it often serves as a broader water policy platform. Members of Congress frequently use WRDA as a vehicle for other water-related provisions, pilot programs, and policy directives.

As this year's WRDA discussions begin to take shape, NOWRA and industry stakeholders will reinforce the role of decentralized wastewater solutions within broader federal water infrastructure conversations and to educate policymakers on how decentralized systems complement larger water resource strategies. Notably, this includes advocating for passage of the Clean Water Allotment Modernization Act, which would modernize EPA's Clean Water State Revolving Fund distribution formula to reflect documented state needs—including decentralized wastewater—and better align funding with real-world infrastructure demand.

Shortly after finalizing most of the federal Fiscal Year (FY) 2026 appropriations process earlier this year, Congress is beginning to consider funding priorities for FY 2027. As this process gets underway, NOWRA will continue to advocate for additional federal resources for decentralized stakeholders and build upon the \$5 million allocated for decentralized water programs (wells and wastewater) included in the FY 2026 USDA funding bill, along with the additional \$1 million specifically designated for subgrants supporting decentralized wastewater stakeholders. These investments represent meaningful progress and recognition of the

sector's importance. As NOWRA continues to press the case for increases in USDA funding, the association will also work to expand opportunities within EPA-funded programs to ensure decentralized systems are appropriately supported.

Beyond annual appropriations, the reauthorization of the "Farm Bill" presents another significant opportunity. The House Agriculture Committee recently approved legislative text to reauthorize agricultural and rural services programs, including the USDA Rural Decentralized Water Systems Program. The proposal authorizes \$20 million per year for five years for this grant program, quadrupling the \$5 million appropriated last year. In addition to maintaining support for construction, refurbishment, and servicing of well water and wastewater systems, the House proposal expands eligible uses to include qualified water quality testing in cases of potentially contaminated groundwater. The House Farm Bill proposal also strengthens technical assistance resources through the Rural Water and Wastewater Technical Assistance and Training Program. This program, reauthorized for five years, would provide funding to non-profit organizations that deliver water and wastewater technical assistance and training. Notably, the proposal

continued on next page

LEGISLATIVE UPDATE

continued

expands allowable uses to include disaster response and recovery assistance, an increasingly important function for communities facing extreme weather events. Technical assistance funding remains essential to ensuring that small and rural communities can successfully plan, finance, and maintain decentralized wastewater systems.

Taken together with current events, these legislative vehicles—WRDA, annual federal appropriations, and the Farm Bill—demonstrate that water and wastewater policy is receiving sustained attention in Congress. For the decentralized sector, this moment presents both responsibility and opportunity. As policymakers respond to high-profile infrastructure failures and seek long-term water resilience solutions, NOWRA and its members are educating lawmakers on the cost-effectiveness, environmental benefits, and public health value of decentralized wastewater systems. Continued engagement and advocacy will be critical to ensuring that federal policy reflects the full range of decentralized wastewater solutions serving communities across the country – from rural towns to suburban developments and growing exurban areas alike.

—*Tim Perrin, Partner, The Southern Group*
Marisa Campbell, Partner, The Southern Group



Marisa Campbell and Tim Perrin, partners with The Southern Group, presented an advocacy update at the 2025 Mega-Conference.



ADVOCACY EFFORTS

The following companies and organizations are supporters of NOWRA's advocacy efforts for 2026 and comprise our Lobbying Board of Governors.

We thank them for their efforts & support.

- American Manufacturing, Inc.
- Anua
- BioMicrobics, Inc.
- Colorado Professionals in Onsite Wastewater
- Eljen Corp.
- Florida Onsite Wastewater Association
- Infiltrator Water Technologies
- Jet, Inc.
- Missouri Smallflows Organization
- National Association of Wastewater Technicians (NAWT)
- Norweco, Inc.
- Ohio Onsite Wastewater Association
- Orenco Systems, Inc.
- Residential Sewage Treatment Co.
- Roth North America
- Virginia Onsite Wastewater Recycling Association (VOWRA)

BECOME INVOLVED!

We would welcome your participation on the Board of Governors if you are able to make that commitment. You are also welcome to contribute at a lower level. All of the funds raised go directly to supporting our advocacy efforts.

To find out more about NOWRA's Advocacy activities, visit our [Advocacy website](#) to get more involved or [contact the NOWRA office](#).

Now Available: Enhanced Training Program for O&M Service Providers

Nearly two decades ago, the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT), representing academic, industry and regulatory professionals collaborated to create a framework for performing operational evaluations of onsite/decentralized wastewater treatment and dispersal systems. The result of this stakeholder-driven effort was a collection of detailed training presentations that have been used across the nation and a comprehensive manual that earned the American Society of Agricultural and Biological Engineers (ASABE) Blue Ribbon for curriculum publications in 2006. NOWRA (with funding from the Environmental Protection Administration [EPA] administered by the Rural Communities Assistance Program [RCAP]) has updated and expanded the training program as well as the manual.

Nature of Revisions

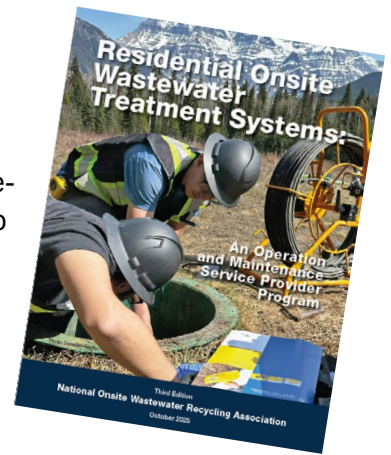
In addition to incorporating more specific troubleshooting elements, the new materials reflect the many innovative products and technologies that have been applied to the onsite/decentralized industry over the intervening 20-plus years. The section on business has been greatly expanded and now includes an extensive section on business planning. Notably, this section broadens the spectrum of system management business models based upon proactive versus reactive maintenance.

The updated materials reflect an increased focus on proactive operation and maintenance activities that keep treatment processes operational. Originally, the materials focused upon documenting component operational status and collecting operational data. The updated version incorporates the performance of routine maintenance activities along with the analysis of operational data to identify variations from normal operating values. This focus on proactive maintenance reduces risk and facilitates the potential for more direct water reuse applications.

Stakeholder Participation

After extensive scrutiny and revision of existing materials, project personnel invited stakeholder review of training presentations. A group of 40 stakeholders reviewed three versions of presentations and provided constructive feedback through virtual meetings, written comments or email messaging. As is

usually the case, stakeholder review was critical to clarifying, expanding and improving the training program. Revisions to the manual mirrored those made to presentations.



Testing and Training Events

Two Train-the-Trainer events have been conducted thus far in Nashua, New Hampshire, (30 participants) and Ellicott City, Maryland (36 participants). These events allow pilot delivery of the training presentations to gauge quality, accuracy and effectiveness. They also allow those who will deliver the materials in their home setting to gain deeper insight into training methodologies. Each event included pre and post testing to assess knowledge gained. The next Train the Trainer event will occur from March 24 through 26, 2026, in Springfield, MO, in partnership with the Missouri Smallflows Organization (MSO). The final event is scheduled for April 21 through 23, 2026 in Madison, Wisconsin in partnership with the Wisconsin Onsite Wastewater Recycling Association (WOWRA). [Register for these events online.](#)

Access to Materials

Thanks to grant funding, these resources are publicly available at no cost. You can access the complete electronic toolkit—including the training outline, presentations, and the O&M Service Provider manual—by visiting the new project page on the NOWRA website. Access the materials [here](#)

Note: You will be asked to provide your contact information and then access will be provided.

Final 2026 Training Pilots. NOWRA, in partnership with RCAP, is hosting two final training events in 2026 to pilot new educational materials. These sessions include a "train-the-trainer" component, offering extra resources for those who plan to teach these materials themselves.

Upcoming Schedule:

- Resolving Challenges in Small Communities | Tulsa, OK
April 7–9
- Operation and Maintenance with WOWRA | Madison, WI
April 21–23

[Registration NOW for FREE.](#)

COMMITTEE UPDATES

NOWRA Committees

NOWRA's committees are the working groups of the organization. They exist to shape the direction of the organization over time. NOWRA welcomes and encourages its members to become involved with its committees and task forces. To belong to a NOWRA committee, you must be a NOWRA member. For information on joining a committee check out the [committee webpage](#) or contact the NOWRA office at info@nowra.org.

Corporate Member Committee

Open to existing NOWRA Corporate Members only
Chair: Ashley Donnelly, Infiltrator

Conference Planning Committee (2026 Mega-Conference)

Chair: Kate Carney, Colorado Professionals
in Onsite Wastewater

Education Committee

Chair: Gary Hawkins, Ph.D., University of Georgia

Emerging Professionals Committee

Chair: Jonathan Kaiser, Infiltrator Water Technologies

Government Relations Committee

Open to existing NOWRA Lobbying BOG only
Chair: Carl Thompson, Infiltrator Water Technologies

Marketing & Communications Committee

Chair: Donna Fiorentino, Infiltrator Water Technologies

Online Education Committee

Chair: Sara Heger, Ph.D., University of Minnesota

Onsite Journal Committee

Chair: Anish Jantrania, Ph.D., Texas A&M University

State Affiliates Committee

Open to existing NOWRA state affiliates
Chair: Jessica Wood, Residential Sewage Treatment Co.

Technical Practices Committee

Chair: Chris Strycharz, Infiltrator Water Technologies

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National Onsite Wastewater Recycling Association

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MEGA-CONFERENCE WRAP-UP

The 2025 NOWRA Mega-Conference took place October 19-22 in Sandusky, Ohio. Over 530 attendees had the choice of 67 presentations featuring topics ranging from business planning to AI-assisted mapping strategies to attend. NOWRA was pleased to partner with Ohio Onsite Wastewater Association to offer a track specifically designed to allow Ohio service providers to earn their continuing education credits. The sold-out exhibit hall had 56 companies showing their products and services.

2025's Opening Session featured a welcome from the Presidents of the Conference sponsoring organizations, Ohio Onsite Wastewater Association (OOWA), National Association of Wastewater Technicians (NAWT), State Onsite Regulators Association (SORA), and NOWRA.

Dr. Christopher Winslow, of Ohio State University, delivered an informative keynote speech about harmful algal blooms on Lake Erie. Ohio EPA gave an update about H2Ohio. Rounding out the conference opener, Tim Perrin and Marissa Campbell of Polsinelli, LLC shared insight into the lobbying efforts conducted to bolster recognition and funding of decentralized and onsite wastewater as an important part of wastewater treatment infrastructure. NOWRA President Chris LeClair capped off the opening session with NOWRA announcements, awards, and news.

The winner of the 2025 Richard J. Otis Industry Achievement Award was Dr. Sara Heger (see page 20). The award was presented during the opening ceremonies of the conference.

continued on next page



RICHARD J. OTIS INDUSTRY ACHIEVEMENT AWARD

The 2025 Richard J. Otis Industry Achievement Award was given to Dr. Sara Heger at this year's Onsite Wastewater Mega-Conference. The award which is named after



NOWRA Past-president, Richard Otis, is presented annually to an individual who has made outstanding contributions to both NOWRA and the onsite industry.

Dr. Heger is a researcher and instructor at the University of Minnesota (UMN) in the Onsite Sewage Treatment Program in the Water Resources Center and is an Adjunct Assistant Professor in the Bioproducts and Biosystems Engineering Department. For over 20 years, she has been providing education and technical assistance to homeowners, small communities, onsite professionals and local units of government regarding onsite wastewater treatment.

Sara is the past-president of NOWRA and has also served on the board of the Minnesota Onsite Wastewater Association. Sara serves on the NSF International Committee on Wastewater Treatment Systems. She is also the chair of the Minnesota State Advisory Committee on Decentralized Systems. She has BS in Biosystems & Agricultural Engineering and a MS and a PhD in Water Resource Science.

The award was presented at the Opening Session of the recent 2025 Onsite Wastewater Mega-Conference held in Sandusky, Ohio, by NOWRA President and her good friend, Chris LeClair.

Congratulations Sara, well deserved!

To learn more about the Richard J. Otis Industry Achievement Award and past recipients, check out the [Otis Award website](#).

2025 was a busy year for the Emerging Professionals Committee. They hosted their oral and poster presentation competition. Lucas Caldwell took 1st place in the oral competition, with his presentation Troubleshooting and Enhancing Onsite Wastewater Systems with Case Studies. Nelson da Luz's presentation Where Are All The Onsite Systems in the US? Machine-learning Based Inventory was the runner-up. Five posters were presented at the conference, with Christopher Anderson's Decentralized Wastewater Influent as a Potential Tool for Community-Level Surveillance of Viral Pathogens and Antimicrobial Resistance poster awarded 1st place. See page 21 for more details.

NOWRA and OOWA also held the ever-popular Backhoe-Roe-D-Hoe competition. Contestants must exhibit speed, skill, and accuracy in a series of games. Nicholas Dykes, of Missouri, was this year's Mega-Conference winner.



The 2025 Mega-Conference also included the first annual Cornhole Tournament to benefit the Emerging Professionals Committee Scholarship Program. Two-person teams began competing on Sunday, October 19, continuing into the semi-finals and finals on Monday, October 20.

Cheering crowds gathered to watch the teams throw at beautifully decorated custom boards. The top team took home their own sets of boards and bags, as well as recognition as NOWRA's first Cornhole Champions. "Keeping Up with the Jones," consisting of Donald and Justin Jones of Jones Pump Service, were the winners of this first competition.

The Emerging Professionals Committee would like to thank the teams that competed, the sponsors who helped make the event possible, and all of the volunteers who helped with every aspect of the competition, from determining the rules and schedule to assisting with time and score keeping.



Unfortunately, weather conditions caused NOWRA to cancel one of the field trip options, as the wind made Lake Erie too rough for the required boat ride to Stone Island Laboratory. Instead, everyone who chose to join the other field trip option saw North American Testing, as well as advanced systems at Muffleheads Brewery, and a residential system featuring UV disinfection and off-lot discharge to a waterway.



As always, the Mega-Conference provided a unique learning and networking opportunity for all attendees.



We hope to see you in Westminster, Colorado, for this year's conference in October!

Emerging Professionals Presentation Prizes

During the annual Mega-Conference, the Emerging Professionals Committee hosts both an oral and poster presentation competition. Young professionals volunteer to present their work in various technical sessions throughout the conference. A panel of industry experts evaluate and score the presentations based on technical merit, clarity, delivery, and overall impact.

The 2025 Oral Presentation Winners are Lucas Caldwell, of Septic Check in Minnesota, who won first place, and Nelson da Luz, research assistant professor at University of Massachusetts, Amherst, who took second place.

Christopher Anderson, a PhD student in the Department of Civil & Environmental Engineering at West Virginia University won first place in the poster presentation.

The winning oral presentations and posters are available in the 2025 Conference Proceedings Page on the NOWRA website.

Congratulations to the Oral and Poster Presentation Winners.

Emerging Professionals Oral Presentation Winners:



1st Place

Lucas Caldwell

O&M Manager
Septic Check (MN)

2nd Place

Nelson da Luz

Research Assistant Professor
University of Massachusetts Amherst



Emerging Professionals Poster Presentation Winner:



1st Place

Christopher Anderson

Ph.D. Student
Dept. of Civil & Environmental Engineering
West Virginia University

New on NOWRA's Website! **REGULATOR FORUM**

NOWRA recognizes the importance of the regulators working in the onsite wastewater industry. We're offering a new benefit for our NOWRA members who serve as regulators at any level of government, from local to regional to state to federal.

As regulations change or get updated and new challenges arise, talking with others in the regulatory sector can be invaluable. NOWRA is now offering a NEW forum strictly for regulator members to connect with each other and discuss timely topics using a nationwide network of fellow regulators.

In our Regulator forum you can:

- Ask questions
- Propose new topics
- Offer suggestions and discussion

NOWRA hopes you will use this forum to not only identify upcoming items of interest, but to also engage in sharing ideas and solutions for tackling some of the issues that are common across many areas. By building your network, you may discover numerous tips, tricks, and ideas to make your job a little easier.

You MUST be a member of NOWRA, a Regulator, and have an account on NOWRA's website to use this forum.

If you are a **MEMBER**, you can log-in or [create a NOWRA website account on our website](#). If you are **NOT** a NOWRA member, you can find out information about joining NOWRA or one of our State Affiliates on our [website](#).

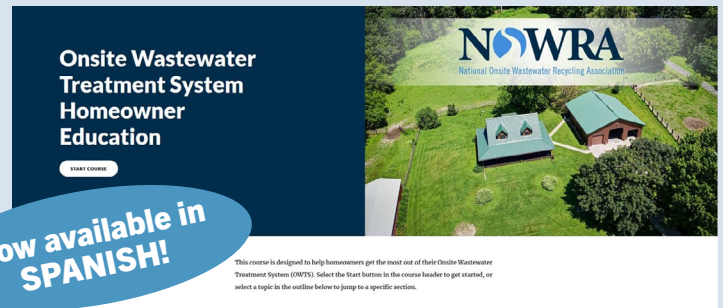
Once you have a NOWRA website account, you can sign up to [JOIN the Forum](#). Once your request to join is received, it will be reviewed and you will get an approval notice.

HELP US EDUCATE HOMEOWNERS

NOWRA's Online Learning Academy now includes a free, online training module to educate homeowners about their onsite wastewater systems.

The **Homeowner's Education Course** was designed to be an engaging way for people to learn the basics of onsite treatment and maintenance. While the training's target audience is property owners with onsite systems, the concepts are also applicable to the general public, realtors, local health officials, and septic system professionals.

MORE
INFO
HERE



Concepts covered in this short and easy-to-use training module include: the importance of wastewater treatment, an overview of treatment in an onsite system, typical onsite system features, final treatment and dispersal, management, maintenance, safety, and system troubleshooting.

The Homeowner's Education Course was developed through a U.S. EPA grant and in partnership with the Rural Community Assistance Partnership (RCAP).

This course is free but users must create an account on [NOWRA's Online Learning Academy](#)

Questions about this course should be directed to NOWRA at info@nowra.org.

Emerging Professionals Award Scholarships

Each year, the Emerging Professionals Committee awards two scholarships to individuals based on their career aspirations and commitment to the on-site sector. This scholarship is intended to support the professional development of applicants who are under 35 years of age, or who have less than 5 years experience in the onsite wastewater field.

The 2025 Emerging Professionals Scholarships were awarded to Kwabena Darko Okyere for his research regarding adsorbent material to reduce nitrogen in onsite wastewater systems and Jianan Feng for his research on modeling sustainable technologies for wastewater treatment.

Congratulations to the scholarship winners.



2025 NOWRA Scholarship Recipient:
Kwabena Darko Okyere

PhD Student
Civil & Environmental Engineering
University of South Florida

Kwabena's research focuses on the use of adsorbent media to enhance nitrogen removal for OWTS. He is expanding his research to investigate how government mandates, funding, and innovation influence the adoption of OWTS. Kwabena is dedicated to leveraging his expertise in environmental engineering to drive innovative solutions for onsite treatment and environmental protection.



2025 NOWRA Scholarship Recipient:
Jianan Feng

PhD Candidate
The Grainger College of Engineering
University of Illinois Urbana-Champaign

Jianan Feng focuses on modeling sustainable technologies for wastewater treatment. By examining greenhouse gas emissions, emerging contaminants, and opportunities for resource recovery, he develops practical insights to strengthen the sustainability of wastewater management while supporting broader climate and circular economy goals.

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To learn more about or to join NOWRA's Corporate Membership program, please contact us at 978-496-1800, by email at info@nowra.org, or on our website at www.nowra.org/about/corporate-members.

CORPORATE MEMBER BENEFITS

Corporate Membership in NOWRA is an investment that enhances your business marketing efforts while showing your support of our mission to advance and grow the onsite and decentralized wastewater industry.

Corporate Membership Benefits

- Conference booth, sponsorship, & advertising discounts
- *Onsite Journal* advertising discounts
- Individual NOWRA memberships
- Recognition in the industry
- Federal advocacy on your behalf

Advocacy Successes

1. NOWRA made tremendous progress in 2025 in advocating for the reintroduction and passage of the Clean Water Allotment Modernization Act. This legislation would modernize how **Clean Water State Revolving Fund** dollars are distributed by updating the Reagan-era funding formula to account for each state's population and current infrastructure needs, including the nation's reliance on decentralized wastewater systems. **Importantly, this legislation could lead to a very significant increase in federal resources dedicated to decentralized wastewater stakeholders.** Through our work, we secured committed Congressional champions, built support for the bill among key Congressional offices, engaged NOWRA members to provide state-specific perspectives to policymakers, and rallied the support of like-minded water organizations. Our work continues into 2026, pushing for this transformative policy change to be included in a broader package of federal water programs to be reauthorized this year.
2. NOWRA continues to prioritize advocacy to increase federal appropriations for the U.S. Department of Agriculture's (USDA) Decentralized Water Systems Program and was successful in securing again \$5 million in grants and loans for eligible well water and decentralized wastewater system stakeholders in FY26. Further, the appropriations legislation passed by Congress includes an additional \$1 million in subgrants specifically targeted for decentralized wastewater systems. These amounts are the same as in FY24 and FY25 and represent a remarkable win for NOWRA in a tight fiscal environment.
3. As part of the process to reauthorize Farm Bill's rural development programs, the House Agriculture Committee unveiled legislation that renews for 5 years the USDA Rural Decentralized Water Systems Grants Program at \$20 million per year. Although Congress has only appropriated \$5 million for this program in recent fiscal years, without being reauthorized this program would likely not receive any funding during the annual appropriations process.

Join Our Stakeholder Groups

Shaping the Future of Decentralized Wastewater Education

NOWRA is excited to announce the launch of several new grant-funded projects focused on developing high-impact educational materials. To ensure these resources meet the needs of our industry, we are seeking experts and practitioners to join our stakeholder groups.

Project Overviews:

- **College-Level Curriculum:** A 3-credit course linking system design and regulation to fundamental engineering, soil science, and water quality.
- **Decentralized Glossary 2.0:** An expansion and digital overhaul of the 2009 CIDWT Glossary into a searchable online tool.
- **Monitoring & Troubleshooting:** Advanced training for service providers focused on life-cycle management and field diagnostics.
- **RME Training:** Materials for establishing Responsible Management Entities, featuring real-world case studies and long-term business planning.
- **Regulatory Professional Program:** Skills-based training for officials to improve oversight, public health protection, and technical problem-solving.

Get Involved: Stakeholders will guide the development and refinement of these materials. If you're interested in lending your expertise, [please complete our interest form](#).

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Learning Just Got SIMPLE!

Online Courses to Meet Everyone's Needs

NOWRA's Online Learning Academy makes it easy for you to obtain high quality onsite wastewater training by bringing the classes to you! It's a great option when:

- you are unable to attend in-person training events,
- you want to train new employees quickly,
- you are a few CEUs short for professional license renewal, or
- you need to better understand onsite wastewater fundamentals.

Our suite of courses has been developed by respected industry professionals from academia, engineering, soil science, and contracting. Each course offers a dynamic mix of classroom lectures, external videos and required readings, along with periodic tests of your knowledge. When you pass a course, you get a personalized Certificate of Completion, which can be used as continuing education documentation.

▶ Onsite A to Z

An overview of onsite wastewater treatment provides a foundation of relevant courses for many professionals.

▶ Installer Training

Ideal for new installers, those preparing for a certification exam, or those looking to brush up on skills.

▶ Troubleshooting

Step-by-step component troubleshooting—for designers, installers, regulators, service providers and more!

▶ Design Courses

These courses lay the groundwork for design and are continuously being expanded with new additions.

▶ Technical Sessions

These courses cover a wide variety of topics and were selected for their continued relevancy to the decentralized industry.

FREE BUSINESS AND INDUSTRY COURSES

The NOWRA Online Learning Academy has free online business and regulator courses available for our members and affiliates.

Our newest business course is **The Ultimate Guide to Growing Your Septic Business Using Digital Marketing and AI Tools**. This course shows how to use a variety of free and low-cost tools to create marketing and bring in more business. *(Available to members only.)*

Other classes offered include:

Building and Running a Quality Business discusses how to better run a small onsite wastewater business. *(Available to members only.)*

Insurance Costs and Risk Management was hosted in partnership with Watercolor Insurance Management and shares ways to get the best coverages for your business, focusing on the different kinds of liability management that are most relevant to the onsite industry. *(Available to members only.)*

The Regulator's Role in Onsite/Decentralized Wastewater gives an overview of the regulator's role in the onsite wastewater industry, as well as safety, ongoing education, and other important concepts.

Onsite Wastewater Treatment—What is it and Where Can I Go for Information? is one of two webinars presented in partnership with NEHA, covering onsite wastewater treatment function, the various types of onsite treatment systems, educating homeowners, and where to find additional resources and training.

Sewage Disposal-A Priority Item you May be Overlooking as a Food Inspector is the second webinar presented in partnership with NEHA. It discusses onsite wastewater treatment systems in relation to food codes, which government agencies may be involved in evaluations, how to help facilities solve issues that may occur, and other resources and training which are available.

Sign up today!

www.pathlms.com/NOWRA

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NOWRA Goes Down Under

The *Australian Onsite Wastewater 25* conference recently wrapped up in Adelaide, and the results are in: it was a groundbreaking success! From the high-tech presentations at the National Wine Centre to the scenic site tours in McLaren Valley, a prestigious and internationally recognized wine region, the event proved that the Australian onsite and decentralized wastewater industry is ready for innovation and future growth. This event marked Australia's first conference of its kind in over a decade. NOWRA was well represented with six active US members attending and providing presentations including a keynote by Dr. Sara Heger.

By the Numbers:

- **A Full House:** 225 attendees gathered to discuss the future of decentralized systems with attendees from all Australian states and territories, the United States, New Zealand, Canada, South Africa, and India.
- **Diverse Insights:** 50 speakers shared their expertise across three specialized streams.
- **Practical Learning:** 112 delegates traveled to McLaren Vale on Friday to see onsite systems in action.
- **Networking:** Cocktail party and "Back in Blackwater" gala dinner were held.

Whether it was exploring cutting-edge tech or navigating regulatory challenges, the collaboration seen over these three days has set the stage for real progress. Thank you to everyone who helped make this milestone possible!

The wait for the next Australian conference won't be another ten years. To maintain this momentum, work is



NOWRA Past President Dr. Sara Heger was the keynote speaker at the Australian Onsite Wastewater 25 conference.

occurring to establish a new affiliate organization with plans for the next conference in 2027! Look out for further details as we would love to expand attendance at the next one.

An important outcome from the conference was strong agreement and commitment from attendees to form a new dedicated industry association focused solely on the onsite and decentralized wastewater sector. This organization will be looking to learn from international experience and establish collaborations with related organizations around the globe. If you are interested in being part of this process, you can respond to the current call for engagement [here](#).



NOWRA was well represented at Australian Onsite Wastewater Conference: (L to R) Jerry Tyler, June Wolfe, Joe Rebori, Sara Heger, Carl Thompson, Jim King, and Anish Jantrania

Understanding the Bacteria Responsible for Nitrogen Transformations

By Kevin M. Sherman, Director of Engineering and Regulatory Affairs

SeptiTech, Inc. | 69 Holland St, Lewiston, ME 04240 | ksherman@septitech.com

Abstract

When addressing the chemical transformations of the element nitrogen, it may surprise some that the majority of those transformations occur inside living bacterial cells. Those wishing to better understand the details of the transformations of nitrogen must develop a basic understanding of taxonomy (i.e., the classification system of living organisms), the challenges that bacteria face and how they react to the presence of oxygen in their environment. Diatomic nitrogen gas (N_2) is the most abundant free element in the Earth's atmosphere and makes up about 78% of it. Nitrogen is part of various vital components of organisms, including proteins, amino acids, DNA, RNA and in the energy currency of the cell, adenosine triphosphate (ATP). The chemistry of the nitrogen atom is fascinating and nitrogen containing compounds have a range of properties from inert to explosive. The nitrogen cycle describes the biogeochemical cycle by which nitrogen is converted into multiple chemical forms as it circulates through atmospheric, terrestrial, and aquatic ecosystems. Biological nitrogen reduction is, ironically, unfathomable until one comes to recognize the particular bacteria involved in the processes and the microbial ecology of the nitrogen cycle.

Introduction

The fields of onsite/decentralized wastewater are positioned between

multiple major branches of natural science such as biology, chemistry and physics. Consequently, the theories, methods and approaches of these foundational sciences must be transferred and adopted by the onsite and decentralized wastewater community. I call the fields of onsite and decentralized wastewater crossroad disciplines (Sherman, 2008).

Working in a crossroad discipline is both challenging and rewarding (Jacobs and Spillman, 2005). To be sure, regardless of the practitioner's prior experiences and background, many new ideas and concepts will need to also be mastered.

Individuals with a formal education must be prepared to broaden their expertise. The flower of backgrounds (Sherman, 2015) displays all the subjects that supply useful information to the fields of onsite and decentralized wastewater (dark brown center of the flower). (See Figure 1).

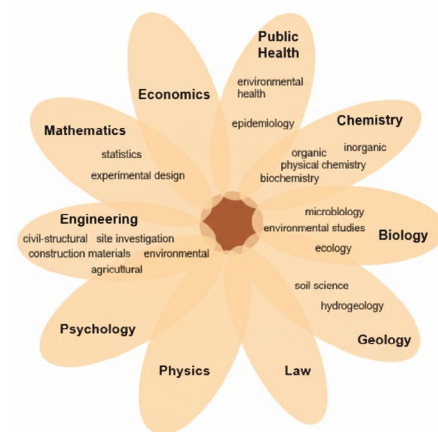


FIGURE 1. Flower of backgrounds (after Sherman, 2015).

A Primer in Biology

Living things are categorized in multiple steps starting with the most inclusive term called Domain. There are three Domains of living things. They are called Archaea, Bacteria, and Eukarya. Each Domain can be split into smaller groups called Kingdoms. A Kingdom can be further subdivided into phyla (singular is phylum). Phyla get further subdivided into classes. Classes can be categorized to their respective orders and further to families. The last two designations of taxonomy are genus and species. When an organism's taxonomy is described, it is summed up in a two-word designation of the particular genus and species. The genus name begins with a capital letter. The species name is in lowercase throughout. Both genus and species are formatted in *italics*.

We will focus on the basic Biology for the one Domain that is the main subject of this paper, namely bacteria. Bacteria can be distinguished from Eukarya by the lack of a nucleus surrounding the genetic material in their cells. The genetic material bacteria use is almost exclusively coded using RNA (ribonucleic acid).

Bacteria have very short lifespans compared to larger organisms. Bacteria divide their cells somewhere between once every 15 minutes to once every 24 hours. So, the average lifespan of a bacterium is around 12 hours or so, before the cell either

continued on next page

Understanding the Bacteria Responsible for Nitrogen Transformations

(continued)

divides asexually into two identical cells or perishes.

A defining criterion of bacteria is how they react to oxygen exposure (Table 1). Bacteria react to the presence of oxygen in their environment either positively, indifferently or negatively (sometimes fatally).

A Primer in Chemistry

This article focuses on the atom nitrogen and its chemistry. The atomic number (number of protons) of nitrogen is 7. The atomic weight of nitrogen (sum of protons and neutrons) is 14.01 (Figure 2). Electrons are deemed to have zero weight. The inner shell of electrons (called K) contains two of nitrogen's 7 electrons. The second shell of electrons (called L) contains 5 of 8 possible spots filled by the remaining electrons (Figure 2). There are five valence (term means outer shell) electrons in the nitrogen atom.

Outer shell electrons predict the chemical reactions nitrogen will make with other atoms. The goal for every element is to have a full electron outer shell such as those of Noble Gasses on the far-right column of the periodic table. Noble gasses share the property of being

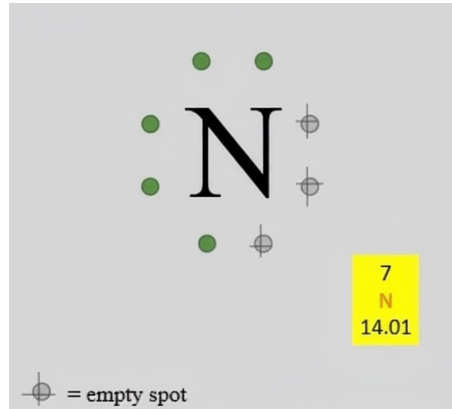


FIGURE 2. Lewis electron dot diagram for the outermost shell of the atom nitrogen (after Tro, 2005),

unreactive with other elements because their outermost electron shells are fully occupied. If nitrogen loses 5 electrons, it would have

the same electron configuration as the Noble gas helium (He in Figure 3). If instead, nitrogen gained three electrons, it would have the electron configuration of the Noble gas neon (Ne in Figure 3).

Nitrogen is found in 7 oxidation states (Oakley, 2005). Oxidation state is a hypothetical charge of an atom in a compound. It shows the total number of electrons which have been removed or added to an element to get to its current state. It indicates the degree of oxidation (loss of electrons) or reduction (gain of electrons) of an atom.

Depending on the other atoms it is combined with, nitrogen compounds could be nonreactive (also called

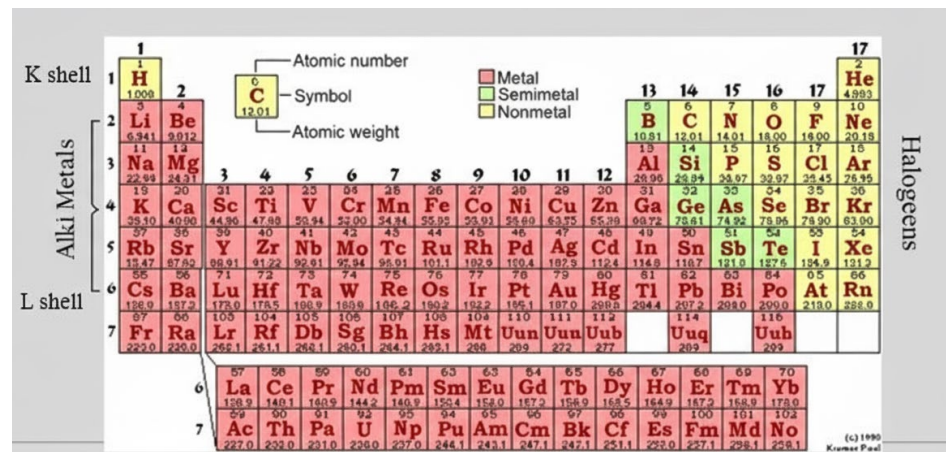


FIGURE 3. Periodic Table of the Elements. (Nitrogen is found on top of column 15; red arrow pointing down.)

TABLE 1. Oxygen classifications for bacteria (after Prakash & Renade, Eds. 2021).

Group name	Definitions	Environment(s) where found	Example species
Obligate (strict) aerobe	Require abundant (22%) oxygen	Animal skin, fast flowing streams	<i>Neisseria meningitidis</i> <i>Bacillus subtilis</i>
Microaerophile	Require a lower oxygen concentration 1-10%	Ruminant animal stomachs (e.g. cow)	<i>Campylobacter jejuni</i>
Aerotolerant anaerobe	Indifferent to oxygen. Not used in metabolism	Drains, marshlands, swamps	<i>Streptococcus spp.</i> <i>Lactobacillus spp.</i>
Facultative aerobe/anaerobe	Have dual metabolic pathways. Can switch between them	Fluctuating aerobic – anoxic – anaerobic conditions	<i>Escherichia coli</i> <i>Staphylococcus aureus</i>
Strict (obligate) anaerobe	Exposure to oxygen causes instant death	Decaying matter, petroleum seeps	<i>Clostridium perringsens</i> <i>Bacteroides spp.</i> <i>Methanobrevibacter smithii</i>

inert). However, other nitrogen containing compounds can be explosive.

When a nitrogen atom is found in an environment where hydrogen is abundant and oxygen is absent, it can take the electrons it needs from three hydrogen atoms and fill Nitrogen's L shell, making the compound ammonia (Figure 4). In an aqueous environment (in water), ammonia will take an additional hydrogen atom, making ammonium (NH_4^+).

When two oxygen atoms take four electrons from nitrogen (two for each oxygen atom), the compound nitrite is formed (Figure 5).

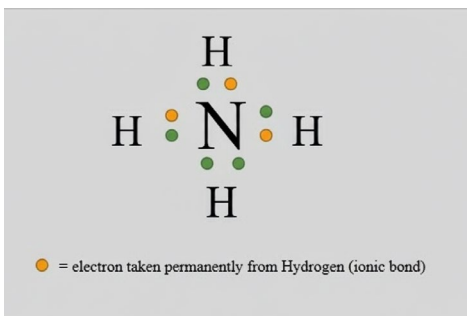


FIGURE 4. Lewis electron dot diagram for the nitrogen-containing compound NH_3 (ammonia) after Tro, 2005.

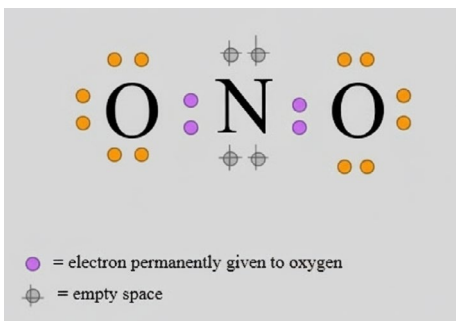


FIGURE 5. Lewis electron dot diagram for the nitrogen-containing compound NO_2^- (nitrite) after Tro, 2005.

Adding an additional oxygen than nitrite has allows the additional oxygen atom to take the one remaining isolated electron in the compound (Figure 6). The negative charge indicates the additional oxygen would

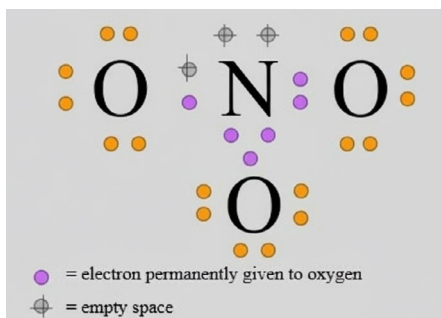


FIGURE 6. Lewis electron dot diagram for the nitrogen-containing compound NO_3^- (nitrate) after Tro, 2005.

like to take another electron, but no more are available in this compound.

The triple bond in Figure 7 represents 6 electrons total. This arrangement creates a covalent bond between the two nitrogen atoms. The six electrons circle one nitrogen atom then the other multiple times in a second. It takes tremendous energy to split a diatomic nitrogen gas molecule. It can happen in nature through lightning strikes and by a variety of specialized bacteria.

In humans, protein fragments are

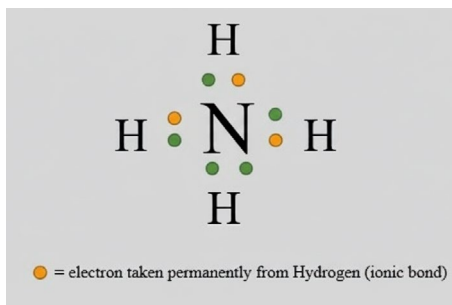


FIGURE 7. Lewis electron dot diagram for the nitrogen compound N_2 (diatomic nitrogen gas) after Tro, 2005.

converted to urea prior to excretion. Reduced forms (meaning oxygen is absent) include ammonia and the positive ion ammonium formed in the presence of water. If oxygen is present, it will take as many of nitrogen's electrons as it needs. Vast reserves of nitrogen are found in the

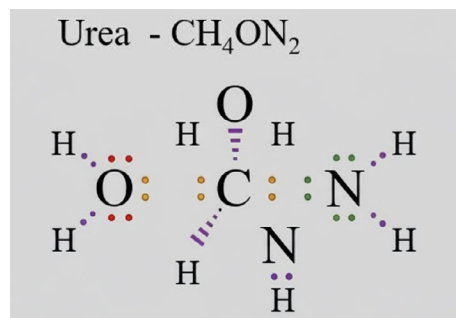


FIGURE 8. Lewis electron dot diagram for the nitrogen, carbon, oxygen and hydrogen compound CH_4ON_2 (urea) after Tro, 2005.

form of diatomic nitrogen gas in the atmosphere.

Nitrogen is removed from the atmosphere and fixed on the ground by three different pathways. The first, shown with the stylized yellow bolt in the upper right hand corner of Figure 9, is lightning (yellow #1 in figure). This pathway is the only one that does not involve catalysis with enzymes inside a living bacterial cell. In the second method of nitrogen fixing (yellow #2 halfway down the figure and to the left), a legume (bean) root nodule contains a receptive environment for certain species of nitrogen fixing bacteria to thrive. In the third path (yellow #3 below yellow #2) other nitrogen fixing bacteria live in soil and create ammonia from nitrogen gas and hydrogen.

We will continue to refer Figure 9, which will lead us in a counter-clockwise rotation as we explore other nitrogen transformations and the bacteria responsible for them.

Human beings have been able to replicate lightning strikes by mounting large electrical capacitors inside unoccupied airport hangers to create man-made lightning. After an explosion, a solid material called

continued on next page

Understanding the Bacteria Responsible for Nitrogen Transformations

(continued)

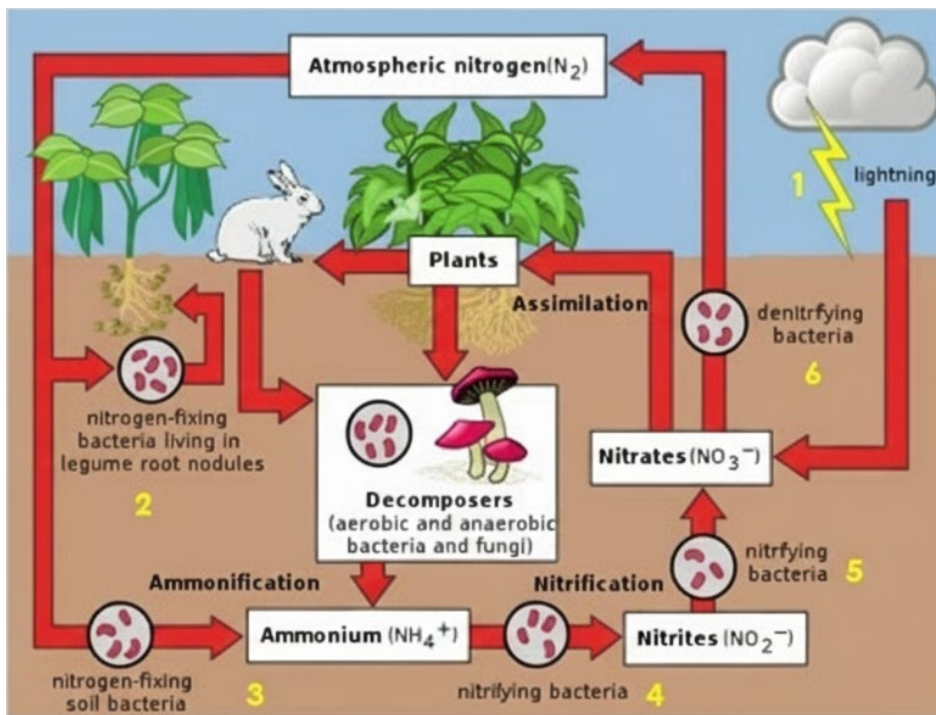


FIGURE 9. Nitrogen Cycle – emphasis on bacteria. (Source: elearning.com)

- Heterotrophic bacteria decomposing organic matter
- Convert Nitrogen gas (N_2) to ammonium (NH_4^+)
- *Azotobacter* spp.
- *Bacillus* spp.
- *Clostridium perfringens* →
- *Klebsiella* spp.
- Form nodules in association with grasses and legumes
- Industrial fertilizer production predicted to exceed natural Nitrogen fixation levels by 2030's



FIGURE 10. Nitrogen Fixing Bacteria. See also Figure 9, yellow 2&3.

ammonium nitrate salt can be swept off the floor and used in agriculture to fertilize food plants that require significant amounts of nitrogen-rich fertilizers for optimal growth, such as corn. The process, called Haber-Bosch in recognition of the two inventors who developed and optimized the process, literally makes nitrogen-fertilizer out of thin air.

Once ammonia is formed by nitrogen fixing bacteria and lightning, it can be oxidized by the single genus of

bacteria *Nitrosomonas* in a unique way (Figure 10).

The genus *Nitrosomonas* begins the ammonia oxidation process. *Nitrosomonas* is an example of a chemoautotrophic bacteria. The word translates to chemically-self-feeding. In other words, *Nitrosomonas* catalyses and facilitates the chemical reaction converting ammonia to nitrite and captures some of the energy released for their sustenance. What kind of environment is

welcoming to *Nitrosomonas*? They do not want to be around organic carbon (they would have to compete with faster growing heterotrophic bacteria for access to the oxygen). Aerobic, dark conditions are needed (they avoid direct sunlight), close to neutral pH and stable. Water temperature at or above 50°F (10°C).

Chemicals have a measurable quantity of energy associated with them (see Table 2) Chemical reactions transforming one compound to another will either require energy expenditure or will release energy. In the case of nitrifying bacteria, bacterially mediated reactions yield energy that the bacteria can capture and use to survive. The amount of energy released can be tracked by using the Gibbs Free Energy for the chemicals in question. A negative Gibbs Free Energy means the reaction will yield energy.

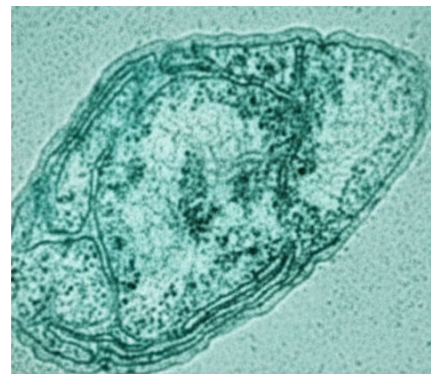
The analogy I use to describe what nitrifying bacteria are doing is think of the helical spring toy slinky perched at the top step of a basement staircase. When the slinky is pointed down the stairs it will convert potential energy (elevation) into kinetic energy (motion) by dropping lower stepwise down the stairs. In the case of nitrifying bacteria, only a fraction of the total energy released

TABLE 2. Gibbs Free Energies for ammonia, nitrite and nitrate and the net energy gained per step (after Oakley, 2005).

Chemical Name	Gibbs Free Energy	Net energy gained (max.)
ammonia	-16.4 kJ/mole	
nitrite	-32.2 kJ/mole	-15.8 kJ/mole
nitrate	-111.3 kJ/mole	-79.1 kJ/mole

- Performed by *Nitrosomonas* spp.
- Uses ammonia as an energy source
- Uses carbon dioxide (CO₂) as a carbon source
- Genus is chemoautotrophic - it gains its sustenance by capturing energy from chemiption cell
- $\text{NH}_3 + 3/2\text{O}_2 \rightarrow \text{NO}_2 + 2\text{H}^+ + \text{H}_2\text{O} + \text{energy}$
- **Converts ammonia to Nitrite**

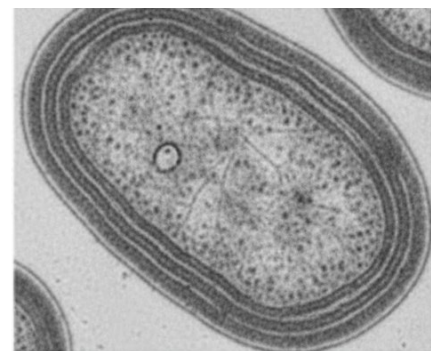
FIGURE 11. Nitrifying bacteria (step one) (after Oakley, 2005).



Nitrosomonas

- Performed by the genera *Nitrobacter*, *Nitrococcus*, *Nitrospina*, *Nitrospira*, *Nitrosospina* and *Nitrosococcus*
- Chemoautotrophic with heterotrophic possible
- $\text{NO}_2^- + 1/2\text{O}_2 \rightarrow \text{NO}_3^- + \text{energy}$
- **Converts Nitrite to Nitrate**
- Obligate (Strict) Aerobe
- Less finicky than *Nitrosomonas*, but success depends on nitrite availability

FIGURE 12. Nitrifying bacteria (step two) (after Oakley, 2005).



Nitrobacter

by the transformation will be captured inside the cell. The payoff for the oxidation of nitrite to nitrate (step two) is five times greater than the first step.

Nitrosomonas is found in the category that needs oxygen available all the time (obligate aerobe in Table 1). This aerobe typically requires temperatures between 20-30°C, pH 6-9 with high alkalinity. The bacterium is instantly killed by organic solvents (such as acetone). In sum, *Nitrosomonas* is a super finicky genus. (See Figure 11.)

Many genera are capable of carrying out the second step of nitrification. In this step, the nitrite initially formed by *Nitrosomonas* is further oxidized to nitrate. Many genera are capable of performing the conversion. In nitrogen reducing wastewater systems, the first step of nitrification process is rate limiting. In other words, if *Nitrosomonas* is not already on the playground, no one else will get to play. (See Figure 12.)

The photos in Figure 13 were taken through a light microscope. The subjects are about 1-2 μm in diameter. For comparison, a human hair is approximately 100 μm thick. Nitrifying bacteria are metabolically complex, but no mouth nor anus are present. Well-developed organelles inside cells are used to catalyze energy-yielding chemical reactions and protect the cells from damage when energy is released.

It is ironic that nitrifying bacteria prefer stable pH because their actions release hydrogen ions, making the water more acidic as populations multiply (Figure 14). The best solution to accommodate *Nitrosomonas*

FIGURE 13. Photos of two genera of nitrifying bacteria through a light microscope. Source: alchetron (2017).

is to have high alkalinity water to begin with so the pH is buffered. An alkalinity of 120 mg/L of calcium carbonate to 300 mg/L of calcium carbonate would be optimal under most circumstances (Oakley, 2005).

More than fifty bacterial genera contain species that operate as denitrifying bacteria (Paul, 2025). They thrive when the water is devoid of dissolved oxygen, but oxygen-containing compounds such as carbon dioxide or nitrate are still present.

continued on next page

- $\text{NH}_3 + 2\text{O}_2 \rightarrow \text{NO}_3^- + \text{H}^+ + \text{H}_2\text{O}$
- Requires Oxygen (4.6 lb/lbN)
- Uses up alkalinity (7.1 lb/lbN)
- Nitrifying bacteria prefer stable, neutral to basic pH with high alkalinity

FIGURE 14. Overall Nitrification Reaction (after Oakley, 2005).

Understanding the Bacteria Responsible for Nitrogen Transformations

(continued)

They use organic carbon, i.e., carbon, hydrogen and oxygen compounds as food sources. Denitrifying bacteria (Figure 15, 16, and 17) release

diatomic nitrogen gas back to the atmosphere, denoted by the \uparrow symbol with curly line below it.

Denitrifying bacteria can obtain energy through two pathways, either aerobic respiration or anaerobic fermentation. I call them double-tank scuba divers of bacteria. Having two different metabolic pathways is costly to the bacteria that have them. The analogy I use is denitrifying bacteria are the switch-hitters of the bacterial world. In a consistently aerobic or anaerobic environment, denitrifying bacteria will be at a competitive disadvantage to obligate aerobic or anaerobic bacteria. The only time they have the upper hand is when conditions flip-flop between aerobic and anaerobic so lots of anoxic conditions exist in between the two poles. In anoxic conditions there is no free oxygen but oxygen containing compounds (carbon dioxide or nitrate) are available and are combined with oxygen.

To describe the process simply, denitrifying bacteria ‘breathe’ the oxygen in nitrate and release diatomic nitrogen gas back to the atmosphere. When this process is fully operative, small bubbles of nitrogen gas will effervesce out of the water surface of the tank. Denitrifying bacteria are adapted to a wide range of environments. They are resistant to many chemical contaminants (Green, S.J. et al., 2012).

Sequential (first nitrify, then denitrify) biological nitrogen reduction is best described as a tale of two cities. Nitrifiers could not be more different from denitrifiers. I used to think my job was technical and lofty. I now realize my job description is I am an interior decorator for bacteria. If you build it just the way both groups want it to be, both will thrive.

- Bacteria, once again, are responsible for the process
- Conditions must be anoxic (no free O_2)
- Nitrate NO_3^- used as the electron acceptor
- More energy released using O_2 , so if it is present, oxygen will be used instead of nitrate
- Organic matter (external carbon source) must be supplied

Various Heterotrophic Bacteria

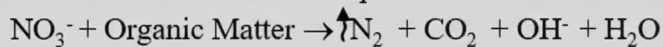


FIGURE 15. Denitrifying bacteria summary (after Oakley, 2005).

- Denitrifying bacteria are facultative aerobes / anaerobes and can shift between wren oxygen respiration and fermenton
- They are outcompeted by obligate anaerobes in a septic tank
- They are outcompeted by obligate aerobes in an aerobic treatment unit
- Denitrifiers only thrive in fluctuating aerobic - anaerobic environments, creating anoxic conditions between the two environments
- carbon source can come from the original wastewater, bacterial cell material, or an external source such as methanol or acetate
- Introduce (or reintroduce) with carbon added
- Sequential Nitrification/Denitrification process

FIGURE 16. Denitrifying bacteria details (after Oakley, 2005).

- | | |
|---|---|
| ◦ Nitrifiers are slow growers | ◦ Denitrifiers are fast growers |
| ◦ They are sensitive to inhibitory compounds | ◦ They are resilient to inhibitory compounds |
| ◦ They desire low organic carbon concentrations | ◦ They require high organic carbon concentrations |
| ◦ They thrive in high dissolved oxygen concentration environments | ◦ They thrive in fluctuating low to absent dissolved oxygen |

Understanding and responding to these different requirements is the greatest challenge to successful onsite and decentralized system nitrogen reduction

FIGURE 17. A comparison of preferences and dislikes of nitrifying and denitrifying bacteria (after Oakley, 2005).

Acknowledgments

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About the Author

Kevin Sherman is director of engineering and regulatory affairs for SeptiTech, Inc. of Lewiston, ME. SeptiTech is a wholly owned subsidiary of BioMicrobics, Inc. In addition to 20 years working in the manufacturing sector, Dr. Sherman has been a state-level regulator, a designer, researcher, instructor and association executive during his career. He was the third president of NOWRA. In 2024, Kevin received the Richard J. Otis Industry Achievement Award.

Kevin has Bachelor’s degrees in Biology and Civil Engineering. Master’s degrees in Biology and Public Health and a Ph.D. in Biological Oceanography. He currently serves as a member of the Technical Practice committee for NOWRA.

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INDUSTRY NEWS

BioMicrobics Announces Launch of the MicroFAST® Flex 0.5 Next Generation Wastewater Treatment Solution for Maximum Installation Flexibility

Lenexa, KS – January 7, 2026. BioMicrobics, Inc, a global leader in decentralized wastewater treatment technologies, today announced the release of its latest innovation: the **MicroFAST Flex 0.5**, the newest extension of its highly successful MicroFAST product line. This next-generation system delivers the same proven wastewater treatment performance the MicroFAST brand is known for, while introducing unmatched installation flexibility to fit virtually any tank configuration. It joins the

The MicroFAST family has set the standard for reliable, easy-to-maintain wastewater treatment in residential and small commercial applications for decades. Building on the strong success of the MicroFAST Flex 0.4 released earlier in 2025, the new Flex 0.5 builds on this legacy by giving installers and engineers greater freedom to design systems without the limitation to tank size or type, making it easier to integrate advanced treatment into both new construction and retrofit projects.

“By combining proven treatment performance with greater installation flexibility, we are giving our partners a powerful new option to meet today’s diverse wastewater challenges,” said Robert Rebori, President of BioMicrobics, Inc.

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The National Precast Concrete Association’s “Precast Show 2026” Draws Record Participation, Showcasing Innovation and Growth Across the Precast Industry

Carmel, IN – February 9, 2026. The National Precast Concrete Association (NPCA) wrapped up The Precast Show (TPS) 2026, the premier trade event for the manufactured concrete products industry, with more than 5,100 attendees from across North America and around the globe. Hosted at the Kansas City Convention Center on February 4–6, the event delivered record-setting engagement for precast innovators, suppliers, emerging talent and industry leaders.

TPS serves as a dynamic hub for business, technology, education and culture in the precast concrete sector. This year’s event featured 368 exhibitors showcasing the latest advancements in precast manufacturing, materials and solutions. Attendees took advantage of nearly 80 hours of educational programming, immersive plant tours, special events and networking opportunities designed to accelerate innovation and business growth.

“This year’s Show wasn’t just big, it was transformative,” said Asher Kazmann, Chair of the Board, NPCA. “From cutting-edge product demos to meaningful workforce conversations and robust education, we’re witnessing the industry evolve in real time. This sets the tone for an increased push the NPCA is making on the benefits of precast concrete across all aspects of modern life in the coming months and years ahead.”

“The innovation on display at The Precast Show reflects an industry that’s moving faster and thinking bigger than ever before,” said Nick Rhoad, President of NPCA. “The conversations, connections and collaboration that happened here will translate directly into stronger companies and a more resilient precast sector.”

Together, these moments underscored the role The Precast Show plays in shaping the future of the precast concrete products industry—bringing together innovation, education and community to move precast forward.

For more information about NPCA and upcoming events, visit www.precast.org.



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