CENTRAL STATES WATER

The Official Magazine of the Central States Water Environment Association, Inc.

MIDWEST STUDENT DESIGN COMPETITON

PLUS:

- The Evolution of Force Main Materials and Technology Shaped Modern Multi-Sensor Inspection
- Committee Spotlight
- The Resource Recovery and Energy (R2E) Committee

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CENTRAL STATES WATER ENVIRONMENT ASSOCIATION MEMBER WEF 1927

Water Environment Federation the water quality people

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DEPARTMENTS

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Advertising Co-ordinator: Stefanie Hagidiakow
Federal tax# 23-7378788

Central States Water, the official magazine of the Central States Water Environment Association, Inc., is published four times per year. Send comments, news items, gloss photographs or digital images to Mohammed Haque, *mhaque@cswea.org*

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Building Tomorrow's Water Workforce

By Timothy Wedin

> "From fourth graders to future engineers, every conversation helps shape tomorrow's water professionals."

As a part of our Strategic Planning, CSWEA identified the Water Workforce as a key initiative for the association to focus on. One part of this initiative is the promotion of careers in the Water Workforce, helping people from various communities and age groups see their path to a rewarding career in the industry.

Recently, I had the pleasure of attending the 2025 AISES National Conference, held in Minneapolis. AISES is, "a national nonprofit organization focused on substantially increasing the representation of Indigenous peoples of North America and the Pacific Islands in science, technology, engineering and math studies and careers." The conference included a job fair, where attendees were able to meet with employers from across North America to learn about careers in the STEM fields. I was excited to have numerous conversations with future Engineers, Operators, Lab Technicians, and other future water professionals about careers in the water workforce.

The Minnesota Section was able to participate in the Metro Children's Water Festival St. Paul again this year. This festival is held annually for 4th grade students in the Minneapolis and St Paul metropolitan area and is held at the Minnesota State Fairgrounds. It is an opportunity for children to learn about water resources, and how they can, "help ensure a future where both the quantity and quality of water resources are protected and managed wisely." Central States members got to work with attendees on various activities related to measuring water quality, the water cycle, collection and treatment of wastewater, the importance of wetlands, and more. This is one of many such festivals that are held, throughout the country, and a great opportunity for CSWEA members to promote careers in the Water Workforce.

CSWEA is also working on other opportunities for members to advance their careers. Attendees at the 2025 Annual Meeting may have seen the Career and Personal Development track. Our Young Professionals put together a high-quality session focused on making connections between Young and Seasoned Professionals, as well as developing Leadership and Productivity skills. These sessions were well received by attendees, and our YPs are working on further developing them for the next Annual Meeting, including a YP Summit.

Developing the Water Workforce can look like many things. You might focus on training individuals to become leaders in the industry. You might focus on volunteering with your State Section to teach students of various grade levels about the water cycle and how they can be a part of providing clean water for future generations. However you participate, I hope that you will continue to help us promote careers in the Water Workforce. CS

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From Goals to Action:
WEF Delegates Advance Water Leadership

By Anna Munson and Autumn Fisher

Anna Munson

Autumn Fisher

The WEF House of Delegates (HOD) business year begins at WEFTEC. Delegates arrive at the conference city early, with meetings and activities that begin on Saturday morning and extend into Sunday before WEFTEC officially begins. We use this time to reflect on the previous year's accomplishments and challenges, to connect with other delegates in person, transfer knowledge from professionals who are exiting the delegate roll, and to welcome new delegates into the HOD. This year, we welcomed Autumn Fisher as a new CSWEA Delegate while Liz Heise rolled off the HOD. Anna will continue to serve as the other CSWEA delegate for one more year.

During our pre-WEFTEC meetings, the HOD celebrated accomplishing several of its goals, which were developed by the HOD Speaker of the House and the selected workgroup chairs. Each year, the goals are set to help the HOD move toward accomplishing WEF's mission of *inspiring the water community in pursuit of human and environmental well-being*. HOD Workgroups and Committees are formed to complete the work. Highlights of the work accomplished by the work groups and HOD committees since conclusion of the previous WEFTEC include:

- Improved delegate-at-large engagement and brought the diverse group together regularly to amplify their impact.
- Supported WEF member associations (MAs) as they adjusted their approach to improving or maintaining equity and inclusion
- Refreshed the new Delegate welcome materials.
- Hosted three in-person and one virtual WEFMAX event to promote cross-MA collaboration and learning.
- Awarded grants to MAs to support activities that benefit their community or MA.

WEF HOD Welcomes Autumn Fisher

Autumn has been an active member of CSWEA and WEF since 2010 and brings 18 years of experience operating and optimizing wastewater treatment processes. She is a licensed Advanced Wastewater Operator in Wisconsin and currently works as a Client Services Manager and Operations Specialist at Donohue & Associates, Inc.

Autumn is passionate about strengthening the water profession through collaboration and engagement. She has presented at the CSWEA Annual Conference, WEFTEC, and the WEF Nutrient Removal and Recovery Symposium, and is a proud member of the Select Society of Sanitary Sludge Shovelers (7S). Within CSWEA, she serves in multiple leadership roles, including Wisconsin Section Membership Committee Chair, Education Seminar Committee Immediate Past Chair, and past Local Arrangements Committee Silent Auction Chair.

Autumn holds a B.S. in Chemistry from the University of Wisconsin–Oshkosh and a M.S. in Project Management from the University of Wisconsin–Platteville. She looks forward to representing CSWEA at WEF and elevating member voices and achievements.

> "The House of Delegates is where collaboration becomes momentum – and momentum becomes impact."

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- Produced six Water Advocacy letters that can be used by Water Advocates to communicate to their political representatives the importance of clean water.

New work groups were formed to maintain forward momentum to continuously improve the service of the HOD to the MAs and WEF. The 2025/2026 workgroups are:

- Developing Strategies for using Artificial Intelligence (AI) for Water – will assist WEF in education and outreach to promote sustainable water use for AI infrastructure while encouraging water utilities to remain open to deploying AI tools to enhance utility performance and resilience. Autumn will serve as a member of this workgroup.
- International MA Development – workgroup will collaborate with the WEF Board of Trustees and WEF Staff to support development of international MAs and improve incorporation of the international MAs into WEF activities.
- HOD, MA, and Community Leadership Council (CLC) Advocacy and Engagement – tasked with improving communication and collaboration between the Delegates, the leaders of the technical communities (CLC), and MA Committee Leaders to ultimately connect the MAs to the extensive knowledge and resources available through WEF.
- MA to MA Engagement – workgroup will build simple platforms to promote coordination and communication between MAs to supplement the engagement currently available through WEFMAX, monthly MA spotlights, and the YP Summit. Anna will serve as a member of this workgroup.

Looking ahead to 2026, there are several WEF conferences that promise to deliver learning and networking opportunities in venues across the US and Canada.

The WEF/AWWA Utility Management Conference (UMC) will take place in Charlotte, North Carolina, from March 24 – 27, 2026. This conference brings together utility leaders in both the water and wastewater sectors.

The WEF/AWWA Young Professionals Summit will be held in Charlotte for the two days preceding the UMC, March 22 – 24, 2026. This Summit is well-attended each year and offers new professionals skill development and leadership training alongside their industry peers.

From May 10 – 14, 2026, WEF will host the Residuals and Biosolids and Innovations in Treatment Technology (RB/ITT) Conference in Kansas City, Missouri.

Finally, the WEFMAX locations and some preliminary dates have been announced. In 2026, Montréal, Canada, will host a WEFMAX in April; a WEFMAX will be held in May somewhere exciting in the Pacific Northwest; Pittsburgh, Pennsylvania will host the third WEFMAX, and a virtual WEFMAX will be offered in the summer. CS

"This year's accomplishments show what's possible when the entire water community pulls in the same direction."

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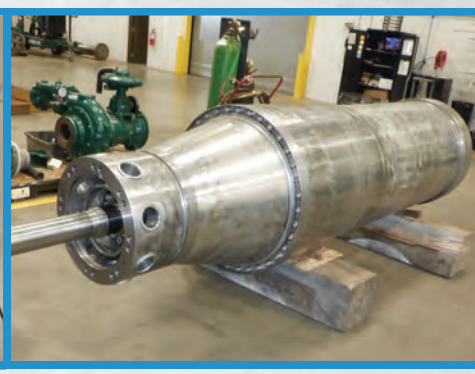

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BUSY! Fortunate and Grateful.

By Tom Romza

Every time I am at a CSWEA event or meeting with a client, the opening line that I receive is always "Hey, how's it going!?" And more frequently than not, before I can get my words out the asker says, "Busy I'm sure!" We laugh and continue the conversation about all the cool things we are working on, or the fun things are families are getting into, etc.

I want to emphasize that this response is not a negative one. Busy is fun. Busy is rewarding. Busy is where we should all want to be in our careers.

As we continue working in the water and wastewater industry, I find myself reflecting on how fortunate I am to do this work. In a world that seems to be changing faster than ever, whether it is economically, technologically, socially, or any other "-ally" you can think of, our mission remains constant and steady. It's easy to take that for granted, but clean water is not a given.

Clean water, whether incoming or outgoing, is one of the most, if not THE most, essential foundations of modern civilization. The mission to protect the environment and the health of our communities is never finished. The planning, labor, and innovation are continuous as we battle aging infrastructure and budgets that never seem to not go far enough. And this is why we are indispensable and I am grateful to be in the industry that we are.

We get to help people and the environment because of our gained experience and common goals. While the world talks about automation and AI reshaping industries, our work will remain. Technology will help us, but it cannot substitute the expertise, judgement, and commitment that is required in our work. That is something to be proud of.

Looking ahead, we continue to support each other, share knowledge, and push for innovation as the challenges will keep coming. Along with the opportunities to make a difference. In short, we in the water industry are going to be BUSY. For a while. And that's good.

If you are looking for ways to be even busier and would like to connect and contribute, join us at the upcoming Illinois Section events and consider joining a committee. You can find the details on the CSWEA website. Make sure to subscribe to our email list as well.

Alright, I've got to get back to work... CS

"Automation and AI can help us, but they can't replace the expertise and commitment our industry requires."

Building Momentum in 2026: Wisconsin Section Celebrates Community and Growth

By Lindsey Busch

As winter settles over Wisconsin, I am reminded of how vital our community is to the success of the Wisconsin Section. Despite the cold, the passion and dedication of our members continue to shine brightly – especially through the tireless efforts of our volunteers.

Every committee meeting, event, student outreach effort, and technical session happens because individuals like you choose to give your time and expertise for the greater good of our profession and our environment. Whether you serve on a committee, plan a conference, present a paper, mentor a student, or help coordinate a local event – **you** make our work possible. Your volunteer spirit is the backbone of CSWEA, and I want to extend my deepest gratitude to each of you for your contributions.

We currently have several open spots on our committees, and we are always looking for new volunteers to get involved. If you are interested or have questions about where you might fit in, please reach out to our Membership Committee Chair, **Autumn Fisher** (*afisher@donohue-associates.com*). There is a place for everyone – whether you are new to CSWEA or looking to take on a larger role.

This season also offers us a moment to reflect on the collective impact we have achieved together. I enjoyed seeing many of you at the CSWEA WEFTEC event – a conference where we advanced research on emerging contaminants, supported operator training, and promoted public awareness. The Wisconsin Section continues to thrive because of your commitment. We also had a great turnout for our November Board Meeting, followed by a lively happy hour, and I'm pleased to share that our section remains financially strong. Everyone is welcome at our quarterly section meetings – the more, the merrier! The collaboration and camaraderie within our organization are what make our section truly exceptional.

Looking ahead, we have a number of exciting events in 2026, starting with the **Government Affairs Seminar** on **February 19** in **Fond du Lac**, followed by the **Operations Seminar** on **February 26** in **Stevens Point**, and the **Spring Biosolids Symposium** on **March 17**, also in **Stevens Point**. Once again, our dedicated volunteers have put tremendous effort into organizing these events, and I hope to see you there!

As we move through these winter months, thank you once again for the energy, expertise, and heart you bring to CSWEA. Your work ensures that Wisconsin's water environment remains clean, resilient, and sustainable for generations to come.

Wishing you a warm, safe, and rejuvenating winter season.

Lindsey Busch
Chair, Wisconsin Section of CSWEA CS

"The work we do together today protects Wisconsin's water for generations to come."

Strengthening the Municipal Voice: Why Greater Involvement Matters

By Shanna Czeck

The New Year is more than just ordering a new planner (which is a high priority for me this time of year!) - it's a psychological reset. January gives us an opportunity to reflect on the past year and set intentional goals which help improve focus and motivation throughout the year ahead. I like to start by reflecting on the current year to identify accomplishments and areas for improvement.

Reflecting on CSWEA, the MN Section has been working hard to fill all committee roles and getting new members connected with resources to help them be successful, plan for multiple conferences, and update the Section bylaws, all of which help the Section and the association as a whole. Sitting in a recent Section meeting, I saw an area of improvement to increase municipal engagement. Expanding the participation of municipal staff – operators, superintendents, engineers, and public works professionals – is vital to the association's future.

Municipal professionals are on the front lines of water and wastewater management; operating treatment facilities, maintaining collection systems, ensuring regulatory compliance and providing a vital, but thankless public service all day, every day. Their firsthand knowledge of what works (and what doesn't) in the field provides invaluable insight into the realities behind policies, technologies, and regulations. When municipal employees engage with CSWEA, they not only gain access to professional development and technical expertise – they help shape the conversations and initiatives that guide the entire sector.

Increased municipal participation enhances CSWEA's ability to advocate for realistic and effective solutions. Whether influencing state-level regulations, guiding workforce development programs, or supporting innovation in sustainable infrastructure, the municipal perspective ensures that decisions reflect practical, real-world challenges. By increasing municipal participation, the association ensures that the people most directly responsible for protecting public health and the environment have a voice.

CSWEA offers diverse opportunities that provide direct benefits to municipalities and their employees. Membership opens doors to training, certification opportunities, and networking with peers who face similar challenges. It allows small and mid-sized utilities to learn from the experiences of others, share best practices, and access new technologies or funding strategies. For younger staff members, participation in CSWEA committees and events provides mentorship, career growth, and a sense of pride in the essential public service they provide. Municipal leadership plays a key role by encouraging staff to attend section meetings, submit papers, or volunteer for committees.

The challenges facing our water sector – from aging infrastructure to emerging contaminants – demand collaboration and shared leadership. When all voices are heard, CSWEA maintains a united community working together for clean water, resilient systems, and a sustainable future. The New Year is an excellent time for municipalities to get more involved with CSWEA. As I consider goals for 2026 and decide the direction I want to take, one of them will certainly be to encourage municipal colleagues to get involved with the Section. I encourage members to do the same – set the goal and follow it up with purposeful action. CS

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Quentin Hahn

Assistant Project Manager, Burns & McDonnell, Minneapolis, MN

Quentin Hahn represents a new generation of leaders shaping the future of water and wastewater. Raised in northeast Kansas, he earned his bachelor's degree in chemical engineering from Kansas State University in 2017, which included an early internship that ignited a passion for environmental stewardship. The internship involved supporting a local municipal client, where he witnessed how unseen infrastructure is vital to public health, a realization that turned a broad interest in engineering into a drive to strengthen communities through resilient water and wastewater systems.

After graduation, Quentin joined Burns & McDonnell's Kansas City headquarters as an engineer, beginning his career working on stormwater modeling, collection system design, and asset management. Over time, his work gravitated toward industrial pretreatment with a touch of municipal treatment projects, building a strong foundation in wastewater process design. The range of experience from those early years continues to shape his perspectives today, equipping him to navigate the variety of complexities in modern wastewater treatment plant projects and be promoted to his current role as Assistant Project Manager.

In 2019, Quentin relocated to Minnesota to join his fiancée (now wife) while continuing his career with Burns & McDonnell. Soon after, he earned his professional engineering license and became an active presence in the state's wastewater community through the Minnesota Section of CSWEA. Seeking connection in a new professional community, he began attending Section events and soon took on leadership roles within the Young Professionals Committee. His initiative and reliability led to continued advancement within the Association, where he now serves as Vice Chair of the Minnesota Section and Chair of the Local Arrangements Committee, which is responsible for the planning and programming for the 2026 Annual Meeting in Minneapolis-St. Paul.

Through his opportunities and advancement within CSWEA, Quentin has become a strong advocate for creating clear, approachable pathways for emerging professionals wanting to get involved. He believes that accessibility and mentorship are key to sustaining the next generation of talent in the water/wastewater sector and concluded that volunteer organizations, such as CSWEA, thrive when members are supported in addressing the roles and challenges that make involvement fulfilling.

In 2021, Quentin took on one of the defining experiences of his career, serving as the on-site resident engineer for a manufacturing facility constructed at the height of the COVID-19 pandemic. Working side by side with contractors and facility staff, he gained a deep appreciation for the craftsmanship, adaptability, and teamwork that bring engineering plans to life. The experience gave him a holistic view of project delivery, from design through construction, sharpening his ability to assess if future designs were both constructable and aligned with operational, environmental, and community goals.

That firsthand familiarity with construction also informed a learned perspective on how projects are delivered across the wastewater industry. He has observed a growing trend and shift toward design-build approaches among both public and private clients. To him, this evolution presents both challenges and opportunities, inviting consultants to expand their role and foster deeper collaboration across every stage of project delivery.

Outside of work, Quentin's interests reveal the same blend of creativity and analysis that drives his professional life. He views video games as a modern art form that combines design and storytelling in unique ways. He also enjoys cooking, fitness, and travel, especially to Japan, a country he and his wife have visited multiple times and whose culture and craftsmanship continue to inspire him.

Quentin's career reflects a belief that infrastructure is not only about systems and structures, but also about the people who design, build, and sustain them. As he helps lead CSWEA into its next chapter, his experience and attitude exemplify the forward-thinking spirit that will continue to drive meaningful involvement and engagement across the water and wastewater profession. Please say hello to Quentin the next time you see him! CS

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CSWEA COMMITTEE SPOTLIGHT:

The Resource Recovery and Energy (R2E) Committee

By Matt Magruder WI R2E Chair and David Quast MN R2E Chair

ABOUT R2E

The CSWEA's Resource Recovery and Energy Committees (R2E) were formed with the mission: To award leaders in the wastewater resource recovery sector who have adopted innovative best practices in energy, biosolids, resource recovery, and emissions mitigation, and to foster communication and information exchanges that advance our sector.

To help execute this mission, the Illinois, Minnesota, and Wisconsin R2E committees convene monthly, offering their members a valuable opportunity to network, share information, and receive feedback on challenges, successes, and opportunities aligned with the committee's objectives. During calls, our members also discuss how we can support the CSWEA organization more broadly and bring meaningful R2E content to the member community, such as supporting the Technical Program Committee with developing the R2E track at the CSWEA Annual Meeting, and how to capture nominations for our annual awards.

Speaking of awards, one of the best parts of serving on an R2E committee is recognizing those who have implemented projects or processes that demonstrate a commitment to R2E. This year, the Wisconsin and Minnesota R2E committees each recognized a utility leader driving our humble sector to a more resilient and sustainable future (See spotlight below).

AWARD HIGHLIGHTS

The Wisconsin R2E Committee awarded the Fond du Lac Regional Wastewater Treatment and Resource Recovery Facility the 2024 Renewable Energy, Energy Efficiency, and Resource Recovery (3R3E) award for the implementation of the Xylem CASPERON simultaneous nitrification and denitrification process. The project has a simple payback of two years and saves over $82K in annual chemical costs and over $71K in energy costs, while improving effluent quality.

The 2024 Wisconsin R3E3 Award was presented to Andrew Forsythe (Left) and Alex Krause (Center) of the Fond du Lac Regional Wastewater Treatment and Resource Recovery Facility by WI R2E Committee Member Matt Seib (Right) during the Operational Seminar held in Stevens Point, WI in February 2025.

(From left to right) Kelsey Hogan, Alexa Chelsey, Lee Pinkerton (receiving the MN R2E Award on February 4, 2025 at the CSWEA Innovative Conference for their work at Eagles Point WRRF.) from Brendan Wolohan and Dave Quast on the R2E committee. George Sprouse, and Colton Janes of MCES also were recipients of the award

The Minnesota R2E Committee presented its annual R2E Award to Eagles Point WRRF, where they achieved significant energy savings by implementing lower dissolved oxygen (DO) setpoints in aeration control within the secondary treatment tanks.

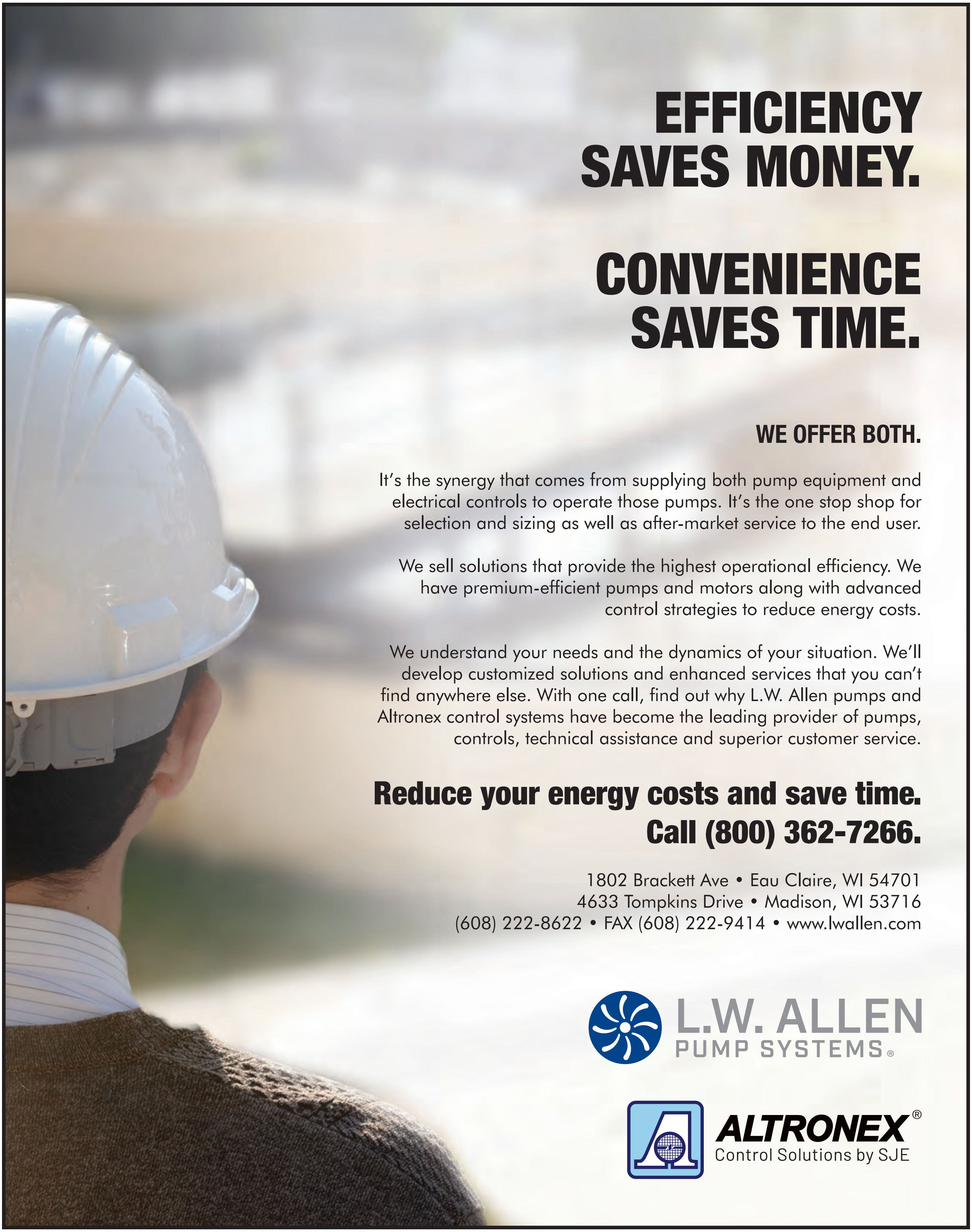
This full-scale project demonstrated improvements in nutrient performance, sludge settleability, dewatering efficiency, and polymer demand. It also incorporated advanced qPCR microbial analysis to monitor ammonia- and phosphorus-removing microbes, offering insights into microbial community shifts under low DO conditions.

Lee Pinkerton (pictured below in the center) further shared the team's findings at the RBITT Conference in Baltimore on May 7, 2025, where the presentation was well attended and received.

Getting Involved

All three state R2E committees are actively seeking new members, and if you are interested, we would love to meet with you to share more about what we do. Additionally, we are always looking for nominations for our annual awards. Please consider recognizing your organization, a partner organization, or a peer that is serving as an R2E trailblazer.

To get involved with your state's R2E committee, please visit *https://cswea.org/about-us/get-involved/* and add a comment to be connected with your state's R2E committee. CS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PREVIEW

Flowing Together: Connecting the Water Workforce

CAREER NETWORKING OPPORTUNITIES

Please help keep our water sector strong. We will have opportunities for job seekers and employers to connect throughout the conference. Building a strong water workforce is something important today and in the future. All who are interested in meeting new candidates, looking for career growth, or learning about opportunities should participate. Exhibitors may participate by encouraging attendees with career growth questions to seek your input while at your exhibit booth. Your booth will be marked with a balloon. Just indicate your commitment on the registration form. **Participate in this opportunity to inspire, engage, and recruit the next generation of water professionals.**

TECHNICAL PROGRAM

The CSWEA Annual Meeting technical program is the best in the Midwest and attracts many engineers, utility managers, plant superintendents, academics, and students. We feature over 60 presentations on the following topics: Collection Systems, Digestion, Energy Production, Recovery and Efficiency, Ethics, Industrial/Pretreatment, Information Technology, Leadership/Soft Skills, Nutrients, Operations & Maintenance, Research & Design, Residuals, Solids and Biosolids, Resource Recovery, Stormwater, Utility Management, Water Reuse, Watersheds, and Stormwater Management.

CONNECT WITH WATER PROFESSIONALS

CSWEA's Annual Meeting has some of the best attendance of a regional conference focused on professionals in the water quality field due to our high quality programming; our attendance numbers continue to increase over the years.

YP SUMMIT

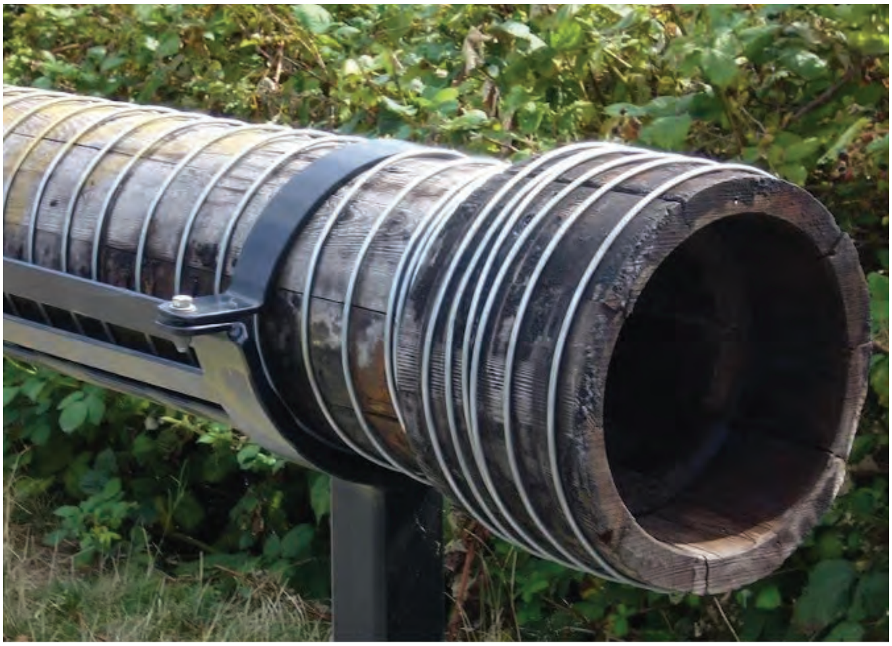
The Young Professional (YP) Summit serves to bring young professionals and students from across CSWEA together to learn from each other, develop their technical and professional skills, and grow into future leaders and stewards of the water/wastewater industry and environment. The YP Summit will kick off the Annual Meeting on Tuesday morning starting with presentations and collaborative activities led by fellow YPs with topics ranging from design tips, treatment troubleshooting, mentorship round-tables with seasoned professionals (SPs), successful habit forming, and the future of water/wastewater treatment. Breakfast and lunch will be provided to attendees. CS

ANNUAL CONFERENCE REGISTRATIONS (IN-PERSON)

2025 - Madison, WI	573	2017 - St. Paul, MN	499
2024 - Schaumburg, IL	557	2016 - Madison, WI	480
2023 - St. Paul, MN	521	2015 - Oakbrook, IL	567
2022 - Madison, WI	441	2014 - St. Paul, MN	428
2019 - Madison, WI	480	2013 - Madison, WI	384
2018 - Oakbrook, IL	477	2012 - St. Charles, IL	316

THE EVOLUTION OF FORCE MAIN MATERIALS AND TECHNOLOGY SHAPED MODERN MULTI-SENSOR INSPECTION

By Steve Burks, General Manager, CPM Pipelines



A Century of Change Beneath Our Feet

When the first sewer force main was installed in Madison, Wisconsin around 1914, few could imagine the complex infrastructure network that would grow beneath our cities. Over the past 110 years, the evolution of force main materials – from cast iron to ductile iron, PCCP, PVC, HDPE, and composite systems – has dictated not only how we move wastewater, but how we inspect, maintain, and rehabilitate it.

Today, condition assessment of pressure pipes has become a discipline of its own, driven by high-resolution, multi-sensor technologies that can 'see' what was once invisible.

Understanding this technological shift begins with looking back at how materials evolved – and how those choices set the stage for modern asset management.

The Early Years: Cast Iron, Steel, and the Birth of Pressure Sewers

From 1910 through 1940, U.S. cities were racing to accommodate rapid urban growth. Welded and riveted steel dominated high-pressure applications, while **cast iron** became the backbone of early sewer force mains. These systems were built for strength, not serviceability. Inspection largely consisted of reactive maintenance; failures were addressed only after catastrophic breaks occurred.

The introduction of reinforced concrete cylinder pipe (RCCP) in the 1920s began shifting thinking toward standardization, but corrosion resistance and joint integrity remained poorly understood. The absence of consistent design and inspection standards meant that operators often had little knowledge of actual pipe conditions – an issue that still challenges utilities today.

The Post-War Boom: Durability and Standardization

The 1940s through 1960s ushered in an infrastructure explosion. Asbestos cement offered a lightweight, low-cost option for smaller diameters, while prestressed concrete cylinder pipe (PCCP) emerged as a high-pressure workhorse for larger mains. In 1948, **ductile iron** was introduced, and by the 1950s, it rapidly displaced cast iron thanks to its flexibility and strength.

The publication of AWWA C104/A21.4 (1953) for cement-mortar linings formalized many of the manufacturing and corrosion-resistance practices that continue to guide specifications today. While initially designed for water applications, many of these standards migrated into the wastewater world, establishing the foundation for uniformity.

Environmental Regulation and Material Diversification

The 1970s brought new priorities. The Clean Water Act (1972) triggered unprecedented investment in wastewater systems, while simultaneously demanding better performance and environmental compliance. AWWA C900 (1975) standardized PVC pressure pipe, and AWWA C906 (1990) later did the same for HDPE.

By the 1980s, PVC and HDPE had become common where flexibility, corrosion

> "The evolution of force main materials has dictated not only how we move wastewater – but how we inspect, maintain, and rehabilitate it."

resistance, and cost were key factors. However, these plastic systems introduced new challenges: joint gap variability, ovality, and deformation – all difficult to detect with conventional inspection tools.

The Wake-Up Call: Failures and the Rise of Condition Assessment

Between 2000 and 2005, the industry faced a wave of high-profile force main failures. Many systems had exceeded their design life, and the lack of redundancy made every break a crisis. Few utilities maintained accurate as-builts or GIS data, and virtually no formal inspection standards existed for pressure sewer mains.

This era gave rise to risk-based asset management, where utilities began prioritizing assessments using the 'likelihood of failure × consequence of failure' (LoF × CoF) approach. The idea was simple: not every mile of pipe needs immediate replacement – only the most critical ones do. But assessing that risk required better data, and that meant new tools.

When CCTV Was the Only Option

In the early years of force main condition assessment, CCTV inspection was often the only tool available. These early projects relied heavily on what was accessible, and in many cases, utilities were doing the best they could with what they had. Running a camera through a depressurized or bypassed force main provided a visual record and, for its time, represented progress.

That early work set a precedent in the industry – it introduced the mindset that inspection and documentation were essential parts of managing buried assets. However, given what we now know about pressure pipe failure mechanisms – internal and external corrosion, wall thinning, joint separation, and structural deformation – CCTV provides little actionable condition data.

Today, using a camera in a pressurized line is more of a checkbox exercise than a diagnostic one. True condition assessment demands multi-sensor tools capable of detecting wall loss through ultrasonics, identifying corrosion and anomalies magnetically, and locating leaks or gas pockets acoustically. These technologies don't just provide imagery – they deliver measurable data that utilities can act on.

From Oil and Gas to Water and Wastewater: The First Smart Tools

The mid-2000s marked the crossover of non-destructive testing (NDT) from the oil & gas industry into municipal pipelines. Magnetic Flux Leakage (MFL) and Remote Field Eddy Current (RFEC) technologies began detecting corrosion and wall loss in metallic pipes. Simultaneously, free-swimming acoustic tools emerged to locate leaks and gas pockets in live lines – no shutdown required.

> "Condition assessment of pressure pipes has become a discipline of its own, driven by technologies that can now see what was once invisible."

> "For decades, operators had little knowledge of actual pipe condition, a legacy challenge utilities are still confronting today."

These innovations, while groundbreaking, were limited by coverage and resolution. Utilities could identify anomalies but not precisely locate or characterize them. The next decade would change that.

2010s: Multi-Sensor Intelligence Becomes Reality

Driven by EPA and Water Environment Research Foundation (WERF) studies, utilities started including force mains in comprehensive asset-management programs. Robotic crawlers capable of ultrasonic thickness (UT) and MFL testing, combined with 3D inertial mapping, began generating detailed, quantifiable data sets.

Tools like INGU Pipers® and Aquarius® foam pigs epitomize this new generation. Using acoustic, magnetic, pressure, and inertial sensors simultaneously, they provide high-resolution profiles of pipe condition under normal operating conditions. Each run can identify leaks, gas pockets, wall loss, debris, joint displacement, and diameter reduction – all in a single deployment. The data integration with GIS and digital twins enables visualization of every anomaly by exact station and depth. What once required excavation, or shutdowns can now be analyzed on an interactive dashboard within hours of retrieval.

The Economics of Insight

The financial argument is equally compelling. In one case, inspecting 9,800 feet of 20-inch ductile iron using a multi-sensor approach cost roughly $350,000 – compared to an estimated $40 million for full replacement. That is less than 1% of replacement cost. The result: utilities can make informed rehabilitation decisions, targeting only the segments that truly need it.

This 'inspect before you invest' mindset has become central to modern infrastructure strategy. As funding from the 2021 Infrastructure Investment and Jobs Act accelerates projects nationwide, cities are shifting from 'replace by default' to 'assess, rehab,monitor.'

Challenges That Remain

Despite these advances, challenges persist. Pressure mains are inherently harder to inspect than gravity lines – there is limited redundancy, complex geometry, and greater risk in taking systems offline. The industry still struggles with

> "Every advance in material science has led us closer to seeing inside pressurized sewers with unprecedented accuracy."

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> "The story beneath our streets is no longer just about pipes – it's about data, insight, and foresight."

incomplete as-builts, inconsistent GIS records, and justifying costs for assets that are largely invisible to the public.

However, regulatory pressure and the increasing use of AI-assisted data analysis are changing that narrative. Utilities now recognize that knowing a pipe's true condition is not a luxury – it is an operational necessity.

Where We Are Headed

The next frontier of force main management is about integration and foresight. Multi-sensor tools are converging with machine-learning algorithms, enabling predictive analytics that can estimate remaining service life. Fiber-optic strain monitoring and phased-array UT promise real-time condition tracking.

In short, the invisible network beneath our cities is becoming a living, digital asset – one that can be managed proactively rather than reactively.

Conclusion: Built Under Pressure, Moving Toward Clarity

The evolution of force main materials over the past century has been a story of adaptation – each generation building on lessons of failure and innovation. From the early cast-iron pioneers to today's AI-enabled inspection platforms, every advance in material science has shaped the technologies that now let us "see" inside pressurized sewers with unprecedented clarity.

As infrastructure funding, regulation, and technology continue to align, one truth stands firm: the future of force main management isn't just about replacement – it's about understanding what's already there. CS


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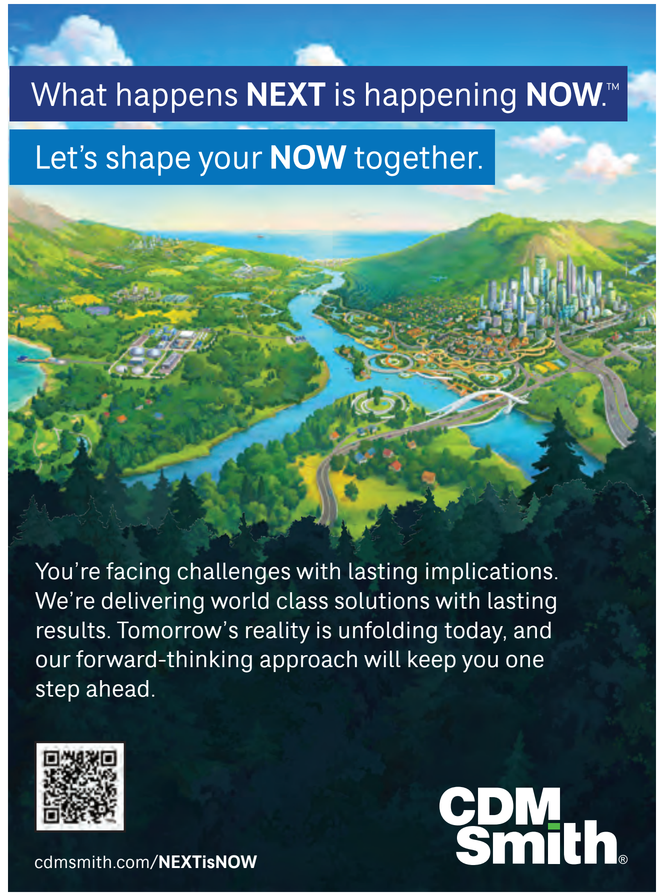
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COLDWATER CREEK RESTORATION: A DUAL-PROCESS FOR URANIUM SEQUESTRATION

Grace Duong, Lindsey Feeley, Naomika Raveendran, Alexa Wienhoff

CSWEA STUDENT DESIGN COMPETITION

On April 22, 2025, four students from the Energy, Environmental, and Chemical Engineering department at Washington University in St. Louis won first place in the Water Environment category at the CSWEA Student Design Competition, in Madison, Wisconsin. The competition challenged students to address issues affecting the water environment.

Washington University's Water Environment team focused on a problem close to home: uranium contamination in Coldwater Creek, located in North County, St. Louis, Missouri. The winning team included Grace Duong, a first-year Ph.D. student; Lindsey Feeley, a graduating M.Eng. student; Naomika Raveendran, a first-year B.S. student; and Alexa Wienhoff, a second-year B.S. student. The team was advised by Professor Zhen (Jason) He and supported by funding from the Central States Water Environment Association (CSWEA) and the Center for Water Innovation (CWI) at Washington University. Together, the team developed a solution to mitigate pollution from decades of radioactive waste exposure. Their project addressed not only uranium contamination but also the need for environmental justice, aiming to support the affected communities.

URANIUM IN COLDWATER CREEK

From 1942 to 1973, approximately 133,000 tons of leftover nuclear waste from the Manhattan Project was dumped and left exposed at sites in North St. Louis County, Missouri[1]. The source of this waste was the Mallinckrodt Chemical Company, which had processed uranium (U) for the development of nuclear weapons during World War II[2].

Decades of rainfall and flooding eroded and mobilized the radioactive waste, washing soluble contaminants into Coldwater Creek[2] Recent testing and resident health surveys confirm that uranium contamination remains an issue for the Coldwater Creek floodplain[1].

Figure 1: Grace Duong (top left), Lindsey Feeley (top right), Naomika Raveendran (bottom left), Alexa Wienhoff (bottom right)

Although U concentrations in soil and sediment declined between 1970 and 2014, surface water in the creek still averages 5 μg/L, with peaks reaching 10 μg/L[3,4]. This ongoing presence indicates that uranium is still leaching from contaminated soils into the creek. While the St. Louis Airport site underwent remediation in 2009, the other sites remain unaddressed[1].

The long-term exposure to radioactive pollutants like uranium has had severe effect on nearby communities, contributing to negative health effects, and socioeconomic burdens[5].

HEALTH IMPACTS OF URANIUM IN COLDWATER CREEK

The health effects of uranium contamination are pronounced in the Coldwater Creek Floodplain[1] region surrounding Coldwater Creek. Cancer 2014-2015 Change According to a survey of over 4,500 Type Cases Cases 2014-2015 community members in 2015, there Autoimmune 320 448 +128 were 2,725 cases of self-reported illness, with 1,993 of those cases being cancer[1]. Other reported diseases include lupus and multiple sclerosis[1]. **Table 1** above presents a breakdown of specific cancers and the rise in cancer cases between 2014 and 2015, indicating that the contamination was still impacting public

Table 1: Self-Reported Cancer Cases in Coldwater Creek Floodplain[1]

Cancer Type	2014 Cases	2015 Cases	Change 2014-2015
Autoimmune	320	448	+128
Appendix	37	45	+8
Brain	113	184	+71
Thyroid	202	332	+130
Total	1,242	1,993	+751

health as of 2015, decades after remediation efforts began[1]. Extended low-dose exposure to radioactive substances can contribute to the development of many of these diseases, suggesting the cases reported in this survey arose from the radioactive uranium in Coldwater Creek[1].

TOXIC INEQUITY: A CASE OF ENVIRONMENTAL INJUSTICE

Beyond environmental concerns, the radioactive waste contamination of Coldwater Creek is also heavily linked to socioeconomic inequality. Poverty rates in regions near the storage sites are 150% higher than both the St. Louis City and County averages[6]. Underserved racial and/or ethnic groups make up 63% of the population near the North St. Louis County storage site, compared to 29% of residents in the county at large[6]. Thus, Coldwater Creek's radioactive waste contamination is an instance of environmental injustice.

Furthermore, residents affected by the contamination might lack the medical, legal, and financial resources to treat adverse health effects. Awareness of this issue has prompted the demand for an equity-focused cleanup solution.

SITE LOCATION

Coldwater Creek is a tributary of the Missouri River that begins near the intersection of Lindbergh Blvd and Interstate 270 in Florissant and flows southeast through several North St.

Louis County municipalities before joining the Missouri River near Spanish Lake as shown in **Figure 2**. The area of interest for this project spans a 13.8-mile stretch of the creek, which passes through residential neighborhoods, parks, schools, and flood-prone zones in communities such as Hazelwood and Ferguson[7].

CURRENT CONDITIONS

The affected area spans approximately 2,000 acres along a 13.8-mile stretch of the creek[8]. The water typically exhibits neutral to basic pH levels, ranging from 8.25 to 10.21, under oxic conditions[9]. These conditions favor the presence of uranium in its soluble form as the uranyl ion (UO_2^{2}), which readily forms complexes with carbonate, enhancing its mobility in water[10]. The creek has a median flow rate of 15 cubic feet per second and an average velocity of 1.37 feet per second, influencing both the transport and dilution of contaminants[11,12]. The average uranium concentration in Coldwater Creek is 5 μg/L, with levels reaching up to 10 μg/L3,4. Uranium is continuously leaching into the water of Coldwater Creek from the soil.

Efforts have been made to remediate Coldwater Creek. **Figure 3** to the right shows the restoration status along the creek as of 2020[13]. While most of the land has undergone soil removal and testing and has been released back to the public (shown in green), most regions directly along the creek (shown in red and yellow) are still being investigated and awaiting remediation[13].

REGULATORY STANDARDS

According to recent testing, uranium levels in Coldwater Creek are below the United States Environmental Protection Agency's Maximum Contaminant Level, or MCL, of 30 μg/L for drinking water[15]. However, this threshold was established based on technical feasibility and cost considerations instead of health risk alone[14]. The health-based Maximum

Contaminant Level Goal, or MCLG, for uranium is 0 μg/L, reflecting that no amount of exposure is considered completely safe[15]. In addition, the Agency for Toxic Substances and Disease Registry at the CDC recommends a drinking water chronic exposure limit of 1.4 μg/L, which is more stringent and less than current uranium concentrations in the creek[3].

Because uranium levels in Coldwater Creek remain under the USEPA's enforceable MCL, the site is not listed on the National Priorities List and is not designated as a Superfund site. Still, residents continue to express concern about the long-term effects of chronic low-level exposure, especially given the wide gap between regulatory limits and health-based recommendations[16].

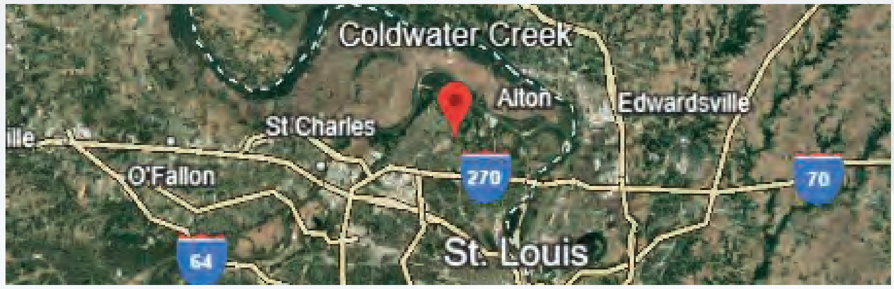

Figure 2: Coldwater Creek Location (Source: Google Earth)[7]

OBJECTIVES

The objective of this project was to design a treatment system to reduce uranium contamination in Coldwater Creek and minimize the environmental and health risks associated with exposure. The design aimed to achieve removal of soluble uranyl ions (UO_2^{2+}) from surface water using a continuous system.

ALTERNATIVES

Physical, chemical, and biological methods were all considered for treatment of the uranium contamination, specifically, biosorption, lime softening, and activated carbon adsorption. The criteria considered were cost, uranium sequestration capacity, required footprint, and waste quantity produced.

MARINE SPONGES: PROMISING, RAPID, BUT NOT YET SCALED

Marine sponges are emerging as biological adsorbents for heavy metal removal due to their porous and fibrous structure and surface functional groups. As water flows through the sponge, uranium ions become adsorbed into the cellular matrix[17].

One advantage of using marine sponges is these systems exhibit minimal ecotoxicity, making them a sustainable choice[18]. Sponges demonstrate a high affinity for uranium, allowing for effective binding[17]. Additionally, marine sponges offer faster adsorption kinetics, reducing the required contact time[19]. Notably, uranium can be desorbed from the sponge material for safe disposal or reuse, enabling media regeneration[17]. Further, their structure supports bioactivity which has potential to enhance performance[20].

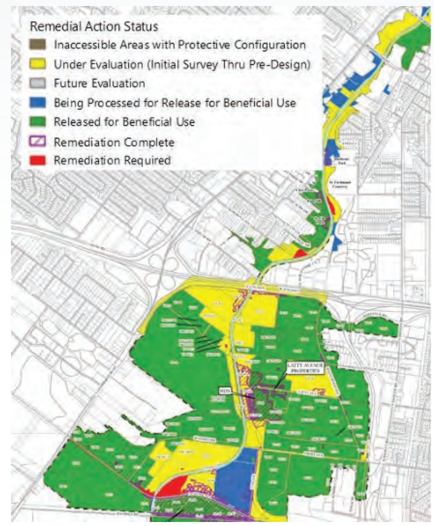

Figure 3: North St. Louis County FUSRAP Sites Map, Aug. 14, 2020 (Source: Missouri Department of Natural Resources)[13]

One limitation of biosorption is that at a neutral pH of 8, the system achieves only 74.5 percent uranium adsorption, adequate for some applications but insufficient for systems requiring near complete removal[17]. Cost is another concern, as scaling up sponge-based systems can be expensive due to the cost of sourcing the biomaterials[21]. Additionally, biosorption performance is highly pH sensitive, with efficacy dropping off outside the optimal operating range[17]. Further, this technology remains in the experimental phase, with limited large-scale data and a lack of standardized protocols[17].

LIME SOFTENING: PROVEN, ECONOMICAL, BUT SLUDGE-INTENSIVE

Lime softening is a conventional and widely commercialized water treatment process that is also effective for uranium removal[22]. The core mechanism involves elevating the water's pH using calcium hydroxide ($Ca(OH)_2$), which causes uranium to precipitate as carbonate or hydroxide complexes[23]. Lime softening offers a

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relatively low-risk implementation due to its established use in municipal treatment systems. A major advantage is its low cost because lime is inexpensive and readily available[24]. In this project, lime softening achieves approximately 85% U removal and is amplified by the presence of Mg^{2} ions[22].

The process also comes with notable limitations. It requires a large footprint for clarifiers, which may be problematic near constrained or environmentally sensitive areas like Coldwater Creek. Additionally, lime softening produces a high volume of spent sludge, complicating handling and disposal logistics[23]. The method is also nonselective, removing other ions unnecessarily and decreasing uranium removal, and it typically requires a downstream polishing step such as adsorption or filtration to meet stringent water quality standards[25].

ACTIVATED CARBON: ESTABLISHED, SCALABLE, BUT LIMITED BY SELECTIVITY

Adsorption is a contaminant removal process where an adsorbate binds to an adsorbent[26]. Activated carbon, an established sorbate, can trap U in its structure through chemical and physical interactions[27].

Granular activated carbon (GAC) sorbent is widely available, low cost, and commonly used for contaminant removal[28]. The mechanisms of adsorption are well characterized in lab, pilot, and full-scale studies. Adsorption onto activated carbon is stable across a wide pH range, allowing for effluent fluctuations[29]. Spent activated carbon can be regenerated, but shows degradation and decreased sorption capacity[30]. Because activated carbon is inexpensive, spent sorbent is more often disposed of and replaced with new sorbent[30].

One limitation is that activated carbon cannot selectively adsorb uranium, reducing the efficacy of uranium adsorption in this context[29]. Competing ions include other heavy metals, as well as calcium and magnesium. Carbonate and bicarbonate play a major role in the conditions of Coldwater Creek[31]. Though the removal of uranium using activated carbon is relatively low, at around 70%, it could be useful as a polishing step at lower uranium concentrations[32]. Activated carbon also poses the risks of hydrogen sulfide (H_2S) formation leading to potential ecotoxicity[30].

Table 2: Biosorption System Design Parameters[34]

Defined Parameters					
Qmax (mg/g)	K (L/mg)	EBCT (min)	H:D	p (kg/m³)	Q (m³/s)
1086	0.11	2	0.75 – 1.5	80	0.110
Calculated Parameters					
q (mg/g)	Dose (g/L)	Req. V (m³)	Act. V (m³)	m (kg/yer)	Req. A (m²
1.19	0.006	14.14	14.138	138000	54
Op Time (days)		R (m)	H (m)	H:D	# Columns
21		1.5	2	1.85	6

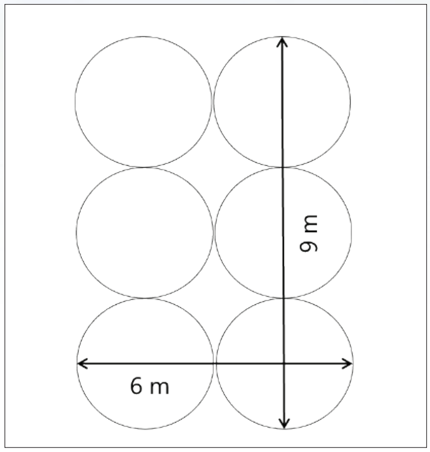

Figure 4: Biosorption System Required Footprint

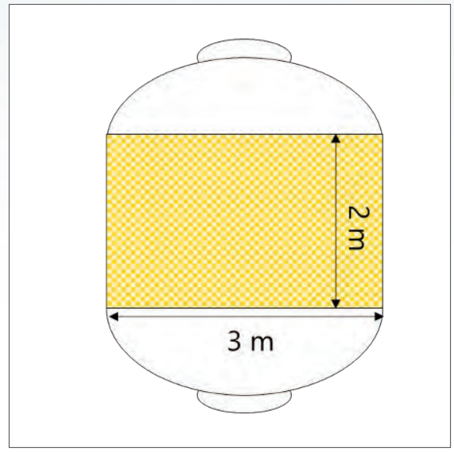

Figure 5: Biosorption Column Design Diagram

DESIGN BASIS: FLOW, LOAD, AND ASSUMPTIONS

Each treatment system was designed based on a median flow rate of 0.45307 cubic meters per second (equivalent to 9.71 million gallons per day, MGD), representing typical site conditions. A higher design flow rate of 10 MGD (0.658 m^3/s) was used to ensure adequate capacity under peak operating conditions[11]. The influent uranium concentration was assumed to be 10 μg/L[3].

BIOSORPTION DESIGN

To design the adsorption column for uranium removal using Aplysina aerophoba, the Langmuir isotherm was used, assuming monolayer adsorption on a single site type with no competing ions[33] The adsorption density, q was determined using **Eq. 1**, based on the constant, K, adsorption capacity, Qmax, and influent U concentration, C0. Using the calculated adsorption density, the sorbent dose per liter of contaminated water was determined with **Eq. 2**, using influent and effluent U concentrations, C0 and Cf, corresponding to 74.5% removal.

Eq. 1: $q = (Q_{max}KC)/(1 + KC_0)$
Eq. 2: Dose = $(C_o - C_f)/Q$

Given the fast kinetics of biosorption, a 2-minute empty bed contact time, EBCT, was selected, and the reactor volume was calculated from the system flow rate[34] Q using **Eq. 3**. The column geometry was designed to maintain a height-to-diameter ratio between 0.75 and 1.5 to ensure adequate mixing[35]. The reactor footprint was calculated from the selected dimensions

Eq. 3: $V = EBCT * Q = \pi R^2 H$

Using **Eq. 4**, the total mass of sorbent required was calculated from the dose and total volume of water treated and subsequently converted to sorbent volume using bulk density and **Eq. 5**. Finally, **Eq. 6** was used to estimate the operational time before replacement, based on the mass/reactor and annual mass requirement.

Eq. 4: m (system) = Dose * V * ρ
Eq. 5: m (year) = Q * Dose * 3.15 x 10^5
Eq. 6: Q = m (year) / m (system)

Final system parameters are summarized in **Table 2. Figure 4** presents a simplified diagram of the biosorption column, while **Figure 5** visualizes the required system footprint.

LIME SOFTENING DESIGN

$Ca(OH)_2$ was selected as the chemical additive. The $Ca(OH)_2$ dissociates into $Ca^{2}+$ and OH- ions to support precipitation through raising the pH to 11, as shown in **Eq. 7**. The lime dose was calculated using the OH- concentrations at pH 9 and 11[36].

Eq. 7: $Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$

When lime is added to hard water solid calcium carbonate (CaCO3) is formed as shown in **Eq. 8**. Contaminants, such as Uranium, are trapped in the $CaCO_3$ sludge, removing them from the aqueous phase.

Eq. 8: $CO_2 + Ca(OH)_2 = CaCO_3 + H2O$

For clarification basin design, the surface overflow rate (SOR) is the defining factor. The (SOR) was assumed based on standard design guidelines[37].

Using Eq. 9, the required surface area was calculated using the required flow rate, SOR and the number of units.

Eq. 9: Area = Q / SOR * #

A target depth was then selected to determine basin volume, and Eq. 3 was used to compute the diameter of each circular clarifier.

Final system parameters are summarized in **Table 3. Figure 7** presents a simplified diagram of the biosorption column, while **Figure 6** visualizes the required system footprint.

ACTIVATED CARBON ADSORPTION DESIGN

To design the adsorption column for uranium removal using activated carbon, the Freundlich isotherm was used, assuming monolayer adsorption on a heterogenous site types with no competing ions[32]. The adsorption density, q was determined using **Eq. 9**, based on the Freundlich constant, K, n, and influent U concentration, C_0. Using the calculated adsorption density, the required sorbent dose per liter of contaminated water was determined with **Eq. 2**, using the influent and effluent U concentrations, C_0 and Cf, corresponding to a 69.5% removal[38].

Eq. 9: $q = KC^{1/n}$

Given the slower kinetics of activated carbon adsorption, a 5-minute EBCT, was selected, and the reactor volume was

Table 3: Lime Softening Design Parameters[34]

Defined Parameters					
Q (m^3/s)		SOR ($m^3/m^2 \cdot day$)		Contact Time (min)	
0.658		50		60	
Calculated Parameters					
Dose (g/L)	V (m^3)	H (m)	R (m)	Footprint (m^2)	# Clarifiers
0.01	3142	19	2	1400	4

Table 4: Activated Carbon Design Parameters[32]

Defined Parameters			
N		K (L/mg)	EBCT (min)
0.368		3.69	5
H:D		ρ (kg/m^3)	Q (m^3/s)
0.75 – 1.5		500	0.073
Calculated Parameters			
q (mg/g)	Dose (g/L)	Req V (m^3)	Actual V (m^3)
0.678	0.01	21.93	24.74
m (kg/yer)	Footprint (m2)	Operation Time (days)	
208000	81	189	
R (m)	H (m)	H:D	# Columns
1.5	3.5	0.86	9

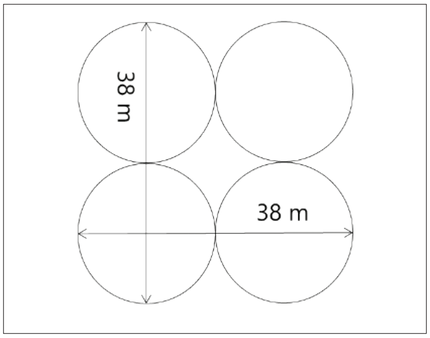

Figure 6: Lime Softening System Required Footprint

Figure 7: Lime Softening Design Diagram

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calculated from the system flow rate, Q using **Eq. 3**. The column geometry was designed to maintain a height-to-diameter ratio between 0.75 and 1.5 to ensure adequate mixing[35]. The reactor footprint was calculated from the selected dimensions. Using **Eq. 4**, the total mass of sorbent required was calculated from the dose and total volume of water treated and subsequently converted to sorbent volume using bulk density and **Eq. 5**. Finally, **Eq. 6** was used to estimate the operational time before replacement, based on the mass per reactor and mass required.

Final system design parameters are summarized in **Table 4. Figure 9** presents a diagram of the GAC column, while **Figure 8** shows the required system footprint.

COST AND PERFORMANCE: SYSTEM TRADE-OFFS AT SCALE

The three categories contributing to capital expenses (CAPEX) in the scope of this study are pump costs, contactor costs, and

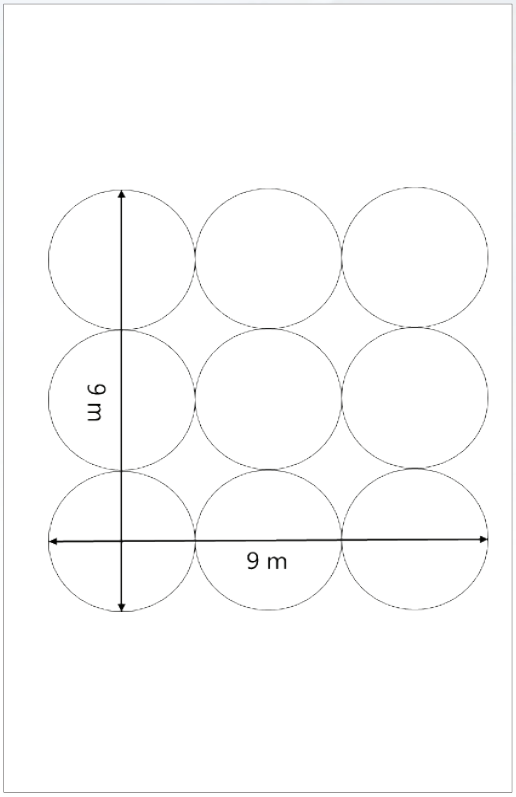

Figure 8: GAC Adsorption System Required Footprint

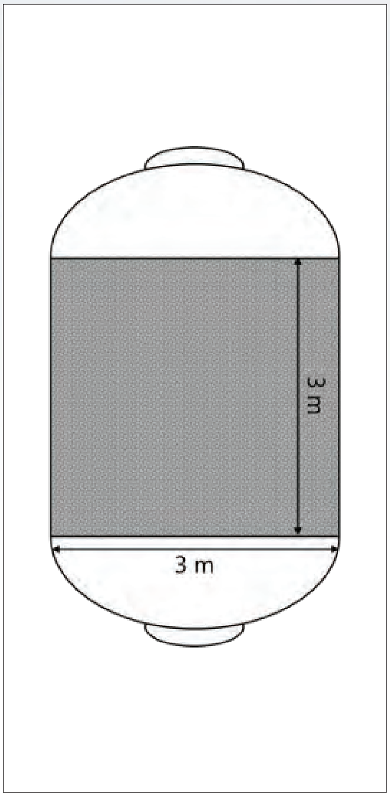

Figure 9: GAC Sorption Design Diagram

installation costs. **Figure 10** visualizes these costs across the three systems. Contactor costs have the greatest impact on the total CAPEX. Notably the GAC system has contactor costs of twice the other two systems. Installation and pump costs are similar across the three systems.

Operational expenses (OPEX) for the three systems are primarily driven by sorbent costs, waste disposal, and maintenance as shown in **Figure 11**. Among these, sorbent cost is the most significant contributor. Lime softening has the lowest operating cost due to, while biosorption is the most expensive. Waste disposal and maintenance costs are relatively low and consistent across all systems, contributing minimally to total OPEX.

As shown in **Figure 12**, the biosorption system has the highest operating OPEX, approximately twice of the GAC system. Lime softening has just over a quarter of the OPEX associated with GAC.

As shown in **Figure 13**, the GAC system has the highest CAPEX at $16 million, over $5 million more than biosorption.

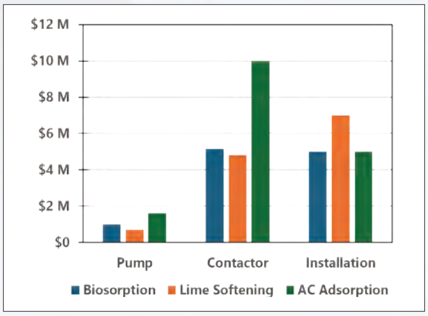

Figure 10: CAPEX Breakdown[38]

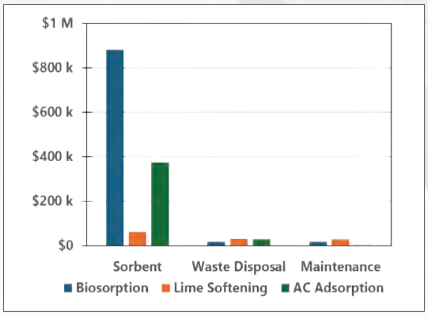

Figure 11: OPEX Breakdown[24, 39, 21, 38]

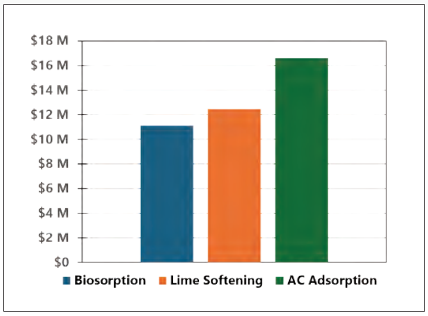

Figure 12: CAPEX Comparison

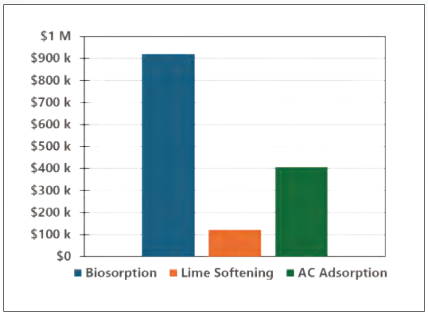

Figure 13: OPEX Comparison

Table 5: Decision Matrix

Category	Weight (%)	Bio-sorption	Lime Softening	GAC
Construction Cost	10	3.93	3.43	2.64
Maintenance Cost	10	0.92	7.00	2.08
Total Cost (10 years)	15	4.36	6.34	4.29
Waste Produced	10	4.99	2.39	2.62
Uranium Removal	15	4.78	5.77	4.46
Cancer Reduction	30	10.97	11.01	8.02
Required Footprint	10	7.05	0.16	2.79
Total Score	37.01		36.09	26.90

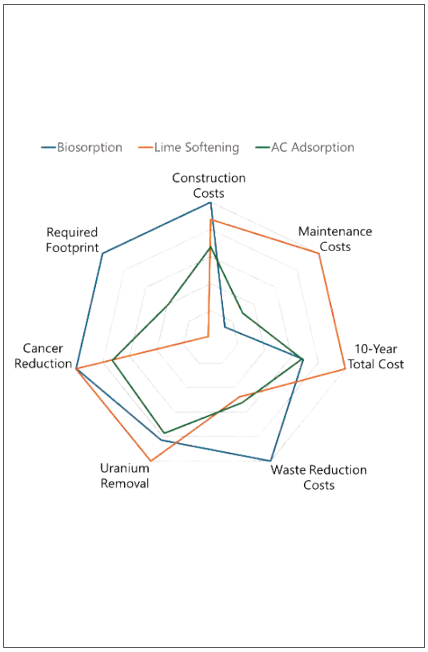

Figure 14: Radar Chart

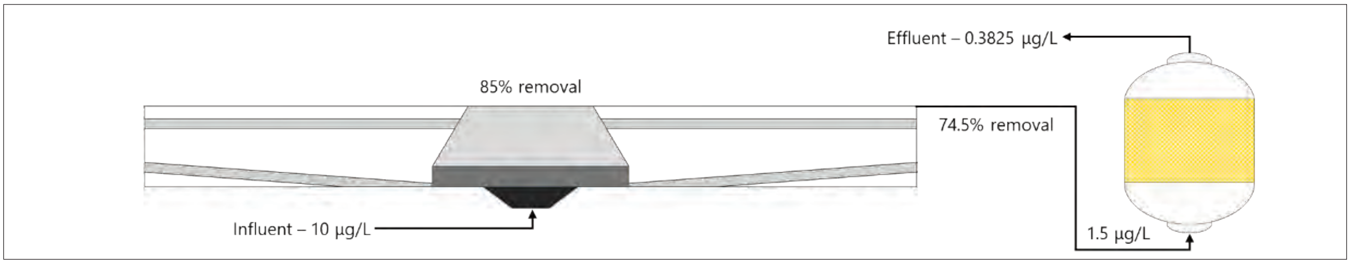

Figure 15: Biosorption-GAC Duel-System

Table 6: Cancer Risk Comparison

Cancer Type	National Risk (%)	Colwater Creek Risk (%)	Increased Risk
Autoimmune	0.0009	0.01	11.3 x
Appendix	0.0073	0.09	12.23x
Brain	0.0129	0.16	12.62x
Thyroid	0.0694	0.16	2.31x

Table 7: Coldwater Creek Healthcare System Burden

Cancer Type	New Annual Cases per Year	Cost per case, per year
Autoimmune	128	$325,000
Appendix	8	$182,913
Brain	71	$333,554
Thyroid	130	$136,378
Total	751	$84 million

Lime softening has a lower CAPEX, and biosorption has the lowest overall capital cost.

SYSTEM SELECTION

To develop the decision matrix, each performance metric was scaled to contribute proportionally to its assigned weight. The highest weighted category, cancer risk reduction (30%), reflects the primary goal of the project. The next most heavily weighted categories, uranium removal efficiency and total cost over ten years, are each assigned 15%, representing the most critical engineering and economic considerations. The remaining categories are each weighted at 10% to reflect their importance in the evaluation.

The results of the decision matrix are presented in **Table 5** and visualized in **Figure 14** as a radar chart. The GAC system scores the lowest in the decision matrix and occupies the smallest area in the radar chart. Lime softening and biosorption are comparable.

MEETING THE STANDARD: A DUAL-PROCESS PATH TO <1.4 µG/L URANIUM

While each treatment alternative offers specific advantages, they share a common limitation: none can independently achieve the target uranium concentration of 1.4 µg/L. Even lime softening, the most effective single-step strategy, would only reduce uranium levels to approximately 1.5 µg/L, falling just short of the goal. To address this, we propose a dual-step treatment process.

The influent from the creek, with a concentration of 10 µg/L, would first be fed through a lime softening system, allowing for an 85% reduction of uranium. The stream, then with a concentration of 1.5 µg/L, would undergo bioadsorption, further reducing its concentration to 0.3825 µg/L, which is well below the desired concentration of 1.4 µg/L, and close to the most ideal outcome of an undetectable uranium concentration. A flow chart of this process is shown in **Figure 15**. With the combination of these two methods, the construction of this process is estimated at $24 million, with an annual operating cost of $1 million.

FUNDING CONTEXT: FUSRAP COVERAGE AND ROI CONSIDERATIONS

Coldwater Creek is public land, and as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the site is eligible to receive a portion of FUSRAP's budget for remediation. In 2024, FUSRAP was allocated $300 million for the remediation of 11 active sites, indicating that the project could be funded by the government. Thus, a return on investment was not deemed to be a vital calculation in determining the project's feasibility[45].

BEYOND ROI: EVALUATING THE HUMAN AND HEALTHCARE COSTS

Rather than conducting a traditional return-on-investment assessment, this study evaluated the public health burden of cancer cases resulting from uranium exposure among residents living near Coldwater Creek. This approach prioritizes human health outcomes over financial metrics.

Coldwater Creek's impact on public health was evaluated using a self-reported, community health survey[40]. It allowed residents of the creek to report a variety of conditions that may be linked to related uranium exposure, the most common of which are autoimmune disease, brain cancer, appendix cancer, and thyroid cancer[40]. The national probabilities of contracting each condition were calculated using the American Cancer Society's data on annual cancer cases, and an overall population of the US of 340 million, as stated by the US Census Bureau[41,42,43,44]. Using Missouri's 2020 census data, the cities the creek runs through, specifically Florissant, Black Jack, and Old Jamestown, were found to have an estimated population of 80,000 people[40]. This population, in tandem with the results of the community health survey, was used to calculate the average cancer risk for Coldwater Creek residents.

These results, shown in **Table 6**, are alarming. Brain and appendix cancers occur over twelve times more frequently near Coldwater Creek than the national average. Even autoimmune diseases, which are rarely tracked in national data, show an 11-fold increase. Every year of delayed cleanup costs the community an estimated $84 million in healthcare expenses, as shown in **Figure 7.**

SUMMARY: DUAL-STEP TREATMENT FOR EFFECTIVE URANIUM REMOVAL.

In summary, Coldwater Creek would best benefit from a dual-step lime softening and biosorption system to maximize uranium reduction and similarly, the restoration of the area's public health. In addition to the process's efficacy, it also has a minimized lifecycle cost, with a construction cost of $24 million and an operating cost of $1 million annually. The recommendation makes use of each step's strengths by implementing lime softening for larger concentrations of uranium and later utilizing biosorption as a polishing step at lower concentrations.

MIDWEST
STUDENT DESIGN COMPETITON

NEXT STEPS: ADDRESSING FEASIBILITY AND ECOLOGICAL CONSTRAINTS

The Coldwater Creek uranium sequestration project faces critical design constraints that affect feasibility and sustainability.

A key concern is the ecotoxicity of treatment byproducts, such as spent biosorbents and lime sludge, which require specialized disposal. The project also assumes no existing infrastructure, meaning treatment must occur directly at the creek. Any attempt to dam or obstruct the creek to increase contact time risks disturbing local wildlife habitats. The system's resilience to flooding and variable creek flow remains uncertain and occasional surges, inadequate design could lead to environmental release of untreated water. For future work, these current constraints must be addressed to ensure effective, dependable, and environmentally sound uranium removal.

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TEC Tecnológico de Costa Rica

MIDWEST STUDENT DESIGN COMPETITON

DESIGN OF A CENTRALIZED WASTEWATER COLLECTION SYSTEM AND WASTEWATER **TREATMENT PLANT FOR THE SANTA TERESA REGION IN CÓBANO, COSTA RICA.**

Global Water Stewardship – Santa Teresa de Cóbano, Costa Rica
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INTRODUCTION

The wastewater treatment plant design presented in this article was developed as part of the Global Water Stewardship (GWS) student competition, which invites university teams to propose sustainable sanitation solutions for communities in Costa Rica.

The team from the Costa Rica Institute of Technology includes students from Environmental Engineering, Construction Engineering, and Architecture and Urbanism, and was advised by Diana Zambrano P., MSc and Mary Luz Barrios H., PhD.

The team developed a multidisciplinary and context-sensitive proposal for a centralized wastewater treatment system and sewer network, emphasizingsustainability, technical feasibility, and responsiveness to community needs.

PROBLEM STATEMENT

In the province of Puntarenas, Costa Rica, several coastal towns, including Malpaís, Carmen, Santa Teresa, Hermosa, and Manzanillo, face significant wastewater sanitation challenges. Most households and businesses rely on individual septic systems, which often suffer from poor maintenance, leading to system failures and runoff contamination. Inadequate septic sludge management further exacerbates the problem, as waste is frequently discharged into the environment rather than properly treated, posing environmental and public health risks. This situation has raised concern among local residents, the tourism sector, Nicoya Waterkeepers, AyA, and the local utility provider, all of whom advocate for a centralized sanitary collection and treatment system. A preliminary conceptual design has been commissioned, emphasizing the need for an effective, environmentally sound solution that protects both ecological integrity and community well-being.

OBJECTIVE

To detail the design of a centralized wastewater treatment plant for the Santa Teresa de Cóbano area, integrating clean energy for its operation, an attractive and sustainable architectural concept, and an efficient sanitary sewer system, in compliance with technical and environmental standards appropriate for the region. In addition, an analysis of the total investment, operation, and maintenance costs to ensure the long-term economic viability of the project.

CONSTRAINTS

Among the primary limitations are the anticipated population growth and seasonal fluctuations in wastewater volume, driven by tourism and rainfall patterns. Additionally, the need to protect existing drinking water sources adds further complexity to the system's planning. A major challenge is the lack of a geotechnical study, which prevents an accurate assessment of trench stability and groundwater levels – critical for determining excavation methods and pipe placement. The complex topography of the region also necessitates the use of pressure sewer systems, which in turn require high-cost pumps that are not available locally and must be imported.

The project also faces logistical and economic limitations. Construction is complicated by the limited availability of land and the remoteness of the site, which lacks nearby concrete batching facilities, making it necessary to install a temporary concrete plant. Operationally, the treatment system demands frequent maintenance, which may be difficult to ensure in a rural context with limited technical resources. Regulatory compliance with strict AyA technical standards – such as pipe slopes, depths, and spacing – further constrains the design.

SITE SELECTION

Defining the project's scope and identifying which coastal towns in western Cóbano to include was the first step in the design process. The team prioritized selecting the three communities most relevant to the local economy, tourism, and residential activity. To support this decision, a set of indicators was developed and combined with field observations and data collection. Building types (homes, hotels, restaurants, schools, etc.) were weighted to quantify each community's relative importance.

Based on this analysis, Santa Teresa & Carmen (46%) and Hermosa (23%) were selected as the primary focus areas for the proposed wastewater collection system. Santa Teresa and Carmen were treated as a single zone due to the absence of a clear territorial boundary between them.

PROJECT HORIZON

The plant is considering a project horizon of 45 years, although AyA recommends 25 years, due to the time required for construction, securing funding, and completing legal and permitting processes. This decision aims to ensure that the system has an adequate lifespan, given the complexity of the project. To estimate the design population, Costa Rica's population growth trends were analyzed, linear regression was applied to project foreign population growth, and tourism trends for both national and international visitors were studied. The population was classified into three groups: permanent (20,000 people), international tourists (66,449 per month, equivalent to 2,215 people per day), and national tourists (17,501 per month, equivalent to 583 people per day). In total, the estimated daily design population is 22,798 people, including both residents and tourists. This figure is essential for properly sizing the project's infrastructure, such as drinking water supply, sewer systems, and wastewater treatment.

FLOW RATES DESIGN

The design of the sewer system for this project is regulated under Chapter 5 of the "Norma Técnica para diseño y construcción de sistemas de abastecimiento de agua potable, de saneamiento y pluvial" issued by the Instituto Costarricense de Acueductos y Alcantarillados (AyA) [1]. This chapter outlines how to calculate design flows, as well as the technical requirements and specific considerations for sanitary sewer systems. Based on the population projection and the calculations established by the standard, the average and maximum flows were determined, which will be used for the design of the treatment plant and the sewer system, respectively.

Table 1

Flow rates design

Ordinary Wastewater		
Description	**Units**	**Value**
Average daily potable water flow	l/p/d	225
Return factor	-	0.8
Average ordinary wastewater flow	l/p/d	180
Infiltration Water		
Infiltration flow per kilometer	l/s/km	0.25
Total pipeline length	km	19.82
Infiltration flow	l/s	4.96
Average Wastewater Flow	**ow**	
Average daily wastewater flow	l/d	4103700
Average wastewater flow	l/s	47.5
Maximum daily flow	l/s	57
Maximum hourly flow	l/s	102.59
Maximum flow	l/s	107.55

COLLECTION SYSTEM

As a basis for the sewer system design, the following conditions were used according to regulations:

- The pipe must be located in the center of the road.
- The depth of the road surface to the crown of the pipe must be at least 1.20 m.
- The minimum nominal diameter is 6 inches.
- The maximum flow velocity is 5 m/s.
- The minimum tractive force of the flow must be 0.1 kg/m^2.

In addition to these conditions, a depth limit of 3 m was established because the trenching for the pipe and manholes was meant to be done manually. Moreover, a minimum slope of 0.50% was used. It is worth mentioning that the maximum depth was defined this way because there was no soil mechanics study in the area. Therefore, the water table level was not considered in the design, and it was assumed that the soil is suitable so that the excavations would not cover the entire width of the road, avoiding traffic disruption. On the other hand, in the region, no territorial plan exists to properly characterize the five towns intended for study: Manzanillo, Hermosa, Santa Teresa, Carmen, and Malpaís. As a result, indicators were created to consider the types and uses of structures present in each community to represent each area in terms of its socioeconomic conditions. As a result of the analysis, only the communities of Hermosa, Santa Teresa, and Carmen were selected to receive sanitary service. As a first task, the sewer system was divided into five sectors of similar length to quantify the contributing areas and determine the flow accumulated in each of them. The first sector corresponds to the Playa Hermosa area, which contributed an initial flow of 0.0240 m^3/s; the second is a sparsely populated transition area between Hermosa and Santa Teresa, where a flow of 0.0253 m^3/s circulated; the third includes Santa Teresa, where 0.0480 m^3/s was accumulated; the fourth sector is Playa Carmen, with an accumulated flow of 0.0816 m^3/s; the fifth sector is shorter in length and its area represents the surroundings of the proposed location for the pumping station for the pressurized sewer, which would receive a final flow of 0.1075 m^3/s. For the sewer system model, Autodesk Civil 3D software was used. It was proposed that a main line be created, to which the secondary networks collecting water in different locations would be connected

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and would contribute their respective flow. All pipes were designed to use PVC with SDR 41, as they are not required to withstand high pressures. In addition, their diameters were calculated so that the hydraulic depth would not exceed 75% of the pipe's diameter. Based on the above, the following equation was used, based on the dimensionless hydraulic relationships for uniform flow and critical flow by Ven Te Chow [2]:

$$d = \left(\frac{nQ}{\sqrt{S_0} * 0.28422}\right)^{\frac{3}{8}}$$

Where:
- d: pipe diameter (m).
- n: Manning's coefficient (0.010 for PVC pipes).
- Q: flow (m^3/s).
- S0: channel bottom slope (%).

In each section, compliance with the minimum slope, maximum velocity, and minimum tractive force was ensured.

Meanwhile, the manholes were designed according to the selection matrices of the standard, which considered the depth, the outlet pipe diameter, and the number of drops in the manhole. Some manholes, due to the area's topography, were designed to be used as pumping manholes, which must have a depth of 1.5 m additional to that required by the pipe's inlet level. These manholes must contain a set of accessories that allow for the flow to be pumped to another manhole. First, submersible pumps of 15 hp, 20 hp, and 25 hp were calculated according to the pumping distance and incoming flow; second, baskets were included to retain solids larger than 20 mm, as clogs in the pumps could occur and cause system failure due to flooding. These baskets require daily maintenance, which must be considered in the maintenance costs; finally, control panels for the submersible pumps must be installed beside the public road. Since the location of the treatment plant is approximately 210 masl and the sewer system is on the coast, there is a height difference of 203 m, which creates the need to establish a pressurized sewer system. A pumping station was proposed to be built at the end of the main collection line in Playa Carmen, with a tank that stores the water for at least one hour. This way, 12 cycles of one hour of operation and one hour of storage would be performed. Given that the final flow is 0.1075 m^3/s, the tank should have a capacity of at least 450 m^3. Additionally, a pump with a power of approximately 600 hp would be required to pump the concrete poured on-site, and there are no nearby ready-mix concrete plants that could provide the service. Therefore, it was recommended that a temporary plant be installed on the lot proposed for the WWTP construction.

Finally, a summary of the works and materials estimated for the construction of the sewer system is presented:
- Total excavation: 40,220 m^3.
- 537 manholes (42 pumping manholes).
- 17,055 m of 6" PVC SDR 41 pipe.
- 2,083 m of 8" PVC SDR 41 pipe.
- 1,293 m of 10" PVC SDR 41 pipe.
- 1,269 m of 12" PVC SDR 41 pipe.
- 5,450 m of 12" HDPE SDR 7 pipe.
- 3 pumps of 335 hp.
- 1 vitrified steel tank with a capacity of 450 m^3.

The map with the proposed sanitary sewer design is shown in the following figure above.

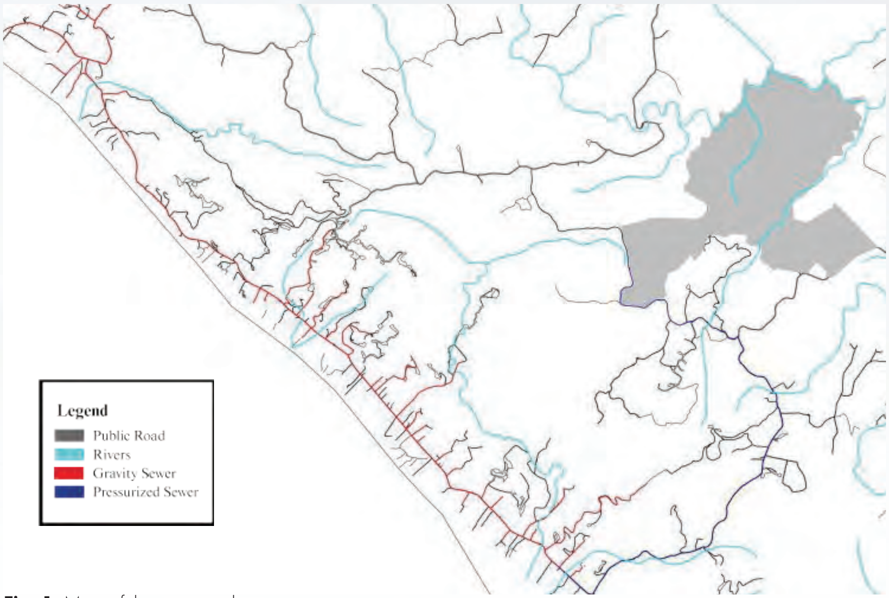

Fig. 1. Map of the proposed sanitary sewer system.

SELECTION CRITERIA

The method implemented for selecting the treatment system was based on the Pareto optimality principles. This method assumes that "All the considered attributes as «the more, the better», except for the cost attribute, where it is «the less, the better»" [9]. The selection process was evaluated based on social, technical, environmental, and economic criteria.

Weights were assigned to each criterion, indicating its importance in the final selection of the treatment system. This value was determined based on the assessment conducted by the members of the Nicoya Peninsula Waterkeeper organization and the considerations from GWS.

To complement the analysis, specific indicators were assigned to each of the criteria. These indicators were selected based on the specific needs of the target population. Each indicator was then assigned a weight, determined both by educated judgment from both the members of the team as well as Nicoya Peninsula Waterkeeper. Based on this, the highest scores were assigned to the oxidation ditch + constructed wetland system.

PROPOSED SYSTEM

The proposed system is composed by a preliminary stage, which includes an Archimedean screening screw, followed by a grit removing equalization tank. The equalization tank is composed of two main sections: a rear chamber acting as a gradient breaker, designed specifically to prevent the resuspension of grit, and a primary storage volume with a sloped bottom (16.67%) towards the back, which enables its operation as an integrated grit removal unit. This rearward-sloped section includes a sand purging compartment to allow for easy maintenance and removal of accumulated solids. The overall tank design provides storage for up to 8 hours of continuous inflow, under the assumption that the incoming volume will be redistributed during nighttime hours. This strategy ensures the treatment plant remains continuously operational, balancing diurnal variations in influence and optimizing downstream biological processing. For the secondary stage, two units of a 5-stage Modified Bardenpho Process (MPB), applied to an oxidation ditch, were considered, followed by a constructed wetland system for polishing. This system allows for constituent removal in both aerobic and anaerobic conditions, avoiding any possible odor concerns and all the while producing a stabilized sludge, removing the need for solids digestion. The oxidation ditch system was selected primarily due to its capacity to remove both organic matter and nutrients, such as nitrogen and phosphorus, with exemplary efficiency. These constituent reductions are shown in **Table 2**.

The design for the preliminary stage initially comprised grit removal and equalization in separate units, however, an innovative design was implemented to combine these processes. View of the internal structure of the grit removal-equalization chamber is shown in **Figure 2** The addition of the screening screw was done to automate the initial solid removal.

For the design of the oxidation ditch, principles established by Chen et al [3] were applied with regards to the reactor microbiology, while dimension calculations were performed following procedures by Davis [4]. Assumptions made during this stage were retention time, effective aeration distances, and depth.

The solids retention time used for the design was of 10 days, the minimum recommended for biological nutrient removal. This also allows for the stabilization of waste sludge.

For the oxidation ditch structure, a depth of 3.6 meters was chosen, with a total length of the ditch of 288 meters, and a channel width of 3.6 meters. The total volume of each ditch is 1,896 m^3, comprising 1,045 m^2 of surface area. Five zones were established in the reactor: anaerobic, anoxic, aerobic, for comprising fractions by volume, of 10%, 30% and 70%, respectively.

After each oxidation ditch, a secondary clarifier is required. Assumptions were made with regards to the clarifier depth, for which a value of 4 meters was selected. The calculated dimensions for the secondary clarifiers are as follows: diameter of 9.9 meters, surface area of 78 m^2, and 311 m^3 of volume. These dimensions allow for constituent removal rates in these units of 95.9% for COD, 82.8% for TSS, 77.3% for N and 87.4% for P.

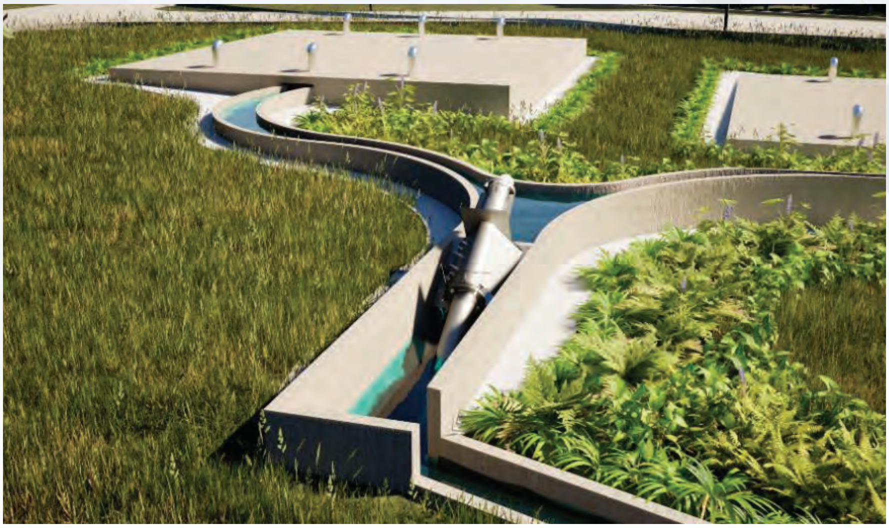

Fig. 2. Cross section of grit removal-equalization tank

Table 2

Constituent removal rates for the proposed system.

Constituent (mg/L)	Influent	Effluent	Requirement by law [5]
COD	550	15,6	150
BOD	280	5	50
TSS	220	7,6	50
N	50	6,8	40
P	20	2,1	20

Following the clarifiers, a FWS constructed wetland was proposed. The purpose of this unit is to pass the clarifier outflow through a polishing stage, allowing for a cleaner effluent and a pleasant scenery, though it covers a significant portion of the total plant grounds. The water hyacinth (Eichhornia crassipes) acts as the vegetation for this unit, due to its aesthetic appearance and its organic matter and nutrient removal capabilities [6]. Dimensions for this unit are: 1 meter depth, 10,502 m^2 surface area, and 10,502 m^3 volume. Assumptions were made in terms of constituent removal rates, following what is stated by Dotro et al [7]. Such assumptions led to the constituent reductions stated in **Table 1**. In addition to the wastewater treatment, solids handling was considered in this proposal. Such system included standard components for sludge processing such as three thickeners, each with a depth of 2.5 meters and diameter of 4 meters. This process increases the concentration of solids in the waste sludge flow from 0.8% to 5%. Furthermore, a dewatering press was included to efficiently reduce moisture in the final solid, without the need for vast amounts of space, like, for example, when using drying beds. Finally, disinfection is performed via addition of lime. The total waste sludge flow of the system is 1,137.8 kg/day, for which 136.5. kg/day of lime is required.

ARCHITECTURAL DESIGN

The architectural design of this project is based on an ecosystemic approach that seeks to address the environmental and social challenges of the Santa Teresa region in Costa Rica. One of its main conceptual pillars is the protection of the Howler Monkey, also known as the Congo Monkey (Alouatta palliata), a species facing an increasing risk of extinction due to uncontrolled urban growth and frequent electrocution accidents when crossing power lines in its natural habitat.

In response to this issue, the project draws inspiration from the "Somos Congos" campaign, launched in 2022, which promotes the installation of aerial bridges to allow these primates to safely cross between fragmented forest areas. This initiative is translated

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architecturally into a network of elevated pathways for visitors, designed with organic forms that evoke the monkey's tail. These bridges not only allow users to explore the site with elements such as viewpoints and rest areas but also symbolize the connection between humans and the natural environment, reinforcing the message of habitat conservation.

Additionally, both the administrative building and the water treatment plant are designed according to bioclimatic principles, considering factors such as solar orientation, the use of overhangs, roof inclination, and the integration of native vegetation such as mahogany (Swietenia macrophylla), which enables passive thermal comfort. The proposed materials include local wood and steel, in line with a sustainable and contextualized approach.

Specifically, the design of the water treatment plant is fragmented through a series of curved axes that break the traditional geometric rigidity, enhancing its integration with the landscape. This holistic approach turns the project into not only a functional infrastructure but also an educational tool of high ecological value.

ENERGY REQUIREMENTS

Due to the large number of pumps required for the wastewater collection system and the impact this would have on the operation and maintenance cost, an energy consumption analysis was conducted to estimate the daily electricity of the whole design. The study was based on the technical data sheets of each device and reports from the Electric Power Research Institute (EPRI).

To estimate the daily electricity consumption of each device, its energy requirement was multiplied by the number of operational hours per day. Subsequently, the yearly electricity consumption of each treatment system component was determined. Finally, the total yearly consumption of each system was obtained by summing up the individual consumption of all its components.

The system energy consumption was estimated to be 570,0270.59 kWh per year Solar panel system.

A solar panel system was designed to supply 20% of the plant's total energy demand (this excludes the wastewater collection system). The decision to integrate a photovoltaic system into the plant's design was based on several factors: the need to reduce electricity costs, the financial viability of the system due to potential revenue from surplus energy sales, and the high solar radiation levels in the region, which would ensure optimal energy production [8].

The photovoltaic system was designed using 720 Wp panels as a reference, along with three-phase current inverters. Based on data from the PVGIS system of the European Commission and the performance characteristics of the solar panels, it was determined that the system would require 353 photovoltaic panels, a surface area of 1,096.54 m^2 for installation, and 9 inverters with a capacity of 30 kW each.

To estimate the economic feasibility of installing solar panels, a financial analysis was conducted over a 25-year period to evaluate the system's viability. The analysis indicated a ROI of 4.1 years.

TOTAL COSTS

The projected sewer system has an estimated total cost of $31,457,881.64, which includes civil works, treatment plant, pumping station, and labor. The specific cost of the sewer system is $5,871,337.87, considering a total length of

Fig. 3. Viewpoints and rest areas for visitors.

Fig. 4. Elevated organic pathways for visitors

Fig. 5. The administrative building of the water treatment plant

25.27 kilometers. This represents a cost of $232,344.20 per kilometer, which illustrates the investment required to extend this type of infrastructure to other communities.

OPERATION AND MAINTENANCE COSTS

The calculation for these values was done with data included in facts sheets corresponding to each technology, published by the United States Environmental Protection Agency []. These data are given in the form "$/volume treated" or "$/volume capacity" for each unit, therefore they represent a valid approximation of the costs for maintaining the WWTP. This adds up to a total O&M cost of $2,391,255/year, equating to a service fee based on independent wastewater production of $1.60 per cubic meter.

ACKNOWLEDGMENTS

Diana Zambrano P. MSc – Instituto Tecnológico de Costa Rica
Mary Luz Barrios H. PhD – Instituto Tecnológico de Costa Rica
Ariadna Sánchez G. Executive director – Nicoya Peninsula Waterkeepers
Luis Gómez V. Environmental Engineer – Nicoya Peninsula Waterkeepers
Carolina Chavarría – Nicoya Peninsula Waterkeepers
Mohammed Haque, MBA – Global Water Stewarship

Table 3
Total costs of the project

Activity		Subtotal
1	WWTP External Works	$674,113
2	Wastewater Treatment Plant	$1,246,907,751
3	Gravity Sewer (Pipeline)	$143,733,551
4	Gravity Sewer (Manholes)	$205,557,701
5	Sewerage System (Pumping Systems)	$32,435,598
6	Pumped Sewer System (Pipeline)	$151,686,297
7	Pumped Sewer System (Pumping Station)	$53,720,641
8	Labor	$ 1,311,072,512
TOTAL COST		**$ 3,145,788,164**

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"THE SOLIDS RETENTION TIME USED FOR THE DESIGN WAS OF 10 DAYS, THE MINIMUM RECOMMENDED FOR BIOLOGICAL NUTRIENT REMOVAL."

WEF, AMAZON, WATER CENTER AT THE UNIVERSITY OF PENNSYLVANIA, AND LEADING UTILITIES OF THE WORLD LAUNCH

WATER-AI NEXUS CENTER OF EXCELLENCE

First-of-its-kind initiative to harness AI to solve critical water challenges. New information released today on data center best-practices to minimize water impact in the age of AI.

The Water Environment Federation (WEF), *Amazon.com*, Inc. (NASDAQ: AMZN), The Water Center at the University of Pennsylvania (WCP), and The Leading Utilities of the World (Leading Utilities) jointly announced today the creation of the Water-AI NexusTM Center of Excellence, a groundbreaking collaboration that will develop sustainable water practices for AI infrastructure while also using AI to solve global water challenges. This knowledge hub at the confluence of water and AI brings together water utilities, technology companies, and researchers to address the complex relationship between digital infrastructure and water sustainability.

The Water-AI Nexus was unveiled during Climate Week NYC, the largest annual climate event in the United States, and will focus on two critical missions:

1. **Water for AI:** Ensuring AI infrastructure uses water as efficiently as possible
2. **AI for Water:** Leveraging AI capabilities to solve pressing water scarcity and management challenges

Organizations across the water and technology sectors are invited to engage in this collaborative effort at *water-ai-nexus.org* – the central hub for the Water-AI Nexus community.

"Water utilities worldwide are facing unprecedented challenges from climate change and aging infrastructure, while simultaneously working to serve communities that depend on reliable, affordable water services," said Howard Carter, president of the Water Environment Federation. "The Water-AI Nexus Center of Excellence will accelerate innovation by connecting water professionals with AI experts to develop solutions that benefit both sectors as well as the communities they serve."

Key Initiatives of the Water-AI Nexus:

- **Framework Development:** Establishing standards and best practices for water use that can be shared across the data processing industry
- **Insight Report:** Today's release of *"Principles for Sustainable Water Use by Data Centers"* provides a roadmap for data center operators to minimize water impacts while maximizing technological advancement.
  The report outlines four core principles:
    - Strategic design and location
    - Optimizing operational efficiency
    - Using sustainable water sources
    - Pursuing water replenishment to deliver water back to communities
- **Knowledge Sharing:** Case studies and research findings through publications and events
- **Cross-Sector Collaboration:** Uniting water utilities, AI developers, researchers and government officials

"We believe responsible innovation means both addressing our water footprint and using technology to solve global water challenges,» said Beau Schilz, water principal at Amazon Web Services (AWS). "At Amazon, we strive to reduce water use in our operations, which include logistics sites such as fulfilment centers, as well as in our corporate offices and grocery stores. We're also committed to returning more water to communities than we use across our data centers by 2030 – being a founding leader of the Center of Excellence will help not only Amazon in its goals, but others as well, as we aim to collectively transform water management worldwide."

The Water-AI Nexus Center of Excellence brings together expertise across water, academic, and utility sectors to ensure AI growth benefits our water resources and reduces stress on our water resources. By maximizing efficiency, eliminating unnecessary water use, and investing in community-tailored solutions, we can collectively ensure that technological advancement and environmental stewardship will – and must – advance together.

"The Water Center at the University of Pennsylvania is proud to bring academic expertise to this critical collaboration," said Howard Neukrug, executive director of The Water Center at Penn. "By connecting research, industry practice, and policy development, we can accelerate innovations that address water scarcity while enabling responsible technological advancement."

Christopher Gasson, publisher of Global Water Intelligence and founder of Leading Utilities, added "The intersection of water management and artificial intelligence is a turning point for the sector, both a critical challenge and unprecedented opportunity. The Water-AI Nexus will be a vital platform where utilities can directly collaborate with technology innovators to ensure water sustainability isn't compromised by digital growth."

Featured Events:

The Water-AI Nexus was featured at WEFTEC in Chicago (Sept. 27 – Oct. 1), with:

- Three full days of dedicated content
- A media panel with the founding leaders
- Panel discussions with industry experts
- Networking opportunities for water and technology professionals

About Amazon

Amazon is guided by four principles: customer obsession rather than competitor focus, passion for invention, commitment to operational

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About The Water Center at Penn

The Water Center at Penn is a community-focused research center working to find integrated solutions to the multiple challenges facing our world's water systems and their watersheds. We strive to be a trusted, reliable partner whose work accelerates water equity by connecting, convening, and collaborating across the sector. The Water Center's research approach is centered around working alongside communities, bringing their knowledge and expertise to the solutions addressing their water challenges, sharing power and responsibility, and encouraging communities to take the lead in determining priorities, questions to be asked, and the approach to answering those questions. We share resources, education, training, and applied knowledge to support community goals. For more information, visit *watercenter.sas.upenn.edu*.

About Leading Utilities of the World

Leading Utilities of the World is a network of the world's most forward-thinking water and wastewater utilities, as defined by the network's 14 distinct innovation areas. Its members represent the gold standard of utility innovation and performance throughout the developed world's water sector. Leading Utilities is an initiative of the Global Water Leaders Group, a not-for-profit organisation helping to tell a better story for water worldwide by recognising achievement, providing a network for sharing ideas, and inspiring others to improve. Primarily a CEO-level organisation, it is funded by its Foundation Partner Jacobs and Corporate Member Grundfos, and collaborates with Association Partner the Water Environment Federation. There are no membership fees for its utilities, who meet three times a year at major water conferences around the world. *www.leadingutilities.org.* CS

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– Beau Schilz, Amazon Web Services

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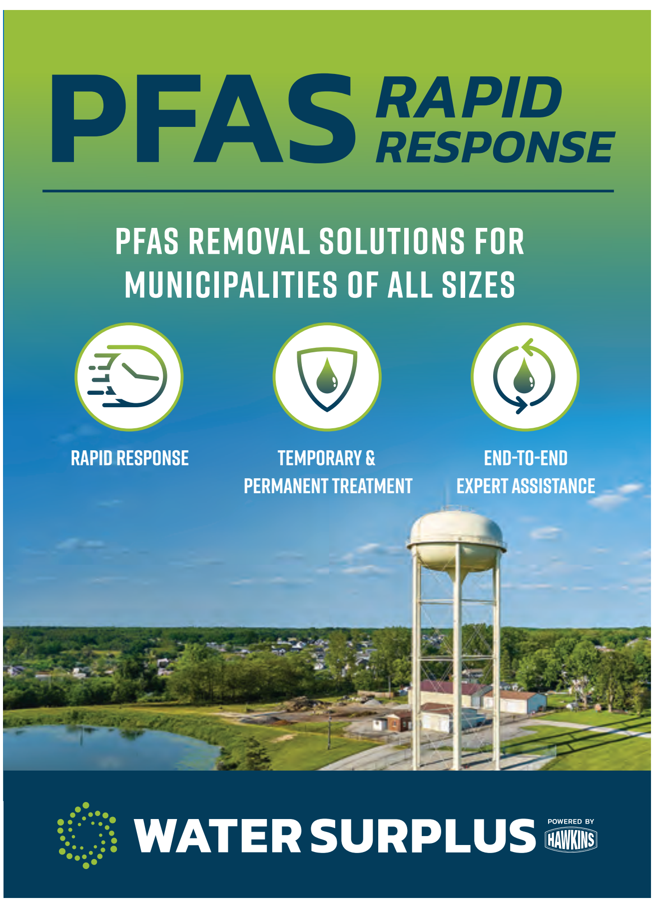
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