Sixth International Symposium on Bioremediation and Sustainable Environmental Technologies

PRELIMINARY PROGRAM

May 8-11, 2023 | Austin, Texas

battelle.org/biosymp
#BattelleBio23

BATTELLE

The Symposium is organized and presented by Battelle.

Battelle's environmental engineers, scientists and professionals offer focused expertise to government and industrial clients in the U.S. and abroad. Combining sound science and engineering solutions with creative management strategies, Battelle works with clients to develop innovative, sustainable and cost-effective solutions to complex problems in site characterization, assessment, monitoring, remediation, restoration, and management. Every day, the people of Battelle apply science and technology to solving what matters most. At major technology centers and national laboratories around the world, Battelle conducts research and development, designs and manufactures products, and delivers critical services for government and commercial customers. Headquartered in Columbus, Ohio, since its founding in 1929, Battelle serves the national security, health and life sciences, and energy and environmental industries.

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Symposium Sponsors

As the Symposium organizer and presenter, Battelle gratefully acknowledges support of the following **Symposium Sponsors**. Their financial contributions help defray general operating costs of planning and conducting the Symposium. The corporate descriptions they provided appear on pages 51-55.

For details about Symposium and event sponsorship opportunities, see the Symposium **Sponsors and Exhibitors** page or contact Susie Warner (The Scientific Consulting Group, Inc.) by phone at 301.670.4990 or email at **bio2023@scgcorp.com**

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GENERAL INFORMATION

The ***Sixth International Symposium on Bioremediation and Sustainable Environmental Technologies*** will be held May 8-11, 2023, at the Marriott Austin Downtown.

The Symposium technical program is designed for and presented by scientists, engineers, regulators, remediation site owners, constructors, and other environmental professionals representing universities, government agencies, consultants, and R&D and service firms from around the world.

It will be a platform for the scientific community to share innovative tools and technologies, research results, practical experiences, and advances in bioremediation. The program reflects the growing body of knowledge about better ways to manage contamination using state-of-the-science data collection, analysis, and visualization, along with novel approaches in remedy design and implementation.

The 2023 program includes sessions and panel discussions focused on emerging contaminants, characterization and management of PFAS, strategies to mitigate climate change, dynamic regulatory frameworks for emerging contaminants, classical bioremediation technologies, tools for natural attenuation and sustainability, and robotic technologies used in the environmental space.

The Bioremediation Symposium event series has been a forum for sharing research results, practical experiences, and opportunities associated with advances in bioremediation and sustainable remediation since 1991.

Location and Schedule

The ***Sixth International Symposium on Bioremediation and Sustainable Environmental Technologies*** will be held May 8-11, 2023, in Austin, Texas, at the Marriott Austin Downtown.

Sponsors and exhibitors are public- and private-sector organizations active in environmental assessment, remediation and management. Attendance is expected to be more than 700 professionals, representing universities, government agencies, consultants, and R&D and service firms from more than 15 countries.

All official Symposium events will be held at the Austin Marriott Downtown. The Austin Marriott Downtown is located in the heart of downtown Austin, Texas, just steps away from world-class attractions and entertainment. Indulge in this chic, urban retreat that offers luxury comfort and sophisticated amenities. The hotel features a rooftop pool with breathtaking views, two-level lobby bar, a signature restaurant, Corinne, and a rooftop tropical bar with tiki cocktails.

Three short courses are scheduled for Monday, May 8, in 4-hour increments. Courses will begin at 8:00 a.m. and end by 5:00 p.m. A Career KickStarter is also scheduled Monday afternoon from 3:00-5:00 p.m. to enhance networking and career development opportunities for students and young professionals.

During the Monday evening Plenary Session, featured speaker, Francis Weiss, will discuss Climate Change Implications and Solutions.

The Exhibit Hall, the Welcome Reception, and display of the Group 1 Posters will open Monday evening at 7:00 p.m. following the Plenary Session.

The technical program, to be held Tuesday morning, May 9, through Thursday afternoon, May 11, will feature 453 platform and poster presentations in 46 breakout sessions. Eight Learning Lab demonstrations are also scheduled that will repeat Tuesday and Wednesday. Five panel discussions will also be presented that will address critical issues.

Poster presentations and receptions will be conducted Tuesday and Wednesday evenings. Receptions and other meals offered throughout the Symposium will afford attendees numerous opportunities to meet informally with one another. The Symposium will conclude on Thursday afternoon with a reception and a wrap-up panel discussion.

Monday through Thursday exhibits from more than 50 companies, government agencies, and not-for-profit organizations will provide additional technical information. These organizations engage in assessment, remediation and management activities or supply related products and services.

Program Committee

Symposium Chairs

- Pamela Chang, PMP, MBA (Battelle)
- Deepti Krishnan Nair (Battelle)

Steering Committee

- Wendy Condit, PE (Geosyntec)
- David L. Freedman, Ph.D. (Clemson University)
- Kate Kucharzyk, Ph.D. (Battelle)
- Carmen Lebron (Consulting Engineer)
- Frank Loeffler (University of Tennessee)
- Charles Newell, Ph.D., PE (GSI Environmental, Inc.)
- Michael Pound (U.S. Navy/NAVFAC SW)
- Michael A. Singletary, PE (U.S. Navy)
- John Wilson, Ph.D. (Scissortail Environmental)

Program at a Glance

Monday, May 8, 2023

- 8:00 a.m.-12:00 p.m. Morning Short Courses
- 2:00-8:30 p.m. Registration Desk Open
- 1:00-5:00 p.m. Afternoon Short Courses
- 3:00-5:00 p.m. Career KickStarter
- 5:30-7:00 p.m. Plenary Session
- 7:00-8:30 p.m. Welcome Reception, Exhibits, Group 1 Poster Display

Tuesday, May 9, 2023

- 7:00 a.m.-7:00 p.m. Registration Desk Open
- 7:00-8:00 a.m. Continental Breakfast
- 8:00 a.m.-5:35 p.m. Platform Presentations
- 9:30-10:15 a.m. Morning Beverage Break
- 11:30 a.m.-1:00 p.m. General Lunch
- 3:00-3:45 p.m. Afternoon Beverage Break
- 5:45-7:00 p.m. Group 1 Poster Presentations and Reception

Wednesday, May 10, 2023

- 7:00 a.m.-7:00 p.m. Registration Desk Open
- 7:00-8:00 a.m. Continental Breakfast
- 8:00 a.m.-5:35 p.m. Platform Presentations
- 9:30-10:15 a.m. Morning Beverage Break
- 11:30 a.m.-1:00 p.m. General Lunch
- 3:00-3:45 p.m. Afternoon Beverage Break
- 5:45-7:00 p.m. Group 2 Poster Presentations and Reception

Thursday, May 11, 2023

- 7:00 a.m.-4:00 p.m. Registration Desk Open
- 7:00-8:00 a.m. Continental Breakfast
- 8:00 a.m.-2:40 p.m. Platform Presentations
- 9:30-10:15 a.m. Morning Beverage Break
- 11:30 a.m.-1:00 p.m. General Lunch
- 2:40-3:30 p.m. Closing Panel Wrap-Up Discussion
- 3:30-4:00 p.m. Closing Reception

**All times are subject to change in the months leading up to the Symposium.*

Technical Program Overview

The Symposium technical program is designed for and presented by scientists, engineers, regulators, remediation site owners, constructors, and other environmental professionals representing universities, government agencies, consultants, and R&D and service firms from around the world.

It will be a platform for the scientific community to share innovative tools and technologies, research results, practical experiences, and advances in bioremediation. The program reflects the growing body of knowledge about better ways to manage contamination using state-of-the-science data collection, analysis, and visualization, along with novel approaches in remedy design and implementation.

The 2023 program includes sessions and panel discussions focused on emerging contaminants, characterization and management of PFAS, strategies to mitigate climate change, dynamic regulatory frameworks for emerging contaminants, classical bioremediation technologies, tools for natural attenuation and sustainability, and robotic technologies used in the environmental space.

Platform and Poster Presentations. Platform sessions will begin Tuesday morning and conclude Thursday afternoon; poster sessions will be conducted on Tuesday and Wednesday evenings. Platform and poster presentations scheduled as of March 10, 2023, are listed by session on pages 13-40.

The 46 sessions and five panel discussions are organized into the following thematic tracks:

- Innovations in Bioremediation Technologies (Sessions A1-A6)
- Bioremediation Implementation Practices (Sessions A7-A11)
- Characterization and Remediation of PFAS (Sessions B1-B7)
- Biodegradation of Emerging Contaminants (Sessions B8-B10)
- Managing Petroleum Hydrocarbon-Impacted Sites (Sessions C1-C3)
- Application of Bioremediation to Complex Sites (Sessions C4-C7)
- Evaluating and Mitigating Vapor Intrusion (Sessions D1-D2)
- Advanced Tools for Assessing Bioremediation (Sessions D3-D9)
- Sustainability and Resilient Remediation (Sessions E1-E4)
- Environmental Impacts of Microplastics, Munitions, and Nitrates (Sessions E5-E7)
- Advances in Natural Attenuation (Sessions E8-E9)

Abstract Submission

Abstracts will be considered for placement in poster sessions if vacancies develop. To submit an abstract, contact the Symposium Office at biosymp@battelle.org for submission instructions.

Panel Discussions. The participants and scope of the five panels can be found on the pages cited below.

- PFAS Program Management in a Rapidly Changing Regulatory Environment (page 21)
- Knowledge Gaps for Fate and Transport at Complex Sites (page 26)
- Status of the 2015 Geology Revolution… Where Are We Now and Where Do We Go from Here? (page 29)
- Opportunities and Challenges for Engineered Biology in Bioremediation (page 37)
- Science, Application, Monitoring, and Illustrative Case Studies of Biogeochemical Remediation (page 40)

Final Program PDF. This Preliminary Program lists all presentations scheduled as of March 10, 2023. It is subject to revision (changes of presenters, withdrawals) in the months leading up to the Symposium. A PDF of the Final Program will be posted on the Symposium website by April 24, 2023.

A printed copy of the Final Program will be provided with onsite registration material. Due to the size of the program—five panels and 453 platform talks and poster presentations—it is recommended that participants review the online Final Program PDF prior to the Symposium.

Proceedings. For each presentation made at the Symposium, the abstract will be included in the proceedings. In addition, the slide files will be included for most platform presentations. The proceedings will be made available only online after the Symposium to all technical program registrants.

Short Courses. Short Courses will be offered on Monday morning and afternoon before the Symposium begins. Course titles and times are listed on page 42. See pages 42-43 for the course schedule and descriptions. Courses are open to both Symposium registrants and non-registrants.

Exhibits, Internet Café, & Learning Lab

Exhibits. Exhibit booths will be provided by more than 50 organizations that conduct remediation activities or supply equipment used in such work. Exhibits will be on display from 7:00 p.m. Monday evening through 1:00 p.m. Thursday afternoon.

A few booth spaces are still available. Visit the **Sponsors and Exhibitors** page to be directed to a list of current Exhibitors and the online booth registration form.

Internet Café. The Internet Café will be located near the Learning Lab in the Exhibit Hall. Computers and charging outlets will be available to participants who wish to check email during Symposium hours Monday–Thursday.

Learning Lab. The Learning Lab, located in the Exhibit Hall, will consist of live demonstrations highlighting specific technologies, tools, and software. Each Learning Lab will be given once on Tuesday and once on Wednesday. See pages 45-49 for an overview of the schedule and descriptions.

Learning Lab Sponsors

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Meals and Receptions

For the convenience of Symposium participants, the following meals, breaks, and light receptions will be provided at no additional cost to program registrants and exhibit booth staff during the food service times listed. Food service for breakfasts, morning and afternoon beverage breaks, and receptions will be in the Exhibit Hall. Buffet lunches will be served in a separate ballroom to accommodate seating. Service times are subject to change in the months leading up to the Symposium and the final schedule will be posted in the Final Program.

Food Service Times

Breaks between sessions may not directly correspond with food and beverage service times. If you wish to attend specific functions, please plan your schedule accordingly.

Continental Breakfast
Tuesday-Thursday, 7:00–8:00 a.m.

Morning Beverage Break
Tuesday-Thursday, 9:30–10:15 a.m.

Buffet Lunches
Tuesday-Thursday, 11:30 a.m.–1:00 p.m.

Afternoon Beverage Breaks
Tuesday-Wednesday, 3:00–3:45 p.m.

Welcome Reception
Monday, 7:00–8:30 p.m.

Poster Group 1 Presentations & Reception
Tuesday, 5:45–7:00 p.m.

Poster Group 2 Presentations & Reception
Wednesday, 5:45–7:00 p.m.

Closing Reception
Thursday, 3:30–4:00 p.m.

For other meals and refreshments not provided by the Symposium, the following additional options are available in the hotel:

- Loaf + Vine: coffee, pastries, grab & go snacks, and essentials
- Corinne: daily breakfast, lunch, dinner, and weekend brunch
- The Lobbyist: bar and lounge with classic cocktails and light bites
- Rye Bar: one of the largest rye and whiskey selections in downtown Austin
- Zanzibar: modern tiki cocktails, island-inspired bites, and unbeatable skyline views

Guest Tickets. If registrants wish to bring guests to meals or receptions, guest tickets can be purchased at the Symposium Registration Desk; guest tickets will be priced equal to the cost incurred by the Symposium for each meal.

Closing Reception Sponsor

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Student Participation

University students are encouraged to attend the Symposium and will find participation valuable to their career development. In addition to the technical information gained by attending presentations and visiting exhibits, students will be able to meet and talk with environmental professionals representing a wide range of work experience and employers. Recruitment is a major focus of many participating Exhibitors and Sponsors and the Symposium will provide an unprecedented opportunity for student jobseekers.

Reduced Student Registration Rate. The student rate is approximately half the university rate and provides full access to all technical sessions, exhibits, and meals. Full-time students are eligible; documentation of current enrollment is required.

Student Paper Competition. Papers received by the February 3, 2023, due date were reviewed, and entrants notified. The winning paper is scheduled for presentation at the Symposium. The winner will be recognized during the Plenary Session and will receive a complimentary registration and, through the generosity of corporate sponsors, a monetary award to help defray travel and related costs.

Career KickStarter. A Career Kickstarter, organized and hosted by Clemson University alumni, for students and young professionals is scheduled from 3:00-5:00 p.m. on Monday afternoon. It is a program designed to foster networking and mentorship within the environmental sector.

All participation is voluntary and there is no cost to attend, but pre-registration is required to match mentors and mentees. A target of 20-30 professionals is desired for successful implementation. See the Student Participation page on the Symposium website to register.

New professionals will be matched with an experienced professional in a mentorship relationship, which both mentee and mentor are committed to sustaining for one year.

Mentors provide guidance and constructive criticism to students, actively engage their professional network on the student's behalf, educate the student on the ins-and-outs of their own profession, have regular meetings to ensure the student's goals are being met, and most importantly, provide encouragement.

Student Events Sponsors

Symposium Registration

The terms and conditions found below are an excerpt of the Registration Terms & Conditions; please review the Registration page on the Symposium website for the full list prior to registering. Terms and conditions are subject to change without notice and are applicable to all levels of registration, including booth staff and Sponsor/Exhibitor waived and discounted registrants. Symposium registration must be completed online, and payment is required to confirm registration. Registration discounts will apply only to payments received by the specified dates.

Technical Program Registration. The technical program fees cover admission to platform and poster sessions as well as exhibits and group food functions. In addition, each person registering at any of the following fees will receive the proceedings, which will be available in digital format after the Symposium. No one under 18 years of age will be admitted to any Symposium event unless registered as a student; valid student ID required at check-in.

Technical Program Registration

	Paid by March 29, 2023	Paid after March 29, 2023
Industry	$1,050	$1,125
Govt/Univ*	$925	$1,025
Student	$450	$500

** The university fee applies to full-time faculty and other teaching and research staff, including post-doctoral students.*
*** The student fee is reserved for full-time students through PhD candidates whose fees will be paid by their universities or who will not be reimbursed for out-of-pocket payment. Documentation of current enrollment is required.*

Payment. Symposium registration must be completed online, and payment is required to confirm registration. Registration discounts apply only to payments received by the specified dates. Checks will be accepted for registrations made through March 29, 2023. After that date, payment may be made only by major credit card. Purchase orders will not be accepted at any time. Symposium information meant for attendees only (e.g., links to mobile apps, abstracts, and registration lists) will be sent only to individuals who have paid in full.

Program Participant Registration Required

No financial assistance is available to support registration or other costs of attending the Symposium. All presenting authors (platform and poster), session chairs, and panel moderators/participants are expected to register and pay the applicable technical-program registration fees. This policy is necessary because registration fees are the major source of funding for the Symposium and a significant percentage of registrants will make presentations or chair sessions. No exceptions are made to this policy.

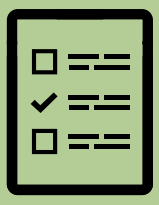
Non-U.S. Registrants. For registrants outside the United States, it is recommended that you wait until your visa application has been approved to register. Refunds will not be granted after the "no refund" date in the event your visa application is denied. If you require an invitation letter from the Symposium Office, please email the request to biosymp@battelle.org.

Substitutions & Transfers. Substitutions or transfers for technical program registrants will be accepted at any time but will incur a **$100 transfer fee**. Substitutions/transfers are valid only for a registration that has not been used. For example, a full Symposium registration (for all event days) may not be transferred between individuals for use on different days.

Cancellations & Refunds. Registration cancellations and refund requests must be received in writing on or before the "cancellation requested date" below to qualify. Paid no-shows will receive all the materials covered by their registration fees. Refunds will be processed to the credit card used for payment. No refunds will be made after April 10, 2023, for any reason.

By registering for the Symposium, you agree to the following registration cancellation refund policy:

- Cancellation requested on or before February 9, 2023—75% of the registration fee (less a $50 service fee)
- Cancellation requested between February 10, 2023, and April 9, 2023—50% of the registration fee (less a $50 service fee)
- Cancellation requested after April 10, 2023—no refunds.



Attendee List Opt-in

When registering for the technical program, you must OPT-IN to be included in Symposium attendee lists by checking the appropriate box on the registration form. Leaving the box unchecked will result in your name not being included in attendee lists.

Sponsor and Exhibitor Waived/Discounted Technical Program Registration. The links to register discounted sponsor/exhibitor technical registrants can be found on the Registration page on the Symposium website. The Organization ID associated with the company's booth reservation will be required to register discounted sponsor/exhibitor technical registrants and can be found in the booth reservation confirmation email. Only those registered for the technical program will be admitted to technical sessions. Anyone making a platform or poster presentation or chairing a session must be registered for the technical program.

Sponsor/Exhibitor Waived/Discounted staff and Booth staff are subject to all applicable registration terms and conditions. Technical program registrants may staff the exhibit booth as needed. Participation as a Symposium Sponsor qualifies an organization to two waived technical program registrations and two discounted technical program registrations ($750/each). Participation as an Exhibitor qualifies an organization to two discounted technical program registrations ($750/each). All booth staff must be registered online by April 7, 2023. Any changes or additions after April 7, 2023, will be assessed a $35 charge.

Identification & Badge Use. Attendee badges are the property of Battelle and are required for admittance to all Symposium functions (e.g., session rooms, Exhibit Hall) and must be visible at all times. Only the attendee named on the badge may pick up his or her badge and registration materials. By registering for the Symposium, you agree not to sell, trade, modify, copy, tamper with, or share/swap your badge. Badge fraud (i.e., theft of services) is detrimental to the Symposium and attendees found to be engaging in such conduct are subject to immediate ejection from the Symposium, registration cancellation, without refund, and possible prosecution and/or ban from future Symposiums.

Photo ID Required

A valid, government-issued PHOTO ID (driver's license/passport/student ID), that matches the name on the badge, will be required for verification upon check-in and/or to request a badge reprint for lost or forgotten badges. Only the attendee named on the badge may pick up his or her badge and registration materials.

Symposium Hotel

The Symposium will be held at the Austin Marriott Downtown (304 E. Cesar Chavez St, Austin, TX 78701). Indulge in this chic, urban retreat that offers luxury comfort and sophisticated amenities. The hotel features a rooftop pool with breathtaking views, two-level lobby bar, a signature restaurant, Corinne, and a rooftop tropical bar with tiki cocktails.

Room Blocks. A room block has been set aside at the Austin Marriott Downtown. The rates below are in effect for reservations made on or before 5:00 p.m. on Friday, April 14, 2023, unless rooms in the block sell out before that date. The group rate at the Austin Marriott Downtown is $285 per night (single/double) plus applicable taxes, fees, and assessments. Subject to availability of rooms at the time reservations are made, the group rate can be used for check-in as early as, Tuesday, May 2, and check-out as late as Sunday, May 14.

Online Reservations. Please use only the room block links listed on the Venue & Hotels page on the Symposium website to book your hotel reservations.

Symposium Hotel

The Bioremediation Symposium has a group rate agreement with only the Austin Marriott Downtown. The Symposium does not partner with any travel agency or third-party for travel/hotel discounts. If you receive a call or an email offering assistance in making hotel reservations or changing existing reservations, we advise caution. The Symposium has no agreement with any organization to contact participants and offer reservation assistance, nor have we provided contact information to anyone for this purpose.

Inquiries

Program details and presenter, session chair, and panelist coordination

Gina Melaragno (Battelle)
biosymp@battelle.org • phone 614.424.7866

Sponsorship, exhibits, registration, and hotel information

Susie Warner (The Scientific Consulting Group)
bio2023@scgcorp.com • phone 301.670.4990

TECHNICAL PROGRAM

The technical program will begin on Monday evening, May 8, with the Plenary Session. It will continue with the 46 breakout sessions and five panels Tuesday through Thursday and conclude Thursday afternoon with the Closing Panel discussion.

The breakout sessions and panels are organized into the following thematic tracks:

- Innovations in Bioremediation Technologies (Sessions A1-A6)
- Bioremediation Implementation Practices (Sessions A7-A11)
- Characterization and Remediation of PFAS (Sessions B1-B7)
- Biodegradation of Emerging Contaminants (Sessions B8-B10)
- Managing Petroleum Hydrocarbon-Impacted Sites (Sessions C1-C3)
- Application of Bioremediation to Complex Sites (Sessions C4-C7)
- Evaluating and Mitigating Vapor Intrusion (Sessions D1-D2)
- Advanced Tools for Assessing Bioremediation (Sessions D3-D9)
- Sustainability and Resilient Remediation (Sessions E1-E4)
- Environmental Impacts of Microplastics, Munitions, and Nitrates (Sessions E5-E7)
- Advances in Natural Attenuation (Sessions E8-E9)

There will be a Closing Panel discussion that will compile and summarize information from the technical program in each of the tracks. The goal for this closing panel is to synthesize information in a way that can be used to move practice areas forward.

Plenary Session

Monday, May 8, 5:30–7:00 p.m.

Welcome and Opening Remarks
Symposium Chairs:
Pamela Chang, PMP, MBA (Battelle)
Deepti Krishnan Nair (Battelle

Presentation of Student Paper Awards

Climate Change Implications and Solutions
Francis K. Wiese, Ph.D.
(Vice President, Science Director for Climate Solutions, Stantec)

Climate change is undeniably affecting all of us. Dr. Wiese will review some of the drivers and socio-ecological consequences of climate change and then focus on the diverse portfolio of feasible solutions we have at our disposal to adapt to and mitigate this crisis, together.

Dr. Francis Wiese is a marine ecologist and Stantec's Science Director for Climate Solutions. He received his B.S. in marine biology from the University of Victoria and Ph.D. in conservation and marine biology from Memorial University of Newfoundland and brings 29 years of experience working in the coastal and marine environment throughout the world, designing, implementing, and managing large inter-disciplinary, multi-institutional science programs that address important socio-ecological issues related to climate change, the ocean, and its uses. Dr. Wiese has been active in increasing ocean sustainability and climate change awareness and providing solutions working for and with academia, government, non-profit organizations, and industry. Throughout his career, he has extensively focused on climate change and other anthropogenic stressors on the environment, system science, adaptive management, resilience, and environmental policy.

He believes that we are better together, taking inclusive approaches and fostering partnerships across non-traditional lines. He is a technical reviewer for over 20 international journals and serves on a variety of national and international committees, science panels, and working groups, including as chair of the Understanding Gulf Ocean Systems (UGOS) and member of the Gulf Research Program Division Committee.

Climate change is undeniably affecting all of us. Sea ice, land ice, and permafrost keep declining; temperate extremes are getting worse, affecting the distribution, abundance, and health of plants, animals, and people, creating food insecurity; sea level rise is eroding shorelines, compromising sensitive coastal assets such as industrial sites, power stations, and hazardous waste material deposits; salt water intrusions are affecting agriculture yields and groundwater quality; increased frequency, intensity, and duration of hurricanes and other extreme weather events are affecting the livelihood of millions of people and costing billions each year; and existing building codes are becoming obsolete. Our natural, social, and economic systems are stressed and at ever increasing risk of collapse.

We have mostly been dealing with these issues one at a time as best as possible, but these compounded and cascading effects are forcing us to rethink our approach and to design and implement system-level risk assessments and solutions. Solutions that not only address the issues at hand in terms of adaptation, but that also bring additional benefits like climate change mitigation, habitat and biodiversity restoration, and increased human well-being and economic opportunities. Solutions that need to be developed with and for people, that are sustainable, and resilient to our future projected climate.

In this presentation, Dr. Wiese will review some of the drivers and socio-ecological consequences of climate change and then focus on the diverse portfolio of feasible solutions we have at our disposal to adapt to and mitigate this crisis, together.

Poster Group Schedule

Poster sessions are divided into two groups for display and presentation as shown below. Presenters will be at their posters during the designated presentation times to discuss their work. Light refreshments will be provided during the poster presentations.

Poster Group 1
Display: Monday 7:00 p.m. – Tuesday 7:00 p.m.
Presentations: Tuesday 5:45–7:00 p.m.

A1. Advances in Amendment Formulation
A2. Engineering Biogeochemical Transformation
A3. Enhanced Methods for Biodegradation/ Biotransformation of Organic and Inorganic Contaminants
A4. Phytoremediation
A5. Optimization of Classical Bioremediation Technologies
A6. Synthetic Biology Driven Remediation
A7. In Situ Bioremediation Applications
B1. Fate and Transport of PFAS
B2. Innovative Treatment Technologies for PFAS In Situ
B3. PFAS Program Management in a Rapidly Changing Regulatory Environment
C1. Natural Source Zone Depletion
C2. Remediation and Management of Petroleum-Hydrocarbon Contaminated Sites
C3. LNAPL Bioremediation/NSZD Modeling
D1. Innovative Tools for Evaluating Vapor Intrusion Risk
D2. Vapor Intrusion from Non-VOC Sources (*e.g.*, Mercury, Methane, PFOAs, and Radionuclides)
D3. HRSC and Conceptual Site Models
E2. Sustainable Remediation Assessment Tools
E3. Robotic Technologies for Environmental Site Assessment and Monitoring
E4. Adaptive Site Management Strategies to Mitigate Climate Change Impacts

Poster Group 2
Display: Wednesday 7:00 a.m. – Thursday 1:00 p.m.
Presentations: Wednesday 5:45–7:00 p.m.

A8. Innovative and Efficient Amendment Delivery Strategies
A9. Ex Situ and Vadose Zone Biological Treatment
A10. Biobarrier Installation and Management
A11. Challenges in Application of Bioremediation Tools
B4. Activated Carbon-Based PFAS Treatment Technologies
B5. Innovative Treatment Technologies for PFAS Ex Situ
B6. Comparing Ex Situ Destructive Technologies
B7. PFAS in Surface Water and Storm Water
B8. Addressing Emerging Contaminants in a Regulatory Framework
B9. Emerging Contaminants: Detection, Degradation, Fate and Transport
B10. 1,4-Dioxane Treatment Technologies
C4. Bioremediation in Complex Geological Settings
C5. Impacts of Mixed Contaminants on Biodegradation
C7. Bioremediation Approaches for the Innovative Management of Large or Dilute Plumes
D4. Big Data and Integration of Molecular Tools in Site Assessment: Advanced Omics
D5. Modeling and Monitoring Approaches to Improve Remedy Design and Implementation
D6. High-Resolution Site Characterization
D7. Chemical Fingerprinting and Forensics
D9. Tools for Site Assessment and Bioremediation Monitoring
E5. Microplastics and Nanoplastics: Degradation and Effects on the Environment
E6. Bioremediation of Munitions Constituents
E7. Treatment of Nitrate-Impacted Groundwater
E8. Advances in Tools and Techniques for Assessing MNA
E9. Groundwater/Surface Water Interactions

Breakout Sessions and Panels

All presentations scheduled as of March 10, 2023, are listed below in alphabetic order by title. In each entry, the author list appears in italics, followed by the name and affiliation of the person scheduled to give the presentation. Each title beginning with an asterisk (*) is to be presented as a poster presentation.

The schedule is subject to revision (e.g., changes of presenters, withdrawals) in the months leading up to the Symposium. To assist participants in planning their time while onsite, the Final Program and abstracts will be made available approximately two weeks prior to the Symposium. Everyone preregistered and paid will receive an email providing links to the resources.

A1. Advances in Amendment Formulation

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Stephen Richardson (GSI Environmental) and Lydia Ross (EOS Remediation)

Carbon + Nutrients = Stronger Bacteria = Faster Remediation. *L. Ross, J.F. Ortiz-Medina, B. Elkins, and B. Yuncu.*
Lydia Ross (EOS Remediation/USA)

The In Situ Treatment of Dissolved BTEX and Gasoline Residues Using Micro Activated Carbon. *R. McGregor.*
Rick McGregor (InSitu Remediation Services Ltd./Canada)

Rhamnolipids Compositions for Hydrocarbon-Contaminated Soil Remediation: Part II. *G. Ren, D.G. Brown, P. Ni, A. Sanders, S. Compston, K. Ayres, and K. Wilson.*
Ginger Ren (Stepan/USA)

Solid Phase Colloidal Organic Amendments Promote Sustained Biodegradation in Permeable Reactive Barriers. *P. Erickson, S. Nguyen, J. Freim, R. Moore, and J. Parker.*
Paul Erickson (REGENESIS/USA)

***Sulfidated Zerovalent Iron: An Innovative ISCR Technology for Discrete Source Remediation.** *A. Danko, D. Fan, H. Rectanus, N. Durant, P. Tratnyek, R. Johnson, and G. Johnson.*
Dimin Fan (Geosyntec/USA)

***Sulfidated Zerovalent Iron: Effects on Subsurface Microbial Communities and Biological Dechlorination.** *P. Tratnyek, G. O'Brien Johnson, D. Fan, H. Rectanus, H. Girod, and A. Danko.*
Helen Girod (Geosyntec Consultants, Inc./USA)

***Sulfidated ZVI Accelerates Bioremediation in Permeable Barriers and Source Zones.** *J. Freim and S. Nguyen.*
John Freim (REGENESIS/USA)

A2. Engineering Biogeochemical Transformation

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Shandra Justicia-Leon (Arcadis) and Frank Loeffler (University of Tennessee)

***Application of a Combined Biological, Chemical and Biogeochemical Treatment of a Trichloroethene Plume in Northern California.** *A. Chemburkar, D. Leigh, and S. Telesz.*
Daniel Leigh (Evonik/USA)

***Low Temperature Thermal Optimization of Source Treatment at Two Chlorinated Solvent Sites.** *J. LaChance and E. Cooper.*
Eliot Cooper (Cascade Environmental/USA)

Min-Traps for Collection and Analysis of Reactive Iron Sulfide Minerals for Abiotic CVOC Degradation. *C. Divine, S. Justicia-Leon, J. Tilton, D. Liles, D. Taggart, and K. Clark.*
Craig Divine (Arcadis/USA)

Passive Treatment of Metals-Impacted Water Using Sulfate-Mediated Metals Reduction (SMMR). *J.J. Smith, T. Carlson, M. Williams, D. Graves, S. Dworatzek, S. Cronk, and K. Cracchiola.*
Jacques Smith (SiREM/USA)

Spatial and Temporal Application of Two Remedial Technologies at an Active Industrial Site Help Manage the Environmental Risks. *R. Srirangam, F. Lakhwala, A. Kokorsky, and J. Wood.*
Ravikumar Srirangam (Evonik/USA)

Viewing the End from the Beginning: Designing for the Transition to Long-Term Passive Phases of In Situ Chlorinated Solvent Treatment. *J.M. Tillotson, M. McCaughey, S. Justicia-Leon, and C. Divine.*
Jason Tillotson (Arcadis/USA)

A3. Enhanced Methods for Biodegradation/ Biotransformation of Organic and Inorganic Contaminants

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Ronnie Britto (Tetra Tech, Inc.) and Michael Lamar (CDM Smith Inc.)

Biogeochemically-Enhanced Treatment of Chlorinated Organics and Metals. *D. Leigh and A. Seech.*
Daniel Leigh (Evonik/USA)

***Bioremediation of Oil Sands Process Water (OSPW).** *D. Saran, C. Nelson, M. Albright, and K. Sorenson.*
Dayal Saran (Allonnia/USA)

* = poster presentation

Characterization and Pilot Testing to Demonstrate Innovative Amendment Emplacement for In Situ Biological/Chemical Reduction of VOCs (as DNAPL) in Bedrock. *R.A. Wymore, E.C. Ashley, and N. Castonguay.*
Ryan Wymore (CDM Smith, Inc./USA)

A Comparative Study of the Ability of ISCO and EISB to Treat Multiple Contaminants at a Complex Industrial Landfill Site. *S. Dworatzek, L. Smith, K. Ashworth, M. Harkness, R. Hornung, J. Vollick, L. Streeter, C. Toth, and E. Edwards.*
Sandra Dworatzek (SiREM/Canada)

***Contaminant Degradation within Colloidal Activated Carbon Treatment Zones: A Multi-Site Review to Demonstrate Complete Destruction and Reduction of CVOCs Contaminants Using Multiple Lines of Evidence.** *C. Ortiz, P. Erickson, B. Griffiths, and C. Sandefur.*
Carlos Ortiz (REGENESIS/USA)

***Ecosystem Restoration by Thermal In Situ Sustainable Remediation (TISRTM).** *J. Munholland.*
Jonah Munholland (Arcadis/USA)

***Expedited Organo-Halide Destruction via Biostimulation without Augmentation Supported by Introduction of Abiotic Electron Donor.** *K.C. Armstrong, K. Rapp, H. Anderson, and M.W. Fields.*
Kent C. Armstrong (TerraStryke Products, LLC/USA)

Fiscally Conscious DNAPL Remediation: Legacy Liability to Managed Closure. *W.L. Brab and K.E. Thompson.*
Bill Brab (AST Environmental, Inc./USA)

Heated Water Recirculation to Enhance In Situ Abiotic and Biotic Degradation. *F.J. Krembs, M. Olson, M. Irianni Renno, S. Quint, R. Hefner, M. Mercier, A. Sansom, Q. Le, N. Geibel, and M.C. Maxwell.*
Fritz Krembs (Trihydro Corporation/USA)

***The Impact of Activated Carbon Grain Size on Bioremediation.** *E.W. Winner.*
Ed Winner (Remediation Products, Inc./USA)

***Living Room, Transportation, and Biofilm Community: The Overlooked Infrastructure in Subsurface Microbial Biodegradation.** *E.W. Winner.*
Ed Winner (Remediation Products, Inc./USA)

Metagenomic Characterization of a Bioreactor with Polyhydroxyalkanoates and Biochar as Biomaterials to Prompt Reductive Dechlorination. *B. Matturro, M.L. Di Franca, M.M. Rossi, L. Lorini, M. Petrangeli Papini, and S. Rossetti.*
Bruna Matturro (Water Research Institute-National Research Council/Italy)

***Microbial Sulfate Reduction in the Presence of Zero Valent Iron: Responses to Purity and Surface Treatment.** *N. Khan and K. Millerick.*
Nofil Khan (Texas Tech University/USA)

***A Sustainable Approach for Chlorinated Compounds Contaminated Groundwater Remediation: Raw Polyhydroxyalkanoates (PHA) from Organic Waste as Electron Donor for Biological Reductive Dechlorination Coupled with Adsorption on Biochar.** *L. Lorini, M. Mariorenzi, M. Petrangeli Papini, B. Matturro, and S. Rossetti.*
Laura Lorini (La Sapienza University of Rome/Italy)

Use of Cutting-Edge Molecular Microbial Technologies to Drive a Successful, Novel, Anaerobic Enhanced In Situ Bioremediation of Legacy Benzene. *E.M. Jennings and T. Frantz.*
Eleanor Jennings (Parsons Corporation/USA)

A4. Phytoremediation

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Heather Henry (National Institute of Environmental Health Sciences, NIH) and Timothy Mattes (University of Iowa)

Bioaugmented Phytoremediation to Treat 1,4-Dioxane Contaminated Groundwater. *R.A. Simmer, P.J. Dixon, L. Licht, T.E. Mattes, and J.L. Schnoor.*
Reid Simmer (University of Iowa/USA)

***Effects of Root Exudates on 6:2 FTOH Biotransformation and Soil Microbiome.** *S.H. Yang, L. Shan, and K.H. Chu.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

New Advances in Phytoremediation and Keys to Success on Challenging Sites. *J.L. Freeman, G. O'Toole, and R. Murphy.*
John Freeman (Intrinsyx Environmental/USA)

PFAS Phytoscreening for Rapid, ad-hoc Detection of PFAS Groundwater Impacts: Initial Results from the Rastatt/Baden-Baden Site, Germany. *A. Würth, P. Martus, M.A. Ikipinar, M. Mechler, R. Boeddinghaus, P. Blum, K. Menberg, and R. Söhlmann.*
Peter Martus (AECOM/Germany)

***Phytoremediation for Management of a Firefighter Training Site Waste Stream.** *K.E. Farrington, D.F. McMillin, A.E. Lumley, R.S. McDonald, W.B. Salter, D. Bennett, E. Torres Soto, H.R. Luckarift, G.R. Johnson, and J.R. Owens.*
Glenn Johnson (Battelle Memorial Institute/USA)

*** = poster presentation**

***Remediation of a CVOC Plume Using TreeWell® Phytoremediation Technologies as Part of a Combined Remedies Approach.** *C. Gale, B. Smith, D. Riddle, and D. Wanty.*
Christopher Gale (Applied Natural Sciences/USA)

***Retaliation of *Alstonia scholaris* (L.) R.Br. to Stable and Radioactive Cesium (^{137}Cs and Strontium $^{(90}$Sr): A Sustainable Remediation Approach for Mitigation of Radionuclide-Polluted Sites.** *B.S.M. Singh, N.K. Dhal, and D.K. Mohapatra.*
B.S. Manisha Singh (CSIR-Institute of Minerals and Materials Technology/India)

Stable Isotope Probing (SIP) of Rhizosphere Bacteria in 6:2 Fluorotelomer Sulfonic Acid (6:2 FTSA)-Contaminated Soil. *S.H. Yang, L. Shan, and K.H. Chu.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

A5. Optimization of Classical Bioremediation Technologies

Platforms Wednesday | Posters (*) Tuesday Evening
Chairs: Daniel Leigh (Evonik) and Michael Singletary (U.S. Navy)

***Chlorinated Solvent Plume Reduced >95% via In Situ Combined Remedy Leading to Long-Term VI Risk Reduction at State-Led Project.** *J. Parker and R. Moore.*
Joel Parker (Hamp, Mathews and Associates/USA)

***Combining ISCR and Antimethanogenic Reagents to Achieve Substantial CVOC Reduction.** *T. Lizer, W. Moody, and M. Scalzi.*
Troy Lizer (Provectus Environmental Products, Inc./USA)

***A Comprehensive Combination of Remedial Treatment Technologies Shows Success for a Complex Site.** *E. Raes, D. Busch, M. Meriney, and A. Peacock.*
Eric Raes (Engineering & Land Planning Assoc., Inc./USA)

Enhanced Reductive Dechlorination after In Situ Chemical Oxidation: Moving Past the Myth to Design Effective Combined Treatment Remedies. *P.M. Dombrowski, S. Pittenger, P. Kakarla, J. Roberts, and P. Dennis.*
Scott Pittenger (In-Situ Oxidative Technologies, Inc. [ISOTEC]/USA)

Evaluating the Effect of Salinity on In Situ Biological Reduction of a 1,2-DCA Plume. *I. Pelz, A. Chemburkar, A. Breckenridge, J. Kerl, and D. Leigh.*
Isaac Pelz (ERM/USA)

***Evaluation and Implementation of Horizontal Biosparging for Expedited Remediation of Petroleum Hydrocarbons.** *T. Will, D. Forse, and M. Sequino.*
Tomas Will (Directional Technologies, Inc./USA)

Field-Scale Evaluation of Biosparging at a CERCLA Site to Deplete Groundwater Contaminants from Creosote and Achieve Remedial Action Objectives. *R. Sillan, R. Holm, G. Jeffries, and J. Smith.*
Randall Sillan (AECOM/USA)

***In Situ Bioremediation of Chlorinated Solvents at a Low pH Site.** *B. Yuncu.*
Bilgen Yuncu (TRC/USA)

In Situ Treatment for Hexavalent Chromium Using ISCR Enhanced Bioremediation in Saturated Clay Soils Results in No Further Action. *O. Miller and R. Moore.*
Owen Miller (REGENESIS/USA)

***Lessons Learned from Large-Scale Bioaugmentation at a Remote Site.** *S. Pittenger, P.M. Dombrowski, K. O'Neal, C. Scales, and J. Roberts.*
Scott Pittenger (In-Situ Oxidative Technologies, Inc. [ISOTEC]/USA)

***Modifying Remedial Strategies to Facilitate In Situ Reductive Dechlorination at a Long-Term Chlorinated Solvents Site.** *M. Apgar and A. Dahlbacka.*
Michael S. Apgar (Fishbeck/USA)

***Optimization of a Permeable Reactive Barrier for Chlorinated Solvents.** *A. Sutton, B. Henry, E.C. Heyse, C. Hewitt, and J. Roberts.*
Aaron M. Sutton (Parsons/USA)

Optimization Techniques for Aging SVE Systems. *M. Ingraham, T. Andrews, and T. Kremmin.*
Miles Ingraham (Jacobs/USA)

***Optimizing Injection and Monitoring of Bioaugmentation Cultures for In Situ Bioremediation.** *C. Scales, J. Roberts, and P. Dennis.*
Corey Scales (SiREM/Canada)

***Site-Specific Reductive Dechlorination Designs Bundling Multiple Abiotic with Biotic Reagents: Lessons Learned.** *P.M. Dombrowski, P. Kakarla, M. Lee, and D. Raymond.*
Paul Dombrowski (In-Situ Oxidative Technologies, Inc. [ISOTEC]/USA)

A6. Synthetic Biology Driven Remediation

Platforms Wednesday | Posters (*) Tuesday Evening
Chairs: Kate Kucharzyk (Battelle) and Dayal Saran (Allonnia)

Biosourcing for Microbially Driven Polyethylene Degradation. *K.K. Kucharzyk, R.W. Murdoch, J. Lilly, S. Higgins, M. Evans, E. Beasley, and C. DeSanti.*
Kate Kucharzyk (Battelle/USA)

*** = poster presentation**

Developing Novel On-Site Handheld Biosensors for PFAS Constituents. *D. Saran, A. Banerjee, and K. Sorenson.*
Dayal Saran (Allonnia/USA)

***Microbial Activity is Higher in Sediments than Associated Groundwater for Shallow Pristine and Contaminated Aquifers.** *H.J. Smith, I. Miller, D. Joyner, K. Walker, T.C. Hazen, and M.W. Fields.*
Matthew Fields (Montana State University/USA)

A Molecular Approach to Lindane Biodegradation. *C. Masini and F. Brogioli.*
Cosimo Masini (DND Biotech srl/Italy)

***Synthetic Biology-Driven Approach to Repurpose Polyamides (STORM).** *E. Beasley, J. Lilly, M. Valiev, M. Cheng, J. Bardhan, and K.H. Kucharzyk.*
Emma Beasley (Battelle/USA)

Tools for the Characterization and Manipulation of Reductive Dehalogenases for Bioremediation of Chlorinated Solvents. *K.J. Picott, C. Bowers, and E.A. Edwards.*
Katherine J. Picott (University of Toronto/Canada)

A7. In Situ Bioremediation Applications

Platforms Wednesday | Posters (*) Tuesday Evening
Chairs: Holly Brown (AECOM) and Will Moody (Provectus Environmental Products, Inc.)

Aerobic Cometabolic Remediation of Chlorinated Ethenes as a Barrier to Impacted Groundwater Discharge to a Brook. *B. O'Dell, S. Sharma, and B. Timmins.*
Brent O'Dell (Wood Environment & Infrastructure Solutions/USA)

***Bench-Test and Pilot-Scale Bioaugmentation of a Hydrocarbon-Contaminated Site by a High-Performance Bacteria Consortium.** *I.J.S. Mello, L.T.M. Cruz, and C. Gonçalves.*
Igor Mello (CPEA/Brazil)

Biological Degradation and Chemical Reduction to Reduce DNAPL and Dissolved COCs to Turn off an Extraction System. *R.E. Mayer, P. Bauer, E. Schlegel, and K. Cronin.*
Robert Mayer (APTIM/USA)

***Biosparging Application Using Horizontal Remediation Wells.** *M. Lubrecht, J. Gallagher, and D. Ombalski.*
Jacob Gallagher (Ellingson Companies/USA)

***A Case Study of In Situ Bioremediation of Low Permeability Soils Using Specialized Waterjet Technology.** *S. Uesawa, J. Yamanobe, K. Takayanagi, K. Ishikawa, T. Shioya, M. Yeh, and R. Borden.*
Susumu Uesawa (Chemical Grouting Co., Ltd./Japan)

***A Combined Remedy of In Situ Chemical Oxidation and Aerobic Bioremediation to Treat the Emerging Contaminant Tetrahydrofuran.** *O. Miller and R. Moore.*
Owen Miller (REGENESIS/USA)

***Combined Remediation Technologies Pave the Way for the Rapid Redevelopment of a Legacy Brownfield Site.** *J. Freim and C. Lee.*
John Freim (REGENESIS/USA)

***Controlling Trichloroethene Aerobic Cometabolism Rate and Microbial Biomass Using Acetylene.** *J.P. Skinner, C. McLaughlin, A.G. Delgado, and J. Chu.*
Justin Paul Skinner (Arizona State University/USA)

***Easy Installation and Quick BTEX Reductions in Poorly Accessible Off-Site Locations Using Biosparging via Nested Horizontal Wells.** *L.I. Robinson and W.F. Wiley.*
Lance Robinson (EN Rx, Inc./USA)

In Situ Treatment of Polychlorinated Biphenyl-Impacted Sediments with Bioamended Activated Carbon. *K.R. Sowers and U. Ghosh.*
Kevin Sowers (University of Maryland, Baltimore County/USA)

In Situ Vadose Zone Perchlorate Remediation Using Emulsified Vegetable Oil. *R. Royer, J. Wood, B. Longino, and G. Hamer.*
Richard Royer (Arcadis/USA)

***Laboratory Development of an Aerobic In Situ Bioreactor for Removal of HCH in Groundwater.** *J. Escobar-Arnanz, J. Berganza, P. Brettes, R. Encinas, T. Alonso, and D. Alcalde.*
Juan Escobar Arnanz (AECOM/Spain)

Steam-Enhanced Biodegradation of TCE in Mixed LNAPL under an Active Building: Naval Air Station North Island. *V. Hosangadi, K. Asam, A. Hoseyni, R. Robitaille, P. Chang, and M. Pound.*
Vitthal Hosangadi (NOREAS, Inc./USA)

***Treatability Study Results for In Situ Treatment of Chlorinated Solvents at a Formerly Used Defense Site.** *M.L. Alexander, V.K. Peterson, D.J. Lowak, and G. Philpy.*
Matthew Alexander (Leidos/USA)

***Using CSIA to Verify Effectiveness of Coupling Synthetic Iron Sulfide Injections with Bioaugmentation to Address a Trichloroethylene Plume.** *A. Karachalios and D. Alden.*
Antonis Karachalios (Tetra Tech/USA)

* = poster presentation

A8. Innovative and Efficient Amendment Delivery Strategies

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Todd Hanna (Legacy Remediation, Inc.) and John Haselow (Redox Tech, LLC)

Accessing Difficult Geology for Characterization and Injection Using the New GeoTAP™ Method. *D. Pizarro and T. McCullough.*
Derek Pizarro (AST Environmental, Inc./USA)

***Amendment Delivery Methodology for Permeable Reactive Barrier (PRB) Installation in a Challenging Lithology at Shaw AFB, Sumter, South Carolina.** *G. Simpson, D.A. Pizarro, D. Christensen, S. Palakur, and J. Chytil.*
Derek Pizarro (AST Environmental, Inc./USA)

***Analysis of the Viability of Gravel as a Backfill Material for Biostimulation Systems.** *A. Alvarez and S.D. Siciliano.*
Alejandro Alvarez (University of Saskatchewan/Canada)

***Combined In Situ Remediation to Address DNAPL in Shallow Overburden and Weathered Bedrock.** *K. Lazzeri, J. McNew, W. Moody, and W. Meese.*
Jason McNew (EA Engineering, Science, and Technology, Inc., PBC/USA)

Coupling Hydraulic Fracturing with Bioremediation for Treatment of Chloroethenes and 1,4-Dioxane in Low-Permeability Formations. *A.M. Baird, C.M. Ross, and M. Klosky.*
Drew Baird (FRx, Inc./USA)

Direct Sonic Injection for Enhanced Remediation. *S. Chen, C. Lacko, and J. Haselow.*
John Haselow (Redox Tech, LLC/USA)

***How Much Carbon and Bioaugmentation Are Needed for Effective Reductive Dechlorination?** *L. LaPat-Polasko and J. King.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

***Hydraulic Emplacement of Zero-Valent Iron Coupled with In Situ Bioremediation for VOC Treatment in a Low-Permeability Aquifer.** *C.J. Voci and C.M. Ross.*
Christopher Voci (Terraphase Engineering/USA)

***In Situ Biological Remediation of Chromium, Nitrate and Chlorinated VOCs Using an Innovative Electron Donor Delivery Approach.** *T. Carlson, H. Cox, C. Marks, and M. Williams.*
Trevor Jason Carlson (Geosyntec Consultants/Canada)

***A New Approach to Amendment Delivery to Multiple Locations.** *M.M. Scalzi.*
Michael Scalzi (Innovative Environmental Technologies, Inc./USA)

***Permeable Reactive Transects for Treatment of Hexavalent Chromium in Varied Geology.** *D.A. Pizarro and T. McCullough.*
Derek Pizarro (AST Environmental, Inc./USA)

Quantifying Delivery of Particulate Amendments in Heterogeneous Aquifers Using Electrical Resistance Tomography. *T.W. Macbeth, I. Lo, J. Romig, T. Johnson, K. Muller, and L. Zhong.*
Tamzen Macbeth (CDM Smith Inc./USA)

Selection of Drilling Method for Effective Amendment Delivery. *R.A. Meyer.*
Robert Meyer (Talon/LPE, Ltd./USA)

A9. Ex Situ and Vadose Zone Biological Treatment

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Francisco Barajas-Rodriguez (AECOM) and Alan Seech (Evonik Corporation)

Bioremediation of Soils Containing Organic Explosive Compounds Using ZVI/Organic Carbon Reagents. *J. Valkenburg and A. Seech.*
John Valkenburg (Evonik/USA)

***Community-Level Bacterial Evolution for the Bioremediation of Biofuel n-butanol.** *K.T. You Mak, E.R. Hanschen, and B.T. Hovde.*
Kayley You Mak (Los Alamos National Laboratory/USA)

Enhanced Bioremediation of Pentachlorophenol-Contaminated Soil. *A.G. Seech.*
Alan Seech (Evonik Corporation/USA)

***Ex Situ Biological Treatment of Hydrocarbon Contaminated Soil with eCUBE Microbial Electrochemical Technology.** *A. Franzetti, A. Espinoza, F. Formicola, T. Stella, V. Suagher, and L. Righini.*
Andrea Franzetti (University of Milano Bicocca/Italy)

Field Test of a Pilot-Scale Sequential Reductive/Oxidative Bioelectrochemical Process for CAH Removal from Contaminated Groundwater. *E. Dell'Armi, M. Zeppilli, M. Majone, and M. Petrangeli Papini.*
Edoardo Dell'Armi (University of Rome "La Sapienza"/Italy)

***Immobilization of Lead in Contaminated Soil Using Enzyme-Induced Calcite Precipitation (EICP) along with Coconut Fiber Biochar (CFB).** *K. Roksana, S.A. Hewage, W. Xue, and C. Zhu.*
KANIZ ROKSANA (Rowan University/USA)

* = poster presentation

***Lessons Learned during Ex Situ Bioremediation at a Large Hydrocarbon Contaminated Site.** *G. Overbeeke and P. Wilson.*
Gavin Overbeeke (AEL Environment/Canada)

Managing the Health of an Ex Situ Anoxic Bioreactor. *J. Hyrman, M. Otto, B. Robinson, J.T. Slater, P. Flaherty, and M. Azad.*
Joshua D. Hyrman (ERM/USA)

Optimizing Bioremediation of Recalcitrant Soil Contaminants in Canada's Cold Climate. *J. Pare and M. Bendouz.*
Jean Pare (Chemco, Inc./Canada)

***Soil Bioremediation at a Former Insecticide Warehouse.** *R.E. Guerra and A. Seech.*
Rodrigo Guerra (SETISA/El Salvador)

***Treatability Testing for Effective In Situ Metals Immobilization at Complex Sites: Objectives, Methods, Results, and Lessons Learned from Vadose Zone Applications.** *R.S. Srirangam and A. Seech.*
Ravikumar Srirangam (Evonik/USA)

A10. Biobarrier Installation and Management

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Arul Ayyaswami (Tetra Tech, Inc.) and Michael Lee (Terra Systems, Inc.)

Challenging In Situ Chemical Reduction PRB Approach on Industry Impacted by Chlorinated/Zinc/Copper Bioremediation in Brazil. *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, R. Moura, N. Nascimento, J. Mueller, T. Lizer, W. Moody, W. Meese, and M. Scalzi.*
Sidney Aluani (SGW Services/Brazil)

***Design and Installation of a Thermally-Enhanced Biological Barrier.** *F. Coelho.*
Flavio Coelho (ERM/USA)

Design of Permeable Reactive Barriers to Reduce Nitrogen Flux. *M.D. Lee, R.L. Raymond, Jr., P. Dombrowski, M. Charrette, P. Henderson, K. Rathjen, T. Parece, M. Owen, J. Marrion, J.C. Thomas, B.L. Howes, B. Paulsen, and D. Heely.*
Michael Lee (Terra Systems, Inc./USA)

Furthering Hydrologic Characterization by Visual Mapping of Injection Data. *A. Kavanagh and D. Davis.*
Andrew Kavanagh (REGENESIS/USA)

Identification of Actionable Data for Maintenance Permeable Reactive Biobarriers. *M. Burns and M.J. Brown.*
Matthew Burns (WSP/USA)

A11. Challenges in Application of Bioremediation Tools

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Bill Newman (RNAS Remediation Products) and Michael Pound (NAVFAC SW)

Achieving Project Success through Remediation Failure. *R. Oesterreich.*
Ryan Oesterreich (Arcadis/USA)

Comparison of In Situ Bioremediation of Perchlorate and Chlorinated Solvents at Three Sites in Close Proximity: Challenges and Lessons Learned. *W.A. Foss, P. Srivastav, and R.E. Mayer.*
William Foss (APTIM/USA)

EVO Use in Hard Water Aquifers: Implications and Strategies for Successful Substrate Distribution. *J.F. Ortiz-Medina, L. Ross, B. Elkins, and R.C. Borden.*
Fausto Ortiz (EOS Remediation/USA)

***Fast-Tracking Aggressive Remediation in Clay Soils with a Challenging Site Setting.** *E. Bishop, A. Gerringer, M. Bennett, P.M. Dombrowski, and K. O'Neal.*
Elizabeth Bishop (Haley & Aldrich, Inc./USA)

Successful Enhanced Reductive Dechlorination in Bedrock with Long-Term Monitoring: Two Case Studies. *P.M. Dombrowski, P. Kakarla, M. Temple, M. Lee, D. Raymond, and C. Weeden.*
Paul Dombrowski (In-Situ Oxidative Technologies, Inc. [ISOTEC]/USA)

***Toluene-Producing Bacteria from Sediments and Groundwater of the Southeastern U.S.** *R.J. Poche, K.G. Namikas, M.M. L'Hoste, and W.M. Moe.*
William Moe (Louisiana State University/USA)

B1. Fate and Transport of PFAS

Platforms Tuesday| Posters (*) Tuesday Evening
Chairs: David Adamson (GSI Environmental Inc.) and Ramona Iery (U.S. Navy)

***Aerobic Biodegradation of PFOA/PFOS: Promising Benchtop Studies and Preliminary Field Applications.** *L. Mankowski, D. Chiang, T. Repas, J. Adams, and H.L. Lord.*
Leonard Mankowski (WSP/USA)

***Biological and Chemical Transformation of a PFAS Precursor with Insights into PFAS Fate and Forensics.** *E.K. Cook, C.I. Olivares, E.H. Antell, S. Yi, A. Nickerson, Y.J. Choi, C.P. Higgins, D.L. Sedlak, and L. Alvarez-Cohen.*
Emily K. Cook (EKI Environment & Water, Inc./USA)

*** = poster presentation**

***Can PFAS Contamination Spread to Soil, Surface Water and Groundwater by Aerosols and Foams Generated in Sea Water?** *S.R. Lenschow, A.G Christensen, A.B. Henriksen, H. Sckerl, and M. Corneliusen.*
Soren Lenschow (NIRAS A/S/Denmark)

***A Decade of Environmental Sequence Stratigraphy at Air Force Bases: Implications for Groundwater Assessment and Remediation.** *M.R. Shultz, C.P. Plank, and M. Anding.*
Mike Shultz (Burns & McDonnell/USA)

***Enzymes Capable of Biotransforming Perfluoroalkyl Acid (PFAA) Precursors and Their Metabolites.** *S.H. Yang, J.H. Kim, C.H. Shih, J.H. Chung, and K.H. Chu.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

Lysimeters to Evaluate PFAS Leaching at AFFF-Impacted Sites. *C.E. Schaefer, Y. Fang, S. Shea, N. Gonda, and C.P. Higgins.*
Charles Schaefer (CDM Smith Inc./USA)

Methods to Estimate Recharge to Determine Mass Discharge from Unsaturated Zone PFAS Source Areas. *C.J. Newell, E.B. Stockwell, K.L. Walker, D.T. Adamson, J. Alanis, and R.H. Anderson.*
Charles Newell (GSI Environmental Inc./USA)

***PFAS Assimilation during Bacterial Biosynthesis.** *D. Ramirez, Y. Xie, and F. Loeffler.*
Diana Ramirez (University of Tennessee/USA)

PFAS Bioremediation: The Tools We Have and the Knowledge We Need. *S. Rosolina, K. Clark, and D. Taggart.*
Sam Rosolina (Microbial Insights, Inc./USA)

PFAS Leaching Test and Soil Threshold Calculations by Means of Analytical Models. *F. Motta, S. Verdelocco, and G. Volpi.*
Francesca Motta (AECOM/Italy)

***Regional PFAS Soil Investigation of the Air Deposition Pathway.** *C. Fath, B. Angerman, and J. Dippert.*
Casy Fath (Barr Engineering Co./USA)

***Research Gaps and Challenges in Terms of Fate of PFAS during Wastewater Treatment, Incineration and Landfill Disposal.** *Y. Kunukcu.*
Yasemin Kunukcu (Roux Inc./USA)

***Using a Multi-Phase, Finite-Difference, Multi-Species Model that Accommodates Dynamic Sorption and Competitive Interactions to Interpret and Predict PFAS Fate and Transport.** *J. Birnstingl and K.M. Gaskill.*
Jeremy Birnstingl (REGENESIS/USA)

***Using Groundwater Plume Analytics® Tools to Assess PFAS Fate and Transport.** *J.A. Ricker and D.C. Winchell.*
Joseph Ricker (WSP/USA)

***Vermont-Wide Assessment of Anthropogenic Background Concentrations of Perfluoroalkyl Substances in Surface Soils.** *E. Maker, W. Zhu, A.R. Badireddy, H. Roakes, and S.G. Zemba.*
Elliot Maker (REGENESIS/USA)

Vertebrae™ Segmented Wells for Monitoring Contaminant Mass Discharge. *K. Hasbrouck, C. Divine, B. Parker, and L. Robinson.*
Kristen Hasbrouck (Tanaq Environmental LLC/USA)

What is Remediation Geology and Why Should It be a Part of Every PFAS Remedial Investigation? *R.S. Cramer, M.R. Shultz, and C.P. Plank.*
Rick Cramer (Burns & McDonnell/USA)

B2. Innovative Treatment Technologies for PFAS In Situ

Platforms Tuesday| Posters (*) Tuesday Evening
Chairs: Stephen Rosansky (Battelle) and Charles Schaefer (CDM Smith Inc.)

***Assessing Potential for PFAS Remediation in Glacial Till.** *A. Oka, K. Kaur, E. Sterzinar, X. Yin, S. Abrams, and B. Blum.*
Amita Oka (Langan/USA)

Biodegradation of Fluorotelomer-Based PFAS by Soil Cultures Enriched with Various Carbon Sources. *J. Kim, K. Chu, M.I. Van Meter, M.L. Kim-Fu, S.W. Leonard, and J.A. Field.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

Colloidal Activated Carbon to Enhance Natural Attenuation of PFAS at Airports Worldwide: A Multiple Site Review. *M. Dooley and R. Moore.*
Maureen Dooley (REGENESIS/USA)

***Coupled High- and Low-Frequency Ultrasound Remediation of PFAS-Contaminated Soils.** *R. Marsh, J.A. Kewalramani, B. Wang, and J. Meegoda.*
Richard Marsh (New Jersey Institute of Technology/USA)

***How Can Nature-Based Approaches Play a Role in PFAS Remediation?** *L. Mankowski, D. Chiang, and A. Quintin.*
Leonard Mankowski (WSP/USA)

***Immediate and Effective PFAS Treatment in Bedrock Aquifer at a Hazardous Sites Clean-Up Act Site.** *G.N. Iosue, J. Dziekan, L. Strobridge, and C.R. Wade.*
Glenn Iosue (REGENESIS/USA)

Passive In Situ Treatment of PFAS-Impacted Groundwater Using Foam Fractionation in an Air Sparge Trench. *D. Nguyen, C. Schaefer, J. Devon, J. Bamer, T. Holsen, J. Guelfo, and B. Chaplin.*
Dung (Zoom) Nguyen (CDM Smith Inc./USA)

*** = poster presentation**

***PFAS Concentrations in Groundwater Reduced to below Drinking Water Standards at a Former Michigan Manufacturing Facility.** *A. Cuellar, R. Moore, K. Gaskill, and E. Bays.*
Angel Cuellar (Tetra Tech, Inc./USA)

PFAS Source Zone Management with Novel Immobilization Methods and Materials. *P. Erickson, S. Barnes, Y. Liu, S. Bartlett, and B. Packer.*
Paul Erickson (REGENESIS/USA)

***Phytoremediation of Per- and Polyfluoroalkyl Substances (PFAS).** *X. Ma, V. Sharma, and O. Adu.*
Samuel Ma (Texas A&M University/USA)

***Thermal Treatment of PFAS-Containing Soil Piles.** *G. Heron, P. Joyce, L. Stauch, and E. Crownover.*
Mark Kluger (TRS Group, Inc./USA)

Transformation of Per- and Poly-Fluoroalkyl Substances (PFAS) by Environmentally Relevant Co-Metabolic Organisms. *J.A. LaFond, A. Jackson, J. Guelfo, P.B. Hatzinger, and R. Rezes.*
Jessica A. LaFond (Texas Tech University/USA).

Panel Discussion—Tuesday, Track B

PFAS Program Management in a Rapidly Changing Regulatory Environment

Moderators
Frank Loeffler, Ph.D. (University of Tennessee/Oak Ridge National Laboratory)
Rula Deeb, Ph.D., BCEEM, PMP (Geosyntec Consultants)

Panelists
Heather Henry, Ph.D. (NIEHS)
Richard Anderson, Ph.D. (U.S. Air Force Civil Engineer Center [AFCEC])
Charles Schaefer, Ph.D. (CDM Smith)
Marc Mills, Ph.D. (U.S. EPA)

Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals used in various industries and in an array of everyday consumer products. PFAS persist in the environment and can be found in 98% of the US population, and reports about human health impacts are alarming. Progress has been made in the development and implementation of remedial technologies for contaminated site cleanup and safeguarding drinking water supplies; however, these efforts are challenged by newly discovered PFAS sources and changing cleanup criteria. In March 2023, the Biden-Harris Administration proposed the first-ever national drinking water standard for six PFAS compounds, setting the stage to establish legally enforceable levels for six PFAS compounds known to occur in drinking water. This panel will discuss the challenges in managing PFAS in a rapidly changing regulatory environment. The panel will present diverse perspectives with representation from the U.S. EPA, the National Institute of Environmental Health Sciences (NIEHS), the Department of Defense, academic research, and environmental consultancy.

B3. PFAS Program Management in a Rapidly Changing Regulatory Environment

Platforms Tuesday| Posters (*) Tuesday Evening
Chairs: Amy Dindal (Battelle) and
Marc Mills (U.S. Environmental Protection Agency)

***Characterizing PFAS IDW from Investigative Soil and Groundwater Data.** *J. Ramey, K. Quinn, and M. Tofte.*
Jeff Ramey (TRC/USA)

***Exploring PFAS Inhalation Exposures and Toxicity.** *K. Patel-Coleman.*
Kanan Patel-Coleman (Burns & McDonnell/USA)

Fate, Transport, and Transformation of Poly- and Perfluorinated Substances (PFAS) in Wastewater Treatment Plants. *M. Modiri Gharehveran and M. Mills.*
Mahsa Modiri Gharehveran (EA Engineering, Science, and Technology/USA)

***Is Your PFAS Project Headed for Litigation? Litigation Lessons Learned with "Forever Chemicals."** *D. Woodward, S. Gormley, and O. Elsharnoby.*
Dave Woodward (WSP/USA)

***PFAS Mobile Treatment: Change Is the Only Given.** *S.L. Knox and N.A. Williams.*
Sheri Knox (WSP/USA)

POETs for PFAS: Lessons Learned and Emerging Concerns from Monitoring >10,000 Private Drinking Water Wells. *D. Woodward, O. Elsharnouby. and B. Malyk.*
Dave Woodward (WSP/USA)

Treating PFAS to Near-Zero Concentrations: Life Cycle Assessment Considerations. *D.S.-Y. Chiang, J. Gal, S. Sharma, and N. Hagelin.*
Dora Chiang (WSP/USA)

What to Recommend When High PFAS Levels Are Discovered but Regulatory Values Are Not Exceeded. *E. Ribeli.*
Erik Ribeli (Norconsult AB/Sweden)

*** = poster presentation**

B4. Activated Carbon-Based PFAS Treatment Technologies

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Jack Sheldon (Antea Group) and Scott Wilson (REGENESIS)

Adsorbents Treatability Evaluation for PFAS Removal from Groundwater Infiltrating into a Chrome-Plating Facility Basement. *F. Barajas, N. Swiger, M. Van Der Eide, and B. Harding.*
Francisco Barajas-Rodriguez (AECOM/USA)

***Biosorption Technology: PFAS Removal in Water by the Use of Novel Carbonaceous Materials.** *M. Senofonte, R. Cuzzola, R. Remmani, C. Riccardi, G. Simonetti, and M. Petrangeli Papini.*
Marta Senofonte ("La Sapienza"; University of Rome/Italy)

***Ex Situ Treatment of PFAS-Contaminated Groundwater from a Petroleum Hydrocarbon-Impacted Site.** *A. Oka, P. Tozzi, A. Arico, A. Hackenberg, M. Wenrick, and S. Abrams.*
Amita Oka (Langan/USA)

Improving Activated Carbon Performance for In Situ Sequestration of Per- and Polyfluoroalkyl Substances. *A. Meservey, K. Manz, K. Pennell, M. Mitchek, and J. Wong.*
Kurt Pennell (Brown University/USA)

The In Situ Treatment of TCE and PFAS-Impacted Groundwater Using Anaerobic Bioremediation, Polylactate Ester, and Colloidal Activated Carbon. *R. McGregor and L. Benevenuto.*
Rick McGregor (InSitu Remediation Services Ltd./Canada)

Large Full-Scale In Situ Remediation of Groundwater with High Concentrations of PFAS Using PlumeStop™. *R.H. Mora, J. Cuthbertson, J. Buzzell, S. Krenz, R. Moore, K. Gaskill, and A. Kavanaugh.*
Rebecca Mora (AECOM/USA)

Longevity of Colloidal Activated Carbon for In Situ PFAS Remediation at AFFF-Contaminated Airport Sites. *G.R. Carey.*
Grant Carey (Porewater Solutions/Canada)

***Mobile Cleanout of AFFF and PFAS in Wastewater and Fire Suppression Systems Using the PerfluorAd Process.** *D. Fleming, G. Knight, E. Crownover, and I. Godinez.*
Lauren Soos (TRS Group, Inc./USA)

***Remediate PFAS-Impacted Soils Using Magnetic Activated Carbon (MAC).** *C.H. Shih, S.H. Yang, A. French, and K.H. Chu.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

***Using Colloidal Activated Carbon to Reduce PFAS and PCE Concentrations in Groundwater to below Michigan's Drinking Water Limits for over Four Years.** *R. Moore and P. Lyman.*
Ryan Moore (REGENESIS/USA)

B5. Innovative Treatment Technologies for PFAS Ex Situ

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Andrew Punsoni (Allonnia) and Joseph Quinnan (Arcadis)

***AFFF Cleanout and PFAS Treatment in a Firefighting Vehicle Using the PerfluorAd Process at a Major West Coast International Airport.** *G. Knight and D. Fleming.*
Greg Knight (TRS/USA)

***Challenges during the Treatment of PFAS at a Wastewater Treatment Plant.** *P.K. Juriasingani, D. Liu, C. Pike, and D. Forester.*
Purshotam Juriasingani (Tetra Tech, Inc./USA)

***Characterizing PFAS-Degrading Microbial Communities in Environmental Samples Collected from a PFAS-Contaminated Site.** *F. Kara Murdoch, K. Dasu, L. Mullins, M. Gander, and K.H. Kucharzyk.*
Fadime Kara Murdoch (Battelle/USA)

De Novo Enzymes Development for PFAS Compounds Degradation. *D. Saran, K. Sorenson, and G. Meshulam-Simon.*
Dayal Saran (Allonnia/USA)

***Feeding Two Birds with One Scone: Regenerable Resin for Today's Treatment Goals and Tomorrow's Destructive Technologies.** *D.M. Kempisty, M. Thompson, J. Haxen, E.F. Houtz, and S. Woodard.*
David Kempisty (Montrose Environmental/USA)

Field Demonstration: Electrochemical Degradation of PFAS Mass in Wastewaters. *R. Casson, R.E. Gwinn, and R.H. Mora.*
Rosa Gwinn (AECOM/USA)

***Field Deployment of a Supercritical Water Oxidation Technology to Destroy Per- and Polyfluorinated Alkyl Substances in Aqueous Film-Forming Foam.** *S. Rosansky, K. Dasu, S. Al-Dirani, and X. Xia.*
Stephen Rosansky (Battelle/USA)

***Firefighting System Cleanout: Lessons Learned from Bench-Scale Treatability Studies and Field-Scale Demonstration.** *D. Nguyen, H. Lanza, C. Bellona, A. Lau, G. Knight, and D. Fleming.*
Dung (Zoom) Nguyen (CDM Smith Inc./USA)

* = poster presentation

***Improved Cost and Performance of PFAS Groundwater Treatment Using a Carbon-Based Micro-Adsorbent and Ceramic Separations Technology.** *J. Quinnan, T. Reid, V. Pulikkal, and C. Bellona.*
Terence Reid (Aqua-Aerobic Systems, Inc./USA)

***Kinetic Routes of PFAS Destruction in Supercritical Water Oxidation.** *J. Li, C. Austin, B. Pinkard, and I. Novosselov.*
Igor Novosselov (University of Washington/USA)

***PFAS Degradation by a Thin Film Gas-Liquid Nonthermal Plasma Reactor.** *L.R. Jenks, R. Gallon, R.K.M. Bulusu, R. Wandell, Y. Tang, B.R. Locke, K. Tate, C. Zhou, and B.K. Marvin.*
Bruce Locke (Florida State University/USA)

***Reed Straw-Derived Biochar (RESCA) for Effective Adsorption Removal of Per- and Polyfluoroalkyl Substances (PFAS).** *N. Liu and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

Removal and Destruction of PFECAs in an Anion Exchange Resin and Electrochemical Oxidation Treatment Train. *Y. Fang, C. Schaefer, P. Meng, and D. Knappe.*
Yida Fang (CDM Smith Inc./USA)

Soil Washing: Sustainable Cost-Effective Treatment for PFAS Source Zones. *J.A. Quinnan, C. Morrell, and N. Nagle.*
Joseph Quinnan (Arcadis/USA)

Status of Gas-Based PFAS Remediation Technologies. *C.J. Newell and P.R. Kulkarni.*
Charles Newell (GSI Environmental Inc./USA)

Supercritical Water Oxidation for PFAS Destruction in Various Matrices. *M.A. Deshusses, S. McKnight, D. Hatler, and S. Viswanathan.*
Marc Deshusses (374Water inc./USA)

***Sustainable Bioremediation of PFAS via Biomimetic Plant-Fungal Nano-Framework.** *J. Li, X. Li, J. Yu, B. Long, J.S. Yuan, and S.Y. Dai.*
Susie Dai (Texas A&M University/USA)

***Thermal Treatment of PFAS in Spent GAC and PFAS-Impacted Soil.** *P. Challa, F. Barranco, F. Xiao, and A. Alinezhad.*
Pavankumar Challa Sasi (EA Engineering, Science, and Technology, Inc., PBC/USA)

***Yorba Linda Water District Installs Largest Ion Exchange PFAS Water Treatment Plant in U.S.** *R. Bergsgaard, R. Weston, and C. Olsen.*
Bob Bergsgaard (Aqueous Vets/USA)

B6. Comparing Ex Situ Destructive Technologies

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Linda Gaines (U.S. EPA) and Ian Ross (CDM Smith)

***Current Insights on Reaction Kinetics and Mechanisms of PFAS Destruction during Hydrothermal Alkaline Treatment (HALT).** *B.R. Pinkard, S. Hao, C. Austin, I.V. Novosselov, and T.J. Strathmann.*
Brian Pinkard (Aquagga, Inc./USA)

Effective Comparison of the Parameters for Per- and Polyfluoroalkyl Substances Destructive Technologies. *P.K. Juriasingani and R. Arnseth.*
Purshotam Juriasingani (Tetra Tech, Inc./USA)

***An Innovative Plasma Technology for Treatment of PFAS-Impacted Water at Two Fire Training Areas.** *S. Richardson, P. Kulkarni, W. Bailey, S. Mededovic, T. Holsen, C. Nau-Hix, W. Knudson, H. Luckarift, and B. Ashley.*
Whitney Bailey (GSI Environmental/USA)

Mechanochemical Destruction as a Scalable Treatment Technology for Per- and Polyfluoroalkyl Substances. *K. Gobindlal, M. Glucina, and J. Sperry.*
Kapish Gobindlal (Environmental Decontamination [(NZ)] Limited/New Zealand)

Nanofiltration followed by Electrical Discharge Plasma for Destruction of PFAS and Co-Occurring Chemicals in Groundwater: A Treatment Train Approach. *S. Richardson, P. Kulkarni, W. Bailey, S. Mededovic, T. Holsen, C. Nau-Hix, W. Knudson, C. Bellona, and C. Schaefer.*
Stephen Richardson (GSI Environmental/USA)

***On-Site Demonstration of Thermal Desorption Coupled with Thermal Oxidation Technology to Treat Solid PFAS-Impacted Soil Investigation Derived Waste.** *F. Barranco, C. Palmer, G. Hay, and I. Harvey.*
Frank Barranco (EA Engineering, Science, and Technology, Inc., PBC/USA)

***PFAS-Laden Spent Media Destruction Using Supercritical Water Oxidation Technology.** *D.S.-Y. Chiang, J. Gal, D. Hatler, and M. Deshusses.*
Dora Chiang (WSP/USA)

***Thermal Destruction of PFAS during Full-Scale Reactivation of PFAS-Laden Granular Activated Carbon (GAC).** *R. Distefano, T. Knowlton, A. Harris, and M. O'Brien.*
Rebecca DiStefano (Calgon Carbon/USA)

*** = poster presentation**

Treating PFAS-Impacted Bulk Soil: Evaluation of High-Pressure Thermal Treatment Technologies. *P.R. Kulkarni, Y. Li, H. Javed, J.S. Cook, C.J. Newell, and R. Iery.*
Poonam Kulkarni (GSI Environmental Inc./USA)

***Utilizing PFAS Aggregation at the Gas-Water Interface for Energy-Efficient PFAS Destruction.** *Y. Fang, J. Devon, C. Schaefer, and J. Liu.*
Yida Fang (CDM Smith Inc./USA)

B7. PFAS in Surface Water and Storm Water

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Purshotam Juriasingani (Tetra Tech, Inc.) and Eliza Kaltenberg (Battelle)

***Development and Field Validation of an Equilibrium Regimen Passive Sampler for PFAS.** *E.M. Kaltenberg and K. Dasu.*
Eliza Kaltenberg (Battelle/USA)

***Development of an Equilibrium Passive Sampler for PFAS Detection and Quantification in Aqueous Environments.** *B.G. Pautler, M. Healey, A. Sweett, J. Roberts, B. Medon, A. Pham, F. Risacher, L. D'Agostino, J. Conder, R. Zajac-Fay, M. Vanderkooy, M. McAlary, H. Groenevelt, J. Gautier, S. Mabury, A.O. De Silva, C.J. Brinovcar, P. McIsaac, A. Patterson, and R. Mitzel.*
Brent Pautler (SiREM/Canada)

Mitigating PFAS in Streams. *P.K. Juriasingani, D. Liu, C. Pike, and D. Forester.*
Purshotam Juriasingani (Tetra Tech, Inc./USA)

Molecularly Imprinted Polymer (MIP)-Based Electrochemical Sensor for Rapid Detection of PFAS on Site. *J. Grove, K. Huynh, E. Zumbro, J. Roberts, L. Goodnight, T. Villafana, N. Walton, and J. Dick.*
Joe Roberts (Mitre/USA)

***Role of Sequence Stratigraphy for Evaluating Topographic Pathways Impacting Distribution of PFAS.** *B. Campanaro, D. Parse, J. Sadeque, and D. Stock.*
Ben Campanaro (AECOM/USA)

***Shifting of Target and Non-Target Per- and Polyfluorinated Alkyl Substances (PFAS) over Municipal Wastewater Treatment.** *C. Wu, Q. Wang, H. Chen, and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

Successful Implementation of Interim Control Measures (ICMs) for PFAS Treatment from Surface Water at Selfridge Air National Guard Base, Michigan. *W. Myer, B. Cuento, C. Paslawski, J. Ralston, J. Santacroce, and S. Tjan.*
Bjorn Cuento (AECOM/USA)

Treatment Train for Removing High Concentrations of PFAS from Stormwater. *J. Cuthbertson, R. Mora, P. Tacy, and M. McCloskey.*
John Cuthbertson (AECOM/USA)

B8 Addressing Emerging Contaminants in a Regulatory Framework

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Hunter Anderson (U.S. Air Force) and Christopher Hook (Tetra Tech, Inc.)

Are Regulatory PFAS Screening Levels Good Enough to Assess the Soil to Groundwater Pathway? *M. Hertz, J. Reeve, and H. Dennis.*
Michael Hertz (EA Engineering, Science, and Technology, Inc./USA)

Change is Always Different: Calibrating the PFAS Regulatory Crystal Ball. *R.E. Gwinn.*
Rosa Gwinn (AECOM/USA)

Clean Water and a Warming Planet: Are Low-Level PFAS Regulations and Greenhouse Gas Reduction Goals Compatible? *B.L. McAlexander, O.G. Apul, M.R. Olson, and J. MacRae.*
Mitchell Olson (Trihydro Corporation/USA)

***Is Something "Fishy" Going On?** *C. Cheatwood, P. Caprio, J. Suski, and E. Thieleman.*
Cynthia Cheatwood (EA Engineering, Science, and Technology, Inc., PBC/USA)

The Reality and Strategies of Conducting PFAS Remedial Investigations in Evolving Uncertainty. *M. Duley, R. Ofili, and M. Wanek.*
Megan Duley (Sustainment and Restoration Services/USA)

B9 Emerging Contaminants: Detection, Degradation, Fate and Transport

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Jovan Popovic (Noblis) and Shalene Thomas (WSP)

1,4-Dioxane Cometabolic Biological Treatment in a Fluidized Bed Bioreactor: Bench- and Full-Scale Results. *J. Hatton, T. Webster, P. Hatzinger, and H. Anderson.*
James Hatton (Jacobs Engineering Group/USA)

Biotransformation of 8:2 Fluorotelomer Alcohol Using Microbial Communities from AFFF-Impacted Soils. *S. Dong, P. Yan, C. Liu, K.E. Manz, M.J. Woodcock, L.M. Abriola, K.D. Pennell, and N.L. Cápiro.*
Natalie Capiro (Auburn University/USA)

*** = poster presentation**

***Discovery of Gram-Negative Sulfonamide Degraders from Municipal Activated Sludge.** *D.N. Pham and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

Effects of Coating Iron Phases with Polyacrylic Acids on the Ammonium Oxidation/PFAS Defluorination by *Acidimicrobium* sp. A6. *J. Park, S. Huang, B.E. Koel, and P.R. Jaffe.*
Jinhee Park (Princeton University/USA)

Implications of 1,4-Dioxane Source Attenuation and Plume Biodegradation on Its Behavior at Groundwater Sites. *D.T. Adamson, L.M. Smith, and P.C. de Blanc.*
David Adamson (GSI Environmental Inc./USA)

***Investigating Microbial Biodegradation of 6PPD-Quinone, A Ubiquitous Rubber Tire-Derived Chemical Killing the Coho Salmon.** *C. McLaughlin and A.G. Delgado.*
Caleb McLaughlin (Arizona State University/USA)

***A Novel Biodefluorination Pathway of Fluorotelomer Carboxylic Acids (FTCAs) by Municipal Activated Sludge.** *C. Wu, Q. Wang, H. Chen, and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

***Testing of a Long-Term Solution for Low-Level 1,2,3-TCP in a Deep Aquifer Using Colloidal Activated Carbon with Monitoring Natural Attenuation.** *A. Kiggen and C. Lee.*
Andrew Kiggen (REGENESIS/USA)

B10 | 1,4-Dioxane Treatment Technologies

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Anthony Danko (U.S. Navy) and Kent Sorenson (Allonnia)

Anaerobic and Aerobic Biostimulation and Bioaugmentation of Chlorinated Solvents and 1,4-Dioxane. *L. LaPat-Polasko, I. Kwok, A. Polasko, and S. Mahendra.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

***Bioremediation of 1,4-Dioxane Using Cometabolic Bioreactors.** *C. Bell, B. Rittmann, C. Zhou, T. Applebury, M. Heintz, and J. Provolt.*
Caitlin Bell (Arcadis/USA)

***Containment of a 1,4-Dioxane Plume Using TreeWell® Phytoremediation Technologies.** *C. Gale and F. Volkering.*
Christopher Gale (Applied Natural Sciences/USA)

***Degradation of 1,4-Dioxane and CVOCs by Iron-Impregnated Activated Carbon (CAT100).** *S. Noland.*
Scott Noland (Remediation Products, Inc./USA)

***Dual-Culture System Enables the Degradation of 1,4-Dioxane and Co-Occurring Chlorinated Aliphatic Hydrocarbons.** *D. Deng, J. Antunes, and M. Li.*
Jose Antunes (New Jersey Institute of Technology/USA)

Enhancing 1,4-Dioxane Bioremediation at Low Concentrations by Combining a Metabolic Degradation Culture with Adsorbents. *C. Zhou and B.L. Petty.*
Chao Zhou (Geosyntec Consultants/USA)

***Examining the Microorganisms Assimilating Carbon from 1,4-Dioxane in Contaminated and Uncontaminated Samples.** *Z. Li and A.M. Cupples.*
Zheng Li (Michigan State University/USA)

In Situ Bioremediation of 1,4-Dioxane in Mixed Contaminant Plume with Metabolic Bioaugmentation and Cometabolism. *F.J. Krembs, M. Irianni Renno, K. McDonald, M. Olson, G.E. Mathes, and S. Dworatzek.*
Fritz Krembs (Trihydro Corporation/USA)

***Innovative Treatment of a Large, Dilute, and Commingled Plume Using a Solar-Powered In Situ Bioremediation and Phytoremediation System.** *F.J. Krembs, M. Hinman, and G. Risse.*
Fritz Krembs (Trihydro Corporation/USA)

***Novel Group-6 Propane Monooxygenases in Charge of 1,4-Dioxane Biodegradation in Psychrophilic Propanotrophic Consortia.** *J. Antunes and M. Li.*
Jose Antunes (New Jersey Institute of Technology/USA)

Novel Organism Deployed for In Situ Bioremediation of 1,4-Dioxane in Groundwater. *A. Banerjee, Z. Pierce, S. Koenigsberg, D. Saran, L. Sazbo, and K. Sorenson.*
Areen Banerjee (Allonnia LLC/USA)

***Propane and 1-Propanol as Auxiliary Substrate Alternatives for Effective Cometabolic Bioremediation of 1,4-Dioxane.** *D. Deng, D.N. Pham, and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

Results from a 1,4-Dioxane Biogeochemical Reactor Field Pilot Test. *C. Walecka-Hutchison, J. Sprague, J. Gamlin, R. Caird, Y. Miao, I. Kwok, and S. Mahendra.*
Claudia Walecka Hutchison (Dow/USA)

*** = poster presentation**

Panel Discussion—Tuesday, Track C

What Are the Knowledge Gaps for Fate and Transport at Complex Sites?

Moderator
Charles Newell, Ph.D., P.E. (GSI Environmental Inc.)
John Wilson, Ph.D. (Scissortail Environmental)

Panelists
Tamzen Macbeth, Ph.D., PE (CDM Smith)
Hunter Anderson, Ph.D. (U.S. Air Force)
Curt Stanley, P.G., CPGS (GSI Environmental)

This panel will review the evolution in our approach to remediate complex sites, identify key knowledge gaps as of 2023, and then speculate how our field may change as we move through the rest of the 2020s. After a brief introduction of the panelists, we will present four "discussion modules":

1. Understanding complex sites in the year 2000 versus the year 2023:
- What are key technologies/practices we no longer use?
- What are the key innovations since the turn of the century?
- Which subfield has progressed the most since 2000: 1) site characterization; 2) understanding fate and transport processes 3) remedial technology?
- What is the most impactful scientific paper, guidance document, regulation written in our field since 2000?

2. Key problems we see today when we are dealing with complex sites:
- What is the most difficult site challenge with complex sites: regulatory, technical, or cost issues?
- If you could change one factor about regulations, what would you do?
- If you could modestly improve a key technology (e.g., characterization, modeling, remediation) what would you improve?
- Can we do better at finding sources?

3. Knowledge gaps at complex sites based on the type of COC and hydrogeologic setting:
- What is the biggest knowledge gap at petroleum hydrocarbon sites?
- What is the biggest knowledge gap at chlorinated solvent sites?
- What is the biggest knowledge gap at PFAS sites?
- How about knowledge gaps for unconsolidated versus fractured rock?

4. Discuss specific knowledge gaps
- How do we recognize and characterize the features of the geology that carry groundwater plumes?
- What techniques do we have to get inexpensive, high resolution values for hydraulic conductivity that can go into transport and fate models?
- What is the best place to look for sources, and what is the best tool to use?
- What would a perfect groundwater remediation model look like?

C1. Natural Source Zone Depletion

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Matthew Rousseau (GHD) and Julio Zimbron (E-Flux)

***Assessing the Genetic Potential for Natural Source Zone Depletion at a Petroleum-Contaminated Site.** *K.L. Sublette, K.C. Clark, S.M. Rosolina, and D.M. Taggart.*
Kerry Sublette (University of Tulsa/USA)

***Challenges in Developing Background Temperature Profiles for NSZD Using the Biogenic Heat Method.** *N. Babu, D. Collins, and K. Waldron.*
David Collins (Stantec/USA)

Comparison of Thermal Methods for Quantifying NSZD Rates Overlying a Shallow Petroleum Hydrocarbon Source Zone. *I. Hers, A. Wozney, S. Kiaalhosseini, C. McGarvey, K. Stevenson, and K.K. Askarani.*
Ian Hers (Hers Environmental Consulting, Inc./Canada)

Enhanced LNAPL Natural Source Zone Depletion by Solar-Powered Bioventing at the Former Guadalupe Oil Field. *B. McAlexander, J. Eichert, C. Smith, E. Daniels, and N. Sihota.*
Justin Eichert (Trihydro Corporation/USA)

Making NSZD-Related Decisions in the Context of Measurement Uncertainty: Common Sources of NSZD Rate Measurement Error. *J.A. Zimbron.*
Julio Zimbron (E-Flux/USA)

***Monitoring Methanogenic and Methanotrophic Activity in Soil Cores Undergoing Natural Source Zone Depletion.** *A. Alvarez, R.T. Thommana, C. Voinorosky, and S.D. Siciliano.*
Alejandro Alvarez (University of Saskatchewan/Canada)

More Data, Less LNAPL: Insights from over 15 Years of Research on Natural Source Zone Depletion (NSZD). *P.R. Kulkarni, K.L. Walker, C.J. Newell, K. Karimi Askarani, Y. Li, and T.E. McHugh.*
Poonam Kulkarni (GSI Environmental Inc./USA)

* = poster presentation

***Natural Source Zone Depletion (NSZD): Advances in Remote Monitoring and Processing Using Temperature Data.** *S.T. Robinson, T.E. McHugh, K.L. Walker, K. Karimi Askarani, T. Sale, and T. Lewis.*
Schuyler Robinson (GSI Environmental/USA)

***Natural Source Zone Depletion is a Remedy Component: Integrating Multiple Lines of Evidence at a Petroleum Hydrocarbon-Impacted Site.** *A.J. Hanson Rhoades, T.C. Sale, S. Gallo, K.K. Askarani, A. Chakraborty, E. Herlugson, F. Hiebert, J. Donlon, and W. Casteel.*
Andrea J. Hanson (Colorado State University/USA)

***NSZD Rate Quantification for a Petroleum-Based DNAPL Body through Biogas Efflux and Aqueous Indicators.** *J. Ford, A. Sidebottom, H. Hernandez, T. Palaia, N. Mahler, and A. Metcalfe.*
Jeffrey Ford (Jacobs/USA)

***Production and Utilization of C11 Acetate to Identify the Spatial Distribution of Methanogens during NSZD.** *R.T. Thommana, S.D. Siciliano, and W. Shannon.*
Rhea Thomas Thommana (University of Saskatchewan/Canada)

***Shifting from Tradition: A Long-Term NSZD Approach for an Active Oil and Gas Facility.** *A. Jimmo, S.D. Mamet, N. Higgs, S.D. Siciliano, D. Nuell, and L. Pickering.*
Amy Jimmo (Environmental Material Science Inc./Canada)

Soil Gas Gradient Method for Estimating Natural Attenuation Rates of NAPL and Specific Chemicals of Concern. *I. Verginelli, M. Lahvis, P. Jourabchi, and G. DeVaull.*
Parisa Jourabchi (ARIS Environmental Ltd./Canada)

***Sulfate Delivery Methods for Enhancing Biodegradation of Petroleum Hydrocarbons.** *K. Sra, R. Kolhatkar, D. Segal, and J. Wilson.*
Kammy Sra (Chevron/USA)

C2 | Remediation and Management of Petroleum-Hydrocarbon Contaminated Sites

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Trevre Andrews (Jacobs) and Brant Smith (Evonik)

***Apparent Total Petroleum Hydrocarbons (TPH) in Uncontaminated Soils: Quantification, Identification, and Implications for TPH Regulation.** *M.I. Silverman, S. Vishnu Sundar, A. Nitzky, E.M. Miranda, P. Dahlen, A.G. Delgado, N. Sihota, and R. Mohler.*
Maxwell I. Silverman (Arizona State University/USA)

Application of an All-in-One ISCO Technology for the Treatment of Hydrocarbons, BTEX and MTBE at a Former Retail Petrol Station in Italy. *A. Leombruni, M. Mueller, and B. Smith.*
Alberto Leombruni (Evonik/Italy)

***Biodegradation of Petroleum Hydrocarbons under Different Redox Conditions to Mitigate Methane Emissions.** *I. Afzal, N. Suri, A. Kuznetsova, A. Ulrich, and T. Siddique.*
Iram Afzal (University of Alberta/Canada)

***Costs, Cost Savings, and Best Practices for High Resolution Site Characterization at Petroleum Underground Storage Tank Release Sites.** *D. Kaufman, T. Schruben, and A. Wardle.*
Thomas Schruben (U.S. EPA OLEM OUST/USA)

***Effective Remedial Decision-Making in Hydrocarbon-Impacted Sites Using Sequence Stratigraphy-Based Conceptual Site Models.** *J. Sadeque and R. Samuels.*
Junaid Sadeque (AECOM/USA)

***Expedited Petroleum Hydrocarbon Destruction via Biostimulation Alone under Baseline Conditions Considered Unsuitable for Bioremediation without Augmentation.** *K.C. Armstrong, H. Anderson, K. Rapp, and A.D. Peacock.*
Kent C. Armstrong (TerraStryke Products, LLC/USA)

***Expedited Remediation of Benzene and Attenuation of Metals in Petroleum-Impacted Groundwater Using Activated Carbon-Based Amendment.** *H. Singh, J.H. Zavala, and T. Fortner.*
Harvinder Singh (Weston Solutions, Inc./USA)

Field Applications of Anaerobic BTX Bioaugmentation Cultures. *J. Roberts, S. Dworatzek, J. Webb, E. Edwards, C. Toth, and N. Bawa.*
Jeff Roberts (SiREM/Canada)

***In Situ Bioremediation of Shallow Dispersed LNAPL Plume Travelling under a Major Highway.** *D. Guilfoil, G. Simpson, N. Thacker, and N. Mau.*
Duane Guilfoil (AST Environmental, Inc./USA)

***In Situ Electrobiochemical Reactor to Address Benzene-Impacted Soil/Groundwater and Stimulate Enhanced Biodegradation.** *D. Gray, T. Vannest, A. Martin, and B. Witt.*
Doug Gray (AECOM/USA)

***In Situ Sorption and Biodegradation of Petroleum Hydrocarbons.** *A. Oka, K. Kaur, S. Sherman, S. Abrams, and M. Spievack.*
Amita Oka (Langan/USA)

***Latest Developments in TPH Risk-Based Strategies.** *L. Trozzolo.*
Laura Trozzolo (TRC Companies, Inc./USA)

*** = poster presentation**

Long-Term Anaerobic Bioremediation of MGP Contaminants by Iron- and Sulfate-Reducing Bacteria following Combined ISCO/ISS Treatment. *D.P. Cassidy and V.J. Srivastava.*
Daniel Cassidy (Western Michigan University/USA)

***Measuring Diesel-Range Organic Concentrations in Groundwater.** *E. Heyse, B. Henry, and B. Blicker.*
Edward C. Heyse (Parsons/USA)

***Multiple Remediation Technologies: A Challenging Contaminated Site in Colombia.** *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, R. Moura, N. Nascimento, J. Mueller, T. Lizer, W. Moody, W. Meese, and M. Scalzi.*
Sidney Aluani (SGW Services/Brazil)

Rapid Remediation of Historic Oil Terminal/Refinery for Redevelopment. *M. Lennertz and P. Downham.*
Myles Lennertz (Roux Associates, Inc./USA)

Remediation and Management Strategies for Redevelopment of a Former MGP Site. *J. Bergman, H. Nord, P. Elander, J. Molin, B. Smith, E. Toumie, and F. Westin.*
Jonny Bergman (Sheeba Enviromental Engineering AB/Sweden)

***Sulfate-Enhanced Bioremediation of Petroleum Sites in Alaska.** *E. Heyse, B. Henry, and B. Blicker.*
Edward C. Heyse (Parsons/USA)

***TBA Remediation Approaches at Two Distinct Sites: One Large-Scale and One with Really High Concentrations.** *A.A. Rees, F.J. Barajas, and D.M. Monson.*
Assaf Rees (AECOM/USA)

Treating and Pretreating Hard to Access Hydrocarbon Contamination in Underground Storage Tank Basins and Utility Corridors with Colloidal Activated Carbon. *T. Herrington and T. Harris.*
Todd Herrington (REGENESIS/USA)

***Treatment Success and Application Insights with Colloidal Activated Carbon for Hydrocarbon Plumes: A Multi-Site Review.** *T. Herrington.*
Todd Herrington (REGENESIS/USA)

Analytical Element Method and Soil Gas Measurements Applied to Biovent System Compositional and Rate Performance. *A. Kirkman, J. Montoy, and M. Del Ciello.*
Andrew Kirkman (BP/USA)

***Case Study for the Injection of BOS 200+ to Remediate Saturated Zone LNAPL at the Former Marshall Iron & Metal Site, Marshall, Michigan.** *M. McGowan, J. Gal, and G.E. Simpson.*
Gary Simpson (AST Environmental, Inc./USA)

***Dynamic LNAPL Distributions and the Conceptual Site Model: Using UV-Induced Fluorescence for Non-Destructive Testing.** *J.A. Zimbron.*
Julio Zimbron (E-Flux/USA)

Enhancing Biodegradation of LNAPL with Bioventing. *S. Gaito, B. Koons, and J. Smith.*
Steven Gaito (AECOM/USA)

***Key Factors for Modeling Jet Fuel-Contaminated Site to Assess NSZD in Subtropical/Tropical Climates.** *H.K. Chang, E.H. Teramoto, M.P.M. Baessa, A.U. Soriano, and M.P.Z. Pede.*
Hung K. Chang (UNESP/Brazil)

Modeling Coupled Heat Transfer and Heat Generation: Lessons for Measuring NSZD Rates Using Thermal Gradient Methods. *J.A. Zimbron.*
Julio Zimbron (E-Flux/USA)

***Natural Source Zone Depletion Rate Comparison over a 40-Foot Thick Smear Zone.** *P.E. Stumpf, M. Shayan, S. Ganna, and J. Lentini.*
Peter Stumpf (AECOM/USA)

Simulating Long-Term Trends in LNAPL NSZD. *K. Sookhak Lari, J.L. Rayner, and G.B. Davis.*
Kaveh Sookhak Lari (CSIRO/Australia)

***Transition from Mechanical-Based Remedies to Natural Remedies: Molecular Biological Tools Demonstrate Petroleum MNA and NSZD in a Fractured Basalt Aquifer in Melbourne, Australia.** *B. Harding, B. Oyston, D. Taggart, and T. Key.*
Barry Harding (AECOM/USA)

C3. LNAPL Bioremediation/NSZD Modeling

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Greg B. Davis (CSIRO Land and Water) and Randall Sillan (AECOM)

C4. Bioremediation in Complex Geological Settings

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Natalie Capiro (Auburn University) and David Freedman (Clemson University)

Abiotic Dechlorination in Clay to Support Natural Attenuation. *C.E. Schaefer, D. Tran, T.M. Blount, and C. Werth.*
Charles Schaefer (CDM Smith Inc./USA)

Adaptive Strategies for In Situ Treatment of Shallow and Deep PCE Plumes in Interbedded Geology. *A.K. Wahi and J. Galemore.*
Arun Kumar Wahi (INTERA Inc./USA)

Application of Sequence Stratigraphy in Developing Bioremediation Strategy in a Complex Geological Site: An Example from the Los Angeles Basin, California. *J. Sadeque, R. Samuels, and K. Carr.*
Junaid Sadeque (AECOM/USA)

Characterization of Contaminant Evolution and Ketones Accumulation in an Aged DNAPL Source Zone within a Sedimentary Bedrock Aquifer. *S. Shafieiyoun, B.L. Parker, and J. Meyer.*
Saeid Shafieiyoun (University of Guelph/Canada)

***Competent Rock Is Complex Rock: Optimized Jet Injection Strategies for Reductive Reagents.** *E.S. Magdar, R. Srirangam, F. Lakhwala, and D. Macaulay.*
Eric Magdar (ARM Group LLC/USA)

Compound Specific Isotope Analysis of 2,3-Dichloroaniline Reveals Aerobic Biotransformation in Constructed Wetlands. *S. Suchana, E. Edwards, L. Lomheim, S. Pimentel Araujo, S. Gavazza, E.E. Mack, and E. Passeport.*
Shamsunnahar Suchana (University of Toronto/Canada)

Enhanced DNAPL Dissolution and Rapid, Complete Reductive Dechlorination of Trichloroethene in a Pilot Test in a Perched Aquifer. *M.M. Lorah, T.P. Needham, E.H. Majcher, E.P. Foss, J.J. Trost, C.T. Livdahl, A.M. Berg, I.M. Cozzarelli, and D.M. Akob.*
Michelle Lorah (U.S. Geological Survey/USA)

Enhanced In Situ Bioremediation within a Complex Heterogeneous Coastal Plain Groundwater Basin. *S.P. Netto, A.M. Donnelly, and D.J. Sealee.*
Steven Netto (Hargis + Associates, Inc./USA)

***Implementation of Monitored Natural Attenuation Combined with Source Zone Control and a Technical Impracticability Waiver at Air Force Plant 4.** *J.R. Woertz and J.C. Wolfe.*
Jennifer Woertz (Los Alamos Technical Associates, Inc/USA)

***In Situ Bioremediation of Chlorinated Ethenes in Heterogeneous Glacial Till.** *R. Britton, E. Huss, and L. LaPat-Polasko.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

***Installation of Four Permeable Reactive Zones for Enhanced Bioremediation and Field Changes to Mitigate Geologic Challenges.** *T. Hartwell, G. Geckeler, and T. Eilber.*
Grant Geckeler (In-Situ Oxidative Technologies, Inc. [ISOTEC]/USA)

Microcosm Evaluation of TCE Degradation in Fractured Rock in Response to Amendments. *H. Wang, D.L. Freedman, R. Yu, and R. Iery.*
Hao Wang (Clemson University/USA)

***Paired Enhanced In Situ Bioremediation and In Situ Chemical Oxidation of Chlorinated VOCs in a Fine-Grained Aquifer.** *H. Schneider, A. Kline, and K. Agustsson.*
Haley Schneider (Geosyntec Consultants/USA)

Polar Organic Chemical Integrative Sampler (POCIS) Allows Compound Specific Isotope Analysis of Substituted Chlorobenzenes at Trace Levels. *S. Suchana, E. Edwards, L. Lomheim, N. Melo, S. Gavazza, E.E. Mack, and E. Passeport.*
Elodie Passeport (University of Toronto/Canada)

Sulfate Enhanced In Situ Biodegradation of MTBE and TBA in Fractured Bedrock for Source Area Treatment and Downgradient Risk Mitigation. *D. Collins, N. Babu, and K. Waldron.*
David Collins (Stantec/USA)

Panel Discussion—Wednesday, Track C

Status of the 2015 Geology Revolution: Where Are We Now and Where Do We Go from Here?

Moderator
Rick Cramer, Ph.D. (Burns & McDonnell)
Rick Wice, PG (Battelle)

Panelists
Gunarti Coghlan, PE (NAVFAC)
Jessica Meyer, Ph.D. (University of Iowa)
Mark Stapleton, Ph.D., PE (Noblis)
John Wilson, Ph.D. (Scissortail Environmental Solutions)

The 2015 Battelle Bioremediation Conference in Miami was earmarked as the "Geology Revolution" in groundwater remediation. Since that conference, environmental sequence stratigraphy (ESS) was recommended by U.S. EPA as a best practice for developing representative conceptual site models (CSMs). It has been established that geology is the primary control on subsurface fluid flow and the migration of groundwater contamination, yet many groundwater projects define contaminant plumes primarily with groundwater data without even a basic geologic evaluation and without representative geologic cross section. Those who have joined the

* = poster presentation

Revolution to develop more sophisticated geologic models have reaped the benefits of more successful remedy designs and project outcomes. Here are a few recent examples:

- In 2022, AFCEC conducted an enterprise-wide (>80 Air Force facilities) evaluation of the elements that affect remediation success and concluded that the CSM overwhelmingly has the greatest impact on the remediation outcome.
- In a separate study conducted in 2022, AFCEC supported a third-party evaluation of the lessons learned from groundwater contaminant projects where ESS was used to develop the CSM and concluded the technology provides a better understanding of the site geology and a more effective means of designing, installing, and optimizing a remedial system.
- In 2021, Naval Facilities Engineering Systems Command (NAVFAC), as part of its Open Environmental Restoration Resources (OER2) Webinar series, presented ESS as a remediation optimization tool.

Although these examples are from the DoD space where technology research and development happens, it's important to know that geology is scaleable and the ESS practice originated from commercial projects of all sizes. As an example, the six case studies presented in the U.S. EPA paper are all commercial projects.

A few questions to consider: How many in situ bioremediation projects have not met the remedial action objective or have seen significant rebound of contaminant concentrations after multiple injections? Were they based solely on groundwater data and estimated radius of influence injection points?

2015 was a call to arms. Today we ask the question, "where are we now and where do we go from here?"

C5. Impacts of Mixed Contaminants on Biodegradation

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Brad Elkins (EOS Remediation, LLC) and Sowmya Suryanarayanan (Tetra Tech)

***Chlorinated/Boron Bioremediation Challenges in Brazil.** *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, R. Moura, N. Nascimento, J. Mueller, T. Lizer, W. Moody, W. Meese, and M. Scalzi.*
Sidney Aluani (SGW Services/Brazil)

Combined Remedy Enhancements to Treat a Groundwater TCE Plume Commingled with Cr(VI) via In Situ Chemical Reduction and Enhanced Anaerobic Bioaugmentation. *K. Diller, D. Griffiths, and T. Blaney.*
Kristi Diller (Parsons/USA)

Effect of Calcium Polysulfide on PFAS-Impacted Media. *A. Oka, K. Kaur, M. Papperman, S. Abrams, and N. Rivers.*
Amita Oka (Langan/USA)

Iterative Selection of Remedial Alternatives for Mixed Contaminants in Complex Geology. *P. Jacob, F. Nchako, S. Barker, and J. Smith.*
Priya Jacob (AECOM/USA)

Optimizing Bioremediation at Mixed Contaminant Sites. *C. Scales, J. Roberts, and P. Dennis.*
Corey Scales (SiREM/Canada)

Treatment Technology Considerations at Plating Facilities Commingled with PFAS and Chromium-6. *K.M. Gaskill, P. Erickson, and R. Moore.*
Keith Gaskill (REGENESIS/USA)

C6. Bioremediation Case Studies

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Matthew Alexander (Leidos) and Vitthal Hosangadi (NOREAS, Inc.)

Comparison of Bioremediation of Biosparge Systems from Two Sites. *A. Lothe and A. Rees.*
Anjali G. Lothe (AECOM/USA)

Development of an Adaptive Framework for Optimizing Bioremediation Implementation at a Fractured Bedrock Chlorinated Solvent DNAPL Site. *J.S. Konzuk, C. Repta, C. Crea, M. Cho, F. Cosme, T. Teoh, and C. Coladonato.*
Julie Konzuk (Geosyntec Consultants International, Inc./Canada)

Enhanced In Situ Reductive Bioremediation of Trichloroethene in an Aerobic, Fractured Bedrock Aquifer at a Military Installation in California. *N.I. Rothell, M. Cutler, and D. Leigh.*
Daniel Leigh (Evonik/USA)

Facilitating Property Transfer Using In Situ Bioremediation within Glacial Till Environments: Three Case Studies. *G. Overbeeke, P. Wilson, W. Lee, L.A. Beese, M. Dotto, and P.M. Dombrowski.*
Gavin Overbeeke (AEL Environment/Canada)

Improving Performance of Abiotic Destruction and Anaerobic Bioremediation at Multiple Sites through the Use of Passive Flux Meters. *C. Lee and C. Sandefur.*
Chris Lee (REGENESIS/USA)

Innovative Bioremediation Approach Implemented in Complex Karst Geology to Treat LNAPL Releasing from Seeps to a Creek and Residential Properties in Gallatin, Tennessee. *D. Guilfoil and G. Stephenson.*
Duane Guilfoil (AST Environmental, Inc./USA)

* = poster presentation

ISCR Remediation on a Shallow and Extremely Variated Geological Conditions: Chlorinated Compounds Contamination in Brazil. *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, R. Moura, N. Nascimento, J. Mueller, T. Lizer, W. Moody, W. Meese, and M. Scalzi.*
Sidney Aluani (SGW Services/Brazil)

Source Area Bioremediation in Fractured Bedrock with Karst Features Revisited as Sustainable and Resilient Remediation. *K.A. Morris and P. Beyer.*
Kevin Morris (ERM/USA)

C7. Bioremediation Approaches for the Innovative Management of Large or Dilute Plumes

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Fritz Krembs (Trihydro Corporation) and Troy Lizer (Provectus Environmental Products, Inc.)

***Bioremediation in a Combined Remedial Strategy for a Complex Contaminated Site with Ecologically Sensitive Receptors in Brazil.** *M. de Q. Omote, A.C. Gatti, G.D.C. de Mello, and R. Campos.*
Mariana Omote (Ramboll Brasil/Brazil)

***Bioremediation of Chromium-Contaminated Groundwater in Complex and Large Plumes.** *B. Liu.*
Beth Liu (EA Engineering, Science, and Technology, Inc./USA)

***Combined In Situ Treatment Methods and Technologies Reduce Mass at Large DNAPL Solvent Site.**
M. Mazzarese and G. Simpson.
Mike Mazzarese (AST Environmental, Inc./USA)

Combining Biotic and Abiotic Treatment Processes Post In Situ Thermal Treatment (ISTT). *J.G. Booth, R.D. Collins, R. Hogdahl, and R. Simon.*
J. Greg Booth (Woodard & Curran/USA)

***Combining Technologies for a Complete Remedial Solution at a Complex Superfund Site.** *L. Soos and K. Cottrell.*
Lauren Soos (TRS Group, Inc./USA)

***Full-Scale Application in Italy of a Combined ISCR and ERD Technology for the Treatment of an Aerobic Aquifer Impacted with Tetrachloromethane and Chloroform.**
A. Leombruni, M. Mueller, F. Lakhwala, and D. Leigh.
Alberto Leombruni (Evonik/Italy)

In Situ Enhanced Bioremediation to Reduce Large TCE/PCE Plumes and Government's Life Cycle Costs.
P. Srivastav, W.A. Foss, and R.E. Mayer.
Praveen Srivastav (APTIM/USA)

Innovative ZVI Application for Sustainable Remediation of Chlorinated Solvent Plumes. *K. Rugge, M. Dreyer, T.H. Jørgensen, J. Wang, D. Fan, M.T. Hag, and N. Tuxen.*
Kirsten Rugge (COWI A/S/Denmark)

Large-Scale In Situ Biotic and Abiotic Dechlorination of Groundwater Impacted with Commingled Chlorinated Ethenes and Chlorinated Methanes. *M.M. Mejac, U. Patel, N. Walchuk, and F. Razmdjoo.*
Mark Mejac (Ramboll/USA)

Scientific and Engineering Considerations for Cost-Effective In Situ Bioremediation of Large, Deep Plumes.
J. Skinner and M.-Y. Chu.
Justin Paul Skinner (Arizona State University/USA)

D1. Innovative Tools for Evaluating Vapor Intrusion Risk

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Loren Lund (Jacobs) and Todd McAlary (Geosyntec Consultants, Inc.)

The Best Method to Assess Whether a Vapor Intrusion Risk is Present and Requires Mitigation: The Preference for Passive Samplers. *H. O'Neill and S. Thornley.*
Harry O'Neill (Beacon Environmental/USA)

***Best Practices for Quality Assurance/Quality Control for Passive Barrier Installations at New and Existing Buildings.** *H. Nguyen and J. Morgan.*
Hieu Nguyen (Land Science/USA)

Building Pressure Cycling to Document Due Care Compliance in Brownfields Redevelopment. *T. Gabris and S. Baushke.*
Theresa Gabris (Geosyntec/USA)

Characterizing and Mitigating Sewer Vapor Intrusion in a Residential Neighborhood. *N. Rezaei and K.G. Pennell.*
Nader Rezaei (University of Kentucky/USA)

Evaluation of Spatiotemporal Variability in Site-Specific Attenuation Factors. *M.A. Lahvis and R.A. Ettinger.*
Matthew Lahvis (Shell Global Solutions/USA)

Measurement of Soil Gas to Indoor Air Attenuation Rates Using Radon as a Naturally-Occurring Tracer Gas.
J. Sanders.
Kimberly K. Bradley (GeoKinetics/USA)

***Passive and Active Soil Gas Sampling along a Sanitary Sewer Line Used for Source Area Delineation and Vapor Intrusion Assessment.** *R.H. Christensen, Jr. and J. Humphress.*
Richard Christensen (Acuity Environmental Solutions, LLC/USA)

* = poster presentation

***Quality Assurance of Real-Time VOC Measurements Using AROMA-VOC.** *H.C. Tay, N. Rezaei, and K.G. Pennell.*
Hong Cheng Tay (University of Kentucky/USA)

Soil Vapor Extraction Technology Implementation for Vapor Intrusion Mitigation. *O. Uppal, P. Bennett, A. Broughton, Y.-V. Van, A. Klopfenstein, G. Plantz, and R. Farson.*
Omer Uppal (Haley & Aldrich, Inc./USA)

***Strategic Approach for VI Assessment and Mitigation along a 1,200 feet Trichloroethene Groundwater Plume.** *R.H. Christensen, Jr. and M. Grzegorek.*
Richard Christensen (Acuity Environmental Solutions, LLC/USA)

D2. Vapor Intrusion from Non-VOC Sources (*e.g.*, Mercury, Methane, PFOAs, and Radionuclides)

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Bart Eklund (Haley & Aldrich, Inc.) and Mike Sequino (Directional Technologies, Inc.)

Advancing Urban Site Remediation Using In Situ Bioaugmentation for Chlorinated Aliphatic Hydrocarbons in Groundwater. *J.P. Yoder and E. Bishop.*
Jarrod Yoder (Haley & Aldrich, Inc./USA)

Big Bang Theory: Evaluation of Sub-Slab Methane at Large Warehouse Sites. *T. McHug, M. Rysz, and L. Beckley.*
Thomas McHugh (GSI Environmental Inc./USA)

***Evaluation of the Vapor Intrusion Potential of Volatile Per- and Polyfluoroalkyl Substances.** *C. Holton and D. Hanigan.*
Chase Holton (GSI Environmental/USA)

***Literature Review of the Physicochemical Controls on the Fate of PFAS in Air.** *G. Carrasco, T. Thomas, R. Rago, and B. Eklund.*
Gabriela Carrasco (Haley & Aldrich/USA)

Measurement of Soil Gas to Indoor Air Attenuation Rates Using Radon as a Naturally-Occurring Tracer Gas. *G. Tofani and J. Sanders.*
Jonathon Sanders (GeoKinetics/USA)

Use of Thoron to Identify Preferential Pathways for Vapor Intrusion. *J. Peters and K. Dilawari.*
Jay Peters (Haley & Aldrich, Inc./USA)

D3. HRSC and Conceptual Site Models

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Junaid Sadeque (AECOM) and Rick Wice (Battelle)

***Changing Long-Standing Conceptual Site Models and Risk Perception with High Resolution Contaminant Distribution (HRCD).** *L.I. Robinson and W.F. Wiley.*
Lance Robinson (EN Rx, Inc./USA)

***Do You Know Your Site? Qualitative Characterization, Modeling, and Remediation to Predict Site Closure.** *W.L. Brab and R. Paulson.*
Bill Brab (AST Environmental, Inc./USA)

***Estimating the Magnitude of 1,4-Dioxane Releases from TCA and Non-Solvent Sources: An Update.** *T.K. Mohr.*
Thomas K. Mohr (Mohr HydroGeoScience/USA)

Expedited Geophysical and Drilling Site Characterization of a Karstic Gasoline Release Site to Develop a Coherent Conceptual Site Model. *D.T. Heidlauf, D. Price, and K. Carson.*
David Heidlauf (Ramboll/USA)

High Resolution PFAS Plume Characterization in Fractured Sandstone to Support Groundwater Remedies. *J. Ramey, K. Quinn, M. Sellwood, and M. Tofte.*
Jeff Ramey (TRC/USA)

High Resolution Site Characterization for Bioremediation in Fractured Rock. *N. Thacker and B. Brab.*
Nathan Thacker (AST Environmental, Inc./USA)

High-Resolution Site Characterization Methods and Applications for Evaluating LNAPL and Dissolved-Phase Plume Stability and Exposure Risk. *W. Johnson and B. Graves.*
West Johnson (Columbia Technologies LLC/USA)

Immediate Benefits from HRSC Techniques for Three PFAS Investigations. *M. Hertz, S. Morrissette, H. Dennis, and C. Boss.*
Michael Hertz (EA Engineering, Science, and Technology, Inc./USA)

***Improving Remedial Designs Using Passive Flux Meter Studies and Plume Dimension Analysis.** *C. Lee and C. Sandefur.*
Chris Lee (REGENESIS/USA)

***Incorporating Molecular Biological Tools into High-Resolution Site Characterizations.** *B.M. McDowell.*
Briana McDowell (Columbia Technologies/USA)

Maximizing Insight and Data Capture from Borehole Logs: The Graphical Approach to Geologic Logging and Its Benefits. *C. Plank, J. Meyer, M. Shultz, C. Newell, and R. Cramer.*
Colin Plank (Burns & McDonnell/USA)

*** = poster presentation**

More Than a Powerful Visual: Using Statistical Modeling and Python to Efficiently Create Project Deliverables and Assess Remedial Options. *J.D. Depa.*
Jim Depa (Jacob and Hefner Associates/USA)

Performing a High-Resolution Investigation to Assess Site Hydrogeology and Contaminant Migration Pathways to Update a Conceptual Site Model. *B.L. Porter, P. Tamashiro, J. Pavlowsky, K. Kehoe, and J. Briegel.*
Johanna M. Pavlowsky (APTIM/USA)

***Refinement of TCE Conceptual Site Model to Develop Remedial Design.** *A. Moore.*
Anothony Moore (Environmental Works, Inc./USA)

Usage of HRSC Tools to Create More Accurate CSMs at Two Large Manufacturing Facilities. *T. Kinney, C. Tort, and T. Fewless.*
Thomas Kinney (GHD/USA)

D4. Big Data and Integration of Molecular Tools in Site Assessment: Advanced Omics

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Fadime Kara Murdoch (Battelle) and Robert R. Rappold, Jr. (Allonnia)

Advancements in Remedial Performance Assessments at Complex Sites with Incorporation of Advanced Data Analytics and Innovative Characterization Tools. *J.S. Konzuk, M. Cho, C. Crea, C. Cheyne, L. D'Agostino, L. Jorstad, J. Stening, and O. Bukhteeva.*
Julie Konzuk (Geosyntec Consultants International, Inc./Canada)

***Advances for the Rapid and Sensitive Biomonitoring of the Reductive Dechlorination's Biomarkers: Digital Droplet PCR.** *B. Matturro, M.L. Di Franca, and S. Rossetti.*
Bruna Matturro (Water Research Institute [IRSA] National Research Council [CNR]/Italy)

***Bioremediation Treatment Optimization Study: The Kuwait Project.** *C. Masini and F. Brogioli.*
Cosimo Masini (DND Biotech srl/Italy)

***Comparison of Whole Genome Sequencing, 16S Amplicons, and qPCR for Assessment and Monitoring of an EPA Superfund Site.** *R.A. Reiss, O. Makhnin, and P. Guerra.*
Rebecca Reiss (New Mexico Tech [Emeritus]/USA)

Gene Markers for Monitoring Anaerobic Dichloromethane Biodegradation: Current Progress and Future Directions. *R.W. Murdoch, F. Kara Murdoch, G. Chen, and F. Loeffler.*
Robert Murdoch (Battelle/USA)

Probing Marine Ecosystems for Novel Polycyclic Aromatic Hydrocarbon Degraders. *J. Walton, E. Bobo, and A. Buchan.*
Jillian Walton (University of Tennessee/USA)

Student Paper Winner

Proteomic Insights into Fungal-Mediated PFAS Precursor Biotransformations. *K. Shah, Y. Gao, G. Nurwono, V. Pandey, A. Mayank, J.O. Park, J. Wohlschlegel, and S. Mahendra.*
Kshitija Shah (University of California, Los Angeles/USA)

Using Environmental Metabolomics to Improve Decision Making at Chlorinated Solvent Sites. *K.C. Clark, S.M. Rosolina, and D.M. Taggart.*
Kate Clark (Microbial Insights, Inc./USA)

D5. Modeling and Monitoring Approaches to Improve Remedy Design and Implementation

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Rick Cramer (Burns & McDonnell) and J. Mark Stapleton (Noblis)

***Advanced Data Analysis (ADA) Guides Remedial Decisions by Improving the Site Conceptual Model with High-Resolution Site Characterization Data.** *W.C. Benni.*
William C. Benni (Improved Analysis through Modeling [IAtM]/USA)

Effects of Heterogeneity and Back-Diffusion on Cleanup Timeframe. *D.K. Burnell.*
Daniel Burnell (Tetra Tech, Inc./USA)

Environmental Sequence Stratigraphy in Numerical Groundwater Models. *J.P. Brandenburg, R.M. Suribhatla, and M. Einarson.*
Raghavendra Suribhatla (Haley & Aldrich/USA)

An Innovative Biocirculation®-System for Chlorinated Aliphatic Hydrocarbon (CAH) Degradation with Groundwater Circulation Well (IEG-GCW®). *P. Ciampi, M. Petrangeli Papini, C. Esposito, E. Bartsch, E. Alesi, and G. Rehner.*
Paolo Ciampi (University of Rome "La Sapienza"/Italy)

***Optimization of Groundwater Recovery and Monitoring Network Facilitated by 3DVA and Innovative Hydrogeologic Evaluation Toolbox.** *J. Jackson, K. Bostick, and J. Drummond.*
Jonah Jackson (Environmental Standards, Inc./USA)

Remedial Design Optimization Using Environmental Sequence Stratigraphy. *J.M. Stapleton.*
J. Mark Stapleton (Noblis/USA)

* = poster presentation

D6. High-Resolution Site Characterization

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Andrew Barton (Battelle) and
John Sohl (Columbia Technologies, LLC)

Case Study: Nutrient-Enhanced Biologic Stimulation (NEBS) Pilot Based on High-Resolution Assessment and qPCR Analysis. *S. Reeves, J. Sohl, and R. Smith.*
Richard Smith (SMME, Inc./USA)

EPA and HRSC at Superfund Sites. *B. Bentkowski.*
Ben Bentkowski (U.S. EPA Region 4/USA)

***High-Resolution Investigation and MIP Visualization to Optimize In Situ Bioremediation of VOCs in Groundwater and Aquifer Sediments.** *T. Houghton and C.S. Alger.*
Tyler B. Houghton (Terraphase Engineering/USA)

Integrating Diverse High-Resolution Data Sets to Assess Aquitard Integrity in a DNAPL-Contaminated Sedimentary Rock Aquifer System. *J.R. Meyer and B.L. Parker.*
Jessica Meyer (University of Iowa/USA)

Interpretation of 2-D and 3-D Images of Ultraviolet Optical Image Profiler (OIP-UV), Hydraulic Profiling, and Electrical Conductivity (HPT/EC) Log Data at Complex LNAPL Sites. *J.V. Fontana.*
John Fontana (Vista GeoScience/USA)

Monitoring of Subsurface Contaminant Remediation at the Former Moab Uranium Mill Site by In Situ Nuclear Magnetic Resonance. *D. Morozov, C. McLaughlin, K.H. Williams, and D. Walsh.*
Darya Morozov (Vista Clara/USA)

Performing High Resolution Site Characterization to Evaluate Site Contaminant Extent, Flux, and Geochemistry for Remedy Selection. *P. Tamashiro, J. Pavlowsky, K. Bunnell, K. Kehoe, and K. Hurley.*
Johanna M. Pavlowsky (APTIM/USA)

Quantitative High-Resolution Site Characterization (qHRSC) and Lessons Learned. *D.A. Pizarro and W. Brab.*
Derek Pizarro (AST Environmental, Inc./USA)

Quantitative High-Resolution Site Characterization to Support Petroleum Remediation in Piedmont Geology. *N. Thacker, S. Ghiold, and A. Quarles.*
Nathan Thacker (AST Environmental, Inc./USA)

***Remedial Design Characterization Using Electrical Hydrogeology.** *T. Halihan, K.W. Spears, and S.W. McDonald.*
Todd Halihan (Oklahoma State University/USA)

Using HRSC to Rapidly Assess LNAPL Distribution, Optimize Well Placement and Accelerate Remedial Design. *E. Gessert, B. Taylor, and R. St. Germain.*
Erik Gessert (Terracon/USA)

***Using Ultraviolet-Induced Fluorescence to Enhance LNAPL Conceptual Site Model for Remedial Design.** *A. Moore.*
Anothony Moore (Environmental Works, Inc./USA)

Utilizing Dye-Laser Induced Fluorescence Tooling with Soil Borings to Map Residual Free-Phase DNAPL at Former Solvent Disposal Trenches. *J. Briegel, J. Pavlowsky, K. Kehoe, B.L. Porter, and G. Watson.*
Benjamin Porter (APTIM/USA)

D7. Chemical Fingerprinting and Forensics

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Kavitha Dasu (Battelle) and
Dora Taggart (Microbial Insights, Inc.)

Advanced Diagnostic Tools as Measures of Petroleum-Hydrocarbon Remedial Performance. *K. Sra, R. Kolhatkar, and E. Daniels.*
Kammy Sra (Chevron/USA)

Case Closed? Full Remediation of a 1980's Era Superfund Site. *T. McHugh and L. Beckley.*
Thomas McHugh (GSI Environmental Inc./USA)

***Determination of Mass Balance for Fluorine Using Three Analytical Techniques (LC-MS-QQQ, F NMR, and Fluorine-ISE) as a Practical Tool for Testing Ultrasonic Treatment for Degradation of Per- and Polyfluorinated Alkyl Substances.** *B.B. Souza, J.A. Kewalramanai, D. Prajapati, R. Marsh, J. Meegoda, and P. Juriasingani.*
Bruno Bezerra de Souza (New Jersey Institute of Technolog/USA)

Groundwater Recovery System Replacement Using a Multiple Lines of Evidence MNA Demonstration. *D. Gray, T. Vannest, C. Wasteneys, and B. Witt.*
Doug Gray (AECOM/USA)

***PFAS Forensics through Applied Statistics: A Review of Case Studies in Chemometrics, Pattern Recognition, and Machine Learning.** *Z. Neigh, R. Gwinn, H.A. Brown, and J.K. McCurdy.*
Zachary Neigh (AECOM/USA)

* = poster presentation

PFAS Signature®: A Forensic Tool to Differentiate AFFF and Non-AFFF PFAS Sources. *K. Dasu, C. Orth, L. Mullins, D. Friedenberg, and B. Hill.*
Kavitha Dasu (Battelle/USA)

***Radial Diagram Visualization and Semi-Quantitative Forensic Methods to Assess PFAS Sources of Origin.** *G.R. Carey.*
Grant Carey (Porewater Solutions/Canada)

D8. Improved Conceptional Site Models that Include Biodegradation Data

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Charles Newell (GSI Environmental Inc.) and John Wilson (Scissortail Environmental Solutions, LLC)

A Bioventing Model: Flow and Component Transport in Porous Media Including Interphase Mass Transfer and Biodegradiation Rate. *M.K. Soureshjani and R.G. Zytner.*
Mohammad Khodabakhshi Soureshjani (University of Guelph/Canada)

Quantifying Order-of-Magnitude (OoM) Impacts of Back Diffusion in Conceptual Site Models. *R.C. Borden.*
Robert Borden (North Carolina State University/USA)

Subsurface Depositional Environment of Ellsworth Air Force Base (AFB), South Dakota, and Its Role in Bioremediation Strategy. *J. Sadeque.*
Junaid Sadeque (AECOM/USA)

Using Molecular Tools to Predict Rate Constants for Anaerobic Biodegradation of cis-DCE and Vinyl Chloride in Groundwater. *J.T. Wilson, B. Wilson, M. Michalsen, K. Kacharzyk, F. Murdock, and F. Loeffler.*
John Wilson (Scissortail Environmental Solutions, LLC/USA)

D9. Tools for Site Assessment and Bioremediation Monitoring

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Jay Shaw (Provectus) and Tomas Will (Directional Technologies, Inc.)

***Advancements in Analytical Techniques to Demonstrate Successful Mineralization of PFAS.** *T. McKnight.*
Taryn McKnight (Eurofins Environment Testing/USA)

Development of ASTM Guidance on Application of Molecular Biological Tools to Assess Biological Processes at Contaminated Sites. *S. Dworatzek, B. Harding, P. Hatzinger, M. Heintz, E. Jennings, T.A. Key, R. Kolhatkar, T. MacBeth, E. Mack, A. Madison, C. Waletka-Hutchinson, C. Acheson, and S. Fiorenza.*
Stephanie Fiorenza (Arcadis/USA)

***Field-Collected Soil Gas Data as an Inexpensive Line of Evidence to Monitor Natural Attenuation.** *K.A. Morris.*
Kevin Morris (ERM/USA)

Groundwater Plume Analytics® Tools for Improved Conceptual Site Models at Bioremediation Sites. *J.A. Ricker and D.C. Winchell.*
Joseph Ricker (WSP/USA)

***Impacts of Hydrodynamic Conditions and Surface Roughness on the Critical Conditions and Thickness of Early-Stage Biofilm Development.** *G. Wei and J. Yang.*
Judy Yang (University of Minnesota-Twin Cities/USA)

***Long-Term Performance of a Carbon Barrier Evaluated through Integrated Use of Aspect Ratio, Passive Flux and Modelling Analytical Tools.** *J. Birnstingl, C. Lee, and C. Sandefur.*
Jeremy Birnstingl (REGENESIS/USA)

***Metagenomic and Metatranscriptomic Analysis of Organohalide-Respiring Microbial Communities in PCB-Contaminated Sediment Microcosms.** *J.M. Ewald, J.L. Schnoor, and T.E. Mattes.*
Timothy Mattes (University of Iowa/USA)

***Microbially Mediated p-Cresol and Toluene Production from Biomass Decay: An Unintended Consequence of Biostimulation for Treatment of Chlorinated Solvents.** *S.J. Reynolds, A.B. Gathings, and W.M. Moe.*
Samuel J. Reynolds (Ramboll/USA)

***Multiple Contaminants and Aquifers: 4D Mass Flux and Volumetric Analyses.** *T. Kremmin, T. Andrews, W. Nolan, and M. Ingraham.*
Todd Kremmin (Jacobs/USA)

***A Novel Biomarker for Monitoring Anaerobic In Situ Degradation of Benzene.** *C.R.A. Toth, O. Molenda, C. Nesbø, N. Bawa, S. Guo, F. Luo, C. Devine, R. Flick, E.A. Edwards, J. Webb, and S. Dworatzek.*
Courtney Toth (University of Toronto/Canada)

Quantitative Proteomics Approach to Monitor cVOC Bioremediation and Degradation Rates. *K.H. Kucharzyk, F. Kara Murdoch, F.E. Loeffler, J. Wilson, P.B. Hatzinger, J.D. Istok, R.W. Murdoch, L. Mullins, A. Hill, and M. Michalsen.*
Kate Kucharzyk (Battelle/USA)

***Rate of Extracellular Transfer of Charge and Bioremediation.** *S.R. Burge, R.G. Burge, E.D. Taylor, and K.D. Hristovski.*
Scott Burge (Burge Environmental, Inc./USA)

Role of Stratigraphic Models to Refine Site Assessments. *B. Campanaro, J. Sadeque, R. Samuels, and D. Parse.*
Ben Campanaro (AECOM/USA)

* = poster presentation

***What's Holding New Site Characterization Technologies Back? New Technologies -v- Business Model Bias.** *A.R. Schindler.*
Russell Schindler (SampleServe, Inc./USA)

Where is the Vinyl Chloride? Alternative Natural and Enhanced Degradation Pathways for Chlorinated Solvents. *J.R. Hesemann.*
John Hesemann (Burns & McDonnell/USA)

E1. Best Practices in Green and Sustainable Remediation (GSR)

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Alison R. Denn (GSI Environmental Inc.) and Richard Raymond, Jr. (Terra Systems, Inc.)

Carbon Sequestration to Stabilize Legacy Alkaline Waste. *D.A. Granger and M. Viganotti.*
David A. Granger (AECOM/United Kingdom)

Environmental Justice as a New Driver for Sustainable Remediation at Superfund Sites. *R. Wice.*
Rick Wice (Battelle/USA)

Sustainable Assessment Tool for the Selection of the Optimal Site Remediation Technology Applicable at any Contaminated Gasoline Site. *C. Dunlop, B. Abbassi, and R.G. Zytner.*
Connor S. Dunlop (University of Guelph/Canada)

The Sustainable Remediation of an Agrochemical Manufacturing Facility. *A.O. Thomas, D. Manning, L. Leclezio, and R. Pollock.*
Alan O. Thomas (ERM/United Kingdom)

E2. Sustainable Remediation Assessment Tools

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Ashley Barker (Battelle) and Wendy Condit (Geosyntec Consultants, Inc.)

Analysis of the Economic, Environmental and Social Sustainability of Soil Remediation Technologies with AECOM's Sustainable Remediation Tool. *F. Motta, S. Boccardo, C. Visccotti, and P. Cellie.*
Francesca Motta (AECOM/Italy)

Assessing the Sociotechnical of Remediation through Humanitarian Engineering and SustainAlytics Framework. *J. Cloninger, B. Moak, M. Harclerode, and C. Silver.*
Breanna Moak (CDM Smith/USA)

Consideration of Unintended Impacts in Sustainable Remediation Options. *K. Waldron and G. Wolf.*
Kyle Waldron (Marathon Petroleum Corporation/USA)

***ENVIRO.wiki: Tech Transfer in the 21st Century.** *B. Yuncu, J. Hurley, and R.C. Borden.*
Bilgen Yuncu (TRC/USA)

***Secure the Bag: Passive Groundwater Sampling as a Sustainable Remediation Assessment Tool at a Large Chlorinated Solvent Site in Texas.** *A.R. Denn and J.M. Skaggs.*
Alison R. Denn (GSI Environmental Inc./USA)

Sustainable PFAS Remediation: Comparing the Environmental Impact of Enhanced Attenuation Using Colloidal Activated Carbon to Pump and Treat. *G. Leonard, J. Laitinen, and K. Thoreson.*
Gareth Leonard (Regenesis/United Kingdom)

E3. Robotic Technologies for Environmental Site Assessment and Monitoring

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Daniel Mummert (Cedarville Engineering Group LLC) and Natahsa Sihota (Chevron Energy Technology Company)

Autonomous Characterization of Chloride and Total Petroleum Hydrocarbons in Contaminated Soils Using Ground-Based Robotic Platforms. *G.V. Lowry, A. Johnson, H. Wang, S. Wang, S. Deng, T. Hoelen, and N. Sihota.*
Gregory V. Lowry (Carnegie Mellon University/USA)

Drone-Based Phytoremediation Reconnaissance Using NDVI/NIR Multispectral Imagery at a Historical Waste Storage Landfill. *C. Austin, B. Harding, A. Martin, and D. Gray.*
Clara Austin (AECOM/USA)

Hyperspectral Technologies for Site Assessment and Remediation. *I.O. Caraballo Alvarez, N. Sihota, and T. Miao.*
Irma O. Caraballo Alvarez (Chevron Corporation/USA)

Long-Term Biomonitoring of Coal Ash Impoundments Using Plants and Unmanned Aerial Vehicle (UAV)-Deployed Remote Imaging Platforms. *J.L. Davalos, J. Amos, A. Butler, N. Harms, M. Kurth, T. Rycroft, and E. Gao.*
Jazmine Davalos (Oak Ridge Institute for Science and Education/USA)

Robotics in Environmental Site Assessment. *J. Eichert, K. Pritchard, and B. McAlexander.*
Justin Eichert (Trihydro Corporation/USA)

*** = poster presentation**

***Unmanned Aerial Systems for Environmental Assessment Applications.** *W.M. Stiteler and J.J. Diamond.*
William Stiteler (Arcadis/USA)

E4. Adaptive Site Management Strategies to Mitigate Climate Change Impacts

Platforms Tuesday | Posters (*) Tuesday Evening
Chairs: Angela Paolucci (U.S. Navy) and Jana Heisler White (Battelle)

Climate Change Resiliency Assessments of Two Coastal Sites in Colombia in Preparation for Resilient Remedy Selection. *K.A. Morris and V. Kolluru.*
Kevin Morris (ERM/USA)

***Communicating the Impact: Moving from Qualitative Inclusion of Sustainable Best Management Practices to an Integrated Sustainable Resilient Remediation Approach.** *J. Gattenby, M. Dupre, and J. Sturza.*
Jessica Gattenby (Arcadis/USA)

Constructed Wetlands as a Viable Remedial Alternative Contributing to Improved Site Climate Resilience. *M. Verbeeck, O. Vounaki, and P. Valle.*
Mattias Verbeeck (ERM/Belgium)

Enhanced Phytotechnology as a Nature-Based Solution for Supporting Climate Resiliency. *K. Waldron, B. Harding, C. Cohu, and J. Freeman.*
Kyle Waldron (Marathon Petroleum Corporation/USA)

***Fitting Environmental Response Actions into Sustainability Reporting Frameworks.** *A. Horwath.*
Andrew Horwath (Civil & Environmental Consultants, Inc./USA)

Incorporating Resilience and Adaptation into the SuRF-UK Sustainable Remediation Framework. *A.O. Thomas, R. Gill, N. Harries, and P. Bardos.*
Alan O. Thomas (ERM/United Kingdom)

A Practical Method to Assess Groundwater Remediation System Resiliency: Groundwater Plume Stability is Your Indicator Light. *T.O. Goist, J.A. Ricker, D. Winchell, and M. Burns.*
Timothy Goist (WSP/USA)

***Understanding the Impact: Comparison of Footprints for Treatment Materials in Fixed Media PFAS Treatment Systems.** *A. Mushtaque, J. Gattenby, M. Goncalves, and A. Fischer.*
Mushtaque Ahmad (Arcadis/USA)

Understanding the Impact: Evaluation of Footprint Reduction Achieved with Adaptive Site Characterization. *J. Vidonish Aspinall, J. Gattenby, J. Quinnan, and P. Curry.*
Julia Vidonish Aspinall (Arcadis U.S., Inc./USA)

Panel Discussion—Wednesday, Track E

Opportunities and Challenges for Engineered Biology in Bioremediation

Moderator
Kent Sorenson, Ph.D., PE (Allonnia)

Advances in our ability to engineer biology for applications from therapeutics to agriculture to bioremediation continue to grow exponentially since the human genome project was completed 20 years ago. What took over a decade and more than $1 billion back then can be done in hours for a few hundred dollars today. Gene editing technologies such as CRISPR facilitate high throughput screening of thousands of genetic modifications at a time, dramatically reducing the time required to develop new biological solutions to challenging problems. In the environmental arena we are confronted with major global issues such as recalcitrant chemicals like PFAS that have extremely low regulatory limits, a drive toward decarbonization of many industries, increasing demand for critical metals while ore quality is declining, and a desire to create more circularity in the lifecycle of manufactured consumer products like plastics. Engineered biology could provide at least part of the solution for many of these problems where mechanical and chemical systems are approaching their limits.

During the panel we will discuss many of the opportunities in front of us, including the engineering of environmental microbes to improve their suitability in specific applications or to give them a novel function such as a new enzymatic pathway for contaminant degradation or upcycling of plastics, or novel protein expression for the binding of target metals. Another important opportunity to be discussed is the synthesis of proteins, including enzymes, that could be applied directly into a treatment or resource recovery process, or that could be applied to a surface such as a bead or membrane. In addition to the opportunities for engineered biology it is important to recognize and discuss some of the challenges with its implementation. In this panel we will discuss regulatory and stakeholder acceptance, as well as potential impacts to the native microbiome in environmental applications and possible mitigation strategies.

*** = poster presentation**

E5. Microplastics and Nanoplastics: Degradation and Effects on the Environment

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Alison Cupples (Michigan State University) and Usha Vedagiri (WSP)

Can We Apply a Site-Specific Ecological Risk Assessment Framework for Microplastics? *R. Zajac-Fay, J.M. Conder, T. Liu, and Z. Pandelides.*
Rachel Zajac-Fay (Geosyntec Consultants, Inc./USA)

***Evaluation of Presence of Nylon 6 and Polystyrene Micro- and Nanoplastics on Degradation of Chlorinated Solvents and Energetics.** *F. Kara Murdoch, Y. Sun, F. Loeffler, M. Fuller, J. Lilly, and K.H. Kucharzyk.*
Fadime Kara Murdoch (Battelle/USA)

Microplastics and Nanoplastics: Degradation and Effects on the Environment. *M. Ellis, T. Boom, S. BinAhmed-Menzies, A. McCabe, and L. Carney.*
Sara BinAhmed-Menzies (Barr Engineering/USA)

***Microplastics as Vectors of Persistent Organic Pollutants and Metals in Aquatic Environment.** *Y. Kunukcu.*
Yasemin Kunukcu (Roux Inc./USA)

Microplastics: Challenges and Options for Removal through Wastewater Treatment Plants (WWTPs). *Y. Kunukcu.*
Yasemin Kunukcu (Roux Inc./USA)

Municipal Activated Sludge-Derived Microplastic Microbiomes: The Good, the Bad, and the Promising. *D. Deng, D.N. Pham, L. Clark, and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

***Plastics Biodegradation and Plastispheres of Engineered and Natural Environments.** *M. Hwangbo, Z. Chen, J. Kameoka, and K.H. Chu.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

Potential for Health Effects of Microplastics: San Francisco Bay Area Example. *U. Vedagiri.*
Usha Vedagiri (WSP/USA)

***Synergistic Interactions of Fungal Enzymes and Bacteria on Polyurethane (PUR) Biodegradation.** *W.J. Park, M. Hwangbo, and K.H. Chu.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

E6. Bioremediation of Munitions Constituents

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Rula Anselmo Deeb (Geosyntec Consultants) and Paul Erickson (REGENESIS)

Application of Proteomics to Assess Degradation of RDX in Pure Cultures and Groundwater from Impacted Sites. *F. Kara Murdoch, R.W. Murdoch, S. Higgins, M. Fuller, A. Hill, L. Mullins, M. Gander, A. Danko, and K.H. Kucharzyk.*
Fadime Kara Murdoch (Battelle/USA)

Bioaugmentation Design for Treatment of Munitions Constituents. *S. Downey, R. Mayer, and Z. Parham.*
Steven Downey (APTIM/USA)

Co-Removal of Energetics and Oxyanions via In Situ Coupling of Catalytic and Enzymatic Destructions: A Solution to Ammunition Wastewater Treatment. *C. Zheng, C. Zhou, and B. Rittmann.*
Chenwei Zheng (Arizona State University/USA)

***Evaluating the Water Reactivity of Expired Propellants.** *J.J. Smith, D. Graves, and K. Eden.*
Jacques Smith (SiREM/USA)

Isolation and Characterization of Nitroguanidine-Degrading Bacteria. *J. Kim, K. Chu, M.E. Fuller, and P.B. Hatzinger.*
Kung-Hui (Bella) Chu (Texas A&M University/USA)

Linking Proven Technologies to Bioremediate TNT and Metabolites and Facilitate On-Site Reuse of Soil. *S.M. Larew, E.D. Meeks, and A.G. Seech.*
Scott Larew (Kennedy/Jenks Consultants/USA)

E7. Treatment of Nitrate-Impacted Groundwater

Platforms Wednesday | Posters (*) WednesdayEvening
Chairs: Matthew Burns (WSP) and Fausto Ortiz (EOS Remediation)

Biostimulation to Promote Total Nitrogen Loss in a Coastal Aquifer. *B. Lazenby, F. Cosme, J. Konzuk, K. Phillips, A. Black, B. Howarth, S. McCollin, and B. Schultz.*
Brent Lazenby (Geosyntec Consultants/USA)

Compound Specific Isotope Analysis to Identify the Source of Ammonia and Nitrate in Surface Water Adjacent to a Fertilizer Plant. *S. Dore, D. Pope, and A. Cox.*
Sophia Dore (GHD/USA)

* = poster presentation

Enhanced Denitrification for Treatment of Nitrate Plumes Associated with Fertilizers: Laboratory and Pilot Studies. *S. Dore, D. Pope, and A. Cox.*
Sophia Dore (GHD/USA)

Nitrogen Compound Metabolism Insights Gained by a Holistic Testing Regime. *P. Dennis, J. Roberts, S. Volkoff, and E. Nesbit.*
Philip Dennis (SiREM/Canada)

***Post-Injection Evaluation of In Situ Chemical Reduction as Treatment Remedy for Nitro-Aromatic Compounds.** *C.A. Montero, C. Macon, and W. Lundy.*
Charles Montero (Wood/USA)

Using Molecular Biological Tools to Address Nitrogen Transformation in Groundwater. *D. Taggart, K. Clark, S. Rosolina, and D. Puckett.*
Dora Taggart (Microbial Insights, Inc./USA)

E8. Advances in Tools and Techniques for Assessing MNA

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Kate Clark (Microbial Insights, Inc.) and Rick Gillespie (REGENESIS)

An Approach to Evaluate Whether There Has Been Sufficient Active Treatment to Justify a Transition to MNA. *J.T. Wilson, B. Wilson, M.L. Ferrey, D.L. Freedman, O. Dunn, D. Adamson, and C. Newell.*
John Wilson (Scissortail Environmental Solutions, LLC/USA)

***Automated Data Analysis and Decision Making to Support Pump and Treat Shutdown Evaluation.** *J. Ford, A. Sidebottom, H. Hernandez, T. Palaia, A. Forsberg, and J. Rankin.*
Jeffrey Ford (Jacobs/USA)

Development of Predictive Tools for Assessment of Natural Attenuation Capacity and Treatment Transition at Chlorinated Solvent Sites. *K.M. Belli, C.F. Wildman, M.C. Kavanaugh, E.J. Suchomel, E. Mendez III, M.A. Widdowson, K.D. Pennell, and N.L. Capiro.*
Claire Wildman (Geosyntec Consultants, Inc./USA)

***Enhancing Remedial Performance Assessments at Complex Sites Using Compound Specific Isotope Analysis and Molecular Biological Tools.** *J.S. Konzuk, C. Cheyne, L. D'Agostino, M. Cho, B. Goodwin, and C. Coladonato.*
Julie Konzuk (Geosyntec Consultants International, Inc./Canada)

***Evaluating Natural Attenuation Using Multiple Lines of Evidence in Complex Geologic/Hydrogeologic Conditions.** *D. Gray, S. Martin, E. Mack, and N. Grosso.*
Doug Gray (AECOM/USA)

Groundwater Monitoring Efficiencies Using Modern Data Collection and Analysis Tools at a Site Transitioning to MNA. *R.T. Simon, V. Ward, and G. Booth.*
Ralph Simon (Woodard & Curran/USA)

***The Importance of Archaea in Biofilm Development and Sustainable Bioremediation Programs.** *K.B. Rapp, J. Neve, R.A. Wojciak, and S.M. Rapp.*
Keith Rapp (Pinnacle Engineering/USA)

***Leveraging a Robust Microbial Profile for an MTBE Sorptive Biobarrier.** *J.K. Sheldon and D. Bush.*
Jack Sheldon (Antea Group/USA)

***Long-Term Evaluation of Chlorinated Solvent Attenuation Rates in Groundwater.** *M.L. Ferrey, W. Bouchard, and J.T. Wilson.*
Mark L. Ferrey (Minnesota Pollution Control Agency/USA)

Matrix Diffusion as a Key Attenuation Process for PFAS in Groundwater. *C.J. Newell, P.R. Kulkarni, S.K. Farhat, and D.T. Adamson.*
Charles Newell (GSI Environmental Inc./USA)

***Packed-Clay Diffusion Columns for Assessment of Natural Abiotic Attenuation of Chlorinated Solvents.** *T. Blount, K. Kearney, D. Tran, C. Schaefer, and C. Werth.*
Timothy M. Blount (University of Texas at Austin/USA)

***Prolonged Effects from Short-Term Bio-Trap Deployment in Monitoring Wells at a Chlorinated Solvents Remediation Site.** *E. Pulcher and E. Dulle.*
Emily Pulcher (Burns & McDonnell/USA)

Remediation of AFFF/PFAS-Impacted Soil by Sequestration and Natural Attenuation. *J. Ramey, K. Quinn, and T. Martin.*
Jeff Ramey (TRC/USA)

***Transition to Monitored Natural Attenuation for a CVOC Plume after 28 Years of Pump and Treat: Lessons Learned.** *J.A. Ricker and D.C. Winchell.*
Joseph Ricker (WSP/USA)

***Using Automated Analytics to Optimize Groundwater Monitoring at MNA Sites.** *V. Ward, K. Elich, K. Hadley, and R. Simon.*
Tori Ward (Woodard & Curran/USA)

* = poster presentation

Panel Discussion—Thursday, Track E

Science, Application, Monitoring, and Illustrative Case Studies of Biogeochemical Remediation

Moderator
Brant Smith, P.E., Ph.D (Evonik)

Panelists

Paul Tratnyek, Ph.D. (Oregon Health & Sciences University)
Alan Seech, Ph.D. (Evonik)
Eliot Cooper (Cascade)
Dora Taggart (Microbial Insights)
Dan Leigh, PG (Evonik)

This panel will discuss the key elements required to be successful in each step of remediation using biogeochemical processes. These steps include understanding the fundamentals and advanced concepts regarding the following:

- **Science.** Biogeochemistry often involves multiple technologies and treatment technologies all capable of reducing many common contaminants of concern. Topics that will be covered include the multiple potential pathways (direct reduction, biotic, and then biogeochemical), contaminants treated, sulfidization of ZVI, reduction of sulfate and other microbial processes involved, and types of iron sulfides formed.
- **Design.** Key elements of a design including iron, carbon, and sulfur sources, pH control, microbial activity as well as typical dosages to be applied in certain scenarios. In addition, there will be a discussion on site assessment as to whether biogeochemical is the appropriate technology given site-specific conditions.
- **Application.** Application methods for various scenarios, key requirements and distribution of reagents and precipitates will be discussed.
- **Monitoring.** Key elements of a monitoring program will be discussed including baseline and post-application monitoring of both microbial and geochemical conditions to ensure the intended treatment mechanisms are being effective.
- **Illustrative case studies.** Biogeochemical remediation has been applied for over a decade. Case studies illustrating how and why biogeochemical remediation was selected and was effective will be presented.

Following initial presentations from each of the panel members, the session will be opened to a question and answer session.

E9. Groundwater/Surface Water Interactions

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Stephanie Fiorenza (Arcadis) and Scott Pittenger (In-Situ Oxidative Technologies, Inc. [ISOTEC])

Assessing the Origin of Groundwater Springs and Implications for PFAS Fate and Transport at Mountain Home Air Force Base, Idaho. *M.R. Shultz and M. Anding.*
Mike Shultz (Burns & McDonnell/USA)

***Assessment of CVOC Attenuation at the Groundwater/Surface Water Interface Using a Combination of High-Resolution Tools and Traditional Methods.** *C.G. Patterson, A. Gavaskar, S. Lee, A. Danko, L. Lefkovitz, J. Sminchak, and A. Jackson.*
Eliza Kaltenberg (Battelle/USA)

***Field Studies of PFAS Retention of Groundwater at Freshwater/Saltwater Interfaces.** *R.D. Cardoso, S.A. Lee, D. Roff, H.M. Hort, B.Y. Li, and C.J. Newell.*
Rebecca Cardoso (U.S. Navy/USA)

Groundwater/Surface Water Interactions at the Transition Zone: Utilizing an In Situ Passive Sampling Program to Evaluate Groundwater Upwelling. *B.G. Pautler, M. Healey, J. Roberts, J. Conder, D. Toler, L. Fontenot, and S. Aufdenkampe.*
Brent Pautler (SiREM/Canada)

***Investigating Groundwater: Surface Water Interaction Using Distributed Temperature Sensing (DTS) Technology.** *S. Lee, H. Tahon, D. Adilman, F. Selker, and C. Gabrielli.*
Sung-Woo Lee (Geosyntec Consultants/USA)

***Natural Attenuation of Metals in an Abandoned Mine in the Spanish Pyrenees.** *M.G. Giannetta.*
Max Giannetta (GSI Environmental Inc/USA)

Natural Occurrence of Feammox Conditions and Anammox Microbiota within a PFAS Plume at the Groundwater-to-Surface Water Interface. *B. Harding, R. Gwinn, and J. Buzzell.*
Barry Harding (AECOM/USA)

A Seep Origin Story: Using Electrical Hydrogeology to Find Mysterious Deep LNAPL Source. *T. Halihan, K.W. Spears, and S.W. McDonald.*
Todd Halihan (Oklahoma State University/USA)

* = poster presentation

SHORT COURSES AND CAREER KICKSTARTER

Short Courses and Career KickStarter

Career KickStarter

Monday, May 8, 3:00-5:00 p.m.

The Career KickStarter is open to all student and early-career/young professional attendees (5 years or less in the field). There is no additional cost to attend.

The Career KickStarter **does require pre-registration** to match mentors and mentees.

See the **Student Participation** page on the Symposium website to register as a mentor or mentee.

Short Courses

Short Course early-bird registration rates are available through March 29, 2023. Limited onsite registration may be available, however, courses that do not meet the required 6 minimum attendees by the early-bird date may be cancelled. Please register as soon as possible to ensure your preferred course continues.

The link to register can be found on the **Short Course** page on the Symposium website.

Monday, May 8, 8:00 a.m.-12:00 noon (morning half-day)

- Applying CSIA to Assess Source and Fate of Contaminants, and the Performance of Remediation Treatments
- Best Practices for Bioremediation and Reductive Technologies

Monday, May 8, 1:00 a.m.-5:00 p.m. (afternoon half-day)

- Application of Molecular Biological Tools to Assess Biological Processes at Contaminated Sites

Monday, May 8, 3:00-5:00 p.m.

- Career KickStarter

Short Course Descriptions

Monday, May 8
8:00 a.m.-Noon

Applying CSIA to Assess Source and Fate of Contaminants, and the Performance of Remediation Treatments

Instructors: Orfan Shouakar-Stash (Isotope Tracer Technologies, Inc.) and David Alden (Tersus Environmental, LLC)

Course Objective: This course will present the latest advancement in the applications of compound-specific isotope analysis (CSIA) and environmental isotopes as forensic tools to discern the origin of specific contaminants and characterize and assess the fate of different contaminants released in the environment. The potential audience includes environmental professionals, engineers, regulators, and community stakeholders engaged in the management and remediation of contaminated sites.

Course Overview: Isotopes, including CSIA, are considered a powerful tool in delineating commingled contaminant plumes, detecting better understanding, and quantifying biotic and abiotic transformation of various contaminants (e.g., chlorinated solvents, hydrocarbons, etc.). The course will cover the theory and background of isotopes, followed by an extended presentation of several field case studies, with a special focus on the latest advancements in combining CSIA with other traditional isotope analysis and classical site characterization approaches. This short course is designed to show the latest advancement in CSIA and the potential applications of stable isotopes in general and in a more specific terms in investigating natural attenuation and active remediation of various contaminants. CSIA has been successfully used in determining the source of contaminations, understanding the fate of contaminants in groundwater, and evaluating the effectiveness of remediation actions, including the performance assessment for a broad range of biological (natural and enhanced), chemical (e.g., in situ chemical oxidation [ISCO] and permeable reactive barriers [PRB]) and physical (e.g., thermal treatment and pump and treat) remediation strategies. In the last decade, CSIA has been extensively applied to many contaminated sites, and the outcome proved to be highly successful in providing information unrevealed by conventional concentration analysis. Most previous studies heavily relied on 13C-CSIA, whereas most recent investigations have employed additional isotopes (37Cl-CSIA and 2H-CSIA). Recent interest in the two-dimensional isotope approach (13C and 37Cl) or, in some cases, three-dimensional isotope approach (13C, 37Cl, and 2H) is driven by advancements in the analytical methodologies, laboratory pieces of evidence, and also field applications that demonstrated the added value of the application of multiple CSIA in distinguishing different sources of contamination as well as better understand the fate of the contaminants in the subsurface. The course will also shed light on the use of CSIA in vapor intrusion.

*Laptops are **not** required.*

Monday, May 8
8:00 a.m.-Noon

Best Practices for Bioremediation and Reductive Technologies

Instructors: Fayaz Lakhwala (Evonik), Sophia Dore (GHD), Paul Dombrowski (In-Situ Oxidative Technologies, Inc. [ISOTEC]), and Alberto Leombruni (Evonik)

Course Objective: The purpose of this course is to present the current best practices for applying bioremediation and reductive technologies to treat common environmental contaminants of concern. The potential audience includes engineers and scientists who are interested in learning about fundamentals and some advanced concepts from industry experts.

Course Overview: This short course will provide fundamental overviews by consolidating decades of experience in applying enhanced reductive dechlorination (ERD), in situ chemical reduction (ISCR) and biogeochemical reduction (BGCR) technologies. The course is intended to benefit experienced practitioners but is primarily intended for those who are less experienced using in situ remediation techniques. The course will be divided into four sections each intended to last for 1 hour. At least 15 minutes will be allocated for discussion during each section. This will be accomplished by focusing on key topics of fundamental science, design considerations, application methods, and using case studies to illustrate how all of these can come together successfully. These will include a presentation of:

- Fundamental science including oxidative versus reductive pathways, abiotic versus biotic processes, the various types of microbes that are commonly used in bioremediation, bioaugmentation, abiotic versus biotic degradation pathways, biogeochemical chemistry, types of electron donors, contaminants commonly treated with reductive technologies and their various reduction potential. A basic understanding of site geology and hydrology will be assumed.
- Design considerations will discuss critical design parameters, dosage strategies for different electron donors, lessons learned of when and where to use different technologies, modifications made due to site constraints, monitoring programs, strategies to achieve various remedial goals, and process optimization.
- Field applications would describe the various commonly used application strategies and equipment as well as outlining the differences between a field pilot study and full-scale efforts.
- Case studies will be presented illustrating these thoughts and processes and how they have been successfully combined for ERD, ISCR and BGCR.

*Laptops are **not** required.*

Monday, May 8
1:00-5:00 p.m.

Application of Molecular Biological Tools to Assess Biological Processes at Contaminated Sites

Instructors: Phil Dennis (SiREM), Sam Rosolina (Microbial Insights), Stephanie Fiorenza (Arcadis), Andrew Madison (WSP), and Barry Harding (AECOM)

Course Objective: This course will provide site remediation professionals and regulators insights and advice on best practices for use and application of molecular biological tools to assess and optimize bioremediation of chlorinated solvents, hydrocarbons and other recalcitrant compounds based on a new ASTM standard guide (ASTM E3354-22).

Course Overview: As remediation sites increase in complexity, the need for accurate characterization of a site's conditions as to its physical, chemical and biological nature also increases. The monitoring and evaluation of remediation also requires a complete understanding of attenuation processes. The application of physical and chemical testing procedures is widely understood and performed. In contrast, evaluations targeting biological processes via molecular biological tools (MBTs) are much less commonly performed, and as a result, most conceptual site models are incomplete. The purpose of the newly published ASTM Standard Guide for Application of Molecular Biological Tools to Assess Biological Processes at Contaminated Sites (ASTM E3354-22) is to provide an overview of MBTs and present a framework through which project managers and other remediation professionals can select and apply MBTs at their sites. This is the first, comprehensive guidance document on MBTs produced specifically for site stakeholders. The instructors are industry veterans and members of the team which developed the Standard Guide. The course will lead participants through the key findings and recommendations of the standard. Real-world scenarios and case studies presented will be used to guide participants through selection, planning, deployment, sampling, quality control and interpretation of MBT data to inform practitioners in the best use of these powerful technologies.

*Laptops are **not** required.*

LEARNING LABS

Learning Lab Schedule

The Learning Lab, located in the Exhibit Hall, will consist of hands-on demonstrations highlighting specific technologies, tools, and software. Each Learning Lab is scheduled twice, once on Tuesday and once on Wednesday. See the schedule below for specific times.

Tuesday, May 9

- 9:40-10:05 a.m.—Sustainable and Cost-Effective Alternative for PFAS Waste Disposal (page 45)
- 10:30-10:55 a.m.—Multi-Site Trend Analysis and Remedial Design Implications of Passive Flux Data from PFAS-, CVOC- and Hydrocarbon-Contaminated Sites (page 46)
- 1:00-1:25 p.m.—Sentinel™ Passive Sampler: Lower Total Cost for PFAS Monitoring and Analysis (page 46)
- 1:50-2:15 p.m.—See Your Site in a Whole New Way: Using Soil Sense to Continuously Monitor NSZD and Hydrocarbon Plume Dynamics (page 46)
- 2:40-3:05 p.m.—Successful Sub-Slab Vapor Data Collection: Best Practices (page 47)
- 3:30-3:55 p.m.—A Non-Destructive Probe for UV-Based Monitoring: Adding Time Dependence to Fluorescence-Based HRSC Tools (page 47)
- 4:20-4:55 p.m.—Use of Passive CO_2 Traps to Quantify the Degradation Rates of Chlorinated Solvents (page 48)
- 5:10-5:35 p.m.—Web Application-Based Digital Conceptual Site Models and Their Use in Remediation Design Optimization (page 48)

Wednesday, May 10

- 9:40-10:05 a.m.—Web Application-Based Digital Conceptual Site Models and Their Use in Remediation Design Optimization (page 48)
- 10:30-10:55 a.m.—Use of Passive CO_2 Traps to Quantify the Degradation Rates of Chlorinated Solvents (page 48)
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- 3:30-3:55 p.m.—Sentinel™ Passive Sampler: Lower Total Cost for PFAS Monitoring and Analysis (page 46)
- 4:20-4:55 p.m.—Multi-Site Trend Analysis and Remedial Design Implications of Passive Flux Data from PFAS-, CVOC- and Hydrocarbon-Contaminated Sites (page 46)
- 5:10-5:35 p.m.— Sustainable and Cost-Effective Alternative for PFAS Waste Disposal (page 45)

Tuesday. May 9
9:40-10:05 a.m.

Wednesday, May 10
5:10-5:35 p.m.

Sustainable and Cost-Effective Alternative for PFAS Waste Disposal

Instructors: John Brockgreitens (Claros Technologies) and Stacy Hanson (Claros Technologies)

Objective: Incineration is no longer a solution for PFAS waste disposal. Studies have shown that incineration generates short-chain PFAS, causing secondary air and land pollution. There is new technology available that is a sustainable and cost-effective alternative. The Elemental™ system achieves 97 to 100% destruction of all PFAS compounds, including ultrashort chains (C1-C3) within 1 to 3 hours. It achieves this performance at ambient conditions which results in low cost and low maintenance. The system has been demonstrated with a variety of industrial wastewater with complex matrices and without any pretreatment. Anyone who is looking for a solution for PFAS waste disposal - Site Managers, Engineers, Consulting Firms, Industrial Manufacturers will benefit from this learning lab.

Description: The Elemental™ is proprietary technology developed by Claros Technologies that allows for the total destruction of toxic persistent chemicals, including long, short, and ultrashort PFAS, into their natural basic elements and harmless byproducts. TThis destruction process works on wastewater, concentrates from ion-exchange resins, reverse osmosis, activated carbon or surface-active foam fractionation (SAFF) systems, fire-fighting foams, and their runoffs. This system has been demonstrated with a variety of industrial wastewater with complex matrices and without any pretreatment. The Elemental™ PFAS destruction system is a low-energy, small-footprint, proprietary photochemical process that operates at room temperature and atmospheric pressure. The process can be used in a batch or continuous mode with low/easy maintenance. The byproducts of the process are free fluoride and CO_2.

Tuesday. May 9
10:30-10:55 a.m.

Wednesday, May 10
4:20-4:55 p.m.

Multi-Site Trend Analysis and Remedial Design Implications of Passive Flux Data from PFAS-, CVOC- and Hydrocarbon-Contaminated Sites

Instructors: Ian Doliana (REGENESIS) and Chris Lee (REGENESIS)

Objective: The demonstration will serve to inform environmental professionals about practical use and significance of in-well direct measurements of contaminant flux and Darcy velocity for successful site characterizations and remedial designs. The information presented will highlight trends in contaminant mass flux and vertical distribution of multiple contaminant types across over 50 sites.

Description: Flux measurement devices have been used within the environmental industry during the past two decades. Flux devices provide a pre-application remedial assessment step by identifying the appropriate contaminant thickness, transport zones and groundwater velocities necessary for successful remedial outcomes. Flux devices can also be used for post-treatment remedial metrics. Flux data will be presented from 10 PFAS sites, 30 CVOC sites and 10 hydrocarbon sites. The flux data demonstrate a clear understanding of the Darcy velocity and contaminant flux profile across the well screen intervals at these sites. Trend analysis of the flux data documents similarities and differences between multiple contaminant type distribution profiles, which will be a focal point highlighted in the presentation. Commonly observed is an increase in contaminant mass flux that occurs within intervals of increased Darcy velocity. Similarly, changes in the site geology appear to correspond to changes in contaminant flux. The combined effects of Darcy velocity and site geology on contaminant flux will be discussed. Attendees will learn:

- The value of directly measuring contaminant flux and Darcy velocity via flux meters
- Understanding the vertical distribution profile of multiple contaminant types
- The relationship between groundwater velocity and contaminant flux
- Improved understanding of the target treatment zone
- How changes in groundwater velocity and contaminant flux estimations impact the remedial design
- Limitations of the technology

Tuesday. May 9
1:00-1:25 p.m.

Wednesday, May 10
3:30-3:55 p.m.

Sentinel™ Passive Sampler: Lower Total Cost for PFAS Monitoring and Analysis

Instructors: Kevin Berner (Aquanex Technologies, LLC) and Ricky Bowles (Aquanex Technologies, LLC)

Objective: Learn how the Sentinel™ Passive Sampler provides precise and accurate single-digit-part per trillion (ppt) measurement of the full EPA Method 1633 suite of PFAS analytes in groundwater, surface water, stormwater and sediment porewater, reducing the total cost of the program by about 30%. Entities with PFAS consultants who plan and perform PFAS characterization and monitoring will learn how they can achieve their PFAS characterization and monitoring objectives at lower total cost; regulators will learn about the demonstrated precision and accuracy of the Sentinel™ Passive Sampler in four large field projects; labs will learn how analysis of Sentinel™ Passive Samplers conforms to EPA Method 1633.

Description: The Sentinel™ Passive Sampler is a novel, single-use passive sampler for monitoring PFAS in groundwater, surface water, stormwater runoff and sediment porewater applications. Sentinel™ uses an engineered media to adsorb PFAS compounds. The Sentinel™ adsorbs PFAS at a linear rate, providing a time-weighted-average measure of PFAS contamination in situ, and it does not require the shipment of water or sample bottles. The Learning Lab will cover: 1. overview of the Sentinel™ Passive Sampler; 2. demonstration of deployment and retrieval in groundwater, surface water, stormwater and sediment porewater applications; 3. demonstration of how the lab analysis of the Sentinel™ conforms with EPA Method 1633, except that the solid phase extraction has been done in the field; and 4. overview of results from four projects(two for DoD/USAF [SERDP], one for US EPA, and one for Orange County Water District).

Tuesday. May 9
1:50-2:15 p.m.

Wednesday, May 10
2:40-3:05 p.m.

See Your Site in a Whole New Way: Using Soil Sense to Continuously Monitor NSZD and Hydrocarbon Plume Dynamics

Instructors: Amy Jimmo (Environmental Material Science Inc.), Steven D. Mamet (Environmental Material Science, Inc.), and Steven D. Siciliano (Environmental Material Science Inc.)

Objective: Participants will gain a practical understanding of how and when Soil Sense can be used to continuously assess natural source zone depletion (NSZD) and petroleum hydrocarbon plumes at an impacted site. The presentation will introduce the theory, the technology, deployment strategies and an overview of how the results are calculated, reported, and used in site management.

Description: NSZD has emerged as a practical alternative for restoration of light non-aqueous phase liquid (LNAPL) sites that are in the later stages of their remediation lifecycle. Site owners and managers are increasingly adopting this as a viable approach towards site closure. This has driven demand for high-density data to better characterize patterns and processes underlying NSZD at daily to seasonal

timescales. Environmental Material Science has developed an economical and robust sensor suite ("Soil Sense") that facilitates construction of networks within and surrounding LNAPL plumes. Soil Sense was developed to provide high-resolution spatial and temporal quantification of LNAPL plume extent and persistence and biological processes. Each Soil Sense collects data every 30 minutes including soil gas (CO_2, O_2, CH_4), pressure, air and soil temperatures, relative humidity, and PHC vapor concentrations. During this presentation, a practical overview of the technology, including how the units are constructed and installed into the subsurface will be provided. The data analytical tools used to provide accurate and informative results that can be used to make appropriate site management decisions will also be highlighted. The presentation will end with a review of case studies that have successfully incorporated Soil Sense into site management and remedial strategies.

Tuesday. May 9
2:40-3:05 p.m.

Wednesday, May 10
1:50-2:15 p.m.

Successful Sub-Slab Vapor Data Collection: Best Practices

Instructors: Laurie Chilcote (Vapor Pin Enterprises, Inc.) and Craig Cox (Cox-Colvin & Associates, Inc.)

Objective: The Vapor Pin® technology provides a secure platform for consultants to quickly and accurately collect essential sub-slab data (soil gas screening data, soil gas samples for laboratory analysis, and sub-slab pressure readings) used in source characterization studies, vapor intrusion assessments, and vapor (VOC and radon) mitigation system design and evaluation. The Vapor Pin® Insert is being specified in drawings and projects across the US and is used to facilitate the collection of soil gas samples and pressure measurements beneath engineered vapor intrusion barriers (e.g., Geo-Seal®), or vapor mitigation coatings (e.g., Retro-Coat™).

Description: The Vapor Pin® is a small sub-slab vapor port that is installed in minutes using commonly available hand tools (hammer drill, drill bits, and dead blow hammer). Once installed, the Vapor Pin® can be securely covered, making it suitable for multiple sampling events, or simply used to gather data during a single event. After the sampling is complete, the Vapor Pin® can be retrieved for reuse. The fact that Vapor Pin® is installed in a rapid, yet minimally intrusive manner, allows practitioners to cost-effectively gather high resolution active soil gas data sets. This increased site coverage provides a better understanding of the spatial variability beneath sites. When used with screening tools, such as multi-gas meters or photoionization detectors (PIDs), areas of interest such as hot spots and preferential pathways can be quickly identified and targeted for analytical sampling. They are also used for continuous monitoring of differential pressure and vapor concentration. A major advantage of the Vapor Pin® over other sub-slab vapor ports is that a leak-proof seal between the port and the concrete is formed immediately by the silicon sleeve that covers its outer edge. Recent enhancements to the Vapor Pin® allow it to connect to a variety of sampling devices through a barb fitting, Swagelok® compression fitting, or quick connect valve. As a result, the Vapor Pin® can quickly and reliably connect to a wide variety of vapor screening instruments, evacuated canisters, bottle vacs, absorbent tubes, manometers, portables GC/MSs, passive samplers and other sensors. In addition, a variety of attachments have been developed to allow for the collection of soil gas samples at greater depths and to isolate VOC-impacted slabs. The Vapor Pin® Insert is being specified in drawings and projects across the US and is used to facilitate the collection of soil gas samples and pressure measurements beneath engineered vapor intrusion barriers (e.g., Geo-Seal®), or vapor mitigation coatings (e.g., Retro-Coat™).

Tuesday. May 9
3:30-3:55 p.m.

Wednesday, May 10
1:00-1:25 p.m.

A Non-Destructive Probe for UV-Based Monitoring: Adding Time Dependence to Fluorescence-Based HRSC Tools

Instructor: Julio Zimbron (E-Flux)

Objective: High-resolution site characterization (HRSC) tools provide detailed vertical mapping of contaminant distributions in the ground, as well as relevant lithology data. The contaminant distributions in the ground are determined by the amount of contaminant present, as well as soil lithology (often heterogeneous), and water soil saturations (often varying in time). HRSC data enable a more complete light, nonaqueous phase liquid (LNAPL) conceptual site model (CSM), despite being used on a one-time basis. In this learning lab, a novel tool that can repeatedly monitor a vertical profile will be presented. This tool can add a time-dependent dimension to HRSC data that current methods do not offer.

Description: E-Flux has developed a technique to transform a bored location surveyed into a monitoring port that can be repeatedly surveyed using HRSC ultraviolet (UV)-based techniques to offer a surveying tool that can register changes in soil LNPAL distributions. The technique consists of lining a borehole with a dry, solid well casing that includes sections that are transparent. A device is deployed in this clear dry well casing that shines a UV light into the formation, revealing detailed, pore-scale distributions of LNAPL. The data are processed to create continuous vertical digital images and LNAPL saturation profiles that

reflect current soil water and contaminant distributions. Upon a change of conditions, such as a sudden groundwater level drop, the device can be deployed to survey the associated LNAPL distribution changes. This tool has the capacity to detect remobilization of LNAPL upon groundwater changes, releases of LNAPL associated with sheens, and evidence of LNAPL biodegradation-induced biogas (ebullition). This presentation will demonstrate the use of this tool, and show how these surveys can shed light into the factors that affect LNAPL soil redistribution upon groundwater level and contaminant mass loading changes. The data will be contrasted with traditional data from LNAPL thickness in monitoring wells.

Tuesday. May 9
4:20-4:55 p.m.

Wednesday, May 10
10:30-10:55 p.m.

Use of Passive CO_2 Traps to Quantify the Degradation Rates of Chlorinated Solvents

Instructors: Thomas Boyd (U.S. Navy Research Laboratory) and Julio Zimbron (E-Flux)

Objective: Biodegradable contaminants break down into dead-end products in stoichiometric proportions. This concept has resulted into the now standard practice of directly measuring field LNAPL and petroleum contaminant degradation rates using respirometric techniques. This presentation will discuss how similar principles apply to the biodegradation of chlorinated solvents and present data from multiple case studies, so that stakeholders (site managers, regulators, consultants) can incorporate these data into their site management decisions.

Description: Chlorinated solvents that biodegrade produce stoichiometric amounts of ethane or ethene, which under aerobic conditions, rapidly break down into the dead-end byproduct carbon dioxide (CO_2) in the soil. E-Flux technique consists of capturing the CO_2 emanating from soil at grade (soil gas efflux) using a passive trap that is deployed for multiple days at the ground surface. The carbon content of the trap is measured, and a correction based on radiocarbon (14C) analysis is applied to eliminate modern carbon interferences produced by soils due to processes not related to chlorinated contaminant biodegradation. The resulting time-weighted average fossil fuel CO_2 flux relates directly to the field rate of chlorinated solvent biodegradation. E-Flux CO_2 fossil fuel traps have been now used at multiple sites contaminated with chlorinated solvents. The data been compared to other field measurements for validation, including in well soil respirometric techniques and the biodegradation model Remchlor. The results indicate that chlorinated solvent biodegradation rates are measurable with this technique, offering a new alternative for direct, easy to implement technique to aid in the risk assessment and risk management of chlorinated solvent contaminated sites. This learning lab presentation will cover the principles of the measurement, a how-to-use overview, the results of these measurements at multiple pilot sites.

Tuesday. May 9
5:10-5:35 p.m.

Wednesday, May 10
9:40-10:05 a.m.

Web Application-Based Digital Conceptual Site Models and Their Use in Remediation Design Optimization

Instructors: John Hesemann (Burns & McDonnell) and Colin Plank (Burns & McDonnell)

Objective: The demonstrated technology facilitates the integration of existing and newly acquired geologic, hydrologic, and analytical data into a dynamic digital conceptual site model (CSM) that can be used to aid interdisciplinary remediation project teams and create a more efficient analysis and decision-making workflow. Participants will gain hands on experience with a web application-based digital CSM to perform a range of problem-solving tasks, including development of site characterization and remedial investigation strategies, evaluating risk-based approaches to site management, and evaluating the feasibility of specific remedial technologies. Project engineers, scientists, program managers, and regulators will benefit from the material presented.

Description: Remediation Geology, Process-Based CSMs, Holistic Approaches to Site Remediation – implicit in each of these terms/phrases recently used to describe an approach to complex sites is the synthesis of disparate data sets by multi-disciplinary teams of geologists, engineers, hydrogeologists, and risk assessors to solve complex remediation problems. Web application-based digital CSMs are revolutionizing the utility, delivery, and value of lifecycle CSMs to project teams, making these approaches practical and cost-effective. Traditional CSM work products (potentiometric and iso-concentration maps, analytical and potentiometric time and depth series charts, lithological logs, geologic cross-sections, source and receptor relationships, and fate and transport parameters) are accessed in a web-based software environment consisting of dynamically scalable visualizations (maps, cross sections, 3-D visualizations), tailored database query tools connected to the visualizations, live infographic charts and tables, and linked static project files and images. These elements, presented in a “dashboard” format, allow for intuitive data interrogation and exploration within the context of the project team’s existing CSM work products. Additionally, when linked to geographic information system (GIS)-based field data collection software, the

CSM becomes an integral part of the field execution and workflow, facilitating more effective real-time decision-making. Because a web application-based digital CSM requires only the use of a web-browser, minimal training is necessary for use and the CSM is readily available for project management, technical working group discussions, and transparent and effective communication with project stakeholders. The platform also provides an effective means of transferring institutional knowledge at a complex site between consultants and/or generations of project staff. Participants will use the digital CSM and data to identify data gaps, define exposure areas and apply screening evaluation criteria necessary for risk assessments, and evaluate potential treatment technologies and their basic placement based on interpretation of site processes.

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MONDAY, May 8	TUESDAY, May 9	WEDNESDAY, May 10	THURSDAY, May 11
7:00-8:00 a.m. —Morning Short Course Check-In 12:00-1:00 p.m. —Afternoon Short Course Check-In 2:00-8:30 p.m. —Symposium Registration Open 3:00-5:00 p.m. —Career KickStarter	7:00 a.m.-7:00 p.m.—Registration, Exhibits, Poster Group 1 Display 7:00-8:00 a.m.—Breakfast 9:30-10:15 a.m.—AM Beverage Break 11:30 a.m.-1:00 p.m.—Lunch 3:00-3:45 p.m.—PM Beverage Break	7:00 a.m.-7:00 p.m.—Registration, Exhibits, Poster Group 2 Display 7:00-8:00 a.m.—Breakfast 9:30-10:15 a.m.—AM Beverage Break 11:30 a.m.-1:00 p.m.—Lunch 3:00-3:45 p.m.—PM Beverage Break	7:00 a.m.-1:00 p.m.—Registration, Exhibits, Poster Group 2 Display 7:00-8:00 a.m. —Breakfast 9:30-10:15 a.m.—AM Beverage Break 11:30 a.m.-1:00 p.m.—Lunch
8:00 a.m.-5:00 p.m. Short Courses	**8:00 a.m.-5:35 p.m. Platform Sessions**	**8:00 a.m.-5:35 p.m. Platform Sessions**	**8:00 a.m.-2:40 p.m. Platform Sessions**
See pages __-__ for short course descriptions. **Short Courses** **8:00 a.m.-12:00 noon (half-day)** • Applying CSIA to Assess Source and Fate of Contaminants, and the Performance of Remediation Treatments • Best Practices for Bioremediation and Reductive Technologies **1:00-5:00 p.m. (half-day)** • Application of Molecular Biological Tools to Assess Biological Processes at Contaminated Sites **3:00-5:00 p.m.** • Career KickStarter for Students and Young Professionals	A1. Advances in Amendment Formulation A2. Engineering Biogeochemical Transformation A3. Enhanced Methods for Biodegradation/ Biotransformation of Organic and Inorganic Contaminants A4. Phytoremediation	A5. Optimization of Classical Bioremediation Technologies A6. Synthetic Biology Driven Remediation A7. In Situ Bioremediation Applications A8. Innovative and Efficient Amendment Delivery Strategies	A9. Ex Situ and Vadose Zone Biological Treatment A10. Biobarrier Installation and Management A11. Challenges in Application of Bioremediation Tools
	B1. Fate and Transport of PFAS B2. Innovative Treatment Technologies for PFAS In Situ **PANEL:** PFAS Program Management in a Rapidly Changing Regulatory Environment B3. PFAS Program Management in a Rapidly Changing Regulatory Environment	B4. Activated Carbon-Based PFAS Treatment Technologies B5. Innovative Treatment Technologies for PFAS Ex Situ B6. Comparing Ex Situ Destructive Technologies B7. PFAS in Surface Water and Storm Water	B8. Addressing Emerging Contaminants in a Regulatory Framework B9. Emerging Contaminants: Detection, Degradation, Fate and Transport B10. 1,4-Dioxane Treatment Technologies
	PANEL: Knowledge Gaps for Fate and Transport at Complex Sites C1. Natural Source Zone Depletion C2. Remediation and Management of Petroleum-Hydrocarbon Contaminated Sites C3. LNAPL Bioremediation/NSZD Modeling	C4. Bioremediation in Complex Geological Settings **PANEL:** Status of the 2015 Geology Revolution… Where Are We Now and Where Do We Go from Here? C5. Impacts of Mixed Contaminants on Biodegradation	C6. Bioremediation Case Studies C7. Bioremediation Approaches for the Innovative Management of Large or Dilute Plumes
	D1. Innovative Tools for Evaluating Vapor Intrusion Risk D2. Vapor Intrusion from Non-VOC Sources (e.g., mercury, methane, PFOAs, and Radionuclides) D3. HRSC and Conceptual Site Models	D4. Big Data and Integration of Molecular Tools in Site Assessment: Advanced Omics D5. Modeling and Monitoring Approaches to Improve Remedy Design and Implementation D6. High-Resolution Site Characterization	D7. Chemical Fingerprinting and Forensics D8. Improved Conceptional Site Models that Include Biodegradation Data D9. Tools for Site Assessment and Bioremediation Monitoring
	E1. Best Practices in Green and Sustainable Remediation (GSR) E2. Sustainable Remediation Assessment Tools E3. Robotic Technologies for Environmental Site Assessment and Monitoring E4. Adaptive Site Management Strategies to Mitigate Climate Change Impacts	**PANEL:** How Can Genetically-Modified Organisms Safely Solve Environmental Challenges E5. Microplastics and Nanoplastics: Degradation and Effects on the Environment E6. Bioremediation of Munitions Constituents E7. Treatment of Nitrate-Impacted Groundwater	E8. Advances in Tools and Techniques for Assessing MNA **PANEL:** Science, Application, Monitoring, and Illustrative Case Studies of Biogeochemical Remediation E9. Groundwater/Surface Water Interactions
5:30-7:00 p.m.—Plenary Session **7:00-8:30 p.m.—Welcome Reception, Exhibits, Poster Group 1 Display**	**5:45-7:00 p.m.—Poster Group 1 Presentations and Reception** **See page XX for sessions in Poster Group 1.**	**5:45-7:00 p.m.—Poster Group 2 Presentations and Reception** **See page XX for sessions in Poster Group 2**	**3:00 p.m.—Closing Panel Discussion** **4:00 p.m.—Closing Reception**

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