
2023 Bioremediation Symposium
May 8-11, 2023 | Austin, Texas
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Closing Panel Wrap-Up Discussion

Track A: Innovations in Bioremediation Technologies and Bioremediation Implementation Practices

- Track Representative: Alan Seech (Evonik Corporation) | Emerging Professional: Isaac Pelz (ERM)

Track B: Characterization and Remediation of PFAS, Biodegradation of Emerging Contaminants

- Track Representative: Amy Dindal (Battelle) | Emerging Professional: Cameron Orth (Battelle)

Track C: Managing Petroleum Hydrocarbon-Impacted Sites, Application of Bioremediation to Complex Sites

- Track Representative: David Freedman (Clemson University) | Emerging Professional: Deepti Nair (Battelle)

Track D: Evaluating and Mitigating Vapor Intrusion, Advanced Tools for Assessing Bioremediation

- Track Representative: Ramona Iery (U.S. Navy) | Emerging Professional: Maria Lemes (Geosyntec)

Track E: Sustainability and Resilient Remediation, Environmental Impacts of Microplastics, Munitions, and Nitrates, Advances in Natural Attenuation

- Track Representative: John Wilson (Scissortail Environmental Solutions, LLC) | Emerging Professional: Ashley Barker (Battelle)

Closing Panel Wrap-Up Discussion
Moderators: Pam Chang | Deepti Nair

1. Welcome
2. Thank you from Jim Cummings
3. Student Poster Award Winner
4. Track A
5. Gift card raffle
6. Track B
7. Gift card raffle
8. Track C
9. Gift card raffle
10. Track D
11. iPad raffle
12. Track E
13. Audience comments (if time permits)

TRACK A: Alan Seech (Evonik Corporation) | Isaac Pelz (ERM)

What's working?

1. Practitioners have increased their willingness to integrate across disciplines (physical/chemical/biological). This leads to better understanding of challenges and more effective solutions (combined remedies).
2. Biogeochemical and microbial monitoring techniques have improved and matured. These techniques (e.g., Quantarray BGC, Min-traps®) enhance understanding of the biogeochemical system. This supports quicker problem solving and leads to better treatment.
3. Use wider range of acceptable remediation endpoints and lines of evidence to negotiate agreements on achievable remedial goals and site closure.

TRACK A: Alan Seech (Evonik Corporation) | Isaac Pelz (ERM)

What needs to be fixed?

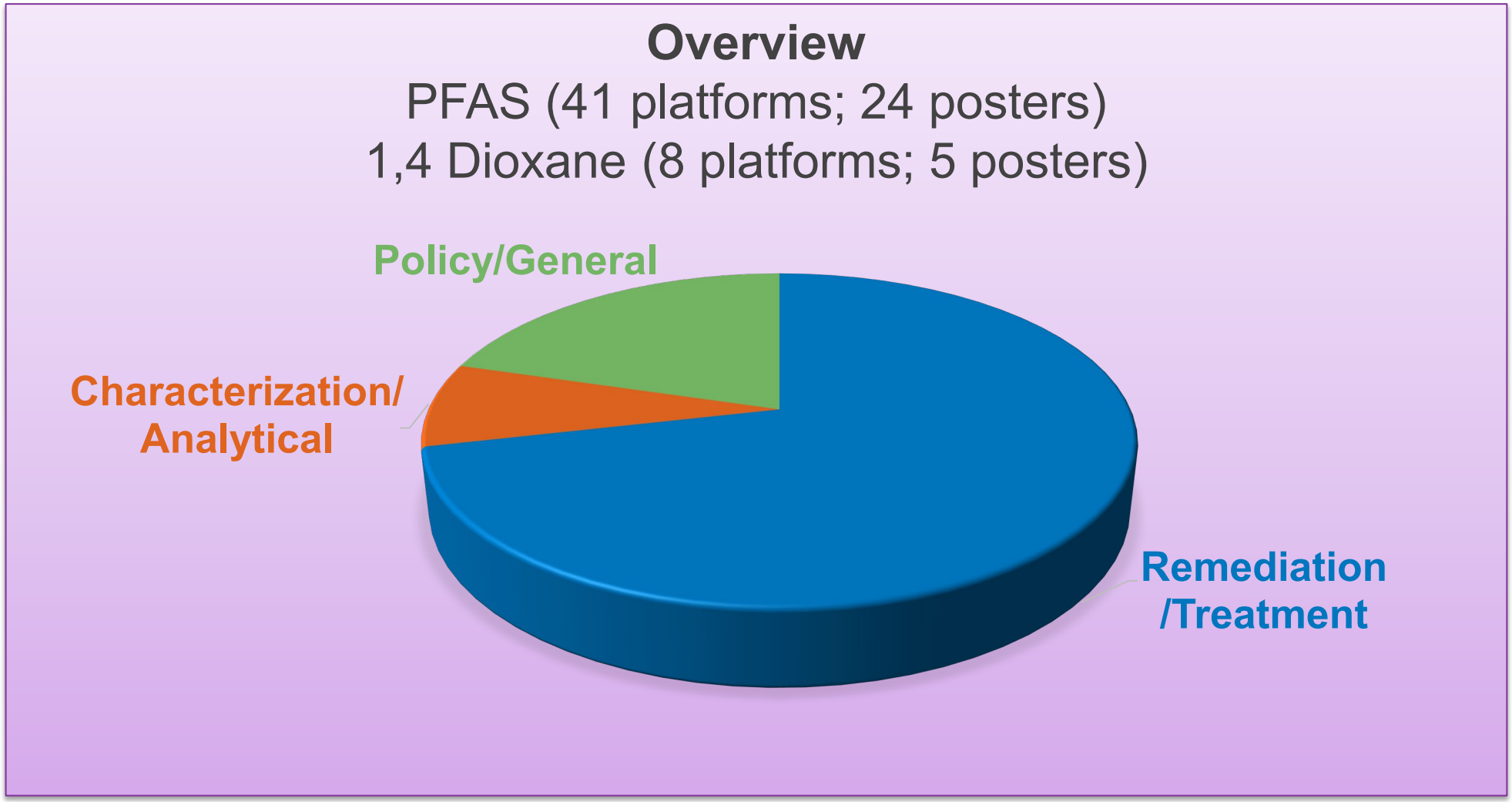
1. Presentation Quality! Consider the audience when preparing and delivering your presentation to better communicate what was learned (e.g., legible visuals, useful content, clarity). Thorough internal review should be completed before delivering platform presentations.
2. Advocate for use of sustainable and nature-based approaches when designing remedies and negotiating remediation endpoints with stakeholders.
3. Willingness to present the results of projects that did not go as planned. Others can benefit from hearing and seeing results that are less than fully successful.

TRACK A: Alan Seech (Evonik Corporation) | Isaac Pelz (ERM)

What's next?

1. Tools for characterization and manipulation of microorganisms and their enzyme systems seems to be developing rapidly. This may enable more economical, effective, and rapid remediation improvements.
2. Increased understanding of biogeochemical remediation to the point we expect development of best practices for creating biogeochemical remediation zones (e.g., guidance document).

TRACK B: Amy Dindal (Battelle) | Cameron Orth (Battelle)



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TRACK B: Remediation/Treatment

Highlights

- Be aware of competing sorption in mixed plumes
- Cyclodextrin is a dynamic sorptive media
- Difficulty of establishing a soil clean-up level
- Mechanochemical destruction as an emerging science
- Ferrihydrite shows promise for defluorination
- POET vs POUT
- 1,4-dioxane plumes are typically similar concentration throughout
- PFAS sticks – consider component contributions in your treatment system
- Avoid placing horizontal well screens on a slope
- Mass discharge/recharge may require multiple methods

Gaps

- Air modeling
- Quantification of the effects of stormwater on water treatment
- Can we (and do we want to) stop biotransformation pathways?

What's Next

- How will improved understandings of fate and transport lead to better remedial design
- Effects of TOC on sorptive media
- Evolution of laboratory scale to pilot scale

TRACK B: Characterization/Analytical

Highlights

- Multiple analytical challenges with sludges
- Importance of precursors
- Allowance of screening tools (8327) in lieu of 1633
- Importance of porewater studies vs leaching studies
- Importance of understanding and/or considering all potential sources
- Progress on real-time sensors for total PFAS
- ESS provides significant potential value for PFAS sites that are in the early RI/FS phase
- 1,4-D modeling tool available as Excel download

Gaps

- A lot of focus on PFOA/PFOS – limited discussions on short and ultra-short chains
- Linear vs branched PFAS and other isomers (does research on linear apply to branched?)
- What makes CSM generation unique for PFAS?

What's Next

- Progress on additional analytical tools to characterize unknowns
- Rapid methods and sensors

TRACK B: Policy/General

Highlights

- Definition(s) of PFAS (are pesticides and pharmaceuticals in the family?)
- 1,4-Dioxane plumes are generally dilute and diffuse

Gaps

- Difficulty in addressing the topic which demonstrates the challenge

What's Next

- More diverse emerging contaminant discussion (e.g., more on microplastics)
- **Show speakers how to use the remote**

TRACK C: David Freedman (Clemson University) | Deepti Nair (Battelle)

What's working?

- Bioaugmentation for anaerobic BTEX biodegradation (really!)
- Methods to quantify rates of LNAPL source zone biodegradation
- Bioventing continues to improve, including for LNAPLs
- Adding sulfate is gaining traction to enhance anaerobic BTEX biodegradation
- CSIA continues to improve as a tool to document biotic (and abiotic) degradation; application to lesser discussed contaminants like chloroanilines and chloronitrobenzenes
- Stratigraphy is an important tool for finding ideal locations in complex geology for biosparging and amendment additions
- Combining ZVI with biostimulation/bioaugmentation

TRACK C: David Freedman (Clemson University) | Deepti Nair (Battelle)

What needs to be fixed

- Incorporation of cell synthesis into estimates of oxygen needed for fuel hydrocarbons
- Faster rates for anaerobic aromatic degradation
- Consider adding sessions that cover case studies of failures and how they were addressed
- More information on risks and regulation of metabolites (e.g., from degradation of TPHs)
- The distinction between biotic and abiotic continues to be blurred; microbes play a key role in abiotic processes and minerals play a key role in biotic transformations
- Knowledge gap on the longevity of in situ sequestration

TRACK C: David Freedman (Clemson University) | Deepti Nair (Battelle)

What's next

- Additional evaluation of the role of advection and diffusion in transport models; Chuck Newell raised the question about turning the focus towards diffusion
- Continued assessment of combined remedies, including bioremediation as a follow-on to ISCO and ISCR; when to transition from one to another
- Methods to document natural source zone depletion (NSZD), including modeling
- Discussion of studies that evaluate combined physical/chemical/biological processes related to mass transfer and remediation in complex geologic settings
- Let's not forget about contaminants other than PFAS – thousands of sites still need to be cleaned of chlorinated VOCs, 1,4-D, PAHs, PCBs, . . .
- For coastal sites, attention is needed for the impacts of sea level rise on contaminated site remediation

TRACK D: Ramona Iery (U.S. Navy) | Maria Lemes (Geosyntec)

- What's Working
- What needs to be fixed
- What's next?

Track D: VI Sessions - Key Points

- Passive samplers are increasingly accepted to measure indoor air
  - Beneficial over short duration
- Building pressure cycling can be used as a rapid diagnostic tool
- VI attenuation factors (AFs) used in screening
  - Vapor concentrations decrease as vapors migrate from subsurface to indoor air
  - AF varies for residential and non-residential buildings
  - Minimize spatiotemporal variabilities in C_{source} and C_{IA} then AF matches theoretical numbers
- Radon can be used to quantify building AFs

Track D: Vapor Intrusion – What's Next

- Broader study to develop a national attenuation factor – will be published in 2024
- Investigate PFAS for vapor intrusion and possibly other contaminants (current focus on PCE and TCE)
- Methane is still an issue and should be investigated

Track D: Vapor Intrusion – What's needed!

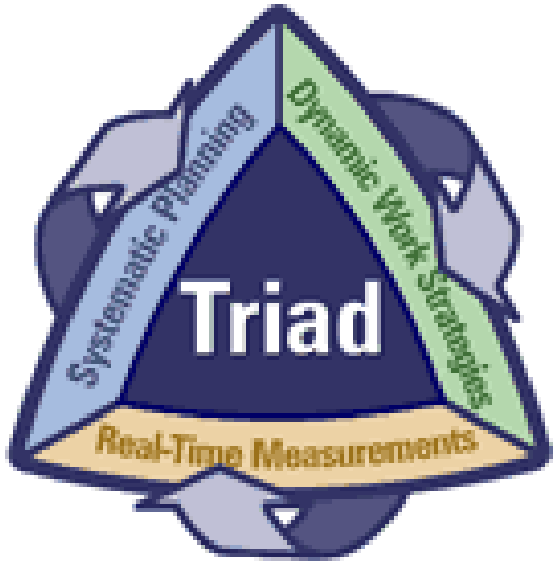
- Regulatory acceptance of innovative technologies
- Framework for selecting the most appropriate innovative tool
- Manage uncertainty in making risk management decisions

Track D: HRSC and CSM – Key Points

- There are many tools for HRSC
- Use diverse tools to optimize HRSC especially for NAPL sites
- Pay attention to subsurface geology
- Paradigm shift in borehole logging – using standardized logs (digital or paper)
- Use of high-resolution vertical gradient profiles for NAPL in fractured bedrock
- Environmental sequence stratigraphy!
- Investing upfront in site investigations saves money during remediation
- Groundwater flowrate between wells should advise sampling frequency

Track D: HRSC and CSMs Tools – Key Points

- ESTCP project – MODFLOW update includes unstructured grids which increases model speed
- Dye laser induces fluorescence tooling and soil borings to map residual DNAPL
- Remote NMR monitoring (water content associated with aquifer properties e.g., porosity, K, transmissivity – monitor injections, remediation progress) - for real time data and cost savings
- Use of the Triad Approach in site characterization (systematic planning, dynamic work strategies and real time measurement systems) – reduces uncertainty, better understanding of the site
- MNA rate constant calculator is an upgraded version of BIOSCREEN and BIOCHLOR



Track D: HRSC and CSMs – What's Needed

- Better understanding and availability of tools
- Methods for integrating chemical, biological and geological site data
- Integrating multiple contaminants into one model
- Incorporate molecular tools into CSMs – repeat sampling over several quarters/years
- Incorporating sustainable metrics in HRSC objectives

TRACK E2: Sustainable Remediation Assessment Tools

John Wilson (Scissortail Environmental Solutions, LLC) | Ashley Barker (Battelle)

- What's Working
  - Branding of humanitarian engineering as a practice area
- What needs to be fixed
  - Many private tools are being developed and used that incorporate different guidance documents contributing to a lack of standardization
  - Develop measures to protect databases from abuse
- What's next?
  - Incorporating climate change into the tools and metrics

TRACK E3: Robotic Technologies for Environmental Site Assessment and Monitoring

John Wilson (Scissortail Environmental Solutions, LLC) | Ashley Barker (Battelle)

- What's Working
  - Opportunity to replace hazardous, labor-intensive, and expensive field sampling techniques with robotics
- What needs to be fixed
  - Few examples of successful applications of robotic technologies
- What's next?
  - Provide project-specific examples of robotic technologies for bioremediation application including demonstrated application of sensors designed to collect data on analytes

TRACK E4: Adaptive Site Management Strategies to Mitigate Climate Change Impacts

John Wilson (Scissortail Environmental Solutions, LLC) | Ashley Barker (Battelle)

- What's Working
  - Traditional approaches for data collection and management do NOT help assess situations that cause change such as climate impacts
  - The Ricker method can be used to assess plume stability and evaluate effects of climate impacts such as sea level rise and subsequent groundwater level rise
- What needs to be fixed
  - No information provided on quantitative results and climate assessments
  - Little discussion on informative metrics such as greenhouse gas emissions or contaminant mass removal
- What's next?
  - Come to agreement for consistent use of words to describe process, tools, and projections
  - Move from overviews and needs/benefits toward providing actual quantitative data and results

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

John Wilson (Scissortail Environmental Solutions, LLC) | Ashley Barker (Battelle)

- What's Working
  - Microplastics in public sewage plants can enrich microorganisms that have:
    - antibiotic resistance and can cause human diseases
    - laccase enzymes that can degrade plastics
- What needs to be fixed
  - Lots of uncertainty on how to measure and regulate microplastics (e.g., count particles or measure mass)
  - Traditional EPA approaches for CERCLA and RCRA are not easily implemented for microplastics
- What's next?
  - Need to develop better information about the hazards associated with microplastics and description of the hazard in a way that it can be used to manage standards for microplastics

TRACK E7: Treatment of Nitrate-Impacted Groundwater

John Wilson (Scissortail Environmental Solutions, LLC) Ashley Barker (Battelle)

- What's Working
  - Clear graphical depiction of the nitrogen cycle
  - Application of molecular biological tools
  - Good case studies and pilot test applications
- What needs to be fixed
  - Provide information on metabolomics during nitrogen cycle
- What's next?
  - Implications of N_2O production during nitrate remediation and effect on global warming
  - Implications of agricultural practices and effect on global warming

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