The Association for Environmental Health and Sciences (AEHS) Foundation is proud to announce

The 30th Annual International Conference on

Soil, Water, Energy, and Air

and the AEHS Foundation Semi-Annual Meeting

March 16-19, 2020
DoubleTree Mission Valley, San Diego, California

Conference Directors: Paul Kostecki, Ph.D. and
Edward J. Calabrese, Ph.D., University of Massachusetts, Amherst, MA

aehsfoundation.org
Welcome to the 30th Annual International Conference on Soil, Water, Energy, and Air. This conference began in 1990, supported by just a few interested parties and focused mostly on petroleum-contaminated soils. It has since evolved to encompass a broad range of important contaminants in many types of media. The conference has drawn interest from around the world and has been supported by an impressive array of dedicated professionals serving on the Scientific Advisory Board. Appreciation goes out to the many Sponsors and Supporters who have generously contributed to our conferences over the years.

In 2010, AEHS Foundation assumed management of its sister conference, The Annual International Conference on Soils, Sediments, Water, and Energy, held every Fall on the campus of the University of Massachusetts. Last October’s conference, the 35th Annual, was a tremendous success and we invite you to consider joining us next October in Amherst. Between the West Coast and East Coast Conferences, the Foundation reaches over 1,200 environmental professionals annually!

Attendees who registered for the West Coast Conference before March 2nd had the opportunity to become a member of the AEHS Foundation for the current calendar year. Members receive the International Journal of Phytoremediation, Human & Ecological Risk Assessment, or Soil and Sediment Contamination as a primary journal (as selected during registration). Please note that you have the option to add either or both of the other journals for a fee of $65/additional journal/year. Members will automatically receive hard copies of their journal(s) and online access (including access to back issues). Please see the Foundation website (www.aehsfoundation.org) or contact the office for details.

The Foundation is proud to announce the continuation of the Charlena M. Seymour Scholarship and the David F. Ludwig Memorial Student Travel Award. Please see our website for further details relating to each scholarship. Applications and contributions are currently being accepted for both scholarships. For further information or to apply for either scholarship, please contact us by phone, mail, or email amanda@aehsfoundation.org.

The Foundation is committed to serving its membership and providing an essential forum for ideas, discussion, and debate, as well as solutions to a wide array of environmental problems. I hope you find that this year’s conference is one of the ways we fulfill this goal.

Sincerely,

Paul Kostecki, Ph.D., President
CONFERENCE at a GLANCE

Conference map is located on back of program

MONDAY, MARCH 16, 2020
Registration: 10:00am – 5:00pm, South Foyer
Afternoon Break: 3:00pm – 3:30pm, Great Rooms 1-5

WORKSHOPS
Workshop 1 1:00pm – 4:00pm, Environmental Forensics: Emerging Challenges and Solutions, Gallery
Workshop 2 1:00pm – 5:00pm, Per- and Polyfluoroalkyl Substances (PFAS): Beyond the Basics, Great Room 6
Workshop 3 1:00pm – 5:00pm, California’s Environmental Challenges: What Do We Do with Large Operating Facilities, Shuters West 1
Workshop 4 1:00pm – 5:00pm, Effective Application of Multiple ITRC Guidance Documents to Hydrocarbon Sites, Shuters East 1

TUESDAY, MARCH 17, 2020
Registration: 7:30am – 7:00pm, South Foyer
Exhibit Hall Hours: 9:00am – 7:00pm, Great Rooms 1-5
Breaks: 10:00am and 3:00pm (30 min), Great Rooms 1-5

MORNING PLATFORM SESSIONS/WORKSHOP
8:30/8:50/9:00am – 12:00pm
Session 1: Site Investigation, Shuters West 1
Session 2: Regulatory Programs and Policies, Shuters East 1
Session 3: PFAS Remediation Strategies, Great Room 6
Workshop 5 8:30am – 12:00pm, Why You Should Monitor Indoor Radon, Differential Temperature, and Pressure During Chlorinated Vapor Intrusion Assessments, Gallery
Luncheon: 12:00pm – 1:30pm, Courtyard
Lunch Speaker: “Waves of Problems to Solve: A Long-Term Perspective of the Remediation Field”
Charles J. Newell, Ph.D., P.E., Vice President/Environmental Engineer, GSI Environmental Inc., Houston, TX

AFTERNOON PLATFORM SESSIONS/WORKSHOP
1:30pm – 5:00/5:30pm
Session 4a: Sustainable Practices and Partnerships to Ensure a Cleaner and Greener Environment, Shuters West 1
Session 4b: Horizontal Well Systems – Principles and Practices, Shuters West 1
Session 5: Environmental Forensics, Shuters East 1
Session 6: Current Regulatory Status and Risk Assessment Considerations for PFAS, Great Room 6
Workshop 5 Cont. 1:30pm – 5:00pm, Why You Should Monitor Indoor Radon… Gallery
SURF Membership Meeting (open to all), 3:00pm – 5:00pm, Courtyard
Poster Presentations & Social, 3:00pm – 6:00pm, West Foyer
Welcome Reception, 5:00pm – 7:00pm, Great Rooms 1-5

EVENING WORKSHOPS
Workshop 6 6:30pm – 9:30pm, Environmental Forensics: Applications and Advances in Fingerprinting… Shuters West 1
Workshop 7 6:30pm – 8:30pm, PFAS 360 – Analytical Challenges and Risk Assessment Update, Great Room 6

THURSDAY, MARCH 19, 2020
Registration: 7:30am – 12:00pm, South Foyer
Exhibit Hall Hours: 9:00am – 12:00pm, Great Rooms 1-5
Break: 10:00am (30 min), Great Rooms 1-5

MORNING PLATFORM SESSIONS, 8:30/9:00am – 12:00pm
Session 15a: Natural Source Zone Depletion, Shuters West 1
Session 15b: In-Situ Thermal Remediation (ISTR), Shuters West 1
Session 16: Innovative Remedial Technologies, Shuters East 1
Session 17: Vapor Intrusion III, Brickstones
Session 18: Innovative Soil, Groundwater, and Sediment Cleanup Technology Solutions, Great Room 6

EVENING WORKSHOPS
Workshop 8 6:30pm – 8:30pm, A Workshop on using the ITRC Guidance Document: Practical Implementation of Advanced Site Characterization Tools, Shuters West 1
Workshop 9 6:30pm – 8:30pm, Fundamentals of Horizontal Well Systems and Modeling Tools, Shuters East 1

DRAWING Enter to win a free registration to one of our next two conferences!
Enter and drawing will take place during each of the Thursday morning sessions.

WINNERS IN EVERY SESSION!
Must be present to win. Several second place winners will receive free 2020 AEHS Foundation Membership! Drawings will take place at the conclusion of each session.

GENERAL INFORMATION

Exhibit Hours (Great Room 1-5)
Tuesday, March 17 ........................................ 9:00 am – 7:00 pm
Wednesday, March 18 ................................... 9:00 am – 7:00 pm
Thursday, March 19 .................................... 9:00 am – 12:00 pm

Poster Presentations (West Foyer)
Tuesday, March 17 ........................................ 3:00 pm – 6:00 pm
Wednesday, March 18 ................................... 3:00 pm – 6:00 pm

Socials
Tuesday, March 17 ........................................ 3:30 pm – 6:00 pm
Accompanies Poster Session (West Foyer)
Tuesday, March 17 ........................................ 5:00 pm – 7:00 pm
Wine/Welcome Reception (Great Room 1-5)
Wednesday, March 18 ................................... 3:30 pm – 6:00 pm
Accompanies Poster Session (West Foyer)
Wednesday, March 18 ................................... 5:00 pm – 7:00 pm

Exhibitors (For full directory, see page 14 in this program and/or separate handout)
ALS
American Environmental Testing Laboratories
AMS, Inc.
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Blaine Tech Services
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Clean Harbors
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Fluid Management Systems
GeoSearch
Graus Chemicals
Gregg Drilling & Testing, Inc.
HP & Mobile Geochemistry
Hepure Technologies
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State Water Resources Control Board
Stego Industries
Sustainable Remediation Forum (SURF) (Partner)
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ANNOUNCEMENTS

STUDENT POSTER COMPETITION

We are proud to announce the 16th Annual Student Poster Competition at the AEHS Foundation West Coast Conference, sponsored by Arcadis. At least one $1000.00 prize and two $500.00 prizes will be awarded to the best student poster presentations. Winners will be contacted Tuesday evening (see registration desk for posting) and will be acknowledged at a special event Wednesday evening.

Must be entered prior to the conference in order to compete.
Open to all full- and part-time students (post-docs excluded).
See aehsfoundation.org for full details and previous winners.

AEHS FOUNDATION SCHOLARSHIPS

The Charlena M. Seymour Scholarship
Established in 2014 to recognize women pursuing an advanced degree in the fields of Public and Environmental Health. This award is made annually at the beginning of the Fall semester to individuals who embody qualities that best exemplify Dr. Seymour’s life. These qualities include a dedication to high academic and professional standards, a vision of effective leadership, helping and mentoring associates, colleagues, and friends, and a consideration for all humanity.

The David F. Ludwig Memorial Student Travel Scholarship
Established in 2017 in memory of dear friend and respected colleague, Dr. David Ludwig. This annual scholarship is designed to assist students pursuing research in Ecology and Ecological Sciences with travel to conferences or research related expenses. Dr. Ludwig’s passion for science, travel, education, and exploration is the inspiration for this award.

For qualifications, application instructions, and deadlines, please visit the website. Donations toward these scholarships are currently being accepted. For further information, to donate, or to apply for a scholarship, please visit the website at www.aehsfoundation.org/scholarship
Announcing the Annual AEHS Foundation Achievement Awards

The Annual International Conference on Soil, Water, Energy, and Air is pleased to announce the recipients of the AEHS Foundation Achievement Award. This award is presented to individuals or organizations that have shown significant contributions to the field as well as outstanding environmental stewardship. This year’s winners are John A. Cherry, Ph.D., PE, FRSC, Director of the University Consortium for Field-Focused Groundwater Research, University of Guelph, and Dr. Charles Newell, Ph.D., P.E., Vice President of GSI Environmental Inc.

**Dr. John Cherry** holds geological engineering degrees from the University of Saskatchewan and the University of California, Berkeley as well as a Ph.D. in geology from the University of Illinois. He currently is an Adjunct Professor at the University of Guelph, Canada, where he is Director at the University Consortium for Field-Focused Groundwater Research and Associate Director of the G360 Institute for Groundwater Research. He holds the title of Distinguished Emeritus Professor, University of Waterloo, Canada, where he was based from 1971-2006 and is an Honorary Professor at the University of Hong Kong. He has received many awards and honors from scientific and professional organizations in Canada, the USA, and UK. In 2016, he was awarded the Lee Kuan Yew Water Prize (Singapore) for global contributions to groundwater science and technology.

John is a Foreign Member of the U.S. National Academy of Engineering, Fellow of the Royal Society of Canada and holds an honorary doctorate from the University of Neuchatel. He was the Chair (2012-2014) of the Canadian Expert Panel on Environmental Impacts of Shale Gas Development (fracking). He is an advisor to the Government of Singapore and is Co-chair of the International Scientific Advisory Committee (ISAC) Chinese Research Academy of Environmental Science (CRAES), which is part of the China Ministry of Environmental Protection. His current research involves collaborative studies of: 1) the chemical evolution of natural and contaminated groundwater in unfractured and fractured aquifers and aquitards, 2) advancement of engineered monitoring systems for groundwater flow and hydrogeochemistry, and 3) use of portable drills to create small capacity wells for safe drinking water in developing countries. As a follow-up to the 1979 textbook Groundwater (by Freeze and Cherry), he initiated a project in 2017 involving more than 100 experts from 12 countries on five continents to create an online comprehensive groundwater textbook with supporting learning materials for global availability free of charge.

**Dr. Charles Newell** is a Vice President of GSI Environmental Inc. He is a member of the American Academy of Environmental Engineers, a NGWA Certified Ground Water Professional, and an Adjunct Professor at Rice University. He has co-authored five EPA publications, 12 environmental decision support software systems, numerous technical articles, four patents, and two books, including Natural attenuation of Fuels and Chlorinated Solvents. His professional expertise includes site characterization, groundwater modeling, risk assessment, natural attenuation, LNA/LDNAPL issues, remediation, management of PFAS sites, environmental software development, long-term monitoring, and tech transfer projects. He has served as a Principal or Co-Principal Investigator for numerous environmental research and development projects for the Dept. of Energy, American Petroleum Institute, U.S. Environmental Protection Agency, Department of Defense and industrial clients. Dr. Newell has been awarded the Hanson Excellence of Presentation Award by the American Association of Petroleum Geologists, the Outstanding Presentation Award by the American Institute of Chemical Engineers, and the 2001 Wesley W. Horner Award by the American Society of Civil Engineers; the 2008 Outstanding Alumni Award from Rice University; Strategic Research and Development Program (SERDP) 2014 Project of the Year as a Co-PI, the ITRC Environmental Excellence Award in 2016, and the 2020 Foundation Achievement Award presented by the Association for Environmental Health and Science.

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**Workshop 1** 1:00pm – 4:00pm, Gallery

Environmental Forensics: Emerging Challenges and Solutions

Ioana G. Petrisor, Ph.D., ToxStrategies, Mission Viejo, CA
Jeffrey L. Caufield, Caufield & James LLP, San Diego, CA
Nick Bubbe, Mission Environmental, San Diego, CA

**Workshop 2** 1:00pm – 5:00pm, Great Room 6

Per- and Polyfluoroalkyl Substances (PFAS): Beyond the Basics

Elizabeth Denly, ASQ CMQ/OE, TRC, Lowell, MA
Amy Wilson, PhD, PE, TRC, Concord, CA
Jenny Phillips, DABT, TRC, Fort Collins, CO
Karin Greenacre, PE, TRC, Rancho Cordova, CA
Erica Kelve, PG, Regional Water Quality Control Board, Oakland, CA
Michael Eberle, TRC, Philadelphia, PA

**Workshop 3** 1:00pm – 5:00pm, Shutters West 1

California’s Environmental Challenges: What Do We Do with Large Operating Facilities

Chair: Ravi Arulanantham, Geosyntec Consultants, Oakland, CA
Co-Chair: Yue Rong, Cal-EPA/LA RWQCB, Los Angeles, CA
Panelists:
- Samuel Brown, Attorney, Hunton Andrews Kurth LLC, San Francisco, CA
- Ed Platt, Global Environmental Program Manager, Shell, Houston, TX
- Samuel Unger, Former Executive Officer, LA RWQCB, Los Angeles, CA
- Peter Garcia, Chief, Southern California Division, Site Mitigation and Restoration Program, DTSC, Cypress, CA
- Lenny Siegel, Executive Director, Center for Public Environmental Oversight, Mountain View, CA
- Rafat Abbasi, CA DTSC, Cypress, CA

**Workshop 4** 1:00pm – 5:00pm, Shutters East 1

Effective Application of Multiple ITRC Guidance Documents to Hydrocarbon Sites

Matthew Lahvis, Shell Project and Technology, Houston, TX
Andrew Kirkman, BP, Naperville, IL
Eric Nichols, Substrata, Newfields, NH
Diana Y. Marquez, Burns & McDonnell, Kansas City, MO
Ross Steenison, San Francisco Bay Regional Water Quality Control Board, Oakland, CA
Laura Trozzolo, TRC, Fort Collins, CO

See online program for full descriptions
TUESDAY MORNING

Session 1: 9:00am – 12:00pm, Shutter’s West 1
Site Investigation
Session Chair: Cristin Bruce, Shell Global Solutions, Houston, TX

9:00 A Case Study for Post-Remediation High Resolution Site Characterization
Maile Gee, Santa Ana Regional Water Quality Control Board, Riverside, CA

9:30 Sediment to Water Column Nexus – Bioaccumulation Study of Organochlorines in San Diego Bay, California
Ashley Parks, Wenjian Lao, Ellie Wang, Keith Maruya, and Steven Bay, Southern California Coastal Water Research Project (SCCWRP), Costa Mesa, CA; Chris Stransky, Wood, San Diego, CA; Jim Leather and Jessica Carilli, SPAWAR SYSCEN, San Diego, CA

10:00 BREAK

10:30 Drones/UAV: Providing Rapid Innovative Leaps in Environmental Remediation Strategies
Dan Bochicchio, Groundwater & Environmental Services, Inc., Exton, PA

11:00 Impacts of Urban Stormwater-Associated Polycyclic Aromatic Hydrocarbons on Receiving Sediment
Dimitrios Athanasiou, Exponent, Inc., Bellevue, WA; Danny Reible, Balaji Rao, Magdalena Rakowska, Ilektra Drygianaki, and Michelle Bejar, Texas Tech University, Lubbock, TX; Bart Chadwick, Gunther Rosen, and Marienne Colvin, SPAWAR Systems Center Pacific, San Diego, CA; Megan Otto and Brandon Steets, Geosyntec Consultants, San Diego, CA; Robert Pitt, University of Alabama, Tuscaloosa, AL; G. Burton, University of Michigan, Ann Arbor, MI

11:30 From MGP to Rail – A Brownfields Story
Lizanne Simmons, Kleinfield, Ternecula, CA

Session 2: 8:30am – 12:00pm, Shutter’s East 1
Regulatory Programs and Policies
Session Chair: Nick Amini, Santa Ana Regional Water Quality Control Board, Riverside, CA

8:30 EPA’s Revised Cost-Benefit Policy: What Does It Really Mean at Sediment Sites?
Norman Dupont, Ring Bender LLP, Costa Mesa, CA; Scott Rowlands, Geosyntec Consultants, Long Beach, CA

9:00 Challenges of Managing Complex Sites and People – A Regulatory Perspective
Alan Kuoch, Regional Water Quality Control Board, Riverside, CA

9:30 Cleanup Challenges of a Small Site Located Within a Large Regional Plume – A Regulatory Perspective
Kayla Kawamura, Regional Water Quality Control Board, Riverside, CA

10:00 BREAK

10:30 Balancing Societal Demands and Long-Term Liability: The Changing Landscape of Environmental Regulations and Corporate Governance
Roy Thun, GHD, Santa Clarita, CA

11:00 Cooperative Interagency Approach to Address Flammability Concerns and Odor Complaints in a Los Angeles County Neighborhood Built on Former Oil and Gas Leases
Christine De Rosa, Katherine Butler, Mandi Bane, Alyssa Rodriguez, and Cyrus Rangan, Los Angeles County Department of Public Health, Los Angeles, CA; Steven Ridenour, Alta Environmental, Long Beach, CA; Charlene Contreras, Los Angeles County Department of Public Health, Baldwin Park, CA

11:30 An Adaptive Approach to Integrating RCRA Corrective Action with Facility Demolition
Diana Marquez, Burns & McDonnell Engineering Company, Inc., Kansas City, MO; David Barker, Burns & McDonnell Engineering Company, Inc., Houston, TX; Charles Grant and Meghan Teegarden, Nutrien Ag Solutions, Loveland, CO

Session 3: 8:50am – 12:00pm, Great Room 6
PFAS Remedial Strategies
Session Chair: Avram Frankel, Integral Consulting Inc., San Francisco, CA

8:50 Introduction: PFAS Remedial Strategies
Avram Frankel, Integral Consulting Inc., San Francisco, CA

9:00 Sustainable PFAS Remedial Technology Applied at Multiple Locations for Military Base Aquifer Remediation
Steve Woodard, ECT2, Portland, ME

Adam Redding, Calgon Carbon, Moon Township, PA; Scott Grego, Jacobs, Syracuse, NY

10:00 BREAK

10:30 In Situ PFAS Sequestration – Plume Management Strategies Using Colloidal Activated Carbon
Kristin Thoresen, REGENESIS, San Clemente, CA

11:00 Thermal Remediation of PFAS Contamination
Brett Trobridge and Katie Renner, TRS Group, Longview, WA

11:30 Drinking Water Treatment and PFAS – The Katherine, Australia Community Experience
Skosfo Tsoukalas, Power and Water Corporation, Wannell, NT, Australia

Workshop 5 8:30am – 5:00pm, Gallery
Why You Should Monitor Indoor Radon, Differential Temperature, and Pressure During Chlorinated Vapor Intrusion Assessments
Henry Schuver, US EPA, Washington, DC
Brian Schumacher, US EPA ORD, Las Vegas, NV
John Zimmerman, US EPA ORD, Durham, NC
Chris Lutes, Jacobs, Cary, NC
Chase Holton, Geosyntec, Denver, CO
Loren Lund, Jacobs, Shelley, ID
Donna Caldwell, NAVFAC, Norfolk VA
Robert Truesdale, RTI International, Durham, NC

While chlorinated vapor intrusion (CVI) is a complex and challenging-to-assess phenomenon largely due the apparently endless number of hard-to-identify, measure, and predict factors influencing the resulting variable indoor air concentrations; the in-depth study of a few readily-measurable/available Indicators and Tracers (I&T) has shown some impressive correlations with indoor CVOC concentrations due to CVI in the buildings studied to-date. Documentation of I&T measurements can significantly increase the quantitative confidence in the probability of measuring the exposure levels of most concern (e.g., RME or 95UCL) to that well above the random probability of typical individual sample efforts (~5%).

Foremost among the I&T metrics is radon (Rn) which is a wide-spread naturally-occurring tracer of soil gas intrusion, mixing and retention in indoor air. The evidence and conceptual understanding indicates that the indoor concentration of Rn incorporates the effects of indicators such as temperature (a potential CVI driver), as well as pressure changes (including barometric, wind speed, and building operations) and integrates its effects across both space and time. More specifically indoor Rn levels integrates their actual effects on soil gas intrusion and indoor air concentrations, in the specific building and under the conditions being investigated. While outdoor temperatures and pressures are readily available from nearby weather station records, the changes in indoor levels of radon, temperature and pressure can be measured ‘continuously’ with relatively inexpensive meters.

This workshop will review new evidence for I&T that have shown correlations with indoor CVOC concentrations in data-rich studies of many buildings (including those with complex preferential pathways) and report the evidence from new building types and climate zones. Presentations will include the results of a study of the ‘antecedent’ I&T levels leading up to indoor CVOC concentrations above the 95th percentile for these buildings, as well as an introduction to technology for automated I&T ‘triggered-sampling’ methods and discussions on selecting I&T ‘trigger-rules’ for automated sampling. The workshop will also present and discuss I&T ‘Fact Sheets’ to assist regulators (& other stakeholders) collecting and/or reviewing I&T evidence supporting CVI Investigations. Additionally, there will be a report on the use of I&T to address spatial variability (i.e., to prioritize among buildings over the source area). Finally, the workshop will hold a panel/open discussion further exploring the conclusions of our previous workshop, with the question: Does the I&T evidence we have now support a general recommendation to: “Document the indoor radon, differential temperature and pressure levels at least at the time of CVOC sampling, and surrounding baseline periods for comparison, to allow and improve future understanding and interpretations of the buildings’ intrusion levels at the time of CVOC sampling?”
TUESDAY AFTERNOON

Session 4a: 1:30pm – 3:00pm, Shutters West 1
Sustainable Practices and Partnerships to Ensure a Cleaner and Greener Environment
Session Chair: Matthew Ambrusch, Langan, Parsippany, NJ

Join SURF as we discuss the importance of implementing sustainable practices within an organization and how to best incorporate sustainability as a strategy to ensure a cleaner environment. The panel will provide dialogue on how their organizations are putting sustainability to practice in impacted cities and communities.

Panelists:
Phillip Reagin, ecoSPEARS, Altamonte Springs, FL
Jason Giffen, Port of San Diego, San Diego, CA
Natasha Sihota, Chevron Energy Technology Company, San Ramon, CA
Gary Goodemote, Burns and McDonnell, San Diego, CA

SURF Membership Meeting immediately to follow
3:00pm – 5:00pm, Meeting open to both members and prospective members. Courtyard

Session 4b: 3:30pm – 5:30pm, Shutters West 1
Horizontal Well Systems – Principles and Practices
Session Chair: Stephen Koenigsberg, EN Rx, Inc., Irvine, CA

3:30 New Perspectives in the Use of Horizontal Wells for Assessment and Remediation
Stephen Koenigsberg, EN Rx, Irvine, CA; Erik Piatt, EN Rx, Flower Mound, TX; Lance Robinson, EN Rx, Parrish, FL; Wes Wiley, EN Rx, Parker, CO

4:00 A Decision Tool to Determine if Horizontal Well Systems can Replace Vertical Well Systems
Richard Laton, California State University at Fullerton, Fullerton, CA

4:30 3D Imaging of Injectate Distribution in Varying Horizontal Well Configurations
Todd Hallihan, Aestus, Stillwater, OK; Stuart McDonnell, Aestus, LLC, Loveland, CO

5:00 Air Sparging Barrier Wall with Vertical and Horizontal Air Supply
Gordon Alexander, Kennedy Jenks, Irvine, CA

Session 5: 1:30pm – 5:00pm, Shutters East 1
Environmental Forensics
Session Chair: Ioana Petrisor, Mission Environmental, San Diego, CA

1:30 Effects of Variable Analytical Parameter Suites on the Identification of PFAS Sources to Surface Water and Groundwater
Mike Eberle, TRC, Philadelphia, PA; Andrew J.B. Cohen, TRC, New Providence, NJ; Amy Wilson, TRC, Concord, CA; Elizabeth Denly, TRC, Lowell, MA

2:00 Using Molar-Based Data for Evaluating Chlorinated Volatile Organic Compound-Impacted Sites
Joe Ricker, Earthcon, Memphis, TN

2:30 1,4-Dioxane – An Environmental Forensic Perspective
Ioana Petrisor, Mission Environmental, San Diego, CA

3:00 BREAK

3:30 Leaky Dump or Leaky Pump: Using Soil Gas Isotopes to Identify Source(s) of Elevated Methane
Tonia Johnson, Barr Engineering Co., Minneapolis, MN; Stephanie Theriault, Barr Engineering Co., Saint Paul, MN

4:00 The Ups and Downs of Developing a New Analytical Method to Satisfy Risk-Based Needs
Rock Vitale, Environmental Standards, Inc., Valley Forge, PA

4:30 Voluntary/Proactive Characterization of PFAS Impacts to Groundwater at Former Marine Corps Air Stations Tustin and El Toro, California
Guy Chammas, U.S. Department of the Navy, San Diego, CA

Session 6: 1:30pm – 5:00pm, Great Room 6
Current Regulatory Status and Risk Assessment Considerations for PFAS
Session Chairs: Matt Small, U.S. EPA, San Francisco, CA
Wendy Linck, State Water Resources Control Board, Sacramento, CA

1:30 Update on California Water Board’s Per- and Polyfluoroalkyl Substances (PFAS) Actions
Wendy Linck, State Water Resources Control Board, Sacramento, CA

2:00 U.S. EPA PFAS Action Plan, Research, and Data Analysis Update
Matt Small, U.S. EPA, San Francisco, CA

2:30 PFAS – Relative Magnitude of Non-Drinking-Water Exposures
Usha Vedagiri, Wood, Oakland, CA; Amy Quintin, Amec Foster Wheeler, Chelmsford, MA

3:00 BREAK

3:30 A Theoretical Assessment of PFAS VI Potential and Implications
Travis Kline and Helen Dawson, Geosyntec Consultants, Washington, DC

4:00 Filling Critical Data Gaps in PFAS Ecotoxicity to Derive Accurate Cleanup Objectives
Lisa McIntosh, Woodard & Curran, Inc., Providence, RI

4:30 Panel Discussion
Bridgette DeShields, Integral Consulting Inc., Santa Rosa, CA

Workshop 5 Continued 1:30pm – 5:00pm, Gallery
Why You Should Monitor Indoor Radon, Differential Temperature, and Pressure During Chlorinated Vapor Intrusion Assessments
Henry Schuver, US EPA, Washington, DC
Brian Schumacher, US EPA ORD, Las Vegas, NV
John Zimmerman, US EPA ORD, Durham, NC
Chris Lutes, Jacobs, Cary, NC
Chris Holton, Geosyntec, Denver, CO
Loren Lund, Jacobs, Shelley, ID
Donna Caldwell, NAVFAC, Norfolk VA
Robert Truesdale, RTI International, Durham, NC

For workshop description, see Tuesday morning

LUNCHEON PRESENTATION
Tuesday, March 17, 2020 12:00pm – 1:30pm, Courtyard
Waves of Problems to Solve: A Long-Term Perspective of the Remediation Field
Charles J. Newell, Ph.D., P.E., Vice President/Environmental Engineer, GSI Environmental Inc., Houston, TX

The remediation field has evolved considerably since it began about 40 years ago, with paradigm shifts sparked by scientific breakthroughs and hard-fought experience superimposed over the emergence of new contaminants every few years. The result has yielded new conceptual site models, waves of innovation, stronger remediation technologies, and more credible management strategies. This talk will attempt to take the key lessons learned in the remediation field since the first pump and treat sites in the 1980s and apply them to our field’s newest, most difficult challenge: management of PFAS in the subsurface.
TUESDAY AFTERNOON

POSTER PRESENTATIONS

The following posters will be presented on Tuesday only.

West Foyer

Urban Forest Ecosystem Risk Assessment in Louisiana using i-Tree Eco Model
Kamran Abdollahi and Zhu Ning, Southern University, Baton Rouge, LA

Simplified Relation Between the Maximum Evaporation Rate Through the Vadoze Zone and the Depth to the Water Table for Sandy Soils
Mohammad Al-Suwayian, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

The Salinas Valley Integrated Hydrologic Model: Supporting Projects and Programs in a Highly Operated Basin
Matthew Baillie and Les Chau, Wood, Oakland, CA

PFAS: A New Emerging Contaminant and Its Impact on Indoor Air Quality
Harry Behzadi, RJLee Group, Monroe, PA

Challenges and Considerations for Conducting Remedial Investigations for Per- and Polyfluoroalkyl Substances (PFAS) and Evaluating Risk of Non-Drinking-Water Exposures
Gina Caldonone, Tetra Tech, King of Prussia, PA; Frank Lesene, Tetra Tech, Tallahassee, FL; Amanda Minter and Katherine Super, Tetra Tech, Pittsburgh, PA

Synthesis of Ni: Co Bimetallic Cathode Electrocatalyst, Supported by Al2O3-GO for Higher ORR in MFC
Amit Chaturvedi and Patit Paban Kundu, Indian Institute of Technology Roorkee, Roorkee, India

Organoclay-based Removal of Lamotrigine from Water
Andrea Guhl and Martin Bertau, TU Bergakademie Freiberg, Freiberg, Germany

Controlled Pressure Method for Vapor Intrusion Pathway Assessment: Protocol Development and Demonstration
Yuanming Guo and Paul Dahlen, Arizona State University, Tempe, AZ; Paul Johnson, Colorado School of Mines, Golden, CO

Analysis of Per- and Polyfluoroalkyl Substances in Drinking Water Using EPA Methods 533 and 537.1 with Semi-Automated Solid Phase Extraction (EZSpe™)
Tom Hall and Rudolf Addink, Fluid Management Systems, Watertown, MA

Post ERD Injection Site Dynamics: Long-term Trends at a VOC Contaminated Site in Monterey, CA
Andrew Halmstad, Integral Consulting Inc., Portland, OR

Efficiency of Constructed Wetlands for Nutrient Removal
Mason Jarvis, Cara Poor, and Kyla Burrill, University of Portland, Portland, OR

Comparing ISCO Effectiveness with and without Pneumatic Enhancement at a Site in San Diego County
Adair Johnson, Scott Stromberg, and Michael Purchase, Orion Environmental, Long Beach, CA

Chemical Dechlorination of Atrazine Using a Magnesium/Palladium Bimetallic System
Sandrine Jurado, Emese Hadnagy, Stanley Menacherry, and Iswarya Gagarin, University of New Haven, West Haven, CT

A Field Comparison of Biogeochemically Enhanced, Biological and Chemical Reduction for Treatment of Chlorinated Organics
Daniel Leigh, PeroxyChem, Walnut Creek, CA; Alan Sech, PeroxyChem, Corona Del Mar, CA

Personnel Optimization: Substituting Technology for Staffing on Long-Term O&M Projects
Kevin Leniau, Groundwater & Environmental Services, Inc., Eagan, MN

Design Considerations for the Mitigation of Vapor Intrusion
Gary Milne, Jon Gamble, and Andrew Campbell, Trinity Source Group, Santa Cruz, CA

Applying Conceptual Site Models to Utilize Social Science Methodologies for Stakeholder Engagement
Rosalie O’Brien and Nicole Smith, Colorado School of Mines, Golden, CO; Kathleen Smits, University of Texas, Arlington, TX

Case Study – Moving Beyond Carbon for More Effective Removal of PFAS
Jim Perlow and Jay Gorman, ECT2, San Diego, CA; Steve Woodard, ECT2, Portland, ME

Closing the PFAS Mass Balance in Sediments and Tissues: The TOP Assay
Eric Redman, Eurofins TestAmerica, West Sacramento, CA

Optimizing In Situ Remediation Amendments Using Innovative Surfactant System Formulations and Pharmaceutical Techniques
John Sankey, True Blue Technologies, Inc., Vancouver, BC, Canada; Gary Bir and David Alden, Tersus Environmental, Wake Forest, NC; Sangho Bang, Tersus Environmental, Cary, NC

Propitious PFAS Remediation: CTA-Organoclay
Paul Scapan, Andrea Guhl, and Martin Bertau, TU Bergakademie Freiberg, Freiberg, Germany

Horizontal Biosparging for Expedited Remediation of Jet Fuel at DOD Sites
Michael Sequino, Directional Technologies, Inc., Wallingford, CT

Assessing Social Vulnerability and Hydrological Risk in Massachusetts
Cielo Sharkus, University of Massachusetts Amherst, Amherst, MA

Synthesis of Magnesium Nanocomposites for the Treatment of Chromium Containing Wastewater
Bharti Verma and Chandrajit Balomajumder, Indian Institute of Technology Roorkee, Roorkee, India

Hydrothermal Liquefaction of Water Hyacinth for the Generation of Biofuels
Priyanka Yadav and N. Siva Mohan Reddy, Indian Institute of Technology Roorkee, Roorkee, India
TUESDAY EVENING

Environmental Forensics: Applications and Advances in Fingerprinting Techniques to Evaluate Who was Responsible for a Spill or Release of Organic Contaminants into the Environment

Paul Philp, University of Oklahoma, Norman, OK

The concept of environmental forensics has evolved significantly over the years. Basically it is concerned with establishing the relationship between a contaminant in the environment and its suspected source(s), or point of release. Such contaminants can cover a wide range of individual compounds or mixtures of compounds. They may be volatile compounds, such as benzene or chlorinated solvents, or complex crude oils, refined products, or complex mixtures of aromatic compounds. They may be present as free product, dissolved in water, adsorbed on soil particles, or present in the vapor phase. A wide variety of techniques exist to characterize and establish their potential relationship with possible sources or points of release. The standard EPA methods, that many are familiar with, are of little use in forensic studies since those methods are directed towards monitoring concentration data for specific contaminants of interest rather than determining the source or point of release.

Forensic investigations typically use a tiered approach in terms of fingerprinting tools. Preliminary characterization is undertaken by gas chromatography (GC) followed by more detailed analyses using gas chromatography-mass spectrometry (GCMS). The fingerprints, or chromatograms, obtained in this manner often provide enough information to determine relationships between contaminant and possible release points. However, there are also many cases where the resulting GC and GCMS data are ambiguous and possibly misleading. In such cases, it is possible to go to a more specialized tier of analyses and utilize the stable isotope composition of individual contaminants. This is particularly valuable for single component contaminants, such as MTBE, BTEX, or PCE, where GC and GCMS are of virtually no use for correlation or source differentiation.

Early applications of stable isotopes to environmental problems were limited to carbon and hydrogen isotopes but chlorine isotopes can now be measured routinely for most of the common chlorinated groundwater contaminants. This introduces the possibility of a 3D isotope approach for both source correlations and attenuation studies. Stable isotopes, including Cl, are well suited for use in the rapidly emerging area of vapor intrusion studies to differentiate indoor sources of contaminants vs. subsurface contaminants. Br and S isotopes of individual compounds can now be determined using GC coupled with ICP MS.

While most of environmental studies have been concerned with stable isotopes, there are a small number of studies using 14C for certain applications. These studies are limited due to the half-life of 14C, but interesting applications related to biofuels and distinguishing brominated compounds biosynthesized by marine organisms from those in fire retardants have been published and will be discussed.

The use of the various fingerprinting techniques for monitoring attenuation at sites undergoing remediation will be discussed. The combined use of the stable isotopes, GC, and GCMS, can be extremely valuable tools for monitoring remediation as well as determination of the onset of natural attenuation.

Finally the potential for using the forensic approach to evaluate the origin and fate of emerging contaminants such as PFAS components will be discussed along with limitations for certain compounds.
**WEDNESDAY MORNING**

**Session 7a:** 8:30am – 10:00am, Shutters West 1

**Green and Sustainable Remediation: Principles in Action**

*Session Chair: Matthew Ambrusch, Langan, Parsippany, NJ*

- 8:30 Assessing Performance of an Endophyte-Enhanced Hybrid Poplar Phytoremediation Program for TCE at an Arid, Fractured Bedrock Site
  - Erik Pearson and Carol Serlin, Rambloll, Irvine, CA; Devon Rowe, Rambloll, Vancouver, WA; John Freeman, Intersynx Environmental, Moffett Field, CA; Christopher Chiu, Phytoirmediation and Phytomining Consultants United, Grand Junction, CO
- 9:00 Combined Technologies to Address Two Complex Chlorinated Hydrocarbon Sites at a Military Installation
  - Betsy Collins, Jacobs, Raleigh, NC
- 9:30 Integrated Large-Scale Green/Sustainable Remediation of Chlorinated Volatile Organic Compounds and Perchlorate in Soil Bermite Facility, Santa Clarita, California
  - Hassan Amini, GSI Environmental Inc., Irvine, CA

**Session 7b:** 10:30am – 12:00pm, Shutters West 1

**Green and Sustainable Remediation: Using the Metrics**

*Session Chair: Maile Smith, GSI Environmental, Oakland, CA*

- 10:30 Sustainable Groundwater Remediation at Coal Ash Pond Sites
  - Krishna Reddy and Girish Kumar, University of Illinois at Chicago, Chicago, IL
- 11:00 Applying Conceptual Site Models to Utilize Social Science Methodologies for Stakeholder Engagement
  - Rosalie O’Brien and Nicole Smith, Colorado School of Mines, Golden, CO; Kathleen Smits, University of Texas, Arlington, TX
- 11:30 Case Study: Transitioning from Active Remediation to MNA by Refining the CSM Using Existing Data
  - Scott Stromberg, Orion Environmental, Long Beach, CA; Kyle Waldron, Marathon Petroleum, Auburn, WA

**Session 8:** 8:30am – 12:00pm, Shutters East 1

**Remediation I**

*Session Chair: Song Jin, Advanced Environmental Technologies, Fort Collins, CO*

- 8:30 Using Horizontal Wells to Mitigate Risk at Sites with Access Issues
  - Erik Piatt, EN Rx, Inc, Dallas, TX; Stephen Koeningsberg, EN Rx, Irvine, CA; Lance Robinson, EN Rx, Parrish, FL; Wes Wiley, EN Rx, Parker, CO
- 9:00 Using GeoTracker to Evaluate Risk Management Strategies for TPHd, TPHg, Benzene, and MTBE
  - Kirk O’Reilly, Exponent, Inc., Bellevue, WA; Matthew Lahvis and George DeVaul, Shell, Houston, TX; Andrew Deines, Exponent, Menlo Park, CO
- 9:30 In-Situ Removal of PFASs with Catalyzed Ultrafine Bubble Ozone and Recirculating Well
  - William Kerfoot, Kerfoot Technologies, Inc., Mashpee, MA; George Heufelder and Brian Baumgaertel, Massachusetts Alternative Septic System Test Center, Barnstable, MA

**Session 9a:** 8:30am – 10:00am, Great Room 6

**PFAS Analytical Approaches and Challenges**

*Session Chair: Liz Denly, TRC, Lowell, MA*

- 8:30 Analytical Issues Concerning Quantitation and Identification of PFAS Compounds
  - Stephen Zeiner, David Byie, and Rock Vitale, Environmental Standards, Inc., Valley Forge, PA
- 9:00 State of the Science: PFAS Sampling Guidelines and Frequency of Cross-Contamination
  - Taryn McKnight, Eurofins TestAmerica, West Sacramento, CA
- 9:30 PFAS in Sampling Products: Fact or Fiction?
  - Elizabeth Denly, TRC, Lowell, MA; James Occhialini, Alpha Analytical, Westborough, MA

**Session 9b:** 10:30am – 12:00pm, Great Room 6

**PFAS in Our Environment: Food, Packaging, & Wastewater**

*Session Chair: Liz Denly, TRC, Lowell, MA*

- 10:30 PFAS Food: How “Forever Chemicals” Impact the Food System
  - Lisa Campe, Woodard & Curran, Inc., Dedham, MA
- 11:00 Are Fluorinated Replacement Chemicals Present in Food Packaging?
  - Eric Redman, Eurofins TestAmerica, West Sacramento, CA
- 11:30 Meta-Analysis of Polyfluoroalkyl Substances Transformation Patterns in Wastewater Treatment Plants
  - Kenia Whitehead and Craig Hutchings, Integral Consulting Inc., Olympia, WA; Anthony Luz and Judi Durda, Integral Consulting Inc., Annapolis, MD

**LUNCHEON PRESENTATION**

Wednesday, March 18, 2020 12:00pm – 1:30pm, Courtyard

1,4-Dioxane’s Long Shadow: Drinking Water Contamination Origins and Treatment

Thomas Mohr, PG, CHG, Mohr HydroGeoScience LLC, Santa Clara, CA
Session 11: 1:30pm – 4:30pm, Shutter West 1

1,4-Dioxane

Session Chair: Caitlin Bell, Arcadis, Seattle, WA

1:30 Use Enhanced Soil Vapor Extraction to RemEDIATE 1,4-Dioxane Contaminated Soil: Laboratory Testing and Modeling
Yuanming Guo and Paul Dahlens, Arizona State University, Tempe, AZ; Paul Johnson, Colorado School of Mines, Golden, CO

2:00 1,4-Dioxane Treatment in Groundwater to Achieve Drinking Water Goals Using a Synthetic Sorbent Media, Yuma, Arizona
Lansana Coulibaly, Macario Nicholas, and Shuangshuang Xie, Wood, San Diego, CA

2:30 Treating 1,4-Dioxane with Activated Potassium Persulfate
Brant Smith, PeroxyChem, Philadelphia, PA; Stacey Telesz, PeroxyChem, Newport Beach, CA; Brianne Desjardins, PeroxyChem, Tonawanda, NY

3:00 BREAK

3:30 Bioremediation Options for 1,4-Dioxane
Phil Dennis, Sandra Dworatzek, Jeff Roberts, and Alicia Hill, SiREM, Guelph, ON, Canada

4:00 Full-Scale Implementation of Propane Biosparge System for In-Situ Remediation of 1,4-Dioxane in Multiple Treatment Zones
Kelli Parsons, Arcadis, San Luis Obispo, CA; Caitlin Bell, Arcadis, Seattle, WA

Session 12: 1:30pm – 5:00pm, Shutter East 1

Remediation II

Session Chair: Tom Szocsinski, Land Science, San Clemente, CA

1:30 Effect of Analytical Approaches on Reported PFAS Source Concentrations in Complex Matrices
Amy Wilson, TRC, Concord, CA; Elizabeth Denly, TRC, Lowell, MA; Michael Eberle, TRC, Philadelphia, PA; James Occhialini, Alpha Analytical, Westborough, MA

2:00 Hydrocarbon Treatability Study of Antarctica Soil with Fenton’s Reagent
Jay Clausen, Samuel Beal, and Ashley Mossell, USACE ERDC-CRREL, Hanover, NH

2:30 Environmental Chemistry and Treatment Methods for Lead and Zinc in Soil and Groundwater
Alan Seech, PeroxyChem, Corona Del Mar, CA; Daniel Leigh, PeroxyChem, Walnut Creek, CA; Stacey Telesz, PeroxyChem, Newport Beach, CA

3:00 BREAK

3:30 Optimization and Performance of ZVI Amendments for In-Situ Chemical and Biological Reduction
Gary Birk and David Alden, Tersus Environmental, Wake Forest, NC; Sangho Bang, Tersus Environmental, Cary, NC; John Sankey, True Blue Technologies, Inc., Vancouver, BC, Canada

4:00 In-Situ Bio-Air Sparge (ISBAS), San Francisco Bay Area Site
Mario Sternad, Madelaine Montilla, and Angus McGrath, Stantec, Walnut Creek, CA; Randall von Wedel, CytoCulture International, Inc., Pt. Richmond, CA

4:30 Full Scale Remediation of TCE in a Low Permeability Aquifer Using Sulfidated Colloidal ZVI
John Freim, REGENESIS, San Clemente, CA; Dan Nunez, REGENESIS, La Mirada, CA; Todd Hanna, Gregg Drilling, Signal Hill, CA

Session 13a: 1:30pm – 3:00pm, Great Room 6

PFAS Assessment and Remediation

Session Chair: Sam Williams, Geosyntec, San Diego, CA

1:30 Design, Installation, Startup and Operation of a Mobile PFAS Removal System for Investigation-Derived Waste
Andrea Sepulveda, ECT2, San Diego, CA; Steve Woodard, ECT2, Portland, ME

2:00 Treatment of Perfluoroalkyl and Polychlorofluoralkyl Substances (PFASs) in Soil and Water
John Sankey, True Blue Technologies, Inc., Vancouver, BC, Canada

2:30 PFAS and Electroplating in Ohio: They’re Here; Now What?
Jeff Hullinger, SME, Westerville, OH

Session 13b: 3:30pm – 5:30pm, Great Room 6

Findings of a PFAS Experts Symposium on Regulatory Policy, Toxicology, Transport/Fate, and Remediation for Per- and Polyfluoroalkyl Substances

Overview
John Cherry, G360, University of Guelph, Guelph, ON, Canada

Regulatory and Policy Issues
Chuck Newell, GSI, Houston, TX

Chemistry and Analytics
Elizabeth Denly, TRC, Lowell, MA

Toxicology and Risk
Bill DiGiuseppi, Jacobs, Englewood, CO

Transport and Fate
Angus McGrath, Stantec, Walnut Creek, CA

Existing Remediation Technologies and Research
Dan Bryant, Woodard and Curran, East Windsor, NJ and Bill DiGiuseppi, Jacobs, Englewood, CO

Closing Remarks
John Cherry, G360, University of Guelph, Guelph, ON, Canada

Session 14: 1:30pm – 5:00pm, Gallery

Vapor Intrusion II

Session Chair: Todd Rine, BP America (retired), Chino Hills, CA

1:30 Comparison of Real-Time TCE Measurement Methods for VI Studies
Marty Hale, Bart Eklund, Ian Rust, Lisa DeGrazia, and Michael Wolfskill, AECOM, Austin, TX

2:00 Is VI Modeling Dead? A Data-Rich Approach to Risk-Based Remediation Goals for Vapor Intrusion
Pujeeeta Chowdhary, Wood, Austin, TX; Stephanie Vivanco, Wood, Costa Mesa, CA; Caryn Kelly, Wood, Rancho Cordova, CA; Usha Vedagiri, Wood, Oakand, CA

2:30 Sub-Slab to Indoor Air Attenuation Factors Determined from Radon Data
Suze Nawikas, H&E Mobile Geochemistry, Carlsbad, CA

3:00 BREAK

3:30 A Regulatory Perspective on Vapor Intrusion Mitigation Systems
Jonathan Sanders and Dilan Roe, Alameda County Department of Environmental Health, Alameda, CA

4:00 Overcoming Shortcomings of Traditional Vapor Intrusion Sampling Approaches via Continuous Monitoring
Blayane Hartman, Hartman Environmental Geoscience, Solana Beach, CA; Mark Kram and Cliff Frescura, Groundswell Technologies, Goleta, CA

EVENING SOCIAL

Hors d’oeuvres and Open Bar (limited)
5:00 pm – 7:00 pm
Exhibit Hall, Great Rooms 1-5
Free to all registered conference attendees
The following posters will be presented on Wednesday (West Foyer)

**Workshop 9**

**6:30pm – 8:30pm, Shutter West 1**

**Fundamentals of Horizontal Well Systems and Modeling Tools**

Erik Piatt, ENRx, Inc., Dallas, TX

Richard Laton, Ph.D., California State University Fullerton, Fullerton, CA

The concept of horizontal wells and their deployment, while not a particularly recent development, has been impacted by inevitable evolutionary processes. Now there is a new paradigm surrounding this technology in certain applications. This Workshop will illuminate the rethinking of applications and the resultant economic advantages. Simply put, it many cases, it has become easier to deploy technologies with the potential for cost reductions and conventional site-mediated limitations ("access issues"). Consequently, we are in a new era of bringing horizontal well technology to more active use, for both assessment and remediation, but there are other factors in play. The concept of a conventional horizontal well has been somewhat monolithic and simplistic, recognizing there was really no way it could have begun otherwise; however; when we look at various design options, new possibilities arise. To reduce it to one simple advance in the technology, we can now "break up the system". In other words, the use of a single horizontal well installation has given way to the concept of using segmented, nested well systems along the same transect and also miniaturizing and bundling the process to dramatically reduce the costs.

In essence this is taking a traditional nested, segmented well system and turning it ninety degrees to the horizontal plane. As we will review in this workshop, this creates new options in flexibility, surgical precision and integrity of the data sets that are collected and then, as needed, present advantages in reagent delivery.

A core contribution of this workshop, other than to review the history and value of horizontal well systems (including case studies), is to quantify the savings inherent in replacing an array of vertical wells with horizontal well systems. We will present a model that considers site variables and the specific nature of what a vertical well is across a variety of configurations. This Model uses equations derived from the literature, to determine the estimated number of vertical wells needed to replace a single horizontal well across a given capture area and a specific groundwater regime. A simplified approach to determining the ratio of horizontal wells to that of vertical wells is to look at the capture area of each. As implied, this has been addressed before with modeling and complex equations (Forouzanfar, Reynolds, & Li, 2012; Losonsky & Beljin, 1992; Sawyer & Lieuallen-Dulam, 1998). A simpler and more "user friendly" approach uses basic geometry to approximate the number of vertical wells required to provide the same capture area as a single horizontal well and calculate any potential concomitant economic savings using Monte Carlo cost distribution techniques.
THURSDAY MORNING

Session 15a: 8:30am – 10:00am, Shutters West 1
Natural Source Zone Depletion
Session Chair: Rick Ahlers, GEI Consultants, Carlsbad, CA
8:30 Natural Source Zone Depletion Estimation with Multiple Permeable Zones and Confined LNAPL
Lisa Reyenga and Camille Carter, GEI Consultants, Denver, CO; J. Michael Hawthorne, GEI Consultants, Keller, TX
9:00 A Framework for Implementing Natural Source Zone Depletion at Petroleum Release Sites
Matthew Lahvis, Shell, Spring, TX
9:30 Monitored Natural Attenuation of a Deep Aquifer System Impacted by LNAPL
Jim Finegan, Kleinfelder, Riverside, CA
10:00 BREAK

Session 15b: 10:30am – 12:00pm, Shutters West 1
In-Situ Thermal Remediation (ISTR)
Session Chair: Rick Ahlers, GEI Consultants, Carlsbad, CA
10:30 Successful DNAPL Removal in Fractured Granitic Bedrock
Erik Pearson and Carol Serlin, Ramboll, Irvine, CA
11:00 Low-Temperature Thermal Remediation and Use
Jonah Munholland, Arcadis, San Diego, CA
11:30 Residual Soil Vapor Challenges Following In-Situ Thermal Conductive Heating at a Commercial Site
Darren Croteau, Terraphase Engineering, Irvine, CA

Session 16: 9:00am – 12:00pm, Shutters East 1
Innovative Remedial Technologies
Session Chair: Ryan Wymore, CDM Smith, Denver, CO
9:00 Angled Injection to Mitigate PCE Intrusion into a Stream at a Federal Superfund Site
Mike Mazzarese, AST Environmental, Inc., Golden, CO
9:30 Zero Valent Iron Remediation Design with Reactivity and Demand Models
Patrick Randall, Hepure Technologies, Inc., Hillsborough, NJ
10:00 BREAK
10:30 Industrial Remediation using Enhanced Soil Vapor Extraction
Charlie O'Neill, HDR, Folsom, CA
11:00 In Situ Bioelectrochemically-Enhanced Biodegradation of MTBE and Benzene in Groundwater at a Former Fuel Station
Song Jin and Paul Fallgren, Advanced Environmental Technologies, Fort Collins, CO; Randy Price, CGRS, Inc., Fort Collins, CO; Jennifer Strauss, Colorado Department of Labor and Employment, Denver, CO
11:30 Isolated Sub-Slab Depressurization – An “Active” Alternative with Long-Term Advantages
Deepa Gandhi, Michael Moes, and John DeWitt, EKI Environment & Water, Burlingame, CA

Session 17: 9:00am – 12:00pm, Brickstones
Vapor Intrusion III
Session Chair: Liz Miesner, Ramboll, San Francisco, CA
9:00 Analysis of Spatial and Temporal Relationships in Empirical Attenuation Factors
Steve Luis, Ramboll, Irvine, CA; Yuan Zhuang, Ramboll, Atlanta, GA
9:30 Lessons Learned from Optimization of Existing SSDS at a Mid-Atlantic Military Installation
Catherine Coffey, Arcadis, Richmond, VA; Carlo Di Tullio, Arcadis, Wilmington, DE; Mitch Wacksmann, Arcadis, Portland, ME; Rachel Saari, Arcadis, Kingsford, MI
10:00 BREAK
10:30 Passive Sampling for Soil Gas and Vapor Intrusion Investigations: Realizing the Cost and Performance Benefits of this Maturing Technology
Brent Pautler, Phil Dennis, Sandra Dvoratzek, and Jeff Roberts, SIREM, Guelph, ON, Canada; Hester Groenevelt, Geosyntec Consultants, Guelph, ON, Canada; Todd McAlary, Geosyntec Consultants, Toronto, ON, Canada
11:00 Using Thoron and Radon to Locate Vapor Entry Points and Choose Indoor Air Sample Locations
Anthony Miller, Gannett Fleming, Madison, WI
11:30 The Importance of Sanitary Sewers as the Expected Preferential Pathway in Vapor Intrusion Evaluations
Craig Cox, Cox-Colvin & Associates, Inc., Plain City, OH

Session 18: 8:30am – 12:00pm, Great Room 6
Innovative Soil, Groundwater, and Sediment Cleanup Technology Solutions
Session Chair: Richard Cartwright, Cartwright Environmental, East Amherst, NY
8:30 Cost Effective Remediation Achieved Using a Technology Treatment Train
Richard Raymond, Terra Systems, Inc., Claymont, DE
9:00 Synergistic Strategies of Direct-Push High-Resolution Site Characterization in Remedial Actions
Eric Garcia, CONETEC, Rancho Cordova, CA
9:30 Managing Environmental Data from the Field to the Map
Dave Rich, Geotech Computer Systems, Centennial, CO
10:00 BREAK
10:30 Planning and Implementing Proactive Combined Technology Remediation
Paul Dombrowski, ISOTEC Remediation Technologies, Lawrenceville, NJ; Tim Eliber, ISOTEC Remediation Technologies, Arvada, CO
11:00 Alternative Sorbent Management of UST Sites Impacted by Petroleum Releases
Robert Barrett and Thomas Merski, United Remediation Technologies, Pittsburgh, PA
11:30 Addressing Contaminated Ground Water to Surface Water Discharge: Application of In-Situ Permeable Reactive Barriers (PRB) to Limit Migration of PFAS
John Collins, AquaBlok, Ltd., Toledo, OH; Richard Stewart, Ziltek Pty Ltd, Thebarton, Australia; John Hull, AquaBlok, Ltd., Swanton, OH

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ENTACT, LLC | 23
Environmental Standards (Sponsor) | 12
EPRO Services, Inc. | 36
Fluid Management Systems | 30
GeoSearch | 22
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Gregg Drilling & Testing, Inc. | 33
H&P Mobile Geochemistry | 21
Hepure Technologies | 34
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JRW Bioremediation | 29
PerkiElmer (Supporter) | 25
PeroxyChem | 07
QED Environmental Systems | 37
REGENESIS (Sponsor) | 26
Remediation Partners (Sponsor) | 04
RNAS Remediation Products | 01
SiREM | 16
State Water Resources Control Board | 09
Stego Industries | 40
Sustainable Remediation Forum (SURF) (Partner) | 02
Terra Petra | 24
TRC (Supporter) | 19
True Blue Technologies | TT8
Vapor Pin Enterprises | 17
VaporSafe | 20
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