Technical Sessions

Day One, Thursday, Dec. 1, 2016

Opening Session

9:00: **A Word from our Founder**
   Nick Albergo, PE, DEE, Senior Engineer, GHD, Tampa

**Keynote Address from the 2016 Conference Chair**
   Jim Langenbach, PE, BCE, Senior Principal, Geosyntec Consultants, Titusville

9:30: **Notes from the (Brown)Field: Limiting Consultant Exposure to Malpractice Risk at Contaminated Redevelopment Sites**
   Michael Goldstein, Esq., Managing Partner, The Goldstein Environmental Law Firm PA, Miami
   The dramatic expansion of the brownfields redevelopment marketplace is being driven by large, traditional developers who, even though historically risk averse, are increasingly forced to acquire contaminated sites as a result of a rapidly diminishing inventory of clean land in infill locations. While this creates more financial opportunity for environmental consultants, especially in Florida—one of the top brownfield markets in the country—it also carries significant malpractice risk for environmental professionals that are not familiar with the many ways in which development and construction activities at contaminated redevelopment sites can influence and alter traditional means and methods of conducting site investigations and cleanups. Michael Goldstein, one of the leading brownfield practitioners in the state and an environmental attorney for over 24 years, will analyze where specifically these malpractice risks exist, provide the legal basis for why they exist, present recommendations for minimizing such risk, and suggest strategies for converting such risk into a platform for creating new business opportunity. This presentation will specifically cover those assessment and remediation aspects of Chapter 62-780, Florida Administrative Code; Chapter 24, Miami-Dade County Code; and Chapter 27, Broward County Code, that most commonly impact and influence redevelopment activities at brownfield sites.

10:00 Break

Session 2: Sustained Release Technology Applications

10:30 **Recent Breakthrough in 2D-CSIA Technology for 1,4-Dioxane**
   Yi Wang, PhD, Director, Pace CSIA Center of Excellence, Pittsburgh, PA
   A dual isotope technology based on compound-specific stable isotope analysis of carbon and hydrogen, 2D-CSIA, was recently developed to help identify sources and monitor in-situ degradation of the contaminant 1,4-dioxane in groundwater. Site investigation and optimized remediation have been the focus of thousands of CSIA applications completed for volatile organic contaminants worldwide. CSIA for the water miscible 1,4-D, however, has been technically challenging. The most commercially available sample preparation settings “purge and trap” for VOC, could not efficiently extract 1,4-D out of water for a reliable CSIA measurement, especially when the concentration is below 100 μg/L. Such a high reporting limit has prevented CSIA from being used for effective site investigation and remediation monitoring at most 1,4-D contaminated sites, where 1,4-D is often present at very low ppb levels. This presentation outlines the recent breakthrough in 2D-CSIA technology for 1,4-D in water, reported down to ~1 μg/L for carbon, and ~10-20 μg/L for hydrogen using solid-phase extraction based on EPA Method 522, and its benefit is highlighted through a case study at a 1,4-D contaminated site.

11:00 **Controlled Release Environmental Reactants – A Green and Sustainable Approach to In-Situ Remediation**
   Lindsay Swearingen, PhD, Managing Partner, Specialty Earth Sciences, New Albany, IN
   The environmental science community has a collective interest in identifying viable and sustainable remedial solutions for groundwater contaminant plumes that reduce carbon footprint, minimize waste generation, and limit energy inputs required for remediation implementation, operations and ongoing maintenance. DOE and DOD sites in particular could benefit from greener cleanup technologies, especially in light of future requirements to remediate vast dissolved phase plumes of emerging contaminants of concern such as 1,4-dioxane.
   Sustained and controlled release reactant technology involves coating or encapsulating environmental reactant materials to facilitate more efficient and user-friendly in-situ remediation implementation. The result is a passive approach to ground...
water remediation that addresses the common challenges encountered with traditional liquid injection applications, such as contaminant rebound, plume migration and the need for multiple mobilizations. Rather than pressurized liquid injection, the energy of concentration gradient-driven diffusion as well as natural groundwater movement is used to deliver oxidants in the subsurface over long periods of time.

Sustained and controlled release reactant materials can be applied to the subsurface in a number of forms and methods. Multiple remediation practitioners have applied sustained and controlled-release reactants at sites across the U.S. and Canada. ESTCP Project ER-201324 is currently underway, which is a slow-release chemical oxidant field demonstration for the remediation of 1,4-dioxane plumes.

Site examples will be presented including site selection, implementation design, cost and monitoring data.

11:30 Highly Successful ERD Pilot via Simple Additive Delivery System Lead to Full-Scale Biostimulation Strategy for Destruction of Residual cVOCs
Kent Armstrong, President, TerraStryke Products LLC, Andover NH
A former dry cleaner site experienced chlorinated volatile organic compound impacts to soil and groundwater. Contaminants-of-concern included tetrachloroethylene (PCE) and associated daughter products at concentrations above Ministry of Environmental & Climate Change Table 3 Site Condition Standards.

In October 2011, the consultant of record completed a pilot study evaluating the efficacy of TerraStryke® biostimulant ERDenhanced™ to enhance reductive dechlorination by native microbials under actual biogeochemical conditions.

The amendment was applied via passive release sock deployment units suspended vertically in saturated screened interval of existing two-inch groundwater monitoring well. Four replacement events were performed during evaluation, the last at week 20 of a 26-week evaluation. Baseline monitoring and sampling/analytical testing was performed prior to additive deployment. Four post-deployment performance monitoring/testing events were completed, the final event in week 26.

Pilot results confirmed rapid electron acceptor scavenging, expedited residual mass solubilization, and enhanced cVOC reductive dechlorination by native dehalorespiring bacteria. Specifically, PCE decreased 46.9% by week 8, increased 233.3% in week 14 (additive enhanced co-solvent effect), then decreased 89.6% in week-26. Total cVOCs decreased 49.6%, increased 282.6%, then decreased 77.4%. Parent/parent-daughter molar ratio decreased from 100% to 29.1%, a 70.9% reduction. Monitoring/geochemical data provided a secondary line of evidence for enhanced reductive dechlorination.

In July 2013, MOECC approved a full-scale strategy combining source and ERDenhanced™ biostimulation. An injection gallery was installed in the excavation footprint. March and July 2014, 990kg and 840kg ERDenhanced™ was gravity fed into gallery using 1,100 liters make-up water.

Five rounds of groundwater monitoring/sampling were completed between March 2014 and October 2015. 19-months post deployment, additive influence was observed at MW-2, MW-3, MW-6—15-20 meters downgradient of gallery. PCE decreased 99.9% at MW-2, 95.0% at MW-3, and 97.9% at MW-6. Total cVOC decreased 89.7% at MW-2, 75.8% at MW-3, and 88.1% at MW-6. Molar parent fractions realized were 99.0% at MW-2, 87.7% at MW-3), and 90.0% at MW-6.

12:00 Day One Luncheon
Luncheon Sponsor: Advanced Environmental Laboratories

Session 3: Combined Remedies for Enhanced Outcomes

1:30 Large Diameter Auger Excavation and Enhanced Bioremediation using CHITOREM® at the former Dixie Cleaners in Jacksonville
Jesse Brown, PE, Associate, Golder Associates Inc., Jacksonville
The former Dixie Cleaners site is located at the north end of Lakeshore Plaza Shopping Center, northeast of the intersection of San Juan Avenue and Blanding Boulevard in Jacksonville, FL. The cleaners occupied the site from 1956 to 1995. Chlorinated solvents were released to the surficial groundwater underneath the dry cleaning building and through the sanitary sewer lift station. A groundwater plume consisting of high tetrachloroethene (PCE) and trichloroethene (TCE) concentrations extended over an area of approximately one acre. The most significant PCE impacts in soils and dense non-aqueous phase liquid were identified at a depth of approximately 18 feet below ground surface, following the contour of the stormwater drain along the northeast corner of the building. It appears that, historically, waste may have been disposed of outside the back door, where it then drained onto the asphalt and into a concrete culvert. The site lithology consists of silty fine grained sand from the surface to a depth of approximately 18 feet bgs, clayey fine grained sand from approximately 18 to 30 feet bgs, limestone from approximately 30 to 32 feet, and a stiff clay unit below 32 feet.

Previous remedial activities conducted at the site included the injection of Hydrogen Release Compound, HRC-X®, and Bio-Dechlor Inoculum. The initial HRC® and HRC-X® treatments were successful in achieving greater than 99 percent mass reduction in the shallow and the deep intervals. However, elevated PCE and TCE concentrations persisted in the intermediate interval located close to the sewer lift station. Golder used an edible oil carbon source, EOS®, below the building along with a
shallow source removal to address this area. Golder also injected ammonium bicarbonate in 2006 to raise the pH of the intermediate aquifer. To address the increasing groundwater contaminant concentrations in the shallow and intermediate intervals, an additional injection of EOS® and AquaBupTM was conducted in 2009. During the injection process an area of DNAPL was identified and further delineated in 2010 along the onsite storm drain at the back of the property. In 2011, Golder developed an interim source removal work plan to address the area of identified DNAPL upon available state funding.

To address the DNAPL source area present along the contour of the stormwater drain, Golder conducted a large diameter auger excavation in January 2016. A total of 18 LDA boreholes were drilled to depths ranging from 17 to 30 bgs. Each borehole was backfilled with flowable fill. Field screening using an organic vapor analyzer was used to assist in segregating excavated soils into roll-off containers for temporary storage. Composite soil samples were collected from each container and submitted to a laboratory for waste characterization purposes. Based on the lab results, a total of 345.19 tons of hazardous waste (greater than 10 times the universal treatment standard) and 61.05 tons of hazardous waste (less than 10 times the UTS) was transported to U.S. Ecology’s facility in Belleville, MI. A total of 125.15 tons of nonhazardous waste was transported to the Omni Waste facility in St. Cloud, FL.

Injection wells were constructed downgradient of the perimeter LDA boreholes. During their construction, a mixture of gravel and approximately 330 pounds of CHITOREM® was placed around the screened section of each well. CHITOREM® utilizes crushed crustacean shells as a carbon substrate that promotes anaerobic degradation. Following the LDA source removal, the storm drain was replaced and the site was restored to match pre-construction conditions.

### 1:50 A Combined Remedy Approach to Address a Trichloroethene Source Zone at a Legacy Hydraulic Containment Site

**Joseph Bartlett, EI, Environmental Engineer, Geosyntec Consultants, Titusville**

Historic releases of trichloroethene, TCE, resulted in the contamination of the surficial aquifer at the Precision Fabricating & Cleaning Co. site in Cocoa, FL. Detailed investigations revealed the presence of onsite source areas and an associated downgradient dissolved plume. Remedial measures implemented at the site in 2002 included a hydraulic containment system to provide flux control at the PFC property line with downgradient dissolved plume monitoring.

After successfully operating and optimizing the system for over a decade, a combined remedies approach, which included an enhanced in-situ bioremediation strategy used in conjunction with the existing hydraulic containment system, was prepared with the goal of reducing the onsite TCE source zone and facilitating the accelerated shutdown of the hydraulic containment system.

The bioremediation design was implemented in October 2015 and included injection of Terra System’s SRS-FRL® slow release electron donor and SIREM Laboratories KB-1® dechlorinating bacteria in the vicinity of a known release area which had been historically investigated by University of Guelph researchers. Immediately prior to injection activities the hydraulic containment system was shut down. Following an initial five-day shut-down period, the extraction system was re-started and operated for a three-day period with an objective of enhancing electron donor and microbial culture transport and distribution within the treatment area and toward the downgradient recovery wells. Following the transport period, the system was shut down for three months to promote biological degradation processes. The system was then restarted following this period in order to maintain hydraulic containment capabilities.

The combined remedy approach, utilizing the existing hydraulic containment system in conjunction with the focused bioremediation source zone reduction, has proven to be successful in documenting significant ongoing mass reductions. The presentation will provide up-to-date performance monitoring results associated with remedy implementation in addition to strategies and considerations for optimizing existing treatment trains using combined remedy approaches.

### 2:10 Combining Adsorption and Bioremediation Technologies for In-Situ Groundwater Remediation

**Gary Birk, PE, Managing Partner, Tersus Environmental, Wake Forest, NC**

Laboratory studies have shown the potential to treat groundwater in situ by using a mixture of activated carbon, aluminum hydroxide and kaolin clay. This combination of materials can immobilize a range of amphoteric metals and organics, including petroleum hydrocarbon constituents. Combining this formulation with an appropriate mixture of amendments should minimize interventions by incorporating both adsorption and biostimulation techniques to manage groundwater plumes and destroy constituents of concern. Current activities include assessing pilot scale effects and implementation effectiveness.

The presentation will include results and lessons learned from laboratory work and the latest field implementation experiences. This dual function approach, which immediately binds contaminants and provides electron acceptors and micronutrients for biodegradation of organics, may provide both short term risk management and a remediation method for contaminated groundwater.

### 2:30 Successfully Integrating Surfactants into ChemOx Technologies

**Dan Socci, Chief Executive Officer, EthicalChem, South Windsor, CT**

Use of surfactants in remediation can significantly improve chemical oxidation results when optimally selected and applied based on site conditions. The idea of surfactant use in remediation however is often met with questions, uncertainty, and reluctance due to concerns of contaminant liberation and offsite contaminant mobilization. Drawing from experience optimizing and implementing surfactant enhanced in-situ technologies, Surfactant-enhanced In-Situ Chemical Oxidation® and...
Surfactant Enhanced Product Recovery™, with data points from a successful coal tar clean up in the New York City area and a petroleum LNAPL site in Texas as well as laboratory data, this presentation provides guidance on surfactant application, and addresses the most common concerns regarding this remedial option while also presenting its advantages. Information will be presented based on site experience as well as laboratory data that addresses many frequently asked questions about surfactant use with oxidants in remediation. Case studies will be presented, demonstrating S-ISCO remedies can achieve complete or near complete contamination removal, eliminating rebound and the need for follow-up treatments.

2:50  A Multi-Site Performance Review of Slow Release Electron Donor and Bioaugmentation Co-Application Strategy
Steven Sittler, PG, Senior Project Manager, Patriot Engineering Inc., Indianapolis, IN
This presentation will include performance data and cost analysis from multiple commercial sites throughout Indiana in which an electron donor and bioaugmentation co-application strategy was successfully implemented. As part of the multi-site review, a discussion on the consistent strategy for success which was implemented at these sites will be shared with the audience. Site challenges, conceptual site model development, baseline analysis and design and implementation of this electron donor/bioaugmentation co-application strategy will be discussed in detail. Site specific comparisons between the co-application strategy and separate injections will be presented. In a few examples, a combined remedies approach involving in-situ chemical oxidation followed by the electron donor/bioaugmentation strategy will be highlighted as well.

In recent years, technological advancements have allowed for a transition towards a co-application of controlled-release electron donors and bioaugmentation cultures of dehalococcoides, DHC. These advancements, such as pH neutral electron donors and a better understanding of the viability of DHC in this environment have allowed many to move away from the old way of thinking of waiting to bioaugment. The result is a more aggressive approach with a significant increase in enhanced reductive dechlorination rates. Data suggests that this co-application approach can rapidly reduce PCE/TCE concentrations in groundwater followed by short-term increases in daughter products—cis-1, 2-dichloroethene, trans-1, 2-dichloroethene, and vinyl chloride. Sustained reductive dechlorination as a result of the slow release electron donor along with the increased degradation rates afforded by direct injection of a microbial culture are leading to complete degradation of the target constituents, thereby facilitating closure following the post-injection monitoring period.

The rapid success of this strategy will be highlighted in multiple data sets showing complete PCE/TCE reduction within three to 12 months with daughter products persisting for three to six months in most cases. Long term performance data showing sustained reduction of daughter products will also be presented. A lessons learned section will also be presented in which the need for small focused, supplemental injections was implemented quickly to minimize the time to cleanup goal attainment and avoid unnecessary monitoring. In conclusion, a comprehensive cost analysis with comparison to other traditional remediation technologies will be presented.

3:10  Combining Technologies to Reach Site Closure
Mark Kluger, President, Dajak, Wilmington, DE
Electrical resistance heating is a well-established, robust and rapid remediation technology. Primarily due to cost considerations, remediation practitioners generally apply ERH in the source zone to volatilize and treat volatile organic compounds. As ERH can maintain fairly uniform temperatures in the subsurface and as elevated temperatures increase reaction rates, there has been significant interest in applying ERH at a reduced cost to provide a plume-wide solution.

Moderately increasing temperature, 20-30 degrees Celsius, the subsurface matrix will increase biotic and abiotic reaction rates and will increase the dissolution rates of sorbed contaminants and non-aqueous phase liquids, making them bio-available. Field results, as well as published research, elucidate the production of short-chain, volatile fatty acids from the naturally occurring organic, non-soluble carbon already distributed throughout the treatment volume. The newly formed, dissolved organic carbon provides electron donors, supporting the biodegradation of chlorinated volatile organic compounds. Further, elevated temperatures help create redox conditions appropriate for anaerobic biodegradation. Keeping temperatures below those that produce steam eliminates the need for vapor capture and treatment, substantially reducing costs.

This strategy is currently being applied at an EPA Superfund site and data will be presented along with the principals of heat enhanced plume attenuation.

3:30  Break

Concurrent Sessions
Session 4A: New for 2016: “Speed Talks” – New Products and New Approaches to Product Delivery

4:00  1) Electrokinetic Enhanced Bioremediation to Effectively Deliver Amendments to Low Permeability Materials at a Florida DNAPL Site
Sandra Dworatzek, Senior Manager, SiREM, Guelph, ON, Canada
2) Replaceable Treatment Cartridges for Groundwater Remediation  
W. Joseph Alexander, PG, Principal, Ai-Remedial Systems LLC, Chapel Hill, NC

3) Materials and Methods to Address Contaminated Ground Water to Surface Water Interaction: Case studies of sites with petroleum, PCBs, DNAPLs and LNAPLs, chlorinated solvents, arsenic and other contaminants.  
John Collins, Chief Operating Officer/General Manager, AquaBlok, Toledo, OH

4) Overburden and Bedrock Remediation Using BOS 200® at Former Retail Petroleum Sites  
Mike Mazzarese, Senior Engineer, AST Environmental Inc., Golden, CO

5) Sped Talk Title, TBD  
Drew Baird, PG, Senior Geologist, FRx, Cincinnati, OH

6) Using Klozur® KP (Potassium Persulfate) as an Extended Release Oxidant and Permeable Reactive Barrier  
Patrick Hicks, PhD, Technical Sales Manager, PeroxyChem, Philadelphia, PA

7) Controlled Discrete Treatment Using Horizontal Well Systems Under Tanks, Roads, Utilities, Buildings and Non-Responsible Owner Properties  
Lance Robinson, PE, Principal Research and Design Engineer, EN Rx Inc., Parrish, FL

8) Horizontal Directional Drilling and Well Installation at Small Sites  
David Bardsley, PG, Bus. Dev. Manager, Directed Technologies Drilling, Bellefonte, PA

**Session 4B: Petroleum Cleanup– When You Can’t “Risk” it Away**

4:00 Multi-Phase Extraction with Enhanced Biostimulation Demonstrates Contaminant Reduction at Petroleum Site  
Matthew Crews, PE, Senior Project Engineer, Golder Associates Inc., Jacksonville  
Multi-phase extraction with enhanced biostimulation using an oxygen injection system has been used to remediate a NAPL and dissolved-phase petroleum contaminant plume that has migrated offsite over 200 feet towards a residential area in Springer, NM. The MPE system was set to maximize NAPL recovery, minimize groundwater extraction and maintain the groundwater elevation during high vacuum MPE. The oxygen injection system is cycled to run concurrently with the MPE system, but within opposite areas of the site, such that oxygen has sufficient time to diffuse into the groundwater. Higher dissolved oxygen concentrations provide a concentration gradient to diffuse oxygen into small pore spaces. The result is the biodegradation of contaminant mass that would otherwise be unavailable for biodegradation or removal by extraction or volatilization methods. Because the resultant oxygen supply is greater than the total oxygen demand, this system creates the desired aerobic conditions for indigenous bacteria to break down hydrocarbons for a more efficient cleanup of the site. After eight quarters of operation, approximately 54,000 pounds of petroleum contaminants have been removed, constituting approximately 97% of the mass in place Golder estimated prior to remedial action implementation. Enhanced biodegradation is estimated to account for approximately 53% of the total mass of hydrocarbons removed at the site to date. NAPL was effectively removed during the first six months of operation. Dissolved-phase contaminant concentrations have declined to levels near or below applicable cleanup target levels onsite and offsite, with the exception of residual contamination present below an active dispenser island.

4:20 From Injection to In-Situ Soil Blending; Switching Application Technology Mid-Remediation  
Brantley Rudd, Vice President, Exo Tech Inc., Monroe, GA  
Petroleum constituent contamination in groundwater was discovered at a state reimbursable site in Chatham County, GA, in 1995. Throughout the site history, a total of 12 monitoring wells were installed on site. Light non-aqueous phase liquid was discovered in only one well. The initial remedial approach was to perform an enhanced fluid recovery event to remove the free product and continue monitoring the remaining wells for free product. Following the extraction event, the LNAPL was removed and was not detected in the other wells. Exo Tech was contracted to reduce the dissolved BTEX that was present in four monitoring wells. Prior to the implementation of any remedial activities, the UST’s were abandoned and removed from the site. The initial approach defined by Exo Tech consisted of installing 56 one-inch injection wells. Two subsequent injections would follow the installation of the wells. The first injection would consist of catalyzed hydrogen peroxide to desorb an LNAPL mass that was sorbed in the soil matrix. The second injection would consist of sodium persulfate to treat the dissolved phase over a longer period of time.

In February 2014, Exo Tech installed 56 injection wells. The injection wells were installed to an approximate depth of 15 feet bgs. During the installation of the injection wells, LNAPL was discovered in an area that has historically never exhibited LNAPL. It was determined to continue with the injection of CHP but to focus the efforts in the area of the LNAPL. Two
Consecutive injections of CHP occurred on-site. The CHP injections consisted of mixing a 7% solution and injecting it in the LNAPL area. After the second injection it appeared that there was more LNAPL sorbed in the soil matrix than anticipated. It was determined to evaluate our approach and find a more economical way to introduce the oxidant. With the amount of LNAPL that was assumed to be present and with the site availability, it was determined to perform in-situ blending to introduce the CHP. An area of approximately 1,950 square feet was delineated. This area covered the assumed LNAPL area and some areas of high dissolved. The blending was performed by first removing approximately five feet of overburden. After reaching the impacted zone, the iron activator was blended into the soils. While the iron was being introduced, the hydrogen peroxide was being prepared. The hydrogen peroxide was dissolved to an approximate ratio of 12.5% and pumped into the excavation where it was blended thoroughly until a complete homogenous mixture was achieved. Backfilling was performed concurrently and Exo Tech demobilized.

Following the CHP blending treatment, the site was allowed to rest and the groundwater was allowed to return to background elevation. Sampling events were performed on a quarterly basis. No presence of LNAPL was detected on site and no further action was granted.

4:40  **Life Cycle Risk Management: A Strategic Approach for Focused LNAPL Remediation**  
Manivannan Nagaiah, PE, Project Engineer, Langan, Fort Lauderdale  
Remediation of light non-aqueous phase liquid to the “maximum extent practicable” at sites both large and small can often be associated with high costs and uncertain timelines. This presentation describes the application of a risk-based, strategic approach for focused LNAPL recovery at a 70-acre asphalt refinery in Savannah, GA. This approach is centered on the development of a robust conceptual site model and recoverability analysis through testing and evaluation of LNAPL transmissivity. Site-wide LNAPL accumulations resulting from historical releases exist in a complex geologic setting adjoining the Savannah River.

We initially developed an LNAPL conceptual site model based on prior activities and in consideration of existing and potential sources, pathways and receptors. Our evaluation of the LCSM identified data gaps to be addressed and led to implementation of LNAPL recoverability testing utilizing vacuum extraction and baildown test methods. We subsequently conducted pilot testing to further evaluate remedial technologies including multi-phase extraction and LNAPL skimming. Based on the investigation and testing findings, we defined priority areas for remediation on a site-wide basis that align with the refinery goals and objectives. We developed a focused and phased recovery program that provides flexibility for remediation of LNAPL toward attainable end-points and is consistent with the Georgia Environmental Protection Division Voluntary Remediation Program. The program’s streamlined approach allows for continuing operations and site redevelopment as well as a significant savings to the refinery. The LNAPL recovery program is designed to provide flexibility, efficiency and responsiveness to address existing product, and to reassess recovery needs based on delineation, monitoring, data evaluation and performance assessments. The recovery approaches were proposed using available infrastructure and off-the-shelf equipment and systems, resulting in cost savings. The proposed five-year program has been approved by the Georgia EPD, and recovery implementation efforts are ongoing. In describing the program components, we will also present a brief overview of the ongoing investigation and site remediation activities.

**Concurrent Sessions**  
**Session 5A: Enhancing Your Foundation for Remedial Success**

9:00  **Innovative Use of Technology at Former NAS Cecil Field, Jacksonville**  
Kara F. Wimbly, Project Manager EnSafe Inc., Jacksonville  
EnSafe is conducting long-term monitoring at former NAS Cecil Field in Jacksonville and maximized multiple technological applications to optimize field and associated reporting activities. EnSafe’s innovative use of technology minimized limitations on current property owners so they could further develop and manage the sites for reuse as an industrial park and aviation center.

We incorporated an innovative application of existing technology to setup a Microsoft Office365 SharePoint website for the geographically-dispersed Cecil Field Team to collaborate on documents and data, and managed field data by implementing ESRI’s Collector for ArcGIS for use on smartphones and tablets to access geographical information system maps, collect data using electronic forms, and capture field photographs.

In addition, an application was created to automate the extraction of data from EQuIS to perform statistical analyses and trend graphing using customized macros within Microsoft Excel, reducing the labor effort by 90% over previous methods.
Finally, we introduced the Cecil Field web-based mapping tool originally built using ESRI’s Flex Viewer and migrated to ESRI’s new WebApp Builder for ArcGIS. This tool allowed non-GIS technical team members to present mapping information in real-time during team meetings to facilitate discussions and decision making.

The collective successes of the Cecil Field Partnering Team were recognized in 2014 by receiving the Fiscal Year 2013 Chief of Naval Operation, Secretary of Navy and Department of Defense Environmental Restoration Team Award, and in 2016 for the ACEC - Grand Award. EnSafe’s innovative use of technology optimized the LTM program at former NAS Cecil Field in Jacksonville, FL, resulting in a cost savings of approximately $1M.

9:30 Dense Non Aqueous Phase Liquid Source Area Delineation Using Membrane Interface Probe and Hydraulic Profile Tool Technology at Space Launch Complex 16, Cape Canaveral Air Force Station, Florida
Timothy Jellett, Senior Scientist, HydroGeoLogic Inc., Orlando
John Langett, GS-12, DAF, Project Manager, Installation Restoration Program, Patrick Installation Support Team
Brad Jackson, PG, CHMM, U.S. Army Corps of Engineers, Mobile, AL

The ability of dense non-aqueous phase liquid to migrate vertically and laterally makes subsurface delineation challenging and costly. Use of membrane interface probe and hydraulic profile tool technologies can reduce an 18- to 24-month field investigation to approximately 3 to 4 months and provide three-dimensional imagery of the source area.

This approach was used successfully for Space Launch Complex 16 at Cape Canaveral Air Force Station, FL. SLC-16 is an inactive missile launch site. Prior groundwater investigations had identified a DNAPL source area with trichloroethene concentrations as high as 1,000,000 micrograms per liter 1,200 feet west of SLC-16 and SLC-19.

MIP and HPT methodologies provided real-time data, qualitative information on variations in contaminant concentrations throughout the source area, and 3D images of the source area. The 3D images facilitated placement of the confirmation samples needed to delineate the contamination to the target concentration of 10,000 ug/L TCE.

10:00 Design Verification Program: Lessons Learned from Pre-Application Assessments at In-Situ Remediation Sites
Chad Northington, Southeast District Technical Manager, Regenesis, Tallahassee

This presentation will focus on pre-application design verification steps that directly improve existing design assumptions prior to field application. The goal of this program is to determine what “lower-cost” field-based methods might provide significant benefits into design and application method selection prior to in-situ application, thus resulting in improved remedial performance outcomes.

Over the past 20 years, application of remedial substrates has had an uneven track record in terms of performance. Generally speaking in-situ remedial performance is the result of multiple factors. This presentation will focus on the identification of aquifer characteristics that can be documented using traditional field methods and provide the most insight into the remedial design and application programs. Specifically this presentation will focus on those target treatment zone, TTZ, characteristics that directly affect application programs and ultimately remedial outcomes.

On most remediation sites, two of the more important TTZ characteristics are soil type and the positional relationship between the soil types. The deposition process of sediments has a critical bearing on COC mass storage and distribution as well as remedial reagent selection and application methods. To assist design and application teams, a set of routine pre-application “design verification” steps were developed and performed on select project sites. Using these steps to identify the relationship between COC mass storage and distribution units within TTZ has contributed to an overall improvement in application programs and is seen to be a key element in higher remedial success rates.

This presentation will discuss the use of a set of lower-cost traditional field-based logging techniques for remedial assessment that have been proven to provide information in design and application program prior to field mobilization. These steps were originally developed for in-house projects across the U.S. As part of this pre-application program, a series of design verification steps were performed to systematically identify TTZ characteristics that might either limit or enhance remedial performance. These characteristics often directly affect the application strategy and methods and, in some cases, remedial reagent selection. Included in these are the quantity of sand size particles present and the use of clear-water injection testing. This discussion will include a couple of case studies as well as data sets collected from over 30 sites across the US.

Understanding percentage of sand size particles present as well as the size sorting in the TTZ can drive application and performance results. As an example, consistent continuous core collection and use of soil particle settling tubes as part of the process of soil logging has assisted in better field accuracy in this area.

Monitoring aquifer response during pre-injection testing greatly increases the ability to predict a more accurate TTZ accommodation rate and volume. Monitoring aquifer response has provided valuable insight into TTZ limitations and improved the process of project infield adjustments.

Session 5B: Emerging Contaminants – Remediation of Perfluorinated Compounds
9:00 PFOA presentation, TBD
9:30 Treatment of Emerging Contaminants of Concern with Activated Ozone
William Kerfoot, PhD, Principal, Kerfoot Technologies Inc., Mashpee, MA
Perfluorinated compounds, for example PFOS and PFOA, and 1,4-dioxane have become emerging contaminants of concern in groundwater and soil. Numerous states have begun to develop desired not-to-exceed levels for the compounds in groundwater supplies foremost, and soil levels secondarily. The purpose of this talk is to present the developing regulatory guidance, present a brief overview of ozone chemistry to treat both compounds, and site examples of treatment.

Perfluorinated compounds have found broad use in fire-fighting foams, are persistent in soils and groundwater and have bioaccumulated, particularly in fish. Treatment of the compounds are difficult because the strong carbon-fluorine bond creates a thermally stable compound requiring an oxidation potential above 2.9 volts for successful attack. Nanobubble ozone coated with hydrogen peroxide as a Perozone® 3.0 solution readily attacks and decomposes the perfluorooctanates. In permeable sandy soils, the ozone gas and liquid peroxide can be delivered through separate tubes to be combined below ground in special stainless steel laminar Spargepoints® that form coated nanobubble emulsions that are injected outwards through capillary pores. Kinetics of the reaction will be discussed, including production of fluorides and sulfate.

The compound 1,4-dioxane has been found with chlorinated solvent spill areas. Being highly water soluble, the associated plume may be larger than the initial TCA or related chlorinated compound plume. Twelve states have developed groundwater and/or soil target levels or remediation goals for the compound. It can be treated in-situ, or in-line treatment can be added to pump and treat systems.

10:00 Treatment of Perfluoroalkyl and Polyfluoroalkyl Substances in Groundwater
Gary Birk, PE, Managing Partner, Tersus Environmental, Wake Forest, NC
Per- and polyfluoroalkyl substances are surfactants and polymers that are widely distributed across the higher trophic levels and are found in air, soil and groundwater at sites across the U.S. Surfactant applications used heavily in the military include aqueous film-forming foams used to extinguish fires involving highly flammable liquids. The toxicity, mobility and bioaccumulation potential of PFASs pose potential adverse effects for the environment and human health. They are persistent in the environment, among the strongest organic compounds and thus considered non-degradable.

Practitioners have difficulty remediating these compounds at a reasonable cost because PFAS tend to be highly soluble, do not favorably partition into the vapor phase, and do not adsorb well to granular activated carbon. To date, GAC has been the only technically feasible method to treat PFAS-aqueous media.

This talk will present a treatment train for ex-situ treatments of aqueous film-forming foam impacted water. In the pretreatment phase, PFASs are precipitated by metering the liquid surface active compound into a stirring tank. The amount of reagent can be adjusted to varying concentrations. The precipitation products are separated from the water as micro-flocks by simple processes such as sedimentation and filtration. The precipitants can be concentrated to a very high degree, which allows for very economical disposal as compared to GAC. Post-treatment of the remaining residual contaminants is performed by a downstream activated carbon and activated carbon/aluminum hydroxide/kaolin filter. Due to the significant reduction in the PFAS-contaminated water in the initial precipitation stage—up to 90%—the PFAS contaminant load reaching the absorbent filter is lowered, which leads to a significant extension of the absorbers lifetime, again significantly lowering operating costs.

The presentation will also provide results of the effectiveness of an activated carbon/aluminum hydroxide/Kaolin mixture to treat PFASs. Studies have concluded that the adsorption capacity of the mixture for the smaller chain fluorinated substances PFBA and PFBS is vastly superior to that of GAC. This is likely due to the presence of the noncarbon components within the mixture creating unique physical chemical interactions with the smaller chain PFAS compounds.

10:30 Break

Concurrent Sessions
Session 6A: Plume Management Using Carbon Injectables

11:00 Multi-Site Performance Review of Liquid Activated Carbon for Groundwater Treatment
Chad Northington, Southeast District Technical Manager, Regenesis, Tallahassee
There is growing interest in the use of carbon injectables to expedite groundwater cleanup through coupling contaminant destruction with sorption. While an appreciation of the theoretical benefits of this approach is widespread, so is a natural caution among experienced remediation practitioners, as is understandable with any new technology. Among questions related to effective practical application of the technology are concerns regarding subsurface distribution in the field, applicability in low-permeability or heterogeneous formations, and short and long term performance.

This presentation will examine evidence from the field exploring these and other concerns. Data will be drawn from more than 20 field applications, variously addressing chlorinated solvent and hydrocarbon impacted sites and encompassing a variety of geological settings within both the United States and Europe. Contaminants investigated range from chlorinated ethenes and ethanes to aromatic and aliphatic hydrocarbons and PAHs. Sites considered include legacy MNA sites, drycleaners, industrial sites, post-industrial development sites and gas stations. Field data will be presented describing performance against remediation goals, performance validation and also lessons learned with regard to material placement, site characterization and the importance of application-feasibility pre-testing.
A pilot study was conducted in two areas near the leading edge of a long, narrow chlorinated volatile organic compound plume located in south-central South Carolina. The pilot study included the application of an in-situ, liquid activated carbon solution that purports to accelerate biodegradation and shorten timeframes for achieving remedial objectives. The cVOC plume extends over 1,700 feet beyond its identified source. Approximately 80 percent of the contaminant mass is found in a Coastal Plain sediment aquifer that is comprised of a relatively low-permeability silt and very fine-grained sand. The impacted zone is present approximately 20 to 40 feet below ground surface. Both overlying and underlying zones are impacted to a lesser degree in the source area but unimpacted near the leading edge of the plume. A residential area is located less than 1,000 feet from the leading edge of the plume.

Enhanced biodegradation and monitored natural attenuation are effective, widely-used remediation tools, but the timeframe for treatment by these methods can be on the order of months to years. The results of a remedial alternatives evaluation recommended accelerated biodegradation using an innovative, in-situ LAC solution. The remediation agent consists of highly sorptive, micron scale activated carbon particles stabilized to transport widely through an aquifer upon injection. The stabilized colloids deposit on soil surfaces, forming a biomatrix that retains contaminants and accelerates their degradation.

Prior to implementing a full-scale remedial effort, two pilot studies were conducted to evaluate the effectiveness of the approach near monitoring wells with higher and lower total cVOC concentrations. The pilot-scale tests consisted of a remedy that coupled the LAC with a controlled release electron donor and bioaugmentation culture to promote enhanced reductive dechlorination. The performance monitoring phase indicated that total cVOC concentrations decreased by 91 percent at the high concentration well and 100 percent in the lower concentration well.

Based on the positive results of the pilot tests, the technology was implemented as the long-term remedial solution for the site at the downgradient portion of the contaminant plume. The full-scale application involved injecting the LAC solution in three passive-diffusion barriers that transect the downgradient plume. Combined with ongoing source-reduction activities, this remedial alternative should effectively prevent the plume from migrating further downgradient, which has been a concern of both the state and federal regulatory agencies. The protective effects of the remedial approach theorized to last many years will be evaluated through ongoing performance and long term groundwater monitoring. Results from the first six months of performance monitoring will be available prior to the conference and will be presented.

Session 6B: Modern Iron Applications

11:00 What Your Mother Never Told You About Iron
John Haselow, PhD, PE, President, Redox Tech, Cary, NC

Ever since researchers at the University of Waterloo observed differences in halocarbon concentrations in cast iron wells, zero valent iron has been used extensively in the soil and groundwater remediation business. Most of the early applications of ZVI employed recycled granular cast iron in barrier walls. This type of iron is known as “regrind” iron. The regrind iron was typically coarse and around 200 to 500 micron. Some regrind material was also known to have trace amount of grease and cutting oils, but more recently regrind suppliers have installed wash processes to minimize the amount of undesirable organic material. As the ZVI technology matured, different materials were tested and deployed.

Atomized ZVI, which is typically made from virgin iron ore, emerged as a cost-effective alternative to regrind ZVI. Injection applicators favored the atomized ZVI for greater reactivity and consistency. Atomized ZVI is available in wide range of particle sizes, but typical mean particles sizes for injection are around 50 to 100 micron.

The next advancement in ZVI was nano-scale ZVI which is known for its high reactivity, but unfortunately, also its high price. There has been some use of nano-scale ZVI but it has not gained widespread acceptance. BASF has been producing carbonyl iron powder, CIP, since 1925 but it has only recently been touted for its perceived ease of injection. Some vendors are recommending CIP for injection through well screens, where ZVI has typically be “fracked” or jetted into formations. CIP is known for its high purity and small particle sizes with a narrow distribution. CIP particles are typically in the 1 to 5 micron range.

North American Höganäs recently began providing a very high surface area ZVI with high surface area and hydrogen generation capacity. Despite development of ZVI technology over the past two decades, data did not exist on the relationship between surface area and hydrogen generation capacity as well as reaction rates with target contaminants. This presentation provides an overview of the evolution of ZVI technology as well as recent reactivity and hydrogen generation testing results.

11:30 The Effect of Emulsified Zero Valent Iron on Trichloroethene in the Presence of Chlorofluorocarbon 113
Les Porterfield, PE, Director of Florida Operations, TEA Inc., Santa Rosa Beach

It has been widely reported that 1,1,2-trichloro-1,2,2-trifluoroethene, or CFC-113, in groundwater can be inhibitory to the anaerobic biodegradation of chlorinated ethenes. Emulsified zero valent iron (EZVI) has been shown to be effective at degrading trichloroethene as dense nonaqueous phase liquids. A field evaluation was conducted on the effects of EZVI and other amendments on TCE degradation in the presence of CFC-113 in shallow groundwater.

The approach involved assessing post-remediation monitoring results from the implementation of a remediation injection scheme with multiple reagents that included EZVI for DNAPL treatment, vegetable oil and KB-1® bacteria culture as remediation...
amendments to enhance the biogeochemistry of the subsurface and accelerate the reductive dechlorination reactions. EZVI was injected to treat the residual DNAPL source in the subsurface; KB-1® bacteria culture was injected to bioaugment the existing dechlorinating bacteria, and vegetable oil was injected to provide additional carbon for the microbial populations. A detailed review of the groundwater monitoring system results was used to assess the effectiveness of the TCE treatment and to evaluate the potential inhibitory effects of CFC-113.

The results indicate that the inhibition of TCE dechlorination by CFC-113 when treated with EZVI in an anaerobic reductive environment did not occur. The EZVI treatment for the TCE DNAPL and the addition of the KB-1® bacteria culture was successful in treating the TCE with no perceived inhibition, and also resulted in the simultaneous reduction in CFC-113. These results are being used in an ongoing laboratory treatability study with subsequent supporting field data using EZVI to remediate a DNAPL source, also containing free product levels of CFC-113, with KB-1® Plus culture capable of degrading CFC-113 and TCE. Results from the field application and laboratory evaluation will be presented and lessons learned discussed.

12:00 Day Two Luncheon: 2016 FRC Charity Introduction: Second Harvest Food Bank of Central Florida
Luncheon Sponsor: The Goldstein Environmental Law Firm, Miami

Session 7: Regulatory Panel Discussion

1:30 Important Changes to Chapter 62.780, F.A.C., and Updates to the Petroleum Restoration Program
Moderator: Joe Applegate, PG, Senior Principal, Geosyntec Consultants, Tallahassee
Panelists: Brian Dougherty, Program Administrator, Office of District and Business Support, DEP, Tallahassee
Steve Hilfiker, President, Environmental Risk Management Inc., Fort Myers
Wilbur Mayorga, PE, Division Chief, Miami-Dade County RER-DERM, Miami
Diane Pickett, PG, Administrator, Petroleum Restoration Program, DEP, Tallahassee
John Wright, PE, Assistant Chief Engineer, Petroleum Restoration Program, DEP, Tallahassee

This year’s FRC’s regulatory panel discussion is entitled “Important Changes to Chapter 62-780. F.A.C. and Updates to the Petroleum Restoration Program.” The panel features senior managers from the Florida Department of Environmental Protection and Miami-Dade County, as well as private industry, who will discuss changes to Rule 62-780 and the Contaminated Media Forum, and provide updates to the DEP’s Petroleum Restoration Program. Joe Applegate, PG, senior principal with Geosyntec, will moderate the discussion. Brian Dougherty, PE, program administrator of the DEP’s Office of District and Business Support, and Wilbur Mayorga, division chief of Miami-Dade County RER-DERM, will discuss 62-780 and provide Contaminated Media Forum updates. Diane Pickett, PG, administrator of DEP’s PRP, and John Wright, PE, chief engineer with the PRP, will provide the latest on their program. Steve Hilfiker, president of ERMI, will provide industry perspective on the PRP program.

3:00 Break

Session 8: Management of Groundwater to Surface Water Discharges

3:15 A Novel Approach to Assess and Quantify Mass Flux of Groundwater Discharge into Surface Water
Paul Favara, PE, Global Practice Director, Vice President, Site Remediation and Revitalization, CH2M, Gainesville, FL

Discharge of contaminated groundwater to surface water occurs at many project sites. Due to a lack of cost-effective tools and methods to quantify mass-flux, cleanup objectives for groundwater are typically very conservative resulting in unnecessary treatment costs. There is a need for more cost-effective tools to better assess the mass-flux of groundwater migrating into surface water boundaries and natural attenuation along the flow path of groundwater as it migrates through the groundwater transition zone. Over the past several years, a sediment-bed passive flux meter has been developed to provide cost effective and reliable mass-flux measurements.

The SBPFM builds off of the significant research on passive flux meters previously performed. The main design challenge in developing the SBPFM was converting the PFM, which measures horizontal flux in groundwater, to a vertical configuration to assess groundwater discharging through the groundwater transition zone into surface water. The SBPFM was designed to be capable of passively and directly measuring local contaminant and water fluxes and provide more accurate information on the temporal mass flux distribution through the sediments in order to better design site remedial and closure strategies. Once laboratory testing of the SBPFM was completed, the flux meter was deployed at several sites. The field deployments were designed to assess ease of deployment as well as information that could be used to determine how mass flux could be interpreted from the deployments.

This presentation will address the results of laboratory testing completed in designing the SBPFM, which led to the final configuration and field test results. The field deployments of the SBPFM showed that the flux meters could be easily deployed...
near shore and could provide results for both tidal and non-tidal waters. Additionally, it was found that both activated carbon and ion-exchange resins could be used to measure a broad range of contaminants. The deployment results demonstrate that higher quality flux measurements could be achieved since the SBPFM results represent an average flux over an approximate two-week period, as compared to “point-in-time” measurements typically used in the industry. An economic assessment of a flux meter deployment compared to other sophisticated sediment flux tools also demonstrate similar benefits and an approximate 50% cost savings.

3:45 **Angled Injection of BOS 100® to Mitigate PCE Intrusion into a Stream**
Mike Mazzarese, Senior Engineer, AST Environmental Inc., Golden, CO

BOS 100® was injected adjacent to and beneath a stream using a direct push angle drilling technique to successfully create a PRB and limit PCE flux from the upgradient source area into the stream.

The Superfund site is a former textiles facility where tetrachloroethylene was used in drycleaning operations. Approximately one-half mile downgradient of the source, PCE was discharging into a stream through the saprolitic formation. Based upon stream bank and bed soil sampling and groundwater modeling, it was determined that the PCE was upwelling into the stream from partially weathered rock as deep as 65 feet below ground surface. The project objective was to determine if a Trap and Treat® BOS 100® permeable reactive barrier could be effectively angle drilled in the wooded and sloped area on the upgradient side of the stream to intersect the plume and reduce or eliminate the contaminant mass flux into the stream.

In the source areas, reductions of 90% to 98% have been observed. The observations made at micro wells and stream bed piezometers demonstrate that effective distribution of the BOS 100® was achieved during the pilot test injections. The analytical data from 12 of 15 micro wells installed in the PRB displayed significant contaminant mass reductions following the pilot test. The eight streambed piezometers located directly downgradient of the PRB have exhibited decreases ranging from 88% to 100% and have illustrated time-trends consistent with the expected mechanics of a PRB. The full scale angled injection was implemented in the fall of 2015. Data from the pilot test and full scale will be presented.

4:15 **Column Studies for Design Optimization of Field Pilot and Full Scale Denitrifying Permeable Reactive Barriers**
Michael Lee, PhD, Vice President Research and Development, Terra Systems, Inc. Claymont, DE

Many of Florida’s sensitive surface waters are impacted with nitrate from septic tank discharges and infiltration of urban and agricultural fertilizers. Sustainable technologies like permeable reactive barriers are being evaluated as nontraditional treatment alternatives for nitrate impacted groundwaters. Terra Systems Inc. has performed a column study to both evaluate the nitrate treatment capability of emulsified vegetable oil PRBs and determine critical PRB design parameters using nitrate-contaminated sandy soils and groundwater from a site on Cape Cod, MA.

The column study allowed for comparison of biological nitrate reduction effectiveness of different EVO formulations and EVO loadings. The columns were operated at groundwater flow rates of one foot per day which is representative of many areas in Florida. The column study determined time to reach complete nitrate removal, removal mass and rate of primary and secondary contaminants, buffer requirements, initial radius of influence of the injected emulsion, and projected emulsion migration distance and rate. Complete nitrate reduction continued even as total organic carbon levels in column effluents fell to between 2.3 and 3.0 mg/L by day 298. Nitrate began to increase after about 340 days when TOC fell below 2 mg/L. The column study shows that EVO effectively stimulates naturally occurring denitrifying bacteria in septic tank-impacted soils and groundwater for sustained nitrate removal while providing multiple parameters for design optimization of field pilot and full scale EVO PRBs.

5:00 **Conference adjourns**