Measurement & Monitoring:
32^{nd} Quarterly Literature Update & Grant Survey

The references selected for this update have been added to the searchable literature database developed for the Measurement and Monitoring Technologies for the 21^{st} Century ($21M^2$) Web site: www.clu-in.org/programs/21m2/litsearch.cfm

1,4-Dioxane: The Impact of Analytical Method -- A Case Study
Linton, P.J., J.C. Alonso, and T. Armstrong.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract G-005, 2008

Commercial laboratories commonly analyze for 1,4-dioxane in groundwater by either EPA Method 8260 or 8270, but Method 8260 generally does not achieve reporting limits that meet regulatory concentrations and 8270 does not list 1,4-dioxane as a reported analyte. Determination of 1,4-dioxane in water at low detection levels also can be accomplished using a modified approach to Method 8270 with isotope dilution. Because of time and sample volume concerns, many laboratories have begun analyzing for 1,4-dioxane using a modified Method 8260 with specific ion monitoring (SIM) GC-MS to improve the detection limits. During a recent characterization sampling at a central Florida site with groundwater impacted by chlorinated VOCs and 1,4-dioxane, split samples of groundwater were collected and analyzed by both Method 8270 and 8260 SIM. A significant difference was evident in reported concentrations of 1,4-dioxane by the two methods, sometimes by orders of magnitude. A study was initiated to evaluate the effect of the different analytical methods on reported concentrations. This paper presents an evaluation of the comparison of Method 8260 SIM, Method 8270, and Method 8270 with isotope dilution using native samples, multiple-level spike addition, and multiple-concentration laboratory control sample analysis to evaluate the overall accuracy and precision of the three methods. Isotope dilution was found to provide a correction factor that consistently provided a higher degree of accuracy and precision than the other methods. Subsequent evaluation of the addition of isotope dilution and a heated purge to the Method 8260 SIM analysis has been conducted by the State of Florida. The results of that evaluation have led Florida to specify the use of that method for all analyses of 1,4-dioxane in groundwater.

4D Geoelectrical Monitoring of Natural Attenuation Processes at a Contaminated Former Gas-Works Site
Wilkinson, P.B., P.I. Meldrum, O. Kuras, J.E. Chambers, S.J. Holyoake, and R.D. Ogilvy.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

A permanent automated geoelectrical imaging system was installed at a contaminated site to monitor resistivity changes associated with groundwater quality after the completion of a remediation program. The former gasworks site had been designated statutory contaminated land due to the risks of pollution of an underlying minor aquifer. The system collected data at regular scheduled intervals from a network of electrodes arranged in vertical borehole arrays on the boundaries of the site. The incoming data were automatically inverted to produce 4D resistivity images. Analysis carried out over one year revealed resistivity fluctuations in the infilled ground beneath the tarmac that were strongly temperature dependent. The underlying sand and gravel aquifer exhibited a steady increase in resistivity that was suggestive of a reduction in groundwater contamination after the removal of the contaminant source zones. A tracer test was also undertaken to investigate the groundwater flow velocity and demonstrate rapid 4D geoelectrical monitoring of natural attenuation processes. The motion and evolution of the tracer were visualized directly in high-resolution volumetric images in near real time. Seepage velocities measured from the images agreed well with estimates based on the piezometric gradient and assumed material parameters.

Advanced Quantitative PCR Techniques for Groundwater Microbial Monitoring
Ritalahti, K.M., S.H. Thomas, A. Nevins, and F.E. Loeffler.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-017, 2008

An advanced variation of the quantitative polymerase chain reaction (qPCR) technique includes multiplex capabilities (i.e., mqPCR) using distinct fluorophores on two to four different linear hybridization (TaqMan) probes in the same PCR tube. The mqPCR approach allows the detection of multiple targets simultaneously with increased sample throughput and reduced costs. The probes target phylogenetic markers (16S rRNA genes), housekeeping and functional genes, as well as internal standards. Also applicable to RNA (i.e., gene trasncripts), mqPCR expedites expression analysis by quantifying cDNA of standards and/or housekeeping genes concurrent with genes of interest within the same reaction tube. The mqPCR method was validated with laboratory cultures that provide high quality, clean nucleic acids where PCR inhibition is negligible. This presentation provides examples to demonstrate that advanced and refined mqPCR assays provide information about the distribution, diversity and composition of target populations, as well as the integrity of environmental sampling techniques.

The Analysis of Dioxins and Related Compounds
Reiner, E.J., Ontario Ministry of the Environment, Toronto, ON, Canada.
Mass Spectrometry Reviews, 2009 Aug 11. [Epub ahead of print]

The analysis of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, polychlorinated biphenyls, and other related compounds requires complex sample preparation and analytical procedures using highly sensitive and selective state-of-the-art instrumentation to meet very stringent data quality objectives. The author reviews analytical procedures (extraction, sample preparation), instrumentation (chromatographic separation and detection by mass spectrometry), and screening techniques for the determination of dioxins, furans, dioxin-like PCBs and related compounds with a focus on new approaches and alternate techniques to standard regulatory methods.

Application of 15N Stable Isotope Probing to Identify Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)-Degrading Microorganisms
Yu, C.-P., H. Roh, K.-H. Chu, and M. Fuller.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-016, 2008

While RDX biodegradation has been observed under aerobic and anaerobic conditions, and several RDX degrading isolates have been reported, microorganisms that are active for RDX biodegradation in situ remain unidentified. With different 13C-labeled substrates, a new technique called stable isotope probing (SIP) has allowed researchers to identify metabolically active microorganisms in complex engineered and natural systems. Until recently, 15N-based SIP has not been applied to identify microorganisms capable of degrading nitrogen-containing compounds like RDX. The authors examined the feasibility of using 15N-DNA SIP to identify active RDX utilizers in RDX-degrading microcosms and groundwater.

Application of a Characterization Methodology of DNAPL Contaminant Episodes Based on the Integration of Field and Laboratory Tools
Puigserver, D., J.M. Carmona, A. Cortes, M. Viladevall, M. Arce, J. Barker, and M. Vandergriendt.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper F-010, 8 pp, 2008

A DNAPL contamination event was detected in a municipal supply well in Torello, Spain, 80 km North of Barcelona in 2000 in the Ges river alluvial aquifer. The well was closed and a water treatment remediation system was installed. Since 2005, a research group from the University of Barcelona has used hydrogeology, geophysics, and soil tools to characterize the episode. Electrical tomography was used to define the fractured marly-calcareous substrate and the paleochannels in the alluvial aquifer. Soil geochemistry enabled a study of the chemical variations and the soil sorption of PCE and TCE. Slug and dilution tests supported characterization of the hydraulic parameters of the aquifer. Bimonthly groundwater sampling surveys confirm that the original DNAPL compound is 99% PCE and that anaerobic conditions on the right bank of the river favor biodegradation of PCE to cDCE. The coexistence of high nitrate and sulphate concentrations explains the slow DNAPL dehalogenation process. The process has been verified by anaerobic microcosm experiments with site soil and groundwater. The experiments also involved additions of Fe0, KMnO4, nutrients, and H2 to enhance contaminant breakdown.

Application of Compound Specific Isotope Analysis to Identify Chlorinated Ethene Plume Source
Moore, C., V. Mankad, P. Sharma, and K. Sorenson, Jr.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Poster Abstract F-019, 2008

Compound-specific isotope analysis (CSIA) is an analytical tool used for quantitative evaluation of the biological transformation of organic compounds under natural and/or enhanced degradation conditions. The CSIA evaluates the ratio of carbon-13 to carbon-12 in a given organic compound. During the biological transformation of parent compound (e.g., TCE) lighter molecular bonds (C-12) are broken down easily, resulting in enrichment of heavier molecular bonds (C-13) in the parent compound (i.e., the ratio of C-13 to C-12 increases in TCE compared to cDCE). The CSIA data can be used as a fingerprinting tool to track the biological transformation of TCE and also differentiate between the sources of TCE in a mixed groundwater plume. This poster presents the results and discusses the effectiveness of CSIA in distinguishing a source of chlorinated ethenes from on-site source area and an upgradient plume movement at a Superfund site. In this project, TCE fractionation ratios will be tracked upgradient and within the on-site source area, which is located within a larger regional groundwater plume. The objective of the investigation is to assess whether TCE concentrations at the site arise primarily from desorption within the on-site source area or from migration from off site. Significant concentrations of cDCE are present between the on site source area and upgradient sources, hence TCE migrating from these upgradient sources is more likely to be enriched in C-13 than the TCE potentially desorbing from the on-site source area, yielding a significantly different ratio of C-13 to C-12. Similar ratios in upgradient wells and on-site source area wells would indicate that TCE concentrations in the on-site source area are attributable to upgradient sources. As a control, samples will be taken from a well located outside the on-site source area to determine the variability of the C-13 of TCE as groundwater moves downgradient outside the site. Groundwater samples from one upgradient well, two wells within the on-site source area, and two wells located cross-gradient to the on-site source area but within the larger regional plume will be sampled. Two CSIA sampling events will be conducted to confirm conclusions drawn and demonstrate duplicability of results with sampling techniques.

Application of Enzyme Probes for Evidence of Aerobic Degradation in Low-Concentration TCE Plumes

Swift, D.L., A. O'Hagan, M.H. Lee, C. Wanyoike, S. Collins, and M. Skelly.

In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

Application of enzyme activity probes (EAP) for 3 low-concentration TCE plumes has provided evidence of aerobic cometabolism in contaminated groundwater. The EAP technique is used to demonstrate the presence and activity of enzymes responsible for aerobic cometabolism. In addition, development of a relationship between cometabolic enzyme activity and the rate of TCE cometabolism provides the opportunity to calculate a specific rate for natural attenuation of TCE. This information can be used to support the decision process for determining whether or not monitored natural attenuation (MNA) remedies are feasible for these low-concentration TCE plumes. The 3-low concentration TCE plumes are in Technical Area-V (TA-V) and Tijeras Arroyo Groundwater (TAG) at Sandia National Laboratories, NM (max TCE concentrations of 26 and 9.6 ug/L, respectively), and the Installation Restoration Program Site 2, El Toro, CA (max TCE concentration of 160 ug/L). EAP application at TA-V and TAG demonstrated positive response for the biological process of aerobic cometabolism at both contaminated groundwater sites. Toluene degradation pathways were evaluated using three enzyme probes. All 13 wells sampled at TA-V and 11 of 12 wells sampled at TAG showed positive response with at least one of the toluene probes. In addition, one probe was used to evaluate the sMMO degradation pathway with a positive response detected at all wells for TA-V and 50% of the wells at TAG. A microcosm study was performed using groundwater from TA-V, and a TCE halflife of 19.7 years was determined with a 95% confidence interval of 8.6 to 30.8 years. Application of 4 distinct EAPs at the El Toro site found that while activity varied across the site, there were numerous significant results in the wells sampled. A follow-on microcosm is planned. The data gathered from application of EAP at these 3 low-concentration TCE sites can be used to support selection of MNA as a remedy.

Application of Magnetic Susceptibility for Wetlands Delineation
Lobred, A.R. and J.E. Simms, U.S. Army ERDC, Vicksburg, MS.
SAGEEP 2009: Symposium for the Application of Geophysics to Environmental & Engineering Problems, March 29-April 2, Fort Worth, Texas. Environmental and Engineering Geophysical Society, Denver, CO. CD-ROM, p 559-570, 2009

A study using magnetic susceptibility was undertaken in central Mississippi to identify the transitional zone between non-hydric (uplands) and hydric (wetlands) soils. The soils were clayey with a minor percentage of sand. A survey line that traversed an upland, transitional zone, and wetland on each end of a transect was revisited four times during a single year. The first survey occurred in the spring 3 weeks after the winter flood inundation (moderately wet soil conditions), and the other three were in the summer (one, dry soil conditions) and fall (two, dry and moderately wet soil conditions). Measurable differences were evident between the magnetic susceptibility values collected in the upland and wetland regions during each survey period. One transitional zone was easily identified using magnetic susceptibility, exhibiting a sharp decrease in susceptibility values between the upland and wetland. The other transitional zone contained an intermediate ridge, which made demarcation of the zone less obvious. The measured magnetic susceptibility values were comparable for the respective upland, transitional, and wetland regions, and the characteristics of the curves were similar for all time periods. A general increase in magnetic susceptibility values was observed in all regions as the site dried throughout the year. Overall, magnetic susceptibility proved to be a successful method for delineating a wetland in this area.

Application of Molecular Biological Tools for Benzene Biodegradation in Southeast Asia
Buscheck, T.E., K.C. Harding, T.P. Hoelen, D. Mackay, and K. Sublette.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-013, 2008

Compound-specific isotope analysis (CSIA) was used to determine that declining concentrations of benzene at a field site in Southeast Asia are due at least partly to intrinsic biodegradation. Groundwater samples were collected from a dissolved benzene plume during May 2007. Carbon and hydrogen isotope ratios were obtained for six monitoring wells, in addition to various geochemical parameters, including sulfate, nitrate, ferrous iron, and methane. Sulfate concentrations remain largely elevated across the site (>180 mg/L) with some depletion within the plume; sufficient sulfate appears to be available for the continued anaerobic transformation of benzene. The CSIA results show enrichment in 13C and 2H isotopes for several of the site wells, providing good evidence for biodegradation of benzene. The slope of the plot for hydrogen versus carbon isotope values is consistent with the published literature for laboratory anaerobic biodegradation. The isotopic signature suggests biodegradation contributes to natural attenuation in this portion of the benzene plume. Bio-Sep(r) bio-traps were deployed in six monitoring wells in August 2007. The bio-trap results show 13C incorporation into biomass, providing strong evidence for benzene biodegradation across the plume. Phospholipid fatty acid (PLFA) analysis suggests anaerobic biodegradation of benzene is occurring. PLFA analysis also identifies sulfate-reducing bacteria, consistent with the geochemical footprint. The CSIA and bio-trap results serve as a baseline for future remediation and provide a means to evaluate remediation effectiveness. Demonstrating the occurrence of biodegradation and the potential for future transformation was instrumental in deciding subsequent monitoring actions to be taken at this site.

Application of PNN (Pulse Neutron) and EM (Electromagnetic) Measurements for Ground Mapping of Polluted Areas
Buckup, P. (Helmholtz Centre for Environmental Research - UFZ), P. Dietrich, and M. Buckup.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

The combined PNN and EM technologies offer new perspectives for control and mapping of polluted soil areas. The authors discuss detection and quantification of different contaminants, as well as the use of time-elapsed measurements to evaluate changes in contamination in situ. New perspectives in complex data processing are related to problems in near-surface geophysics.

Approaches for High-Tier Assessments of Vapor Intrusion
Nixon, E. and C. Shan, Northgate Environmental Management, Inc., Oakland, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper A-015, 6 pp, 2008

VOC-contaminated sites can have soil vapor intrusion (VI) problems assessed in a tiered process. Sites failing to pass Tiers 1 and 2 screening need to perform high-tier vapor intrusion assessments. These assessments account for site-specific conditions that might require enhanced field investigation and appropriate mathematical modeling. Because vapor intrusion is a transient process, the authors propose the use of a transient solution. The application of the model in high-tier assessment can go through three steps. At Step 1, the model is calibrated against available field data to minimize uncertainties, such as the slab crack ratio and effective air-exchange rate. Because a transient model usually generates different results at different times, the inverse application of its solution can help estimate more parameters. At Step 2, the calibrated model is used to predict the variation of VOC concentrations in indoor air under different conditions. The results can help identify site-specific cleanup criteria, focus air sampling and monitoring programs, and guide actions on VI mitigation. At Step 3, the predictions of Step 2 are validated with monitoring data. Necessary adjustments for monitoring or mitigation, if required, are made at this step. Example applications are provided to demonstrate the approach.

Aquifer Characterization for an ISCO Treatment of an RDX-Contaminated Aquifer
Albano, J., C. Chockjaroenrat, S. Comfort, V. Zlotnik, S. Onanong, and T. Halihan.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract M-018, 2008

Adequate aquifer characterization is one of the most important prerequisites for successfully implementing a groundwater remediation treatment. The spatial resolution of monitoring well networks sometimes is too coarse to identify aquifer heterogeneities and local hydraulic gradients. This poor resolution can cause plume continuity uncertainties or trajectory miscalculations. This paper described a project in which the objective was to use a fine network of monitoring wells, non-invasive geophysical techniques, and aquifer cores to characterize an RDX-contaminated aquifer for implementation of in situ chemical oxidation (ISCO) treatment using sodium permanganate. Site hydraulic conductivities and transmissivities were obtained from fully screened slugtests, multilevel slugtests, and grain-size analyses. Electrical resistivity imaging (ERI) measurements were conducted to acquire transect and 3-D images, which were calibrated to on-site hydraulic conductivities measurements. Using test site aquifer material, laboratory batch and column experiments were designed to observe permanganate/RDX degradation kinetics, permanganate transport characteristics, and the soil oxidant demand. Sodium permanganate was applied to the aquifer by extracting groundwater from a center well, spiking it with permanganate and bromide and injecting it into two lateral wells in an effort to create a curtain of permanganate. Bromide was used as a conservative tracer to calculate groundwater velocities and calculate permanganate consumption in situ. ERI measurements were made throughout the injection process to monitor curtain development and continued throughout the sampling process to observe permanganate transport. Aquifer characterization data are correlated with ISCO results.

Assessment and Monitoring Tools for Aerobic Bioremediation of Vinyl Chloride in Groundwater
Begley, J.F., E. Hansen, A.K. Wells, S. Fogel, and G.S. Begley.
Remediation Journal, Vol 20 No 1, p 107-117, 2009

This article describes the development and testing of two techniques--a microbiological tool and a molecular tool--for evaluating and optimizing aerobic bioremediation of vinyl chloride (VC). Both methods are based on detection of bacteria that can use VC and ethene as growth substrates in the presence of oxygen. The microbiological tool is an activity assay that indicates whether bacteria capable of degrading ethene under aerobic conditions are present in a groundwater sample. This activity assay gave positive results in the area of active VC degradation of an aerobic VC bioremediation test site. A rapid semiquantitative genetic assay was also developed. Based on polymerase chain reaction (PCR) detection of a gene involved in the metabolism of both ethene and VC, this molecular tool revealed the presence of potential VC degraders in an enrichment culture and site groundwater. These tools could provide a basis for judging the potential of aerobic VC degradation by ethenotrophs at other sites in addition to offering a mechanism for treatment monitoring and system optimization.

Assessment of Biodegradation at a Site Contaminated with Chlorinated Ethenes and Ethanes Using Stable Isotope Analysis

Hoelen, T.P., T.E. Buscheck, and K.C. Harding, Chevron Energy Technology Company.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-044, 2008

Application of compound-specific isotope analyses (CSIA) can sometimes indicate whether or not a certain compound is being degraded, independent of concentrations and knowledge of parent and degradation products. CSIA was used at a site contaminated with various chlorinated ethenes and ethanes to determine (1) which contaminants were being degraded, (2) which degradation pathways were followed, (3) if the extent of degradation was consistent across the site and outside the site boundaries, and (4) if contamination was caused by one or by multiple sources. The presumed parent contaminants were PCE, TCE, and 1,1,1-TCA. Transects of monitoring wells were selected to investigate if contaminant degradation occurred downgradient of the source area and outside site boundaries. Contaminant concentration and CSIA data from three sampling events (July '05, February '06, and July '06) using 7 groundwater monitoring wells indicate that at least two pathways are responsible for the occurrence of vinyl chloride: one produces cis-DCE, and the other produces 1,1-DCE. Abiotic transformation of 1,1,1-TCA produces 1,1-DCE, followed by reductive dechlorination to vinyl chloride (VC). This is an important pathway contributing to the occurrence of vinyl chloride that would not be easily identified without CSIA. The data further suggest the existence of an off-site, chlorinated ethene-only source. Elevated deltaC-13 values for VC and chloroethane in on-site wells indicate that degradation is ongoing and that complete dechlorination is occurring at the site, but transformation of VC and ethene appears to be less pronounced in off-site wells. Strongly negative deltaC-13 values in off-site wells compared to elevated values for on-site wells suggest that ethene has been more recently produced off site, consistent with the operating histories of the facility.

Baffles May Allow Effective Multilevel Sampling in Traditional Monitoring Wells

Britt, S. (ProHydro, Inc.); M. Calabria (CH2M Hill).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-005, 2008

With sufficient effort, aspects of multilevel monitoring in traditional wells combined with utility for compliance monitoring continues to make traditional wells valuable. Several approaches exist for sampling traditional wells. Passive methods and to some extent low-flow methods have been used to collect samples at specific intervals within wells to find contaminant stratification. Because contaminants can travel vertically, mix and dilute, or stratify at different intervals than they enter, multilevel sampling in an open well may not be an effective tool to determine adjacent aquifer concentrations, even using low-flow purge techniques or passive, no-purge, techniques. On the other hand, flow-weighted inflow and in-well mixing can occur under ambient conditions to create a flow-weighted average of concentrations across the screen interval, which may be useful for collecting a single passive sample to represent the whole interval. In any case, caution is warranted during interpretation of data collected from multiple intervals in an open monitoring well. One aspect of multi-interval sampling that has received some attention is the use of packers, baffles, or other flow inhibitor devices to limit the vertical exchange of water within an existing traditional well. When using pump methods, these efforts are only marginally useful because pump-induced gradients will simply draw water around the packer in the sand pack; however, passive samples collected within isolated portions of screens can yield results that correspond to the adjacent aquifer. The discrete multi-level sampler has been used to this end. The device is somewhat cumbersome, usually requiring a winch or rig to install, and it has not been consistently commercially available. Other packer or baffle methods can be user-installed, such as Snap Samplers with intervening mixing inhibitor devices. This method can generate interval data that more clearly defines contaminant profiles in comparison with those deployed in an open well bore. These data are helpful for understanding contaminant distribution without installing multiple wells or permanently retrofitting an existing well. Temporary multilevel testing can be accomplished and the well can still be used for traditional single-sample compliance monitoring. While this approach may not answer all questions asked of a monitoring network, it can help save costs by limiting the number of multilevel monitoring points needed to characterize a site and can allow traditional wells to serve a dual purpose: high-resolution characterization and inexpensive long-term monitoring.

Biodegradation of Petroleum Hydrocarbon Vapors in the Vadose Zone
Wilson, J.T., K. Jewell, and C. Paul.
Proceedings of the 21st Annual National Tanks Conference and Expo, Sacramento, CA, March 30-April 01, 2009. 36 presentation slides, 2009

The current state of practice to estimate the risk from intrusion of vapors of petroleum hydrocarbons from spills of gasoline is to measure the concentration of the chemical of concern in groundwater under the spill, use Henry's Law to estimate a concentration of the chemical in soil gas in equilibrium with the groundwater, and then assume that the chemical is transported by molecular diffusion in soil gas to the point where it enters the building (The Johnson and Ettinger or J&E model). This approach can be problematic for compounds such as benzene, which can be removed from soil gas by aerobic biodegradation. This presentation offers an alternative approach. First, collect core samples at various depths. Then extract the cores and determine concentrations of TPH and benzene in the sediment (mg/kg), and determine weight loss of core sediment on drying. Use this information to calculate the concentration of benzene in pore water in the core samples. Then multiply the concentration of benzene in pore water by the Henry's Law Constant to calculate the concentration of benzene in soil gas. Finally, compare the calculated concentration to the concentration expected from vapor diffusion (the transport mechanism in the J&E model). If the calculated concentrations are significantly lower than would be expected from diffusion of the chemical from groundwater, then calibrate J&E with the estimated concentration of the chemical in pore water in the unsaturated zone at the appropriate depth of the core sample. The approach was applied to field data from a fuel spill in Green River, Utah. Core samples were acquired and extracted and analyzed for concentrations of TPH and individual petroleum hydrocarbons. The predicted concentrations of benzene in soil gas were compared to measured concentrations of soil gas sampled from adjacent vapor monitoring wells. Concentrations of benzene in shallow vapor monitoring wells were 100 to 1,000-fold lower than would be expected from vapor diffusion alone. The predicted concentrations of benzene in soil gas generally agreed with concentrations of benzene in soil gas sampled from the vapor monitoring wells.
http://www.neiwpcc.org/tanks09/presentations/Wilson%20Vapor%20Intrusion%20Mon.pdf

Characterization and Delineation of a Highly Viscous PCB DNAPL
Aragona, B.N., J.J. Johnson, and W.C. Hardison.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract I-016, 2008

This paper presents novel methods of field screening for delineation of a PCB DNAPL in fill and sediments at a former wire and cable plant site on the Hudson River north of New York City. The remedial investigation conducted at the site revealed the presence of a highly viscous DNAPL. The DNAPL was observed during installation of a groundwater monitoring well located 10 ft inland from the Hudson River. The DNAPL was described as a "liquid rubbery matrix" due to its highly viscous nature. Unlike other DNAPLs, this material was observed to become increasingly adhesive and elastic when exposed to the atmosphere. Due to the unique nature of the DNAPL, different physical and chemical analyses were conducted to determine the most appropriate field screening methods to aid in its delineation. Chemical analyses indicated that the DNAPL was primarily composed of PCBs, PCTs, PCNs, and a mixture of aromatic solvents. The presence of aromatic solvents indicated that the material likely would emit a fluorescence response when excited at the proper wavelength. The DNAPL emission spectrum showed two broad bands with peaks at 351 and 434 nm. This analysis showed that the DNAPL would emit fluorescence within the UV and visible light spectrum when induced. Additional physical testing indicated a density of 1.48 g/mL, a viscosity of ~300 centipoise (cp), and ready adherence to steel. An innovative field screening program was designed to assist in delineation of DNAPL at the site using several non-traditional investigative methods, including adhesion testing and ex situ Rapid Optic Screening Tool (ROST(tm)) laser-induced fluorescence (LIF). During the investigation, on- and off-shore borings were completed using sonic drilling methods with continuously collected soil cores at 5-ft intervals. Collected soil cores were visually inspected and screened for the presence of the DNAPL using ex situ ROST(tm)/LIF. Adhesion testing was conducted by driving stainless steel spatulas through soil cores to determine the presence of DNAPL. This presentation provides an overview of field screening efforts for the delineation of DNAPL, the selection of the investigative methods, and a summary of the field effort results.

Characterization and Validation of a Bioluminescent Bioreporter for the Direct Detection of *Escherichia coli*
Birmele, M., S. Ripp, P. Jegier, M.S. Roberts, G.S. Sayler, and J. Garland.
Journal of Microbiological Methods, Vol 75 No 2, p 354-356, 2008

A two-component bacteriophage-based bioluminescent reporter system was developed for the detection of *Escherichia coli* in environmental samples. The bioreporter system consists of a luxI integrated lambda bacteriophage and a lux-based bioluminescent reporter cell that responds to the event through acyl-homoserine lactone (AHL) mediated quorum sensing and bioluminescent signal stimulation. This paper addresses the ability of the bioreporter system to detect and quantify the target pathogen in response to two analytical challenges: (1) detection of target cells in the presence of lactonase-producing non-target organisms that could interrupt AHL signal transduction, and (2) detection of physiologically stressed target cells. The signal response and limit of detection for the two-component bioreporter system were affected by the physiology and environment of the target, but the bioreporter maintained target specificity demonstrating its potential application for remote sensing of pathogens.

Characterization of Contaminant Migration Potential Through in-Place Sediment Caps
Sass, B.M., R.L. Fimmen, E.A. Foote, V.S. Magar, and U. Ghosh.
Strategic Environmental Research and Development Project (SERDP) Project ER-1370, 112 pp, Apr 2009

Field efforts were conducted at Eagle Harbor in June 2006 to study potential freshwater upwelling within and around the cap boundary, potential contaminant migration through the sand cap, and effectiveness of rapid screening approaches in the field to develop real-time data for field decision purposes for total polycyclic aromatic hydrocarbon (t-PAH) analysis. Additionally, sediment and cap materials were collected and shipped to the University of Maryland, Baltimore County (UMBC), for PAH and particle size characterization and to develop column transport experiments. A conductivity survey verified the presence of freshwater in the intertidal region, but further investigation is necessary to quantify the extent to which upwelling occurs. There appeared to be some migration pattern or mixing of PAH-contaminated sediments within the cap profile and some indication that other anthropogenic sources might be contributing to the t-PAH concentration on the cap surface. While potential migration patterns might exist, additional laboratory analyses could provide valuable insight into the mechanisms by which PAH translocation in the cap profile is taking place. The collective results of particle size distribution analyses of select core segments, particle specific sorption isotherm studies, and laboratory column transport experiments have improved the understanding of the sedimentary translocation of PAH contaminants. Available at
http://www.estcp.org/viewfile.cfm?Doc=ER%2D1370%2DFR%2Epdf

Characterizing the Microbial Community in a TCE DNAPL Site: Sabre Column and Field Studies
Dworatzek, S., R.F. Herrmann, T. Dahling, C.M. Acheson, D.W. Major, M. Harkness, M.D. Lee, and E.E. Mack. In Situ and On-Site Bioremediation: 10th International Symposium, Baltimore, MD, 5-9 May 2009. Battelle Press, Columbus, OH. 2009

The SABRE (Source Area BioREmediation) project is evaluating accelerated anaerobic bioremediation of chlorinated solvents in areas of high concentration, such as DNAPL source areas. In support of a field-scale pilot test, column studies were conducted to design the system and obtain modeling information. Samples for microbial characterization have been collected throughout this project from microcosm and column studies, as well as from field studies during the baseline, biostimulation, and post-bioaugmentation periods. While treatment performance is assessed based on the chemical concentrations of trichloroethene (TCE) and dechlorination products, the microbial community could provide useful information on treatment operation and might assist in troubleshooting problems. For the SABRE project, the microbial community was characterized using three techniques: quantitative polymerase chain reaction (qPCR) for enumeration of *Dehalococcoides* (Dhc) organisms and for the vinyl chloride reductase (vcr) gene, denaturing gradient gel electrophoresis (DGGE), and phospholipid fatty acid analysis (PFLA). Dhc were tracked as these microbes are capable of complete reductive dechlorination of

TCE to ethene. The vcr test provides quantitative information regarding the relative abundance of the gene that encodes for the enzyme that dechlorinates vinyl chloride to ethene. This test determines if the detected *Dehalococcoides* will degrade vinyl chloride to ethene efficiently and can be used to evaluate the activity of indigenous and bioaugmented Dhc. DGGE was used to assess and monitor changes in the composition of the microbial communities based upon DNA samples taken from various laboratory studies and over time in the field study. PLFA was used to describe the size and structure of the microbial community based on the phospholipids present in cell membranes. In combination, these three molecular techniques provide a robust understanding of the microbial community. This presentation summarizes the column study microbial characterization results and compares them to the results obtained from the field-scale pilot test.

Comparative Phylogenetic Microarray Analysis of Microbial Communities in TCE-Contaminated Soils

Nemir, A., M.M. David, R. Perrussel, J.-M. Monier, T.M. Vogel, B. Remenant, and A. Sapkota.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-023, 2008

In contaminated sites, information about the microbial community can aid in determining the level and type of contamination and designing a remediation strategy. Using principle component analysis and phylogenetic microarrays spotted with 16S probes, the authors examined the relationship between microbial communities in soils amended with varying quantities of TCE for increasing periods of time. First, the results from in vitro microcosms demonstrated that microarrays constitute a sensitive tool at low concentration and within a very short time. The results also indicated resilience of soil microcosm several weeks after TCE treatment. Next, comparison of the in vitro results with samples removed from sites historically contaminated with chlorinated solvents focused on locations in which soils show active bioremediation as seen from their chemical analyses. By comparing them with negative controls and polluted soil without active bioremediation, key microarray probes for dechlorination were identified with the aim of defining an active core group for any soil. Results show that phylogenetic microarrays are sensitive enough to differentiate between samples based on certain environmental conditions, and suggest that variations on the slides used in this study show promise for applications in identifying and classifying contaminated soils.

Comparison of Performance Assessment Techniques for In Situ Electrical Resistance Heating Treatment of TCE DNAPL

Truex, M., K. Lynch, J. Powers, E. Pitre, and J. Gillie.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract P-034, 2008

In situ electrical resistance heating was used to treat DNAPL composed of TCE and oils/lubricants at the East Gate Disposal Yard (EGDY), Fort Lewis, WA. Extensive characterization and monitoring were conducted using multiple techniques to support the treatment process. Characterization and monitoring techniques ranged from standard groundwater and soil sample analyses to tests specifically designed to measure contaminant mass flux. Initially, defining the pre-treatment conditions was important to support characterization of the source strength, determine appropriate targets for treatment, and provide a baseline condition from which the performance of the treatment was evaluated. As part of treatment design and operation, performance assessment techniques provided input to system optimization. After treatment, performance assessment techniques provided information to determine the amount of source reduction from treatment and quantify residual contamination. A comparative analysis was conducted to examine how the different performance assessment techniques applied at EGDY contributed to each of the data uses and to recommend how and when each technique can be applied to be complementary to each other and to provide a cost-effective approach to performance assessment.

Compound-Specific Isotope Analysis and Solvent Case Studies: Forensic and Remedial Insights
McLoughlin, P.W. and R.J. Pirkle, Microseeps, Inc., Pittsburgh, PA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-018, 2008

Both natural and enhanced attenuation of chlorinated solvents are complex processes involving volatilization, adsorption, dilution, advection, and degradation. At sites where chlorinated ethanes are present with chlorinated ethenes, the issues become even more complex, but there are still five types of attenuation. The first four mechanisms must be considered as well as the fifth. Compound specific isotope analysis (CSIA) allows a differentiation between destructive and nondestructive attenuation mechanism that is not possible with concentration measurements alone unless many assumptions are made. Because the sensitivity is the same for biodegradation and abiotic degradation, CSIA is ideal for sites with mixed chlorinated solvent plumes. When a chlorinated solvent plume is discovered, two main questions arise; the first is principally aimed at forensics: "Can we figure out where the contaminant came from?" The second question is more directed toward remediation: "Can the most efficient destructive pathways be identified?" CSIA can be used to address both questions. A review of several case studies highlights the insights gained by the use of CSIA in answering these two questions.

Conceptual Method for Assessing Long-Term Natural Attenuation for Commingled Plumes
Wani, A.H. and R. Bost, Environmental Resources Management, Houston, TX.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-007, 7 pp, 2008

In commingled chlorinated and non-chlorinated petroleum hydrocarbon plumes, petroleum hydrocarbons facilitate the microbially mediated reductive dechlorination of commingled chlorinated solvents. The two essential components of the biodegradation reactions are the electron donors (petroleum hydrocarbons and labile natural organic matter) and the electron acceptors (chlorinated solvents in addition to dissolved oxygen, nitrate, manganese IV, iron III, and sulfate). A method for assessing source depletion and the sustainability of biodegradation is illustrated for an example site with a complex mixture of chemicals and lithologies. The objective of the method is to estimate the time required for source depletion within different lithologic units and to assess the adequacy of naturally occurring electron donors to sustain the intrinsic biodegradation of chlorinated solvents after depletion of the petroleum hydrocarbons. The long-term source depletion calculations for the case example site indicate that the mass of residual source constituents adsorbed in place within different lithologic units could persist for more than 100 years. The rate of depletion matches the rate of migration from an affected overlying low permeability clay unit, thereby prolonging the constituent mass depletion from the deep transmissive unit for as long as the downward migration and diffusion continues from the overlying unit.

Contaminant Concentration Variability in a Dynamic Hydrologic Setting: Implications for Monitoring

Peterson, R.E., S.B. Yabusaki, and M.D. Williams, Pacific Northwest National Laboratory.
Program and Abstracts: The 7th Annual Washington Hydrogeology Symposium, 28-30 April 2009, Tacoma, Washington. Washington Department of Ecology and the U.S. Geological Survey, p 50, 2009

Contaminant concentrations and mobility characteristics in groundwater at a contaminated site near the Columbia River are influenced by rapidly changing hydrologic conditions. The principal driver for these changes is cyclic variability in river discharge, along with the corresponding variability in river stage near the site. The cyclic variations in the presence of highly transmissive aquifer sediment result in the intrusion of river water into the near-river aquifer and changes in water table elevation throughout the area of groundwater contamination. Contaminant concentrations in this dynamic environment change rapidly because of mixing between groundwater and uncontaminated river water and the resupply of contaminants to groundwater via downward movement through the lower portion of the vadose zone. Concentration variability for some contaminants can be introduced also by rapid changes in the geochemical environment where groundwater and river water mix. The implications of these dynamics for monitoring involve the rapidly changing hydraulic gradients and geochemical conditions. An appropriate sampling frequency might need to be tied more closely to seasonal cycles than to sampling at equal time intervals. The rapid change in river conditions even might warrant sampling as frequently as hourly. Likewise, rapid changes in the geochemical environment, which can influence the exchange of contaminants between dissolved forms and aquifer solids, should be considered when developing a monitoring strategy. The variability in contaminant conditions and the periods during which ecological receptors are vulnerable also can be factored into the monitoring strategy. This analysis of groundwater monitoring results emphasizes the importance of understanding the features and processes associated with contaminant behavior in subsurface environmental pathways when developing a conceptual model to support remediation decisions.

Continuous Plume Monitoring Using Wireless Sensors: Proof of Concept in Intermediate Scale Tank

Porta, L., T.H. Illangasekare, P. Loden, Q. Han, and A.P. Jayasumana.
Journal of Environmental Engineering, Vol 135 No 9, p 831-838, Sep 2009

With the development of wireless sensor networks (WSNs), that allow sensors to be incorporated into a distributed wireless communication and processing system, the potential exists to develop new, efficient, economical, large-scale subsurface data collection and monitoring methods. This paper presents a proof-of-concept study conducted in a 2-D synthetic aquifer constructed in an intermediate scale test tank to demonstrate the feasibility of using WSN for subsurface plume monitoring. The tank was packed to represent a heterogeneous aquifer, and a sodium bromide tracer was used to create a plume. A set of 10 wireless sensor nodes (motes) equipped with conductivity probes to measure electrical conductivity formed the network. Software for automated data acquisition was developed and tested. This paper describes results of two experiments conducted using this test system. The lessons learned from the first experiment were used to make modifications to the way the sensors were placed, how they were calibrated, and how the sensors were interfaced with the data acquisition system. The findings are used to identify future research directions and issues that must addressed before field implementation of a WSN based data collection system for plume monitoring.

Correlation between Inverted Chargeabilities and Organic Compounds Concentrations in Soils: A Field Experiment
Deceuster, J. and O. Kaufmann.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

Resistivity and induced polarization tomographies were performed along profiles on an industrial property to detect and delineate hydrocarbon-impacted areas. Four boreholes were drilled to confirm geophysical results and conduct cross-hole measurements. Concentrations of organic compounds in the area soils were compared to inversed chargeabilities obtained from surface measurements. The comparison showed that chargeabilities were linked to contaminant concentrations in soil samples except from areas where clays were found. A filtering technique based on normalized chargeability values was implemented and validated to discriminate chargeabilities linked to the presence of clayey sediments and contaminant concentrations in soil samples.

Creosote Delineation by Rapid Optical Screening Tool (ROST(tm)) Laser-Induced Fluorescence System
Maxwell, S. (ENSR, Langhorne, PA); S. Ross (ENSR, Columbia, SC).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-026, 8 pp, 2008

A cone penetrometer (CPT) equipped with a Rapid Optical Screening Tool (ROST(tm)) was utilized in conjunction with traditional assessment technologies to delineate subsurface creosote impacts at a former wood-treating facility. The creosote treatment process generated wastewater, which was discharged to ponds to separate and reclaim the creosote. Four other surface impoundments were utilized during the site's operation: a fire-water pond, three boiler ponds, and an evaporation pond. The ponds, the production area, and the treated-wood storage area are considered the areas of concern (AOCs). The site assessment was completed in two phases. Phase I was completed to delineate pockets of residual creosote, provide real-time data for investigators to evaluate the AOCs, and assess potential constituent of concern migration to surface water. During Phase I, 34 ROST(tm) CPT locations were installed. Phase II of the investigation was designed to fill in data gaps from Phase I and further delineate the extent of subsurface creosote impacts. Phase II contained 43 ROST(tm) CPT locations as well as additional soil borings and temporary monitoring wells. The ROST(tm) probe uses a UV laser pulse that causes the petroleum hydrocarbons to emit fluorescence, which is detected by sensors in the CPT rig. The relative concentration of the hydrocarbon is determined by the intensity of the emitted fluorescence, and the hydrocarbon signature is determined by the wavelength of the emitted fluorescence. During both phases of investigation, fluorescence waveforms associated with creosote were detected at numerous locations across the site. At ROST(tm) locations that were collocated with soil borings or monitoring well locations, correlation between the fluorescence logs and the soil boring logs was documented. By using the ROST(tm) data with the traditional assessment methods, a 3-D picture of subsurface creosote impacts was produced and will be used to guide future assessment and remediation efforts.

Degradation of Diffuse Pesticide Contaminants: Screening for Microbial Potential Using a Functional Gene Microarray
Liebich, J., T. Wachtmeister, J. Zhou, and P. Burauel.
Vadose Zone Journal, Vol 8, p 703-710, 2009

A rural aquifer was screened for potential microbial activities involved in atrazine degradation using a functional gene microarray called the GeoChip. Specific microbial atrazine degraders were detected even for conditions of minor levels of atrazine contamination (about 2 ug/L). Microbial communities in these oligotrophic environments appear to be sensitive to relatively small quantities of contaminants.

Demonstration of Monitored Natural Attenuation of a Mixed Plume to Assist Remedial Design
Zeng, L., K. Everett, and P. Srivastav.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-006, 2008

This paper summarizes work performed for U.S. Army Corps of Engineers and includes data collection and analytical methods for the degradation of chlorinated ethenes, perchlorate, nitro-group explosives, and methylene chloride (MC) that co-occurred in a mixed plume at a DoD site in Texas. The chemicals of concern at this site are perchlorate, MC, TCE, 1,2-DCA, and nitro-group explosives (2,4-DNT, 2,6-DNT, 4-NT, and 6-NT). Three tiers of lines of evidence (LOEs) were used to evaluate the contaminant degradations. Based on the historical analytical results, perchlorate appears to be inhibiting biodegradation of chlorinated organic compounds and nitro-group explosives, while MC seems to have promoted biodegradation of all other contaminants. The geochemical conditions at this site vary with locations, ranging from aerobic to anaerobic and from oxidative to reductive as measured by the geochemical parameters. Based on the spatial correlation of contaminants and geochemical conditions, MC is easily degraded to formate and acetate, which can act as electron donors to enhance the biodegradation of other contaminants under aerobic and anaerobic conditions. Perchlorate degradation occurs under nitrate-reducing conditions, which competes with TCE, DNT, and NT isomers for electrons. The degradation of DNT and NT isomers can occur under aerobic and anaerobic conditions via multiple pathways, but their degradation can stall due to the presence of perchlorate and absence of MC. An alternative degradation pathway, such as cometabolism, can be the primary mechanism driving TCE and 1,2-DCA biodegradation, supported by the lack of daughter products and unfavorable geochemical conditions for reductive dechlorination. Furthermore, the molecular microbial analysis indicates the absence of Dehalococcoides sp, suggesting a degradation pathway other than reductive dechlorination for chlorinated organic compounds. The evaluation of monitored natural attenuation (MNA) suggests the mixed plume is controlled effectively by natural attenuation mechanisms; however, absence of contaminant degradation was observed at one location where MC concentration was detected at 7 g/L (50% of its solubility). The lack of degradation likely is due to the toxicity posed by elevated MC concentrations. The results also support the proposed remedy, which entails chemical oxidation implemented at the area exhibiting elevated MC and MNA for the remainder of the mixed plume.

Demonstration/Validation of the Snap Sampler Passive Ground Water Sampling Device for Sampling Inorganic Analytes at the Former Pease Air Force Base
Parker, L., N. Mulherin, G. Gooch, W. Major, R. Willey, T. Imbrigiotta, J. Gibs, and D. Gronstal. Environmental Security Technology Certification Program (ESTCP), Project ER-0630, ERDC/CRREL TR-09-12, 116 pp, July 2009

Laboratory studies and a field demonstration were conducted to determine the ability of the Snap Sampler to recover representative concentrations of several types of inorganic analytes from groundwater. The test inorganic analytes included non-metals (bromide, chloride, nitrate, perchlorate, and sulfate), a metalloid (arsenic), several alkali metals (sodium and potassium), alkaline earth metals (magnesium and calcium), and transition metals (cadmium, chromium, manganese, and iron). In laboratory studies, concentrations of analytes in Snap Sampler samples were comparable with concentrations of the analytes in samples collected from a standpipe (i.e., control samples). For the field demonstration, sampling events were carried out at the former Pease Air Force Base. Samples taken using a Snap Sampler were compared with samples collected using conventional low-flow purging and sampling and a regenerated cellulose passive diffusion sampler. Based upon statistical analyses, analyte concentrations were found to be equivalent to those in the low-flow samples with the exception of unfiltered iron, where concentrations were significantly higher in the Snap Sampler samples. Differences were most pronounced in samples collected from the two stainless steel wells and from wells with higher turbidity levels. Elevated turbidities may have resulted from installing additional sampling equipment (including the baffle, pump, samplers, and bottom weight) in the well before sampling. http://www.estcp.org/Technology/upload/ER-0630-FR-2.pdf

A Depth-Proportional Intake Device for Automatic Water Samplers
Lecce, S.A., East Carolina Univ., Greenville, NC.
Journal of the American Water Resources Association (JAWRA), Vol 45 No 1, p 272-277, 2009

This paper describes the construction and testing of a device for pumping water samplers that collects suspended sediment samples by moving the intake vertically to keep it at the same proportion of flow depth. The device uses a simple sprocket mechanism that can be mounted vertically on the downstream side of culverts and bridge pilings to protect against damage from floating debris during storms. Suspended sediment samples collected from an urban stream with the depth-proportional device were compared with manual samples taken with a depth-integrated sampler. Scatter in the relationship between pumped and manual samples probably are explained by horizontal variability in concentrations, poor mixing associated with lateral sediment inputs from construction site erosion, the downstream orientation of the intake, and the failure of the concentration at 60% of the flow depth to match the average vertical concentration.

Design and Application of an Oligonucleotide Microarray for Monitoring Reductive Dechlorination Processes
Loeffler, F.E., E. Padilla-Crespo, C. Cruz-Garcia, K.M. Ritalahti, C. Lebron, L. Hug, A.S. Waller, and E.A. Edwards.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

Dehalococcoides bacteria, which are crucial for achieving detoxification of chlorinated ethenes, possess multiple reductive dehalogenase (RDase) genes. RDase genes are promising targets for monitoring dehalogenation reactions. To assign function to putative RDase genes and enhance bioremediation monitoring tools, the authors designed an oligonucleotide microarray with probes targeting all RDase genes (341) identified in public databases. Also included were probes targeting Dehalococcoides hydrogenase genes (109), 16S rRNA genes, and housekeeping genes for normalization. Three oligonucleotide probes (40-50 bp long) were designed per target gene using Oligoarray 2.1 software and tethered to an epoxy-coated glass slide via C6 amino linkers. An integrated approach combining cultivation of dechlorinating consortia and enumeration of known Dehalococcoides biomarker genes with quantitative real-time PCR (qPCR) tested functionality of the RDase microarray. Hybridizations used cDNA generated from total RNA extracted from dechlorinating consortia maintained under defined batch and continuous growth (i.e., chemostat) conditions to gain insight into expression of individual RDase genes and to assign functions to Dehalococcoides RDase genes of interest. This work revealed that RDase transcription is a dynamic process and that multiple RDase genes are responsive to a single chlorinated substrate, suggesting functional redundancy. Ongoing experiments explore the transcriptional changes in response to culture conditions and feeding regimes. Experiments also used DNA extracted from contaminated groundwater to monitor RDase gene presence and to gain insight into RDase gene diversity in a subsurface environment undergoing bioremediation. The findings demonstrate that the RDase array is an excellent tool for identifying process-specific target genes and to advance understanding of the reductive dechlorination process.

Design and Performance of an Innovative Vapor-Sampling Apparatus
Domaradzki, C. and M. Frak (United Chemists Inc., Farmingdale, NY); G.K. Shkuda and A. Coenen (Environmental Resources Management, Melville, NY).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-028, 7 pp, 2008

Increased regulatory agency focus on vapor intrusion has led to increased demands for sampling equipment and vapor analyses. U.S. EPA Method TO-15 specifies use of specially prepared stainless steel pressure vessels with a flow controller and specially prepared interior surfaces (commonly referred to as SUMMA canisters). Laboratories must clean and certify a canister clean prior to reuse. Batch and individual canister certification methods are used to certify the cleanliness of canisters, adding time and cost to canister reuse. Batch certification can lead to uncertainty in the results because of concern that all canisters in a batch might not be uniformly clean. An overriding issue is, therefore, if a recycled canister is actually clean or at a minimum does not contain target compounds at concentrations above the reporting limits. If low-level contaminants are detected in a recycled canister, it also is important to know whether the contaminants are site-related or an artifact of the cleaning process. To overcome the cleanliness issue, the authors have been working on the design of an alternative sampling device that will eliminate the need to clean and recycle SUMMA canisters.

Detecting Groundwater Pipelines Using Transient Electromagnetic Method: A Case Study
Zhang, S.
ICPTT 2009: Advances and Experiences with Pipelines and Trenchless Technology for Water, Sewer, Gas, and Oil Applications. ASCE, Reston, VA. ISBN: 978-0-7844-1073-8, p 787-792, 2009

The transient electromagnetic method (TEM) has qualities that make it amenable to pipeline detecting and environmental monitoring. TEM was carried out to locate the groundwater pipelines and to detect the spread of groundwater contamination in an abandoned industrial service site. Based on the analysis of electrical conductivity and in-phase electromagnetic component of the survey area, the geophysical anomaly zones were delineated. The TEM method is sensitive to the conductive layers and demonstrates the ability to measure small changes in subsurface properties involving groundwater. The measurement shows the position of groundwater pipelines and the behavior of groundwater contamination. The results indicate that TEM can be valuable to waste management processes and for determining possible locations of monitoring wells in the survey area. The study shows that the TEM technique has a high accuracy and that it can provide a rapid, reliable, and time-saving means for the maintenance and renewal of an underground pipeline preceding drilling.

Detecting Marine Hazardous Substances and Organisms: Sensors for Pollutants, Toxins, and Pathogens
Zielinski, O., J.A. Busch, A.D. Cembella, K.L. Daly, J. Engelbrektsson, A.K. Hannides, and H. Schmidt.
Ocean Science Discussions, Vol 6, p 953-1005, 2009

Significant technological advancements have been made in recent years for the detection and analysis of marine pollutants, toxins, and pathogens using sensors deployed on a variety of mobile and fixed-point observing platforms. This review presents state-of-the-art sensor technology for the detection of harmful substances and organisms in the ocean. Sensors are classified by their adaptability to various platforms, addressing large, intermediate, or small areal scales. Current gaps and future demands are identified with an indication of the urgent need for new sensors to detect marine hazards at all scales in autonomous real-time mode. Progress in sensor technology is expected to depend on the development of small-scale sensor technologies with a high sensitivity and specificity toward target analytes or organisms; however, deployable systems must comply with platform requirements as these interconnect the three areal scales.

Future developments will include the integration of existing methods into complex and operational sensing systems for a comprehensive strategy for long-term monitoring.
http://www.ocean-sci-discuss.net/6/953/2009/osd-6-953-2009.pdf

Detection and Characterization of Preferential Flow Paths in the Downstream Area of a Hazardous Landfill
Perozzi, L. and K. Holliger, Univ. of Lausanne, Switzerland.
Journal of Environmental & Engineering Geophysics, Vol 13 No 4, p 343-350, 2008

Surface-based electrical resistivity tomography was used to detect and characterize preferential hydraulic pathways in the immediate downstream area of an abandoned, hazardous landfill. The landfill occupies the void left by a former gravel pit, and its base is close to the groundwater table and lacks an engineered barrier. Outflows of pollutants contaminated local drinking water supplies and necessitated a partial remediation in the form of a synthetic cover barrier, which is meant to prevent meteoric water from percolating through the waste before reaching the groundwater table. Any future additional isolation of the landfill in the form of lateral barriers thus requires adequate knowledge of potential preferential hydraulic pathways for outflowing contaminants. Results inferred from a suite of tomographically inverted surfaced-based electrical resistivity profiles oriented roughly perpendicular to the local hydraulic gradient indicate that potential contaminant outflows would occur mainly along an unexploited lateral extension of the original gravel deposit, which is expressed as a distinct and laterally continuous high-resistivity anomaly in the resistivity tomograms. This interpretation is ground-truthed through a litholog from a nearby well. Because the probed glacio-fluvial deposits are largely devoid of mineralogical clay, the geometry of hydraulic and electrical pathways across the pore space of a given lithological unit can be assumed to be identical, which allows for an order-of-magnitude estimation of the overall permeability structure. These estimates indicate that the permeability of the imaged extension of the gravel body is at least 2 to 3 orders of magnitude higher than that of its finer-grained embedding matrix.

The Detection and Tracking of Mine-Water Pollution from Abandoned Mines Using Electrical Tomography
Ogilvy, R.D., O. Kuras, B. Palumbo-Roe, P.I. Meldrum, P.B. Wilkinson, J.E. Chambers, and B.A. Klinck, British Geological Survey, Nottingham, UK.
Proceedings of the International Mine Water Conference, 19-23 October 2009, Pretoria, South Africa. Document Transformation Technologies, ISBN Number: 978-0-9802623-5-3, p 917-925, 2009

The British Geological Survey has developed a tomographic imaging system known as ALERT (Automated time-Lapse Electrical Resistivity Tomography) that allows the near real-time measurement of geoelectric properties on demand, thereby giving early warning of potential threats to vulnerable water systems. Permanent in situ geoelectric measurements are used to provide surrogate indicators of hydrochemical and hydrogeological properties. The ALERT survey concept uses electrode arrays permanently buried in shallow trenches at the surface. The arrays also can be deployed in mine entries or shafts or underground workings. This sensor network is interrogated from the office by wireless telemetry (e.g., GSM, low-power radio, internet, and satellite) to provide volumetric images of the subsurface at regular intervals. Once

installed, no manual intervention is required; data are transmitted automatically according to a pre-programmed schedule and for specific survey parameters, both of which can be varied remotely as conditions change (i.e., an adaptive sampling approach). The entire process from data capture to visualization on the web portal is seamless, with no manual intervention. Examples are given where ALERT has been installed and used for remote monitoring of (i) seawater intrusion in a coastal aquifer, (ii) domestic landfills and contaminated land, and (iii) vulnerable earth embankments. The full potential of the ALERT concept for monitoring mining waste has yet to be demonstrated, but manual electrical tomography surveys are being used to characterize mine-waste pollution at an abandoned metalliferous mine in the Central Wales orefield in the UK. Hydrogeochemical sampling confirms that electrical tomography can provide a reliable surrogate for the mapping and long-term monitoring of acid mine drainage.
http://www.imwa.info/docs/imwa_2009/IMWA2009_Ogilvy.pdf

Detection of Dehalogenase Activity in Crude Protein Extracts from 1,2-Dichloroethane-Contaminated Groundwater
Lyman, I. and R. Reiss (New Mexico Tech); P. Guerra (AMEC Earth & Environmental).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-019, 2008

Microbial enzymes are responsible for degradation of chlorinated hydrocarbons such that protein assays can provide a rapid evaluation of attenuation potential. Groundwater microbes were collected from a gasoline-contaminated site by on-site sterile filtration. The proteins were extracted using a combination of sonication and ultracentrifugation, and then concentrated using micro-filtration, resulting in a 10,000-fold reduction in volume. Typical yields were 1.3 mg protein per liter of water. Results of 1- and 2-D electrophoresis of the crude protein extract showed that adequate protein from uncultured groundwater samples can be isolated for proteomic analysis. An enzymatic assay was performed using 1,2-DCA as a substrate, and the production of chloride ions was monitored using a chloride probe. The probe is susceptible to static electricity, so the assay must be performed in a static-free environment. This method was able to detect the degradation of 1,2-DCA in 5 mg of crude protein extracted from groundwater microbes. Preliminary experiments indicate a specific activity of ~3.5 x 10(-4) moles of DCA degraded per gram of protein at a pH of 7.8, which falls within previously reported values. A rapid assay for risk assessment and intrinsic biodegradation rates is under development. In addition, there is adequate protein in crude extracts for direct protein sequencing methods.

Detection of Newly Deposited Sediments Via Frequency Response Measurements: Dredging Residuals Density Profiler (DRDP)
Welp, T., M. Tubman, D. Wilson, P. T. Puckett, and N. Greiser.
EPA 600-R-09-120, 75 pp, 2009

EPA's Environmental Sciences Division and the U.S. Army Engineer Research and Development Center (ERDC) signed an interagency agreement to have ERDC modify the ADMODUS probe (a navigation fluid mud survey system successfully demonstrated in the Gulfport, MS, navigation channel and in the laboratory) for use in characterizing dredge residuals for environmental dredge projects. Specifically, the system is to be optimized to

identify the dredging residuals and facilitate sediment sampling efforts in conjunction with EPA's new Undisturbed Sediment Sampler designed for environmental dredging projects. The Dredging Residuals Density Profiler (DRDP) is capable of delineating fluid mud layers of 2-cm thickness or greater, when it profiles these layers at an insertion speed of 1.27 cm/s or less. The average difference between the DRDP measured thicknesses and those measured with a measuring tape was -0.34 cm with a standard deviation of 0.69 cm. In comparison to the densimeter, the average difference between the DRDP density measurements (for Type A, Type D, and Type E tests at insertion speeds of 1.27 cm/s or less) and the densimeter readings is 0.0023 g/cm3 with a standard deviation of 0.0063 g/cm3. In comparison to the sediment laboratory sample analyses, the average difference between the DRDP density measurements (for Type D and Type E tests at insertion speeds of 1.27 cm/s or less) and the sample analyses is 0.0095 g/cm3 with a standard deviation of 0.0156 g/cm3. The average precision of the DRDP measurements during the evaluation was 0.0007 g/cm3. The initial prototype of the DRDP was successful in delineating the mud layer thicknesses and in determining the density of each mud layer. The fastest profiling speed that would produce reasonable results may be higher when the DRDP operates at a sample output speed greater than the 8 Hz needed for this laboratory evaluation. The results of this evaluation will be incorporated into recommendations to modifying the Phase I prototype during Phase II and in the subsequent delivery of the final DRDP prototype.
http://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=214343&fed_org_id=770&SIType=PR&TIMSType=Published%20Report&showCriteria=0&address=nerl&view=citation&sortBy=pubDateYear&count=100&dateBeginPublishedPresented=01/01/2009

The Determination of Pesticidal and Non-Pesticidal Organotin Compounds in Water Matrices by In Situ Ethylation and Gas Chromatography with Pulsed Flame Photometric Detection
Evans, O.M., P. Kauffman, A.M. Pawlecki-Vonderheide, L.J. Wymer, and J.N. Morgan.
Microchemical Journal, Vol 92 No 2, p 155-164, 2009

This paper describes concurrent determination of pesticidal and non-pesticidal organotin compounds in several water matrices, using a simultaneous in situ ethylation and liquid-liquid extraction followed by splitless injection mode capillary gas chromatography with pulsed flame photometric detection. The speciation analysis of nine organotin compounds includes low molecular weight/low boiling (non-pesticidal) and high molecular weight/high boiling analytes (pesticidal) of significant environmental interest. The minimum time for sodium tetraethylborate alkylation, using mechanical agitation, is determined to be 15 min to ensure complete derivatization of the complete list of analytes. The utilization of a "hot needle" and a rapid injection rate is shown to be an efficacious means to eliminate "mass" or "needle" discrimination when determining the mixture of organotin compounds. Method detection limits are calculated to be in the low ng/L range. The final method was applied to various water samples, e.g., storm water from the Cincinnati area demonstrated low native levels of three of the organotin compounds.
http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=211131&CFID=7246687&CFTOKEN=42307346&jsessionid=4a3058c6aa0d466868a750364527b547fe11

Determining In Situ Degradation Rates for Petroleum Compounds via Push-Pull Tests under Natural and Biostimulated Conditions

Raes, E.J., J. Istok, K.L. Sublette, J. Busch-Harris, E. Jennings, A. Peacock, and G. Davis.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-004, 2008

Push-pull tests were utilized to determine site-specific natural attenuation capacity (bio-degradation rate kinetics) under both unamended and amended (biostimulation) conditions. The analytical results produced from the push-pull tests allowed for the segregation of abiotic versus the biotic (biological) components of the in situ degradation rates, thereby creating a process to determine the significance of the biological component of the degradation rate versus abiotic processes such as dilution and absorption. This approach was implemented at a large petroleum distribution facility in New Jersey. Baited BioTraps(tm) were used to screen the response of the indigenous microbial community when exposed to a suite of electron acceptors (nitrate, sulfate, and dissolved oxygen). Each BioTrap was amended with a different electron acceptor and a mixture of (12)C-benzene and (13)C-labeled benzene. Control BioTraps were amended only with benzene (i.e., no terminal electron acceptor). Total benzene loss and incorporation of C-13 into microbial biomass were measured for each BioTrap condition. The relative biodegradation rates under amended conditions (based on total benzene loss) were compared to the relative degradation rates in the unamended controls to determine whether biodegradation is enhanced under certain terminal electron-accepting conditions. Review of the data revealed positive responses to the presence of dissolve oxygen and nitrate addition; conversely, the exposure to sulfate produced an inhibition in the uptake of (13)C-labeled benzene, and sulfate addition was eliminated from consideration. A series of single-well push-pull tests were conducted to determine in situ kinetics in the same wells. Push-pull tests consist of the injection of prepared test solutions into existing site wells. The test solution contains the same electron acceptors (oxygen, nitrate, and unamended) used in the Bio-Trap study, in addition to a conservative tracer (bromide) to segregate abiotic and biotic in situ degradation rates of the chemicals if interest over time (short term) when exposed to different biostimulation substrates. Review of the push-pull test data supports the conclusion that biodegradation rates increase under biostimulated conditions using both oxygen and nitrate as terminal electron acceptors. A cost analysis will determine if the observed increase in rate kinetics under stimulated conditions is economically beneficial when compared to natural attenuation under unamended conditions.

Development of a Real-Time PCR Technique to Enumerate Aerobic, VC-Degrading Bacteria in Environmental Samples

Mattes, T., Y.O. Jin, J. Livermore, S. Schmidt, and S. Fogel.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-024, 2008

In some cases, ethene generated during reductive dechlorination could co-migrate with vinyl chloride (VC). Recent research indicates that indigenous, aerobic, ethene-degrading microbes can cometabolize VC. There are also reports that ethene-degrading microbes adapt to VC as a growth substrate in the laboratory. Previous studies indicate that aerobic VC- and ethene-degrading bacteria use alkene monooxygenase (AkMO) to attack both VC and ethene, transforming them into the epoxides chlorooxirane and epoxyethane, respectively. These epoxides are assimilated into central metabolism by epoxyalkane:coenzyme M transferase (EaCoMT). The purpose of this study is to develop a quantitative, real-time polymerase chain reaction (qPCR) method for quantifying both the AkMO alpha subunit gene (etnC) and the EaCoMT gene (etnE) in environmental samples as a means of detecting the presence and activity of VC- and ethene-degrading bacteria. Groundwater samples were taken from VC-contaminated sites in MA (Carver) and in VA (NAS Oceana). Efforts are being made at both sites to stimulate aerobic VC degradation by indigenous VC-degrading bacteria via addition of electron acceptor. An aerobic, ethene-degrading enrichment culture developed from Carver groundwater samples was used as a positive control. DNA was extracted from the samples either by centrifugation and beadbeating or from Sterivex filters (Millipore) using an enzymatic approach. PCR analysis of environmental DNA (4 ng/uL) was conducted using three different degenerate primer sets that amplify etnC, etnE, and the 16S rRNA gene. PCR products of the expected size were observed with the etnC primers (360 bp), and the 16S rRNA gene primers (1,500 bp), while PCR products were not observed with the etnE primers (981 bp). PCR experiments with a series of groundwater DNA dilutions (0.4 to 4 ng/uL) suggested that slight PCR inhibition at template concentrations above 0.4 ng/uL. Optimization of PCR conditions for etnE amplification from environmental DNA is ongoing, as are PCR analyses of ethene enrichment cultures developed from specific Carver wells. Once developed, this technique is expected to provide quantitative estimates of the presence and activity of VC-degrading bacteria, which in turn will facilitate the rapid generation of microbiological lines of evidence in support of aerobic VC bioremediation strategies at contaminated sites.

Development of Assessment Tools for Evaluation of the Benefits of DNAPL Source Zone Treatment
Abriola, L.M., P. Goovaerts, K.D. Pennell, and F.E. Loeffler.
Strategic Environmental Research and Development Program (SERDP), Project ER-1293, 173 pp, Sep 2008

Research under SERDP project ER-1293 has led to the development and validation of four important concepts: (1) partial source-zone mass removal can result in substantial local concentration and mass flux reductions; (2) potential remediation efficiency is closely linked to source-zone architecture (ganglia-to-pool ratios); (3) biostimulation and bioaugmentation approaches are feasible for treatment of DNAPL source zones; and (4) the uncertainty in mass discharge ([M/T]) estimates can be quantified through application of geostatistical methods to field measurements. Major contributions of this research include (a) establishment that rates of metabolic reductive dechlorination can exceed rates of DNAPL dissolution, resulting in aqueous contaminant concentrations in the presence of DNAPL that are substantially lower than saturation levels and are not toxic to the dechlorinating organisms; (b) evidence that enhancements in dissolution will be transient and a function of physico-chemical and biological conditions adjacent to the DNAPL; (c) demonstration that mass flux reduction behavior can be linked directly to DNAPL source-zone architecture; (d) development of a series of geostatistical approaches capable of quantifying mass discharge uncertainty and guiding real-time sampling design for uncertainty reduction through hot-spot delineation; and (e) creation of a source-zone remediation cost estimation tool. These accomplishments provide DoD site managers, federal

and state regulators, and other stakeholders with new insight on the mechanisms controlling the strategies employed to remediate and manage chlorinated solvent DNAPL sites.
http://www.estcp.org/viewfile.cfm?Doc=ER%2D1293%2DFR%2Epdf

DNAPL Detection and Monitoring Using Electrical Resistive Tomography: A Case Study in North Italy, Rho-Milan
Orlando, L. and P. Viotti.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

The detection and monitoring of DNAPL using electrical resistivity tomography (ERT) on the topographic surface and in boreholes was investigated in an industrial area contaminated by chlorinated solvents. The ERT survey data revealed a scenario of distributed resistivity variations in an area that was once associated with the movement of the contaminating chemicals over the ground surface. The geophysical data interpretation was constrained by sedimentary stratigraphy, revealed by boreholes drilled in the area. The results validate the use of ERT for the detection and monitoring of DNAPL.

Economical Site Characterization Using High-Resolution Passive Soil Gas Sampling
Hodny, J.W. (W.L. Gore and Associates, Inc., Elkton, MD); G. Schaefer (CH2M Hill, Knoxville, TN); D. Timmons (DoD, Arnold Air Force Base, TN). Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-016, 8 pp, 2008

Solid waste management units (SWMUs) at Arnold Air Force Base (Base), Tennessee, are undergoing a RCRA Facility Investigation (RFI) to evaluate the contamination nature and extent of soil and groundwater affected by releases of VOCs and mercury. Base testing activities over the years have lead to potential releases of contaminants to the soil and groundwater, and these release areas were not clearly identified prior to the start of the RFIs. The SWMUs are located within the Base's heavily industrialized area, which contains numerous surface and subsurface structures and utilities. Due to site access limitations, the large size of the SWMUs (>50 acres), and associated high investigation costs, innovative sampling methods in the form of passive soil gas (PSG) samplers (GORE(tm) Modules) were deployed across each site to delineate source areas and approximate the extent of the contaminants in the subsurface. Beginning in July 2004 through March 2006, nearly 1,000 PSG samplers were deployed at the Engine Test Facility and the Propulsion Wind Tunnel areas. The PSG results were used to focus additional sampling in potentially impacted areas, while eliminating other sections of the SWMUs from further investigation. The PSG results revealed unsuspected areas of contamination and confirmed areas of known subsurface contamination identified during previous investigations. Subsequent sampling has confirmed the PSG results and identified areas with light- and dense nonaqueous-phase liquids (LNAPLs and DNAPLs) in subsurface media. The PSG approach provided an accurate, rapid, high-resolution sampling method for characterizing large areas of the Base easily and economically, while optimizing remedial programs and long-term site monitoring.
http://www.gore.com/MungoBlobs/792/573/Economical_Site_Characterization.pdf

Efficiency of Sampling and Analysis of Asbestos Fibers on Filter Media: Implications for Exposure Assessment
Vallero, D. A., J. R. Kominsky, M. E. Beard, and O. S. Crankshaw.
Journal of Occupational and Environmental Hygiene, Vol 6 No 1, p 62-72, 2009

To measure airborne asbestos and other fibers, an air sample must represent the actual number and size of fibers. Typically, mixed cellulose ester (MCE, 0.45 or 0.8 um pore size) and to a much lesser extent capillary-pore polycarbonate (PC, 0.4 um pore size) membrane filters are used to collect airborne asbestos for count measurement and fiber size analysis. In this study decribed in this paper, chrysotile asbestos (fibers both shorter and longer than 5 um) were generated in an aerosol chamber and sampled by 25 mm diameter MCE filter media to compare the fiber retention efficiency of 0.45 um pore size filters vs. 0.8 um pore size filter media. In addition, the effect of plasma etching times on fiber densities was evaluated. A significant difference was observed in fiber retention efficiency between 0.45 um and 0.8 um pore size MCE filters for asbestos aerosols (structures longer than or equal to 0.5 um length). The fiber retention efficiency of a 0.45 um pore size MCE filter is statistically significantly higher than that of the 0.8 um pore size MCE filter; however, for asbestos structures longer than 5 um, there is no statistically significant difference between the fiber retention efficiencies of the 0.45 um and 0.8 um pore size MCE filters. The mean density of asbestos fibers (longer than or equal to 0.5 um) increased with etching time. Doubling the etching time increased the asbestos filter loading in this study by an average of 13%. The amount of plasma etching time had no effect on the filter loading for fibers longer than 5 um. Many asbestos exposure risk models attribute health effects to fibers longer than 5 um. In these models, both the 0.45 um and 0.8 um pore size MCE filter can produce suitable estimates of the airborne asbestos concentrations; however, some models suggest a more significant role for asbestos fibers shorter than 5 um. Exposure monitoring for these models should consider only the 0.45 um pore size MCE filters as recommended by U.S. EPA's Asbestos Hazard Emergency Response Act protocol and other methods. http://www.eqm.com/eqmailers/2009/Asbestos_Filter_Efficiency.pdf

Electrical Geophysical Performance Monitoring of Amendment Enhanced Bioremediation
Versteeg, R.J., W. Major, and T. Johnson.
SAGEEP 2009: Symposium for the Application of Geophysics to Environmental & Engineering Problems, March 29-April 2, Fort Worth, Texas. Environmental and Engineering Geophysical Society, Denver, CO. CD-ROM, p 324-332, 2009

Blind introduction of amendments to accelerate bioremediation can lead to sub-optimal or ineffective remediation as it generally is unknown how the introduced amendments are distributed throughout the treatment zone. As amendments and degradation products often have electrical properties that differ from ambient soil properties, time-lapse electrical geophysical monitoring has potential utility as a performance monitoring tool. The authors discuss the field implementation and initial results of a hydrogeophysical performance monitoring system (HPMS) that provided performance monitoring data on a current enhanced bioremediation effort at a site in Brandywine, Maryland.

Electrical Resistivity and Induced Polarization Geophysics for Noninvasive High Resolution Characterization of DNAPL Distribution
Clark, B.L., C. Fontenot, and J. Cloonan, ARCADIS. Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper F-001, 8 pp, 2008

Direct-current electrical resistivity and induced polarization are geophysical techniques that can provide high-resolution imaging of the shallow subsurface in a noninvasive manner for the purpose of horizontal and vertical characterization of NAPL accumulation and potential migration pathways. In this study, a shallow coastal aquifer containing wood-preserving compounds was evaluated using 2D resistivity to image the subsurface lithology, while induced polarization was utilized to identify areas with potential DNAPL accumulation. The survey area was ~1.5 acres in size. Nine electrode lines (arrays) were installed to collect both resistivity and induced polarization data. Eighty-four electrodes on 1-meter spacing achieved a depth of penetration of 70 ft below land surface. Raw data were inverted to create 2D pseudosections. The results of the inverted data indicate several induced polarization anomalies that are characteristic of DNAPL accumulations. Positive and negative responses were evaluated with test pits to confirm the findings of the geophysical survey. With the results of this survey, a better understanding of the site conceptual model with regard to DNAPL location and movement was possible.

Electrical Resistivity and Induced Polarization Tomography in Identifying the Plume of Chlorinated Hydrocarbons in Sedimentary Formation: A Case Study in Rho (Milan, Italy)
Cardarelli, E., and G. Di Filippo, 'Sapienza', The Univ. of Rome, Italy.
Waste Management & Research, Vol 27 No 6, p 595-602, 2009

A geophysical survey was performed to identify a plume of chlorinated hydrocarbons in sedimentary formations of the Pandania plain. The test site is characterized by three sand and gravel aquifers containing a quantity of clay particles that influence the overall bulk resistivity and chargeability. According to data obtained using shallow boreholes, DNAPLs were the primary contaminants found in the first and second aquifers. The geoelectrical methods were applied in both 2- and 3-D approaches. Steel and copper electrodes were used in the process of field data acquisition, and the survey results were compared. The geophysical survey revealed anomalies that could be explained by the presence of DNAPLs in the soil medium. The concept of normalized chargeability facilitates the interpretation of detected induced polarization anomalies. The shape of the plume was inferred from maps of resistivity and chargeability to a depth of 25 m below ground surface.

Electrical Resistivity Imaging Revealed the Spatial Properties of Mine Tailing Ponds in the Sierra Minera of Southeast Spain
Martínez-Pagan, P., A.F. Cano, E. Aracil, and J.M. Arocena.
Journal of Environmental and Engineering Geophysics, Vol 14 No 2, p 63-76, 2009

Investigators demonstrated the use of electrical resistivity imaging (ERI) combined with soil chemical analyses to determine the structural and chemical composition of mine tailing ponds to assess efficient measures of environmental protection. A Syscal R1 resistivity meter was used to generate 2-D/3-D ERI images from El Lirio and Brunita mine tailing ponds. Soil samples were collected at 1-m intervals to a depth of 15 m and were analyzed for pH, electrical conductivity, and content of Cd, Cu, Pb, and Zn. Materials in the ponds can be classified into three categories: fine tailings--low ER (<8 ohm-m), coarse waste rock--intermediate ER (8 to 150 ohm-m), and bedrock--high ER (>150 ohm-m). Interpretation of the 2-D/3-D ERI images with respect to the historical depositions of materials in the ponds show that at El Lirio, decant water outlet initially was at the center and advanced to the east of the tailing pond as mining activities progressed. At Brunita, the intermediate ER values on the west side of the pond marked the deposition of coarse waste rock materials released during a pond breakage in 1972. The ERI helped to image the spatial distribution of tailings and its qualitative spatial correlation with chemical properties (i.e., pH, EC, metals content). Low ER values are related to high amounts of Zn, Pb, Cu, and Cd. These qualitative relationships underline the usefulness of the combined geophysical and soil chemical approaches to gain an improved understanding of the properties of mine tailing ponds.

Electrochemical Sensor for Rapid Detection of Triclosan Using a Multiwall Carbon Nanotube Film.
Yang, J., P. Wang, X. Zhang, and K. Wu, Huazhong Univ. of Science and Technology, China.
Journal of Agricultural and Food Chemistry, Vol 57 No 20, p 9403-9407, 2009

Triclosan, a potent-wide spectrum antibacterial and antifungal agent that has been widely used in household products, can form highly toxic dioxin-type derivatives. This paper describes an electrochemical sensor based on a multiwall carbon nanotube (MWCNT) film that has been developed for the rapid detection of triclosan. In electrochemical response, the oxidation of triclosan is irreversible and involves one electron. At the MWCNT film, the oxidation signals of triclosan increase, suggesting that the MWCNT film exhibits a considerable signal-enhancing effect. The authors optimized the analytical parameters, such as pH value, amount of MWCNT suspension, and accumulation time and found that the linear range is from 50 ug/L to 1.75 mg/L, with a limit of detection of 16.5 ug/L (about 57 nM). The new method was employed successfully to detect triclosan in different samples, and the results were verified using high-performance liquid chromatography.

Electrokinetic Sample Extraction and Enrichment: a New Method for the Isolation of Analytes from Sludge-Type Matrices
Schmidtkunz, C. and T. Welsch, Ulm Univ., Germany.
Analytical and Bioanalytical Chemistry, Vol 395 No 6, p 1831-1841, 2009

Electrokinetic sample extraction and enrichment is a newly developed concept for the analysis of substances in sludge- or paste-like matrices. It is based on electrokinetic transport phenomena, such as electromigration and electroosmosis, that occur when an electrical field is applied to the fresh, wet samples. Problems usually associated with sample drying (e.g., losses of volatile analytes or contamination) can be avoided. A suitable apparatus has been constructed for electrokinetic sample extraction and enrichment. Appropriate operating conditions (field strength, buffer composition, concentration, and volume) were identified in experiments with an artificial sludge model and real-world lake sediments. A proof of principle of the method was provided by the electromigrative extraction and online enrichment on a solid-phase sorbent disk of an azo dye from a diatomaceous earth slurry. Electroosmotic extraction and enrichment of a cyanobacterial hepatotoxin at trace levels also was investigated as an application example using lake sediments. Rather clean extracts were obtained even from sediment with high organic content, as shown by high-performance liquid chromatography with diode array detection.

Electronic Noses for Monitoring Environmental Pollution and Building Regression Model
Morsi, I., Arab Acad. for Science & Technology, Alexandria, Egypt.
IECON 2008: the 34th Annual Industrial Electronics Conference of IEEE, 10-13 November 2008, Orlando, FL. IEEE International, ISBN: 978-1-4244-1767-4, p 1730-1735, 2009

This paper presents an examination of the use of a sensor grid system for urban air pollution monitoring for carbon monoxide and carbon dioxide (CO, CO2) gases for three different regions in Alexandria, Egypt. The sensor system is based on the integration of distributed sensors, data integration, and a simple air pollution model. Analysis and characterization of environmental data was obtained by building a prototype multi-sensor monitoring system (an electronic nose), for TGS 822, TGS 2442, TGS 813, TGS 4160, TGS 2600, temperature, humidity, and wind speed measurements. All sensors were connected to the microcontroller (Pic 16F 628A) and a PC to visualize and analyze data. A quadratic surface regression method was used to find possible correlations between pollutants, elaborated by Matlab software and statistical analysis. The influence of meteorological quantities was taken into account to improve the model, as well as weather conditions, topography and local situation. To investigate the performance of the quadratic model, the interpolation quadrate function obtained was compared using the reduced data set after eliminating data in a random way with the results obtained using the original data set, followed by calculation of the mean square error. Analysis of variance (ANOVA) was used to detect the significant factors in the final quadrate equation and understand the functional relationship between a set of independent factors.

Environmental Technology Verification Report: Abraxis 17beta-Estradiol (E2) Magnetic Particle Enzyme-Linked Immunosorbent Assay (ELISA) Test Kits
Buehler, S., Z. Willenberg, and A. Dindal (Battelle); E. Kleiner, M. Henderson, and J. McKernan (U.S. EPA).
U.S. EPA, ETV Advanced Monitoring Systems Center, EPA 600-R-09-127, 36 pp, Sep 2009

Based on information provided by the vendor, the E2 magnetic particle ELISA Kit applies the principle of ELISA to determine 17beta-estradiol in water samples and uses a colorimetric procedure to indicate detection. The sample to be tested is added to a disposable test tube and pre-incubated for 30 minutes with paramagnetic particles attached with antibodies specific to 17beta-estradiol followed by the addition of an enzyme-labeled estradiol conjugate. A competitive reaction occurs for a finite number of antibody binding sites between the estradiol that may be in the sample and the enzyme-labeled estradiol. The reaction is allowed to continue for 90 minutes. At the end of the incubation period, a magnetic field is applied to retain the paramagnetic particles (with estradiol and labeled estradiol bound to the antibodies on the particles in proportion to their original concentration) in the test tube, and allow the unbound reagents to be decanted. After decanting, the particles go through a washing solution. A substrate is added and enzymatically converted from a colorless to a blue solution. After an incubation period, the reaction is stopped by the addition of diluted acid. The estradiol concentration is determined by measuring the absorbance of the sample solution with a photometer (450 nm) and comparing it to the absorbance of standards. The E2 magnetic particle ELISA Kit measures 14 by 6.25 by 3.5 inches. Final results and calibration curves are printed from the photometric analyzer or sent directly to a laboratory computer. List price is $350 for a 100-test kit. This report summarizes the results reported by three different laboratories concerning the performance of the Abraxis E2 magnetic particle ELISA test kit for detection of E2 in water using four different water matrices. http://www.epa.gov/etv/pubs/600r09127.pdf

Environmental Technology Verification Report: Abraxis Ecologenia(r) 17beta-Estradiol (E2) Microplate Enzyme-Linked Immunosorbent Assay (ELISA) Test Kits
Buehler, S., Z. Willenberg, and A. Dindal (Battelle); E. Kleiner, M. Henderson, and J. McKernan (U.S. EPA).
U.S. EPA, ETV Advanced Monitoring Systems Center, EPA 600-R-09-125, 36 pp, Sep 2009

This report provides results for the verification testing of the Abraxis 17beta-estradiol (E2) microplate ELISA test kit. The description of the test kit is based on information provided by the vendor. The 17beta-estradiol (E2) microplate ELISA kit applies the principle of ELISA to determine 17beta-estradiol in water samples. The E2 microplate ELISA kit uses a colorimetric procedure to detect 17beta-estradiol. The standards and samples, and an enzyme labeled estradiol conjugate are added to a disposable microtiter plate (uncoated), and mixed. 100 uL aliquots of the mixture are then added to antibody (monoclonal anti-estradiol) coated wells in a 96-well microplate. At this point a competitive reaction occurs between estradiol that might be in the sample and the enzyme-labeled estradiol for a finite number of antibody binding sites. The reaction is allowed to continue for 60 minutes. At the end of the incubation period, the plate contents are decanted to remove the unbound reagents from the estradiol and labeled estradiol that remain bound to the antibodies on the plate, in proportion to their original concentration. After decanting, washing solution is applied to the plate, and then a substrate is added and enzymatically converted from a colorless to a blue solution. After an incubation period, the reaction is stopped by the addition of diluted acid. The estradiol concentration is determined by measuring the absorbance of the sample solution with a photometer (450 nm) and comparing it to the absorbance of standards. The E2 microplate ELISA Kit measures 7 by 5 by 4.5 inches. Final results and calibration curves are printed from the photometric analyzer or sent directly to a laboratory computer. List price is $699 for a 96-test kit. This report summarizes the results reported by three different laboratories concerning the performance of the Abraxis E2 magnetic particle ELISA test kit with the use of SPE cleanup for detection of E2 in water in four different water matrices. http://www.epa.gov/etv/pubs/600r09125.pdf

Environmental Technology Verification Report Abraxis Ecologenia(r) Ethynylestradiol (EE2) Microplate Enzyme-Linked Immunosorbent Assay (ELISA) Test Kits
Buehler, S., Z. Willenberg, and A. Dindal (Battelle); E. Kleiner, M. Henderson, and J. McKernan (U.S. EPA).
U.S. EPA, ETV Advanced Monitoring Systems Center, EPA 600-R-09-126, 34 pp, Sep 2009

This report provides results for the verification testing of the Abraxis Ecologenia(r) Ethynylestradiol (EE2) Microplate ELISA test kit. According to information provided by the vendor, the EE2 microplate ELISA test kit applies the principle of ELISA to determine EE2 in water samples. The EE2 microplate ELISA kit uses a colorimetric procedure to detect EE2. The

standards, samples, and an enzyme-labeled EE2 conjugate are added to a disposable microtiter plate (uncoated) and mixed. One hundred uL aliquots of the mixture are added to antibody (monoclonal anti-EE2)-coated wells in a 96-well microplate. A competitive reaction occurs between the ethynylestradiol that might be in the sample and the enzyme-labeled ethynylestradiol for a finite number of antibody binding sites. The reaction is allowed to continue for 60 minutes. At the end of the incubation period, the plate contents are decanted to remove the unbound reagent from the ethynylestradiol and labeled ethynylestradiol that remain bound to the antibodies on the plate, in proportion to their original concentrations. After decanting, washing solution is applied to the plate, and then a substrate is added and enzymatically converted from a colorless to a blue solution. After an incubation period, the reaction is stopped by the addition of diluted acid. The ethynylestradiol concentration is determined by measuring the absorbance of the sample solution with a photometer (450 nm) and comparing it to the absorbance of standards. The EE2 microplate ELISA test kit measures 7 by 5 by 4.5 inches. Final results and calibration curves are printed from the photometric analyzer or sent directly to a laboratory computer. List price is $699 for a 96-test kit. The ability of the Abraxis EE2 microplate ELISA test kit to detect EE2 in water was evaluated by three different laboratories with the use of SPE cleanup in four different water matrices. The test kit results were evaluated against the expected spike concentrations and the reference measurements of the same samples made using GC-MS.
http://www.epa.gov/etv/pubs/600r09126.pdf

Environmental Technology Verification Report: Applikon MARGA Semi-Continuous Ambient Air Monitoring System
Goodwin, B., D. Deojay, K. Cowen, T. Kelly, Z. Willenberg, and A. Dindal (Battelle, Columbus, OH); J.L. McKernan and M. Henderson (U.S. EPA, Cincinnati, OH).
U.S. EPA, ETV Advanced Monitoring Systems Center, 47 pp, Sep 2009

This report provides results for the verification testing of Applikon BV's MARGA semi-continuous ambient air monitoring system. (The description of the MARGA is based on information provided by the vendor and was not verified in this test.) The MARGA ADI 2080 is an on-line analyzer for semi-continuous measurement of gases and soluble ions in aerosols. The MARGA utilizes a wet rotating denuder (WRD) to collect acid gases and ammonia by diffusion into an aqueous film. Particles pass through the WRD and are collected in a steam jet aerosol collector (SJAC). Within the SJAC, a supersaturated environment is created that grows particles by a process known as deliquescence, allowing them subsequently to be collected by inertial separation. As cooling takes place, steam condenses and washes the collected particles into an aqueous sample stream. The aqueous solutions from the WRD and SJAC are subsequently analyzed by ion chromatography (IC) for soluble anions and cations. Software integrated within the MARGA calculates atmospheric concentrations based on air sample flow rate and the ion concentrations in the collected solutions. The analyzer consists of two boxes: the upper sampling box and the lower analytical box. Air is drawn through the sampling system in the upper box where inorganic gases and aerosols are absorbed and collected into separate aqueous solutions. In the analytical box, the inorganic compounds in the gases and aerosols are determined by IC. The analytical box also contains an IPC running instrument software that controls all elements in the process with a fold-up liquid crystal display as well as a keyboard with mouse. The MARGA software running on the IPC controls the instrument and provides a user interface. In addition, the analyzer can be checked and controlled remotely via an internet or modem connection. The reviewers describe the performance of the tested unit in terms of accuracy (regression analysis and median absolute relative percent difference analysis), precision, data completeness, reliability, and operational factors (ease of use, maintenance, consumables/waste generation). http://www.epa.gov/etv/pubs/600r09083.pdf

Estimating the In Situ Sediment-Porewater Distribution of PAHs and Chlorinated Aromatic Hydrocarbons in Anthropogenic Impacted Sediments
Arp, H.P.H., G.D. Breedveld, and G. Cornelissen.
Environmental Science & Technology, Vol 43 No 15, p 5576-5585, 2009

Traditional models based on octanol/water partitioning generally overestimate native porewater concentrations, and modern approaches accounting for multiple carbon fractions, including black carbon, appear sediment specific. To assess the diversity of this sorption behavior, the authors collected all peer-reviewed total organic carbon (TOC)-normalized in situ sediment/porewater distribution coefficients, K(TOC), for sediments impacted by PAHs, PCBs, PCDD/Fs, and chlorinated benzenes, covering a large variety of sediments, locations, and experimental methods. The literature indicated that compound-specific K(TOC) could range up to over 3 orders of magnitude. Output from various predictive models for individual carbonaceous phases found in impacted sediments, based on peer-reviewed polyparameter linear free energy relationships (PP-LFERs), Raoult's Law, and the SPARC online-calculator, were tested to see if any of the models could predict literature K(TOC) values consistently within a factor of 30 (i.e., 1.5 orders of magnitude, or half the range of K(TOC) values). The Raoult's Law model and coal tar PP-LFER achieved the sought-after accuracy for all tested compound classes, and are recommended for general, regional-scale modeling purposes. As contaminated sediment/porewater distribution models are unlikely to become more accurate, this review underscores that the only way to obtain accurate porewater concentrations is to measure them directly rather than inferring them from sediment concentrations.

Estimating VOC Emissions from Vapor Management Systems for Air District Permitting
Reinis, S. and J.F. Ludlow, Treadwell & Rollo, Inc., San Francisco, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper A-007, 8 pp, 2008

Treadwell & Rollo, Inc., designed passive sub-slab vapor management systems (VMS) to mitigate VOC vapor intrusion into indoor air for 28 buildings at a new shopping mall. The site formerly was occupied by a manufacturing facility. VMS discharge of VOCs is subject to Bay Area Air Quality Management District (BAAQMD) regulations and permitting requirements, which can include significant fees and monitoring requirements. The contractor applied for a permit exemption with the BAAQMD. To evaluate the request for exemption, the BAAQMD required an estimate of the total annual VOC emissions from the VMS effluent (discharge) risers from the 28 new buildings. This paper describes the methodology used to calculate estimated VOC emissions for the site. Two empirical parameters were derived based on an evaluation of pre-construction soil gas data and post-construction VMS monitoring data (effluent concentrations and airflow measurements) obtained at three existing buildings at other properties. The BAAQMD granted the requested permit exemption, resulting in significant cost savings to the project.

Estimation of Vapor Migration Rates to Building Interiors
Tofani, G., J. DeReamer, and K. Lea, GeoKinetics, Irvine, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper A-017, 10 pp, 2008

A 2-D computer model for estimating potential soil gas and VOC flux rates to building interiors considers both pressure-driven flow and diffusion transport through the soil, across sub-slab barriers, and through building foundations systems. Pressure differentials associated with building ventilation systems and atmospheric barometric pressure fluctuations associated with both diurnal and weather effects are evaluated. The authors compare simulation results to field data and discuss the use of the calculated soil gas or VOC flux rates in a risk-based analysis to design appropriate mitigative measures. The benefits of sub-slab vapor barriers and ventilation systems are evaluated with potential contaminant attenuation factors.

Evaluation of a New Passive Diffusion Sampler for Improving the Calibration of Models to Evaluate Vapor Movement at UST Sites
Paul, C.J., D.C. Digiulio, J.T. Wilson, and K.P. Jewell.
Abstracts of the Proceedings of the 21st Annual National Tanks Conference, March 30-April 1, 2009, Sacramento, California.

Generally, screening models, such as the J&E, are used to estimate the affect of biodegradation on the upward diffusion of hydrocarbon vapors. A simple and affordable passive diffusion sampler (PDS) was developed that can be used to estimate depth-discrete concentrations of contaminants in soil gas and groundwater. This approach replaces the estimates of a mathematical model with monitoring to see if there are vapors in the soil gas immediately above the capillary fringe that can diffuse into buildings. The PDS consists of a 40-ml VOA vial fitted with a modified cap where the Teflon-lined septa is replaced by a permeable membrane to allow contaminants to diffuse into the water-filled VOA vial. The PDS is inserted into a holder or "messenger" for deployment down monitoring wells. A field study was conducted to provide 3-D site characterization of gasoline plumes at two UST sites to evaluate the effectiveness of the PDS for determining BTEX concentrations. PDS concentrations were compared with those obtained with traditional groundwater and soil gas sampling techniques. The messengers containing the PDS were lowered into each monitoring well so that the cap of the PDS was exposed within the well screened interval. The PDS was left in the monitoring wells for ~1 month. Previous laboratory studies showed that 1 month was sufficient time for BTEX compounds to diffuse across the membrane and reach equilibration. Results show that the PDS provides a simple and affordable alternative to traditional sampling techniques at UST sites. The PDS provides an effective method of sampling both groundwater and soil gas in low permeability formations. Additionally, results of discrete depth contaminant concentrations can be used to provide information on whether natural attenuation processes are controlling risk associated with the site.

Evaluation of a Technetium-99 Detector Based on Laboratory Testing for Use in In-Situ Vadose Zone Applications
Mann, F.M. and D.A. Myers.
RPP-ENV-42667, 31 pp, Sep 2009

This document evaluates the feasibility of in-situ detection of technetium-99 in Hanford Site vadose zone soils (the soils between the surface and groundwater) based on the results of laboratory tests. The detector system performs adequately for high technetium concentration, but more development and laboratory testing is needed before field demonstration is performed.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=0&page=0&osti_id=964001

An Evaluation of Extraction Techniques for Quantifying Tc-99 in Contaminated Sediments
Valenta, M., C.F. Brown, R.J. Serne, A. Hylden, and D. Smith, PNNL, Richland, WA.
Program and Abstracts: The 7th Annual Washington Hydrogeology Symposium, 28-30 April 2009, Tacoma, Washington. Washington Department of Ecology and the U.S. Geological Survey, p 91 [poster], 2009

A study to test different extraction techniques for their ability to fully extract Tc-99 from contaminated sediments was conducted using 25 Hanford Site sediments containing Tc-99 at activities ranging from 1 to greater than 1,000 pCi/g. Water extraction (WE), acid digestion (AD) and microwave-assisted digestion (MD) were performed on each sample. Half of the filtrate from each extraction was immediately analyzed for Tc-99 (using ICP-MS), and the other half was treated using TEVA(r) resin prior to Tc-99 analysis. A laboratory control sample (LCS) was prepared and taken through the same extractions as the sediments. The LCS consisted of an uncontaminated sediment that was put into a ball mill for several seconds to further homogenize the sample. After grinding, a known activity of Tc-99 was added to the sediment. The non-resin treated samples had 70% recovery of Tc-99 in the LCS from WE, 90% recovery from AD, and 120% recovery from MD. For the resin-treated samples, the MD results became more accurate, resulting in 102% recovery of Tc-99 from the LCS. Recovery for the WE and AD remained approximately the same post-resin treatment. An additional LCS was created that excluded grinding of the sediment prior to the addition of the Tc-99 spike. The WE for this LCS resulted in an average recovery of 104% vs. 82% recovery in the AD and 116% recovery in the MD. While the MD results were comparable to the previous LCS experiment, the WE resulted in a much higher recovery, and the AD resulted in a slightly lower recovery. The lower recovery of Tc-99 in the water extracts of the LCS that was ground in the ball mill suggests that some of the Tc-99 in the spike may have been reduced by fresh ferrous iron surfaces exposed during grinding of the sediment. These results imply than a technique more robust than water extraction could be required to quantify total Tc-99 concentrations in contaminated sediments obtained using split-spoon sampling or drive barrel techniques where disaggregation of Hanford gravel and coarse sand particles might expose fresh iron-bearing minerals that could lead to technetium reduction.

Evaluation of Landfill Disposal Boundary by Means of Induced Polarization and Electrical Resistivity Imaging
Legaz, A., A.V. Christiansen, E. Auken, and A. Viezzoli.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

Induced polarization measurements (IP) and electrical resistivity tomography (ERT) were used to define the spatial boundaries of a former municipal landfill in Eskelund, Denmark. The work also involved an investigation of a plume of contaminated groundwater in the vicinity of the waste site deposits. A clearly chargeable and conductive anomaly was evidenced that could--in agreement with drill-hole information--represent percolation through the landfill. Further analysis should enable a check of the seepage and development of 3-D tomography of the area.

An Evaluation of the Performance of Multiple Passive Diffusion Devices for Indoor Air Sampling of VOCs
Odencrantz, J.E., S.C. Thornley, and H. O'Neill.
Remediation Journal, Vol 19 No 4, p 63-72, 2009

U.S. EPA is considering recommending longer-term sampling to achieve more accurate time-weighted-average detections for indoor air monitoring of VOCs. The authors compared longer sampling times using passive diffusion samplers to the results from shorter-term testing periods using sorbent tubes and low-flow pumps (EPA Method TO-17) at great frequency for TCE in indoor air. A controlled release of TCE in a large room allowed for daily concentration variability of about two orders of magnitude during the 2-week monitoring event. The daily concentration measurements by Method TO-17 and the passive diffusion samplers were performed in triplicate and had excellent reproducibility. The results of daily tests were averaged and compared with four passive diffusion devices exposed to indoor air for 3, 7, 10, and 14 days in accordance with ASTM D6196-02. The researchers evaluated a specific uptake rate for each of the passive devices at the four different time intervals and the statistical significance of the time-varying uptake rates, and then determined performance of each passive diffusion device using a statistical performance criterion. The average concentration for all of the exposure periods could be predicted reliably using the established uptake rates for two of the four passive devices.

Evaluation of Three DNAPL Field Screening Test Methods
Song, Y., K. White, B. Loebner, and K. Gerber.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-009, 2008

A DNAPL investigation was conducted in June 2007 as part of a supplemental remedial investigation at Site 15, Vandenberg AFB, CA, where TCE and daughter products have been detected in soil and groundwater. Three hydrophobic field screening methods: NAPL FLUTe(r) system, Oil Red O dye, and OilScreenSoil (Sudan IV)(r) were used at five sampling locations to evaluate the presence/absence of TCE DNAPL in the subsurface and to compare the effectiveness of the DNAPL testing methods. TCE concentrations detected in groundwater at the five locations ranged from 12,000 ug/L to 260,000 ug/L, providing presumptive evidence that DNAPL might be present at the site based on the "one percent of solubility" criterion. At each location, FLUTe liners were installed with direct push technology. After a few hours, the color-reactive liners were recovered and examined for staining that indicates presence and extent of layers of DNAPL in the subsurface. Six-inch intervals of soil subsamples from continuous GeoProbe cores were mixed with Oil Red O dye in test vials and with Sudan IV in OilScreenSoil (Sudan IV)(r) test jars. With both methods, a bright red coloration appears in the presence of DNAPL. In the OilScreenSoil test kits, a fluorescing water-soluble dye is included that colors the water green to provide a visual contrast. Soil immediately above the low permeability zone of the site also was tested for DNAPL to locate potential hot spots in the cores. In addition to field testing, soil samples from low permeability portion of the cores were analyzed for TCE at an off-site analytical laboratory. No color change was observed during the field testing with all three methods. Oil Red O dye test was of minimal benefit due to the difficulty of distinguishing the color change when mixing with soil samples. Based on the field experience and results of the study, Sudan IV test kits were more cost effective than FLUTe(r) liners and provided rapid identification of probable DNAPL areas.

Evaluation of Vapor Intrusion Impacts Using Induced Building Depressurization
McHugh, T.E,, T.N. Nickels, S. Brock, and K. Gorder.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract A-005, 2008

To evaluate the utility of induced building depressurization for the evaluation of vapor intrusion impacts, investigators conducted a comprehensive sampling program at three residences over-lying groundwater affected by TCE near Hill AFB in Utah. In each residence, at least three indoor air samples, three sub-slab gas samples, and one ambient air sample were collected and analyzed for VOCs and radon under baseline building operating conditions and depressurization conditions. In addition, sulfur hexafluoride (SF6) was released as an indoor air tracer gas for measurements of building air exchange rates under baseline and depressurization conditions. Following the collection of baseline samples, a negative building pressure was induced through the use of a window box fan. Site conditions were allowed to stabilize for at least 12 hours prior to the collection of depressurization samples. Throughout the baseline and depressurization sampling, cross-foundation pressure gradients were monitored using a differential pressure transducer. For the three buildings studied, building depressurization resulted in a 4- to 8-fold increase in building air exchange rates; however, the indoor air concentration of chemicals associated with the subsurface (i.e., TCE and radon) changed little, ranging from 90 to 200% of baseline concentrations. In contrast to subsurface associated chemicals, VOCs not detected in subsurface samples and believed to be associated with indoor sources (e.g., PCE, 1,2-DCA, and BTEX) typically decreased in concentration in indoor air samples by 50% or more. The use of building depressurization combined with analysis of radon as a subsurface gas tracer and SF6 as an indoor air tracer provided an improved understanding of the potential for vapor intrusion at the residences studied compared to a typical vapor intrusion sampling event.

Failure Leads to Success of Innovative Geophysics for Detecting Potential Transmissive Zones in an Aquitard
Leipert, M., D. Sirkis, B. Donovan, and T.D. Bechtel.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

The Lipari Landfill is located in Mantua Township, NJ. About 3 million gallons of bis(2-chloroethyl) ether (BCEE) were dumped at the unlined landfill between 1968 and 1970. Contamination has been found in the water table aquifer and the confined Kirkwood aquifer. Fifteen feet of natural clay (Kirkwood clay) separates the two aquifers. U.S. EPA is investigating the feasibility of remediating the Kirkwood aquifer. Historical research suggested that a drainage trench or historical wells might have allowed contamination to enter the confined Kirkwood aquifer. EPA tasked the project team to find the pathway and determine whether remediation is feasible. A seismic survey had been conducted previously, but EPA wanted an image of the clay with greater resolution, and a geophysical method was developed for this purpose. Dipole-dipole and Wenner measurements were combined with Mise a la Masse-style measurements in which current is directly injected into a buried conductive body. An initial survey used surface and submerged electrodes in specially designed wells screened just at the top of the clay layer. The results were unsatisfactory, even failing a clear image of the top of clay. A post-mortem revealed that the survey might have been tainted by down-hole electrodes in wells that were found to have significant turbidity due to suspension of clay particles. Subsequently, three wells were redeveloped, and a successful pilot survey was performed, followed by a complete re-survey done with fully developed wells. The final survey successfully mapped the top of the clay, correlated well with known anomalies, and revealed previously unknown anomalies. This method, which has not been utilized at Superfund sites, might be an important mapping tool.

Field Assessment of Vapours
Davis, G.B., J. Wright, and B.M. Patterson.
Cooperative Research Centre for Contamination Assessment and Remediation of the Environment, Adelaide, Australia. Technical Report no. 13, ISBN: 978-1-921431-18-0, 88 pp, 2009

This report describes the processes underlying soil vapor behavior, reviews available guidance, suggests a framework for vapor assessment and screening, describes design issues for field assessment of vapors, compares investigation and sampling techniques, and summarizes observations on this work. http://www.crccare.com/publications/technical_reports/index.html

Field-Based Detection and Monitoring of Uranium in Contaminated Groundwater Using Two Immunosensors
Melton, S.J., H. Yu, K.H. Williams, S.A. Morris, P.E. Long, and D.A. Blake.
LBNL-2327E, 25 pp, 2009 [Manuscript of paper published in Environmental Science & Technology 43(17):6703-6709(2009)]

This paper describes two kinetic exclusion-based immunosensors--a field-portable sensor (FPS) and an Inline sensor--that were deployed at DOE's Integrated Field Research Challenge Site in Rifle, CO. Both sensors utilized a monoclonal antibody that binds to a U(VI)-

dicarboxyphenanthroline complex (DCP) in a kinetic exclusion immunoassay format; these sensors were able to monitor changes of uranium in groundwater samples from ~1uM to below the regulated drinking water limit of 126nM (30ppb). The FPS is a battery-operated sensor platform that could determine the uranium level in a single sample in 5 to 10 minutes if the instrument had been previously calibrated with standards. The average minimum detection level (MDL) in this assay was 0.33 nM (79 ppt); the MDL in the sample (based on a 1:200 to 1:400 dilution) was 66 to 132 nM (15.7 to 31.4 ppb). The Inline sensor, while requiring a grounded power source, had the ability to analyze multiple samples autonomously in a single experiment; the average MDL in this assay was 0.12 nM (29 ppt); the MDL in the samples (based on 1:200 or 1:400 dilutions) was 24 to 48 nM (5.7 to 11.4 ppb). Both sensor platforms showed an acceptable level of agreement (r2=0.94 and 0.76, for the Inline and FPS, respectively) with conventional methods for uranium quantification.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=0&page=0&osti_id=971506

Field Comparison of Passive Air Samplers with Reference Monitors for Ambient Volatile Organic Compounds and Nitrogen Dioxide under Week-Long Integrals

Mukerjee, S., K. Oliver, R.L. Seila, H. Jacumin, C.W. Croghan, H. Daughtrey, L.M. Neas, and L.A. Smith.
Journal of Environmental Monitoring, Vol 11 No 1, p 220-227, 2009

The performances of nitrogen dioxide (NO2) and VOC passive samplers with corresponding reference monitors were compared at two sites in the Detroit area during the summer of 2005. Ogawa passive NO2 samplers and custom-made, re-useable Perkin-Elmer tubes with Carbopack X sorbent for VOCs were deployed under week-long sampling periods for 6 weeks. Precise results (5% relative standard deviation, RSD) were found for NO2 measurements from collocated Ogawa samplers. Reproducibility also was good for duplicate Perkin-Elmer tubes for BTEX species, all 6% RSD. As seen in previous studies, comparison of Ogawa NO2 samplers with reference chemiluminescence measurements suggested good agreement. The investigators also noted generally good agreement between the Perkin-Elmer tubes and reference methods for BTEX species.

Fluorescent Dye Tracing of PCE and TCE Impacts in Karst Limestone Aquifer in France

Warfield, J.T., M. Otz, and D. Nuyens, ERM France, Paris.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-016, 2008

Field investigation activities at an active industrial property in central France have been accelerated in an effort to characterize PCE and TCE groundwater impacts in the karst limestone aquifer. A fluorescent dye tracer study was implemented to evaluate the importance of any solution cavities or fractures and to understand the effect they have on groundwater flow direction and velocity. The results of the tracer study will also be used to locate additional monitoring wells for evaluating potential off-site plume migration. The 28-acre site is located at the southern edge of the Beauce plateau within the Loire River alluvial corridor. Groundwater contaminated with PCE and TCE occurs in the uppermost water-bearing zone (~30 m bgs), which is the karst limestone aquifer. Below this formation is a thick clay layer, which protects a deeper aquifer used for drinking water supply. The deep aquifer has been sampled and is not affected by the PCE and TCE plume above. The general regional direction of groundwater flow in the limestone aquifer (both upper and deeper zones) is to the southeast, toward the Loire River. Localized groundwater flow in the northern quadrant of the site is to the north. Previous investigation activities indicate multiple (2 to 3) sources of chlorinated solvents at the site, primarily beneath a large building that is the hub of current site operations. Contaminant concentrations beneath the main site building are 88 mg/L TCE and 8 mg/L PCE. Delineation and evaluation of off-site migration has proven difficult for this site due to the solution cavities present in the karst limestone aquifer, as well as the difficulty of drilling through this formation (to 30 m depths). Access issues associated with facility operations also have prevented direct investigation of the source area. The results of the tracer study indicate a fast-flowing narrow plume; groundwater velocity is ~1 meter per day. Dye tracing demonstrated that the installation of additional monitoring wells off-site is imperative at the downstream site boundary, specifically in the footprint of the identified groundwater flow path. The tracer study results also contribute to further interpretation of source area migration, resulting in the potential discovery of a separate source area.

Fluorescent Dye-Tracing Used to Investigate Preferential Flow Paths in a DNAPL-Contaminated Aquifer
Sents, R.C., M.H. Otz, and J.S. Fox.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-031, 2008

Geologic conditions at a DNAPL-affected site located in New York State limit the use of conventional hydrogeological investigation techniques to evaluate preferential groundwater flow paths and velocities from source areas to an area of concern beneath an active industrial facility. The investigators evaluated the feasibility of using fluorescent dyes in the heavily contaminated aquifer to assess potential sources and possible associations of DNAPL, LNAPL, and the aqueous phase to identify and map preferential groundwater flow paths. Implementation of fluorescent dye-tracing (FDT) involved injection of five different organic dyes to delineate the source and dispersion of contaminants of concern, mainly 1,1,1-TCA, TCE, and associated dechlorination byproducts, as well as xylenes, ethylbenzene, and toluene. Periodic groundwater samples were collected from selected monitoring wells and analyzed for dye concentrations. FDT also provided an objective check of the remedial efficiency of a nearby DNAPL recovery system by providing confirmation of preferential flow paths toward the recovery wells and objective quantification of the radius of influence of active recovery wells. Although geologic materials in the affected area consist predominantly of relatively impermeable fine-grained silty clay matrix, fluorescent dyes were found within as little as 6 days in wells proximal to the various dye injection sites. Within 81 days, the main concentration of the fluorescent dye sulforhodamine G reached a monitoring well 42 m away from the injection site, producing a measured flow velocity of 0.52 m/day. This value is much faster than previously estimated average linear velocity of 4.7 x 10(-6) m/day using a site-specific measured saturated hydraulic conductivity of 1.7 x 10(-7) cm/sec for the silty clay formation. The groundwater velocity calculated from site-specific geotechnical data is consistently significantly slower than the empirical travel times observed in the FDT study. These data confirm the presence of macropores or fracture networks in the study area, demonstrating the importance of preferential pathways at this site. Similar relationships might exist at many other sites with predominantly fine-grained soil matrix. FDT techniques have been applied successfully at dozens of sites, providing a useful "reality check" on modeled or calculated aquifer parameters derived from more conventional hydrogeological techniques and often revealing additional information that is useful in delineating preferential groundwater flow paths.

Fluorescent In Situ Hybridization (FISH) Techniques for Remediation
Lee, M.H, J. Weidhaas, T. Macbeth, D. Swift, and J.S. Rothermel.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

Fluorescent in situ hybridization (FISH) with rRNA-targeted probes was performed at several sites undergoing active treatment for chlorinated solvent groundwater plumes to (1) track microbial community changes (abundance) in response to remedial treatments, (2) track the activity of these populations to determine the range under which they are viable and active, and (3) delineate the relationships (metabolic and physical) between important microbial communities in situ. At the Test Area North (TAN) site at Idaho National Lab, FISH techniques were used to evaluate the microbial population dynamics and activity over three zones of the contaminant plume: the residual source area undergoing active anaerobic bioremediation, the distal aerobic zone of the plume undergoing natural attenuation, and the transition zone between the anaerobic and aerobic zones. FISH probes targeting Dehalococcoides spp., various methanogens, and aerobic cometabolic organisms were applied throughout the plume from the high-concentration source area to the distal aerobic portion of the plume. These analyses showed that both Dehalococcoides spp. and methanogenic organisms were found outside the strictly anaerobic source area, although the associated activity of these organisms was much less compared with activities in source areas. Aerobic cometabolic organisms were abundant and active within the distal aerobic portion of the plume as expected, but they also showed levels of activity in micro-aerobic environments (< 1 mg/L). At the second site in Ft. Lewis, WA, FISH was used to evaluate the presence and activity of specific populations prior to, during, and following whey injections to promote bioremediation of a TCE DNAPL area. In general, activities of the targeted populations (methanogens, Dehalococcoides spp.) were enhanced as a result of donor additions, decreased with distance from the source/injection area, and flourished under strictly anaerobic conditions. These data demonstrate that FISH can provide a means for direct evaluation of microbial populations and is particularly useful in evaluating microbial community structural and functional dynamics.

From Individuals to Community: Molecular Tools Shed Light on the Environmentally Relevant Organisms
Lee, P.K.H., L. Alvarez-Cohen, E.L. Brodie, G.L. Andersen, T.W. Macbeth, K.S. Sorenson, Jr., and R.A. Deeb. Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-018, 2008

In field experiments, quantitative PCR (qPCR) was coupled with reverse transcription (RT) to analyze both copy numbers and transcripts expressed by the 16S rRNA gene and three reductive dehalogenase (RDase) genes (tceA, vcrA, and bvcA). These genes are biomarkers of

Dehalococcoides spp. in the groundwater of a TCE DNAPL site at Ft. Lewis, WA, that was subjected serially to biostimulation and bioaugmentation. Genes in the Dehalococcoides (Dhc) genus were targeted as they are the only known organisms that can dechlorinate TCE completely to the innocuous product ethene. Biomarker quantification revealed an overall increase of more than three orders of magnitude in the total Dhc population, and measurement of the respective RDase gene concentrations indicated different growth dynamics among Dhc strains. Quantification of transcripts in groundwater samples verified that the 16S rRNA gene and the bvcA and vcrA genes were highly expressed consistently in all samples examined, while the tceA transcripts were detected inconsistently, suggesting a less active physiological state of the strain with this gene. Overall, based on the gene and transcripts data, the authors concluded that Dhc spp. played an active role in the reductive dechlorination process at that site. They also applied a high-density phylogenetic microarray (16S PhyloChip) that simultaneously monitors over 8,700 unique taxa to track the bacterial and archaeal populations through different phases of treatment. While Dhc spp. were active in the remediation process, the PhyloChip also detected dechlorinators from other phyla, such as Sulfurospirillum multivorans, Desulfitobacterium sp. str. TCE1, and Dehalobacter restrictus. Although these organisms only dechlorinate TCE to DCE, their populations increased at the site over time, suggesting that they played an important role in the first step of TCE reduction. Biostimulation with whey enriched over 300 subfamilies of the indigenous population at the site, while about 250 subfamilies exhibited population decreases. By hybridizing total RNA to the PhyloChip, nearly 600 subfamilies were found to be active in the microbial community during biostimulation. Many of the active organisms were identified as those involved in key geochemical processes. Overall, integrating the data obtained using the PhyloChip, qPCR, and RT-qPCR allowed a comprehensive view of the microbial community and generated useful knowledge for optimizing TCE bioremediation processes.

Further Studies on the Uptake of Persistent Organic Pollutants (POPs) by Polyurethane Foam Disc Passive Air Samplers

Chaemfa, C., J.L. Barber, K.-S. Kim, T. Harner, and K.C. Jones.
Atmospheric Environment, Vol 43 No 25, p 3843-3849, 2009

Passive air samplers can be used to monitor SVOCs in the atmosphere. Polyurethane foam (PUF) disks are a popular sampling medium because they have a high retention capacity for such compounds. This paper reports a highly time-resolved uptake study conducted to derive uptake rate data under field conditions and investigate the effects of using different foam densities on the uptake rate. PUF disks were deployed alongside an active sampler for periods of up to 12 weeks. The uptake rates were measured for a range of gas- and particle-bound persistent organic pollutants (PCBs and polybrominated diphenyl ethers (PBDEs)), of different properties, to explore whether gas/particle partitioning affected uptake rate. Uptake rates for two different densities of foam (0.021 and 0.035 g/cm3) were not statistically significantly different from each other. Uptake rates of light PCBs averaged 6.5 m3/day, somewhat higher than in previous studies; higher wind speeds and lower temperatures in this study are the likely reason for this difference. The study showed that the uptake rate of the compound with lowest KOA considered in this study (PCB-28/31) declined in the later weeks, indicating an approach to equilibrium. Uptake rates of lighter BDEs and heavier PCBs (compounds of intermediate KOA in this study) remained similar throughout the study period, indicating that they were not approaching equilibrium during the 12-week-study. Uptake rates were typically 8 m3/day for PCB-52, 9.5

m3/day for PCB-95, 11 m3/day for BDE-28, and 2 m3/day for BDE-99. The latter compound has an important particle-bound component, and this lowers the sampling rate compared to predicted uptake rates for compounds that are in the gas phase only. Knowledge of gas/particle partitioning is needed to correct for this effect and to improve predicted uptake rates.

Geoelectrical Methods for Detection of Oil Contaminations in Soils and Bioremediation Process Monitoring
Zogala, B., M. Robak, R. Dubiel, W.M. Zuberek, M. Steininger, and K. Wzientek.
SAGEEP 2009: Symposium for the Application of Geophysics to Environmental & Engineering Problems, March 29-April 2, Fort Worth, Texas. Environmental and Engineering Geophysical Society, Denver, CO. CD-ROM, p 348-362, 2009

An experiment was conducted to verify geoelectrical methods as a tool for detection of oil contamination in soil and to monitor bioremediation processes. Situated in the former military camp Borne Sulinowo in NW Poland, the survey area of ~2,000 sq m is covered by fluvioglacial sediments composed of sands and gravels with the first water level at 11 to 12 m depth. Numerous shallow boreholes were drilled to recognize the detailed geological structure. In fall 2007, conductivity measurements were taken with a Geonics EM-31Mk2 and resistivity measurements with the Lund Imaging System, and soil samples were taken for laboratory tests. Seventy liters of diesel fuel was spilled on a 3 m2 area and introduced into the soil. Results from repetition of the geophysical measurements and laboratory tests showed the distinct anomaly of resistivity or apparent conductivity related to oil contamination of soil. Yarrowia Lipolytica yeast were introduced into the contaminated soil in spring 2008 to encourage bioremediation, which was observed and monitored using EM, resistivity imaging measurements, and laboratory tests of soil samples.

Geoelectrical Resistivity and Ground Penetrating Radar Techniques in the Study of Hydrocarbon-Contaminated Soil
Hamzah, U., M.A. Ismail, and A.R. Samsudin.
Sains Malaysiana, Vol 38 No 3, p 305-311, 2009

Geophysical surveys--ground penetrating radar (GPR), geoelectrical resistivity tomography (ERT), and vertical resistivity probe (VRP)--were used in mapping the subsurface geological structures and groundwater contaminants at Sungai Kandis, Klang, to identify the approximate boundaries of contaminant plumes and to provide stratigraphic site information. The study area was formerly an illegal dumping site of hydrocarbons and toxic waste. A good correlation existed between GPR signatures, ERT layers, vertical resistivity probe and the contaminated soil. The presence of contaminant plumes in the water table was observed in the GPR and ERT sections at depths of ~0.5 to 1 m. Sixteen GPR traverses and 10 ERT lines with lengths from 30 to 100 m were established. VRP measurements were conducted in 14 shallow boreholes with a maximum depth of about 1 m. The VRP results show high apparent resistivity values ranging from 200 to 10,000 ohmm associated with an oil-contaminated layer. The presence of this layer was also detected in the 2D resistivity sections as a thin band of high resistivity values ranging from 60 to 200 ohmm. In the GPR section, the oil-contaminated layer exhibited discontinuous, subparallel, and chaotic high-amplitude reflection patterns.
http://myais.fsktm.um.edu.my/7899/

Geoelectrical Resistivity Monitoring for Localizing Gas at Landfills
Dahlin, T., V. Leroux, H. Rosqvist, M. Svensson, M. Lindsjo, C.H. Mansson, and S. Johansson.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

To assess the potential of electrical resistivity for imaging gas migration at landfills, two relatively well-known sites--a bioreactor landfill and a conventional landfill--were monitored successively. A 3-D resistivity image was constructed every two hours on both sites, and meteorological parameters were monitored at one measurement per hour. Methane concentration was measured in the air on several occasions, the pore pressure was monitored at two locations, and relative estimations of moisture in the top layer were made at the second site. The results show imperfect but interesting correlations between the different parameters and indicate how the method could be refined. The resistivity depends on several parameters, but the areas where the resistivity is most variable seem to be clearly related to higher gas emissions.

Geophysical Monitoring of Hydrological and Biogeochemical Transformations Associated with Bioremediation
Hubbard, S.S., K. Williams, M. Conrad, J.E. Peterson, B. Faybishenko, J. Ajo-Franklin, T.C. Hazen, and P. Long. Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-037, 2008

Bioremediation treatments to address hexavalent chromium, or chromate, are being performed at at DOE's Hanford facility at the 100H and 100D sites using amendments such as vegetable oil, molasses, and HRC(r). Batch and flow-through column experiments have and are being performed at lab scale to understand how different geophysical (seismic, radar, electrical) attributes respond to various transformations that are expected to occur during field-scale stimulation, e.g., the replacement of pore water electron donors, the onset of gas bubble production, the variation in total dissolved solids (primarily nitrate and sulfate) as systems are reduced, and the formation of precipitates (such as FeS). Time-lapse geophysical tomographic datasets, collected in conjunction with field-scale biostimulation experiments, are interpreted using constraints offered by laboratory experimental results and field aqueous geochemical data sets. Although more research is needed to develop these techniques into routine monitoring methods, an integrated interpretation suggests that the geophysical data sets can provide a wealth of information about coupled hydrobiogeochemical responses to remedial treatments in high spatial resolution in a minimally invasive manner.

Geophysical Monitoring of Recirculation of Leachate on Landfill Sites in the Netherlands
Kruiver, P.P., R.S. Westerhoff, R.P. Noorlandt, N.N. Hoekstra, H. Woelders, and W.J. van Vossen.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

Geophysical investigations carried out on two modern landfill sites (Vlagheide and Kragge) in the Netherlands employed geoelectrical and EM-31 measurements to reveal the effect of recirculation of leachate on homogenizing moisture content in the waste, which is needed to stimulate attenuation processes. At Vlagheide, geoelectrical and EM-31 measurements were taken before and 5 months after the recirculation of leachate. The resistivities patterns are consistent between the geoelectrical lines and with depth. The geoelectrical and EM-31 measurements both show an average decrease in resistivity after recirculation, which possibly is linked to a less heterogeneous moisture content caused by the recirculation process. At Kragge, the recirculation system is not yet installed. The geoelectrical profiles show a marked difference between the covered and open waste due to the HDPE foil on the covered waste. From the very high resistivities measured on the covered waste, it can be concluded that no significant leaks are occurring in the foil at the location of the measured geoelectrical line. On the open waste, the resistivity pattern shows a higher resistivity layer of a few meters thickness on a lower resistivity zone, which probably reflects differences in moisture content.

A Geophysical Technique for the Verification and Quantification of Zinc Slag in Roads
Koomans, R.L., P. van der Wal, T.P.J. Kamsma.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

In the De Kempen area in the Netherlands and Belgium, zinc slags were used in the past to improve public and private roads. Due to the now-recognized potential ecological risk of heavy metals, measures are required to locate and remediate these zinc slags. Given the size of the affected area, a rapid, synoptic method is needed to locate the slags. This paper describes a method by which the presence or absence of zinc slags in the roads of De Kempen can be quantified and verified. The method is based on the measurement of concentrations of naturally occurring radionuclides, and the approach is calibrated and validated by a laboratory investigation. The project involves mapping 280 km of roads. The predictive maps from the geophysical measurements were validated by analyzing samples, and review of the data showed excellent agreement between predictions and drilling. The result of the project is a rapid, concise, and non-invasive method to establish presence or absence of zinc slag in roads, enabling a complete inventory of zinc slag in the De Kempen area.

Handbook of Pesticides: Methods of Pesticide Residues Analysis
Nollet, L.M.L. and H.S. Rathore.
CRC Press, Boca Raton, FL. ISBN: 9781420082456, 664 pp, 2009

This handbook provides a systematic description of the principles, procedures, and technology of the modern analytical techniques used in the detection, extraction, cleanup, and determination of pesticide residues present in the environment. This book provides the historical background of pesticides and emerging trends in pesticide regulation. Various techniques for analysis are discussed, including supercritical fluid extraction, disposable electrochemical biosensors, matrix solid-phase dispersion, voltametric methods, and liquid chromatography. The authors also address the scope and limitation of neem-based products in plant protection as well as the analysis of medicinal plants.

Heavy Oil Detection (Prototypes) Final Report
Hansen, K.A., M. Fitzpatrick, P.R. Herring, and M. VanHaverbeke.
Report No. CG-D-08-09, 74 pp, July 2009

Current methods for locating and recovering submerged oil spills are inadequate. Detection methods often are improvised on-scene, and recovery techniques are labor intensive and not always successful. The U.S. Coast Guard Research and Development Center has embarked on a multi-year project to develop a complete approach for dealing with spills of submerged oils. This report describes an assessment of detection techniques using sonar, laser fluorometry, real-time mass spectrometry, and in situ fluorometry to locate oil sitting on the sea floor. Evaluation of four proof-of-concept devices was conducted at the Oil and Hazardous Material Simulated Environmental Test Tank (OHMSETT), now called The National Oil Spill Response Test Facility, in Leonardo, New Jersey, between November 2007 and February 2008. Further testing of two of these prototype devices, plus three additional detection systems, was conducted at OHMSETT in January 2009. This report contains the results of the tests and provides recommendations in Appendix E for federal on-scene coordinators when responding to spills of heavy oil.
http://www.crrc.unh.edu/workshops/liquid_asphalt/RDC_submergedoildetection_Report_june09.pdf

Hemimicelles of Alkyl Carboxylates Chemisorbed onto Magnetic Nanoparticles: Study and Application to the Extraction of Carcinogenic Polycyclic Aromatic Hydrocarbons in Environmental Water Samples
Ballesteros-Gomez, A. and S. Rubio, Campus de Rabanales, Cordoba, Spain.
Analytical Chemistry, Vol 81 No 21, p 9012-9020, 2009

Hemimicelles and admicelles are flexible materials with unique features for the solid phase extraction of a variety of pollutants from the environment. The multiple reaction mechanisms that come into play make these materials excellent sorbents for multi-class pollutant extraction. Some applications have been hindered because disruption of surfactant aggregates during analyte elution produces extracts containiing high surfactant concentration that may suppress ionization in MS or interfere with MS, UV, or fluorescence detection. In a cartridge format, however, hemimicelles/admicelles are used preferentially, which results in slow extraction and low breakthrough volumes. The authors assessed the ability of new surfactant/mineral oxides systems (alkyl carboxylate/magnetite) to circumvent these shortcomings. Magnetic nanoparticles (MNPs) coated with hemimicelles of alkyl (C10-C18) carboxylates, which traditionally have been used to prepare ferrofluids for technological applications, were used for the first time to extract organic contaminants from environmental water samples. The nanoparticles were coated by following a simple, rapid procedure (30 min at 85 degrees C) that uses commercially available magnetite of 20-30 nm mean particle diameter. The strong chemical bonding between the surfactant and magnetite prevented leaching of the surfactant and permitted it to be reused and surfactant-free extracts to be obtained. Tetradecanoate hemimicelles were used to extract carcinogenic PAHs prior to analysis by liquid chromatography and fluorescence detection. The procedure involved stirring of aqueous samples (350 mL) with 200 mg of tetradecanoate-coated MNPs for 15 min, isolating the sorbent with a Nd-Fe-B magnet, and eluting the PAHs with a mixture of acetonitrile and tetrahydrofuran. The limits of quantitation obtained, 0.2-0.5 ng/L, met the stringent water quality requirements established by the recently amended European Water Framework Directive 2000/60/EC and also U.S. EPA for the determination of PAHs in surface and groundwaters. The proposed method was applied successfully to the determination of these pollutants in surface and groundwater samples collected in southern Spain. Recoveries from samples spiked with PAHs at concentrations of 1-10 ng/L ranged from 85 to 94%, and relative standard deviations from 1 to 7%.

High Resolution Resistivity Mapping of Subsurface Controls on Acid Rock Drainage at an Active Mine Site
Glaser II, D.R., J.B. Fink, R.M. St. Louis, and R.S. Bell.
SAGEEP 2009: Symposium for the Application of Geophysics to Environmental & Engineering Problems, March 29-April 2, Fort Worth, Texas. Environmental and Engineering Geophysical Society, Denver, CO. CD-ROM, p 988-997, 2009

2-D and quasi 3-D high-resolution resistivity imaging of a refractory ore stockpile area at an active mine identified several distinct electrically conductive features. A residual potential mapping survey delineated the possible flow pathway between two known acid rock drainage (ARD) seeps. Subsequent drilling showed a strong correlation between the resistivity imaging results and the pre-development drainage patterns, the associated clay base fill, and the seeps. The drilling indicated no pooling of ARD and strongly suggested lateral movement of the ARD along the top of the clay fill layer. This initial interpretation confirms that the clay fill base prevented vertical permeation of the ARD into the bedrock and suggests that the ARD pooling to the east and upgradient of the investigation area likely is due to a malfunctioning French drain.

Hydrodynamic of Leachate Plume in Bioreactor Landfill: Contribution of 3D Time-Lapse ERT
Clement, R., L. Oxarango, and M. Descloitres.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

Leachate recirculation in bioreactor waste landfills is designed to increase the moisture content that optimizes biodegradation. The wastes comprise a heterogeneous and anisotropic porous medium, and the water recirculation process often is poorly understood at the scale of such a site. To gain a better understanding of recirculation hydrodynamics at a bioreactor landfill, investigators used 3D time-lapse electrical resistivity tomography (ERT). After optimization using numerical modeling, time-lapse ERT was applied at the field scale during an experimental injection. Comparison of ERT with injected volumes showed that time-lapse ERT can be used to characterize some hydrodynamic properties of waste and delineate plume migration.

Identification of Chlorinated Solvent Sources in the Indoor Air of Private Residences Around Hill Air Force Base, Utah
Hall, Andrew J., Master's thesis, Utah State University, 154 pp, Dec 2008

Volatile chlorinated solvents such as trichloroethene (TCE), 1,2-dichloroethane (1,2-DCA), and perchloroethene (PCE) have been identified in the indoor air of residences located near Hill Air Force Base (AFB), Utah. These vapors can originate either from volatilization of

contaminants in shallow groundwater and transport into residences or from sources within the residence. The focus of this thesis was the development of a testing strategy for determining sources of TCE, 1,2-DCA, and PCE in the indoor air of residences near Hill AFB. Eight residences were selected for study based on prior detections of the three contaminants in indoor air. Residents were asked to turn off the heating, ventilation, and air conditioning system and keep windows and doors closed for at least 3 hours prior to the sampling visit to reduce mixing of residence air. Indoor air samples were collected on Tenax(C); sorbent tubes from various locations within the residences to determine the location of the potential source(s). Sampling tubes were analyzed by thermal desorption gas chromatography/mass spectrometry. Results from a tracer experiment using sulfur hexafluoride gas confirmed the effectiveness of sampling approach. In cases where elevated levels of chlorinated solvents were found, the suspected source materials(s) were removed and the room air was re-sampled. If removal of the materials reduced or eliminated indoor air contamination, an emission chamber was used to determine contaminant emission from the materials. Sources were identified in three of the sampled residences. Sampling in two of the residences was discontinued due to scheduling problems. Sources were not located in the remaining residences. The emission of contaminants from items identified as sources in two of the residences was measured using an emission chamber developed for this project. An ornament from residence U8-8452 was found to be emitting 36.4 ng/min/cm^2 of 1,2-DCA. The emission of 1,2-DCA from a wedding dress located at residence U8-8211 was below the method detection limit of 1.99 pg/min/cm^2, but the emission of PCE was 18.9 ng/min/cm^2, which decreased by a factor of 7 during repeated measurements.
Thesis at http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1060&context=etd

Imaging Fourier Transform Spectrometry of Chemical Plumes
Bradley, K.C., K.C. Gross, and G.P. Perram, Air Force Inst. of Technology.
Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing X. Proceedings of SPIE: The International Society for Optical Engineering, Vol 7304, 2009

A midwave infrared (MWIR) imaging Fourier transform spectrometer (FTS), the Telops FIRST-MWE (Field-portable Imaging Radiometric Spectrometer Technology-Midwave Extended) has been used for the standoff detection and characterization of chemical plumes. Successful collection and analysis of MWIR hyperspectral imagery of jet engine exhaust allowed the production of spatial profiles of both temperature and chemical constituent concentrations of exhaust plumes. Successful characterization of this high temperature combustion event led to the collection and analysis of hyperspectral imagery of lower temperature emissions from industrial smokestacks. This paper presents MWIR data from remote collection of hyperspectral imagery of methyl salicilate (MeS), a chemical warfare agent simulant, during the Chemical Biological Distributed Early Warning System test at Dugway Proving Grounds, UT, in 2008. The data did not contain spectral lines associated with emission of MeS, although a few broad spectral features were present in the background-subtracted plume spectra. Further analysis will be required to assign these features and determine the utility of MWIR hyperspectral imagery for analysis of chemical warfare agent plumes.

Improvement of Electrical Resistivity Tomography for Leachate Injection Monitoring
Clement, R., M. Descloitres, T. Guenther, L. Oxarango, C. Morra, J.-P. Laurent, and J.-P. Gour.
Waste Management, Vol 30 No 3, p 452-464, Mar 2010

Leachate recirculation is a key process in the scope of operating a bioractor landfill and to optimize biodegradation. Given that liquid flows exhibit a complex behavior in very heterogeneous porous media, in situ monitoring methods are required. Using numerical modeling with typical 2D and 3D injection plume patterns and 2D and 3D inversion codes, incorrect changes of resistivity can be calculated at depth if standard parameters are used for surface time-lapse electrical resistivity tomography (ERT) inversion. Major artefacts typically exhibit significant increases of resistivity (more than +30%) which can be misinterpreted as gas migration within the waste. To eliminate these artifacts, testing of an advanced time-lapse ERT procedure involved two advanced inversion tools and two alternative array geometries. The first advanced tool used invariant regions in the model. The second advanced tool used an inversion with a "minimum length" constraint. The alternative arrays were a pole/dipole array (2D) and a star array (3D). These two advanced inversion tools and the two alternative arrays removed the artifacts almost completely within +/− 5% for both 2D and 3D situations. In a field study, time-lapse ERT was applied using the star array during a 3D leachate injection in a non-hazardous municipal waste landfill. To evaluate the robustness of the two advanced tools, a synthetic model incorporating both true decrease and increase of resistivity was built. The advanced time-lapse ERT procedure eliminated unwanted artifacts, while keeping a satisfactory image of true resistivity variations.

In Situ Sensors Improve the Remediation Efficiency in Complex Aquifers
Huettmann, S. and G. Broekmann, Sensatec GmbH, Kiel, Germany.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

The success of in situ remediation strategies depends on the efficiency of the distribution of chemical or biological reactants in a contaminated aquifer. A major uncertainty linked with the detail engineering of in situ remediation lies with the heterogeneity of the aquifer geology, hydrology, and chemistry. The site-specific reaction patterns, spatial reaction differences, and reactant distribution patterns often cannot be predicted but must be determined empirically in the field. With in situ chemical oxidation (ISCO) processes and partly with aerobic biological processes, process parameters such as redox potential, in situ pressure, pH value, electrical conductivity, and oxygen content can change within minutes or hours and therefore are difficult to detect using traditional groundwater sampling technologies. Control of rapid processes instead requires frequent measurement at high spatial resolution of the data of concern. Technologies for data collection using robust in situ sensors with digital data transfer and high recording frequency are available for this purpose. Redox potential/oxygen concentration indicate spatial stabilization of anaerobic redox conditions for the treatment of DNAPL plumes, spatial dynamics of oxygen distribution and consumption in gas curtains, and preferential distribution of permanganate and Fenton's distribution in ISCO applications. Temperature readings indicate reaction temperatures for chemical (ISCO) and biological remediation processes. The pH value indicates the biological acid production during fermentation of sugar-based co-substrates (e.g., molasses) and pyrite oxidation in gas curtains. Electrical conductivity indicates an increase of ion concentrations (e.g., pyrite oxidation). In situ pressure indicates pressure increase due to gas production during Fenton's reaction and dynamic processes of gas storage in the aquifer (e.g., in gas curtains). The authors present examples of in situ sensor-based remediation process control, including an overview of state-of-the-art environmental sensor systems.

In-Well Sediment Incubators to Evaluate Microbial Community Stability and Dynamics Following Bioimmobilization of Uranium
Baldwin, B.R., A.D. Peacock, Y.-D. Gan, C.T. Resch, E. Arntzen, A.N. Smithgall, S.M. Pfiffner, B.M. Freifeld, D.C. White, and P.E. Long.
Remediation Journal, Vol 19 No 4, p 73-89, 2009

An in-well sediment incubator (ISI) was developed to investigate the stability and dynamics of sediment-associated microbial communities to prevailing subsurface oxidizing or reducing conditions. During a 7-month period at the Old Rifle Uranium Mill Tailings Remedial Action site, oxidized Rifle Aquifer background sediment (RABS) incubators were deployed in previously biostimulated wells under iron-reducing conditions. Cell densities of known iron-reducing bacteria, including Geobacteraceae, increased significantly, showing the microbial community response to local subsurface conditions. Subsequent phospholipid fatty acid profiles of the RABS were strikingly similar to those of adjacent sediment cores, suggesting ISI results could be extrapolated to the native material of the test plots. Results for ISI deployment with laboratory-reduced sediments showed only slight changes in community composition and indicated the potential for using ISIs to monitor microbial community stability and response to subsurface conditions.

Increasing Confidence in Treatment Performance Assessment Using Geostatistical Methods
Cai, Z. and R. Wilson (Univ. of Sheffield, UK); M. Simon (U.S. EPA, Cincinnati, OH).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-014, 2008

Mass flux changes in time or travel distance is rapidly gaining acceptance as a performance metric for remediation of chlorinated compounds (e.g., TCE) in groundwater. Where one or more rows of multilevel samplers are installed perpendicular to the direction of contaminant transport (i.e., MLS transects), flux is obtained by integrating discrete concentration data across the transect, which often is accomplished using Theissen Polygon or standard kriging methods. Both approaches have inherent uncertainty that affects the reliability of performance considerations. The Theissen Polygon method requires that groundwater velocity is known at each MLS point, while accurate kriging is sensitive to the assumed variogram model. Error contributions also come from analytical imprecision of measured concentrations (~5 to 15%) and determination of velocity (~10 to 50%). When an assumed velocity is used, these can vary over orders of magnitude through the formation at the scale of a MLS transect and are distributed non-uniformly. Integrating these errors in the interpolation of concentrations should improve the reliability of performance assessment significantly. The authors applied a robust geostatistical method to interpolate transect concentration data from the Source Area BioREmediation (SABRE) experiment currently underway in the UK. Accounting for analytical error and measured spatial variability of velocity allows assignment of a confidence interval to each interpolated value. The result is a "true" concentration value and a probability. Incorporating the probability into concentration integration increases the confidence in treatment performance assessment in heterogeneous aquifers by rigorously attaching uncertainty to mass flux estimates.

Influence of HCl/HF Treatment on Organic Matter in Aquifer Sediments: A Rock-Eval Pyrolysis Study

Tambach, T.J. (TNO Geological Survey of The Netherlands/Deltares, Utrecht), H. Veld, and J. Griffioen.

Applied Geochemistry, Vol 24 No 11, p 2144-2151, 2009

Rock-Eval pyrolysis is used increasingly for the routine characterization of natural organic matter in soils and sediments. The authors studied the bulk composition of sedimentary organic matter (SOM) in sandy aquifer sediments, as well as purified samples (isolation of SOM) by HCl/HF treatment. This treatment is necessary to avoid detection limit problems for samples with low SOM contents, but the results presented here indicate that this treatment influences the organic geochemistry of the aquifer sediment samples. The FID and CO2/CO pyrograms show a shift of 10 to 40 degrees C of the major peak to a lower temperature. Organic matter alteration or removal of components containing O-bearing groups may explain this. Additionally, destruction of the mineral matrix might lead to reduced retention of the material. For the change of the CO2/CO pyrograms of the RC fraction, only organic matter alteration seems to be likely. Concentrated organic matter samples could also accelerate the release of exothermic energy and influence the pyrograms. Results indicate that organic matter concentration in the sample influences the measured total organic matter content and the T(max) of the FID pyrogram, while the sample loading (absolute organic matter amount) up to 80 mg in the Rock-Eval apparatus does not. The FID pyrograms can be deconvoluted into four subpeaks, which allows comparison of samples at various depths. Rock-Eval pyrolysis should be routinely applied to characterize SOM in aquifer sediments only when such systematic and analytical phenomena are taken into account.

Innovative Approaches to Evaluate Geochemical Risk Related to Sulphide-Bearing Abandoned Mine Lands

Servida, Diego, Ph.D. thesis, University of Milano, 119 pp, 2009

In the present work, a space and time-related approach to geochemical hazard evaluation is discussed and applied. The hazard level is related to high heavy metal concentration, acid mine drainage development, and topographic setting. The approach followed allows identification and evaluation of the morphology and dimension of mine dumps using bibliographic data and CAD software, with characterization completed and refined by electrical resistivity ground imaging (ERGI) investigations. ERGI investigations can supply 3-D information over an extended area. Analysis by XRF of residual soils, waste rocks, and debris materials for major elements and for acid mine drainage (AMD) potential follows the AMIRA procedure. Hazard evaluation is performed by geostatistical analyses, resulting from 1) the interpolation of the terrain chemical features of the whole area, 2) the overlapping of previous results, and 3) consideration of the topographic setting. This approach allows identification of areas where the presence of metal and metalloids is significant. It also supports the prioritization of areas that need treatment. In a preliminary step, the likely persistence of AMD processes over time can be calculated from

common data, such as yearly rainfall, mining water pH, and the acid production or neutralizing potential of terrains. The next step considers the results of kinetic tests. These approaches have been developed on pilot sites with different geoenvironmental settings, at the Rio Marina mining district (Elba Island, LI), characterized by hematite + pyrite ore association, exploited for iron from the Etruscan age till 1981, and the Libiola Mine (GE), characterized by chalcopyrite + pyrite ore association, exploited for copper from 1864 till 1962. The application of the proposed methodologies and techniques allows a better geoenvironmental characterization of mine waste. Moreover, the proposed approach for the assessment of geochemical risk related to abandoned mine land could contribute to decreasing the footprint of the areas that need remediation, thus potentially reducing the costs and adverse impacts of remediation activities.
Thesis at http://air.unimi.it/bitstream/2434/64130/1/PhD_thesis_Servida.pdf

An Innovative Continuous Flow System for Monitoring Heavy Metal Pollution in Water Using Transgenic Xenopus laevis Tadpoles
Fini, J.-B., S. Pallud-Mothr, S. Le Mvel, K. Palmier, C.M. Havens, M. Le Brun, V. Mataix, G.F. Lemkine, B.A. Demeneix, N. Turque, and P.E. Johnson.
Environmental Science & Technology, Vol 43 No 23, p 8895-8900, 2009

This paper describes a real-time flow-through system based on Fountain Flow cytometry that measures in situ contaminant-induced fluorescence in transgenic amphibian larvae immersed in water samples (i.e., tadpoles that glow green in the presence of heavy metals). Portable and self-contained, the system allows on-site measurements and requires minimal human intervention. Optimization exploited a transgenic Xenopus laevis (African clawed frog) bearing a chimeric gene with metal responsive elements fused to eGFP. The transgene was selectively induced by 1 uM Zn2+. Using this tadpole, the continuous flow method is rapid and sensitive as image analysis. Flow-through readings accelerate the overall process of data acquisition and render fluorescent monitoring of tadpoles suitable for on-site tracking of heavy metal pollution. African clawed frog tadpoles modified with jellyfish genes show promise as a faster and less expensive way to detect pollution than traditional methods.

Innovative Monitoring Techniques for Fracturing and Injection Activities
Schnell, D.L., Pneumatic Fracturing, Inc., Alpha, NJ.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract E-026, 2008

Following application of pneumatic fracturing and injection, several methods of tracking fractures or injections have been used. Some of these methods include pressure influence monitoring at surrounding locations, tracers, and visual presence of remedial products in adjacent or surrounding wells. Other mapping methods can be utilized in addition to the conventional methods and are dependent upon the depth of application and the availability of surrounding wells. These methods include surface deformation modeling and absolute pressure and temperature influence in wells. In addition, a newer geophysical technique of mapping mechanically induced fractures has been demonstrated at the bench scale. Surface modeling is conducted using an array of tiltmeters. This method is used widely when conducting structural monitoring but can be expanded outside of that scope. Tiltmeters measure bi-axial surface movement. The tiltmeters record rotation about two axes, oriented such that each meter monitors North-South and East-West heave. The tiltmeter data are used to create a matrix that can be used for graphic mapping of surface heave. Tiltmeter data can be used to infer the direction of injection pathways and to identify any preferential pathways that might affect the injection activities. Leveloggers measure hydrostatic or pressure influence and temperature in a well. They are used widely for pump tests. The change in absolute pressure in the well is based on the change in water elevation. If injected product causes an adjacent groundwater elevation to mound, an increase in pressure will result. Temperature measures the airspace above the water column and the fluctuation of it. If injected product connects to an adjacent well, the temperature will decrease in the well; likewise if exiting groundwater mounds to an adjacent well, the temperature will increase. Hydrostatic influence and temperature influence is not an indication of actual radius of influence of the injected product but may represent potential connectivity between well locations based on depth and influence on the aquifer. Applications of these technologies are presented for four sites. Both tiltmeters and Leveloggers were used at a site in New Jersey to monitor fracturing and injection activities. The geology at the site is silty clay and fractured shale. Three additional sites are presented in which tiltmeter monitoring was conducted in other geological settings: flowing sands, stiff clays, and silty sands and plastic clays. Structural monitoring using tiltmeters at three of the four sites will be discussed further to demonstrate the versatility of the method. Considerations of the field approach to using geophysical methods will be presented including background, equipment requirements, and limitations.

Integrating Uncertainty Analysis in the Risk Characterization of in-Place Remedial Strategies for Contaminated Sediments
Adriaens, P., S.J. Wright, C.L. Gruden, J. Wolfe, T. Redder, N. Barabas, and J. DePinto.
Strategic Environmental Research and Development Program (SERDP), Project ER-1371, 268 pp, Mar 2009

The overarching goal of Project ER-1371 was to characterize and bound the uncertainties associated with the impact of sediment processes (with focus on ebullition and advection) on the long-term performance of in situ capping strategies. The approach was a combination of experimental work and modeling to enable evaluation of the impact of ebullition and advection on both sediment bed stability and contaminant (PAHs) fluxes from the sediment. The experiments were focused on the quantification of ebullition metrics, PAH flux measurements, and sediment resuspension measurements conducted in batch systems and flume configurations using sediments collected from the Anacostia River capping project. These site-specific data were aimed at narrowing the process uncertainties currently reported in the literature. A geostatistical model was developed and applied to enable comparison of microbial data collected at the field and laboratory scales. The integrative modeling approach evolved from a generic water quality model to a custom-designed sediment flux model that allowed for the integration of data collected at various scales to link the flume and field aspects of the study.
http://www.serdp.org/Research/upload/ER-1371-FR.pdf

Integration of Advanced Site Characterization Tools/Techniques into More-Targeted Bioremediation Injection Designs
Cooper, E. (Vironex, Inc. Wilmington, DE), F. Stolfi, and M. Mazzarese.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

The effectiveness of in situ accelerated anaerobic groundwater bioremediation is a function of the delivery of appropriate substrates and bioaugmentation cultures into direct contact with contaminants located in the dissolved, sorbed, and NAPL phases. Recent case studies are presented as examples of sites where use of the membrane interface probe (a direct-sensing advanced site characterization technology) was integrated with targeted injection designs for effective delivery of carbon substrates. This methodology is termed "search and destroy." The cases studies demonstrate a robust contaminant (chlorinated and petroleum hydrocarbons) delineation methodology coupled with innovative delivery technologies for a variety of subsurface conditions.

Integration of Electrical and Electromagnetic Investigation for Contaminated Site
Godio, A. and M. Naldi.
American Journal of Environmental Sciences, Vol 5 No 4, p 561-568, 2009

To verify the reliability of geophysics for the detection of buried wastes in an industrial area, two geophysical methods were applied: (1) the electromagnetic frequency domain, using a multi-frequency broadband system with fixed spacing between the transmitter and receiver coils (2 m) to observe soil electrical conductivity and in-phase response, and (2) electrical resistivity and chargeability tomographies, performed along several transects. The authors applied the Kriging method to map conductivity and in-phase response. Standard inversion procedure was adopted to interpret the resistivity and chargeability data. The investigators found a very similar response of the electromagnetic survey between 2,000 and 40,000 Hz. The investigation depth (3-4 m) was mainly related to the coil spacing. The survey pointed out some anomalies caused by biogeochemical activity in the active waste deposits. The resistivity and chargeability sections confirmed that the electromagnetic anomalies were related to the waste. The high chargeability values (up to 100 mV/V) were associated with the leakage of metals from the wastes. Although sensitive to the presence of cultural noise (e.g., a fence or metallic object on the ground), the electrical resistivity and chargeability data pointed out the main contaminated zones with good accuracy. Further development might focus on the relationship between the nature of the waste and the geophysical response. http://www.scipub.org/fulltext/ajes/ajes54561-568.pdf

Investigation of Carbon Tetrachloride DNAPL at the 216-Z-9 Trench, DOE Hanford Site, Washington
Morse, J., A. Tortoso, W. Bratton, K. Moser, and R. Holm.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-003, 2008

At DOE's Hanford facility, a 24-month field investigation and conceptual model study was undertaken at the 216-Z-9 Trench and adjacent waste sites to determine if any carbon tetrachloride (CT) DNAPL source zones still existed and could be identified. The investigation focused on vadose zone source zones and possible groundwater sources. The investigation followed a graded approach to maximize the effectiveness of the investigation relative to budget and schedule. Passive soil gas analysis and cross-well seismic surveys were conducted prior to using more invasive cone penetrometer and other soil sampling techniques. Some of the most beneficial techniques were passive soil gas (covered a large area in a cost-effective manner), cross-well seismic techniques (identified the geometry of fine-grained layers where the DNAPL was likely to be trapped), and the hydraulic hammer rig (HHR) (collected depth-specific sediment samples in highly radioactive contaminated areas with minimal waste generation). An improved conceptual model for CT distribution was created for the 216-Z-9 Trench using data from all three techniques, as well as an analysis of the waste disposal and potential transport processes. The investigation identified a silt lense at a depth of 65 ft on the south end of the trench with a CT concentration of 390,000 ug/kg. This concentration is believed to be near the saturation limit for these soils and represents DNAPL in this lense. The high CT concentrations are limited to a small area of this lense on the south side of the trench. Small-diameter soil vapor wells were installed in the lense with the HHR and currently are being used with the SVE system to remove CT vapors. The field investigation data were used to update the site conceptual model, improve estimates of the vadose zone/groundwater CT inventory, and develop remedial alternatives.

Investigation of Coal Tar Mobility at a Former MGP Site
Moo-Young, H.K. (California State Univ., Los Angeles), X. Mo, R. Waterman, A. Coleman, and S. Saroff.
Journal of Hydrologic Engineering, Vol 14 No 11, p 1221-1234, 2009 [Special issue: Contaminant Hydrology for Radioactive Waste Disposal]

This paper presents the Res-SAT Field Tool(tm), a new and innovative field device, and lab procedures that can be used to determine the saturation/capillary pressure relationship for a soil/water coal tar system and the critical pressure for coal tar mobility.

Laboratory Validation Study of New Vapor-Phase-Based Approach for Groundwater Monitoring
Adamson, D.T., T.E. McHugh, M.W. Rysz, and C.J. Newell.
Remediation Journal, Vol 20 No 1, p 87-106, 2009

The authors have completed a laboratory validation study to identify instruments and sample-collection methods that can provide accurate measurement of VOC concentrations in groundwater. The study identified two field-portable instruments (a gas chromatograph and a photoionization detector) with sufficient sensitivity to measure VOCs in groundwater at concentrations below typical monitoring standards (i.e., 1 to 5 ug/L). The accuracy and precision of these field instruments was sufficient to satisfy typical data quality objectives for laboratory-based analysis. Two sample-collection methods--direct headspace sampling and passive diffusion sampling--were identified that yield vapor-phase samples in equilibrium with water. These sample collection methods allow the field instruments, which measure VOC concentrations in vapor-phase samples, to be used to measure VOC concentrations in water. After further validation of these sample-collection methods in the field, this monitoring method will provide a simple way to obtain accurate real-time measurements of VOC concentrations in groundwater using inexpensive field-portable analytical instruments.

Land Redevelopment Case Study: Assessing Potential Health Risks Related to Vapor Intrusion of VOCs and Radon Using Static and Dynamic Flux Chambers
Schmidt, C.E., T.L. Copeland, and M.K. Jones.
AWMA Vapor Intrusion Conference 2009. Air and Waste Management Association, ISBN: 9781615670451, Vol 2 No 180 CP, p 913-959, 2009

Undeveloped parcels of land formerly used as industrial waste evaporation ponds were assessed for potential health risks associated with the indoor flux of hazardous compounds as part of the remedial action/health risk assessment (HRA) effort necessary to meet regulatory agency redevelopment requirements. VOC and radon flux rates from open soil were measured using U.S. EPA methods for flux chamber sampling and laboratory analysis. The VOC sample collection and analysis approach utilized the EPA surface emission isolation flux chamber technology and EPA Method TO-15 analysis (full scan and selective ion mode GC/MS analysis) for the study VOCs. Radon gas flux was assessed using a static flux chamber approach with activated charcoal canisters for radon gas detection, and the EPA flux chamber in concert with an innovative real-time analyzer for radon gas. This paper presents the sample collection and analytical methods employed in the site investigation and the associated HRA methodology. Also presented are VOC and radon flux data representative of method detection analyses, comparisons of the two radon flux methodologies, and site-specific reported flux rates for study compounds based on laboratory requirements for data quality indicators that meet HRA criteria. A technical framework is proposed that can be followed when employing surface flux data for VOCs and radon as the basis for characterizing indoor air exposure concentrations. Health risk-based criteria for selected VOCs and EPA mitigation criteria for radon are presented in 'flux' units. http://secure.awma.org/presentations/VaporIntrusion09/Papers/8-Schmidt.pdf

Lifecycle Remedial Design for a 60-Acre CAH Plume Supported by Innovative Site Characterization
Bond, B., T. King, A. Hackenberg, and S. Ueland.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-020, 2008

Innovative subsurface characterization tools and methods were applied during the remedial investigation of a former industrial site because conventional characterization methods were impractical for a plume of considerable magnitude and complexity. The Triad Approach was used to rapidly delineate the overburden plume of chlorinated aliphatic hydrocarbons (CAHs), which extends over 4,000 ft in the glacial till aquifer, beneath >50 mostly residential properties. This approach was also used to identify at least five off-site sources contributing mixed VOCs to the distal commingled plume, most of which are not being addressed by regulators. A detailed characterization of preferential migration pathways in fractured mudstone bedrock was accomplished using an integrated array of downhole bedrock logging, vertical profiling, and geophysical techniques at a minimal number of key drill sites. Analysis and 3-D visualization of the hydrogeologic data revealed that buried paleotopography is responsible for the elongated plume geometry observed in the overburden aquifer, and that roughly the same geometry in the bedrock aquifer has resulted from preferential flow along strike within intensely fractured bedding plane partings. Interim remedial measures carried out on site in 2002 and 2003 produced no significant change in dissolved-phase concentration trends, indicating that residual CAH mass was still present. Passive soil gas sampling was conducted for further characterization of the extent of CAHs and identification of any secondary source areas within the 7.5-acre site. The soil gas sampling results and supplemental soil characterization data indicated that the mass remaining on site is generally diffuse and distributed primarily within a 1.5-acre area of the saturated zone. Microbial, geochemical, and field parameter data collected through 2007 have shown that Dehalococcoides ethenogenes are present and that reductive dechlorination of CAHs is occurring proximal to the former on-site source areas; however, calculated attenuation rate constants indicate that MNA alone would require over 100 years to reach the cleanup goals. To achieve the remedial objectives, an aggressive, flexible, and adaptable strategy integrates in situ physical and enhanced biological technologies that will be deployed to reduce mass loading and mass flux from the residual on-site overburden sources areas until mass flux from on-site sources is less than that from off-site sources, and conditions are suitable for stand-alone MNA to become the final long-term remedy.

Logic-Based Design of Groundwater Monitoring Network for Redundancy Reduction
Dhar, A. and B. Datta, Indian Inst. of Technology.
Journal of Water Resources Planning and Management, Vol 136 No 1, p 88-94, Jan-Feb 2010

Redundancy reduction is an important issue in the optimal design of a monitoring network. This paper introduces a developed methodology that reduces monitoring redundancy by incorporating the inverse distance weighting method for spatial interpolation of concentration data and solving the formulated logic-based mixed-integer linear optimization model using the branch-and-bound algorithm. The proposed methodology is tested for a real world problem. The methodology was evaluated for different scenarios using available historical concentration data. Results showed that the methodology performs satisfactorily when compared with other existing methodologies.

Long-Term Monitoring at the Sydney Tar Ponds: Canada's Largest Remediation Project
Noble, B., C. Patterson, M. Janes, J. Green, F. Potter, and W. Kaiser.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract N-042, 2008

Remediation of the Sydney Tar Ponds started in 2006 and is expected to take 8 to 10 years, with an anticipated completion date of 2014. The remedy encompasses encapsulation with rerouting of surface water, in situ solidification/stabilization of sediment and soil, groundwater control through groundwater collection and barrier walls, and site-wide capping. The monitoring for this project is particularly rigorous due to the complex stakeholder group and detailed recommendations from the Canadian government. The long-term monitoring plan will be implemented after the performance of the remedial systems has been confirmed. This final step is intended to provide ongoing performance verification, while decreasing monitoring effort over time, until it is ultimately discontinued. This presentation reviews the long-term approach for monitoring Canada's largest remediation project and the methods to address the unique technical challenges of monitoring this environment.

Long-Term Monitoring Optimization at Camp Lejeune
Laudermilch, D., C. Bozzini, G. Tysor, and B. Lowder.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper N-041, 5 pp, 2008

The groundwater long-term monitoring (LTM) program at Marine Corps Base Camp Lejeune, NC, historically included semi-annual sampling of 276 monitoring wells, surface water, and sediment at 13 different sites. To reduce monitoring costs, the LTM program was examined for redundancies and opportunities to reduce the amount of sampling. Optimization of the LTM program followed a two-tiered approach. The first tier involved a records review to determine each site's regulatory requirements. The second tier involved evaluating parameters and sampling points for their appropriateness within the overall LTM program using MAROS software. Based on the optimization study results, changes were implemented that achieved LTM program savings in level of effort and cost while meeting all regulatory requirements. The number of monitoring points and frequency of sampling were reduced by over 50%, and the analyte list was reduced. Efficiency of current field procedures was increased by over 50% by switching from low-flow sampling techniques to sample collection using passive diffusion bags in half the monitoring wells remaining in the LTM program. Reporting and data management protocols were reduced by 40% by submitting a single annual monitoring report. The cost of the optimization effort was roughly $75,000. After the first year of implementation, the combined cost savings of the LTM optimization recommendations was ~$800,000, paying for itself 10 times over in the first year.

Long-Term Monitoring Program Optimization at Fresno Sanitary Landfill Superfund Site
Nyznyk, Y., R. TerBerg, G. McCurry, and G. Slater.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-043, 7 pp, 2008

Over 70 monitoring wells in the groundwater pump-and-treat system for the Fresno Sanitary Landfill Superfund site are sampled at routine intervals for varying suites of constituents. This paper describes a long-term monitoring optimization process implemented at the FSL to provide a continual assessment of the groundwater monitoring program's individual elements so that only the data needed for a critical assessment of the remediation system's performance are collected.

Long-Time Geoelectrical Monitoring of Groundwater Contamination: Case Studies from Romania
Ioane, D., P. Georgescu, B.M. Niculescu, and F. Chitea.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

This paper describes 2 case studies of long-term geoelectrical monitoring of aquifer contamination: a marine intrusion generated by excessive exploitation of drinking water in the Costinesti resort (located on the Romanian Black Sea shore), and contamination resulting from natural meteoric water infiltrations along a fault system in the vicinity of Brazi oil refinery (Ploiesti region, Romania). Both the long-term monitoring of the marine intrusion and the determination of meteoric water infiltrations along faults were confirmed by data obtained from hydrogeological wells. A potential method for simulating the apparent resistivity anomalies within this context (media with a continuous variation of the resistivity) is represented by the application of harmonic alpha media theory.

Mass Flux Distribution Using the High-Resolution Piezocone and GMS
Kram, M., N. Jones, J. Chau, G. Robbins, and A. Bagtzoglou.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-017, 8 pp, 2008

The objective of this project was to demonstrate the use of the high-resolution piezocone direct-push sensor probe to determine direction and rate of groundwater flow in three dimensions. Field-measured hydraulic conductivity, head, effective porosity and calculated seepage velocity distributions can be estimated through interpolation methods recently incorporated into the GMS (Groundwater Modeling System). Probe data comprising soil type and co-located hydraulic information is particularly amenable to innovative data fusion-based interpolations available through the modeling platform. Following chemical concentration data collection, these innovative data processing approaches allow for the determination of flux distributions at resolutions and spatial configurations never before available. Field-scale data collection, interpolation, and modeling results from deployment at a site in Port Hueneme, CA, in 2006 and 2007 are presented and discussed.

Measurement of Bioaccessibility of Organic Pollutants in Soil
McAllister, L. and K.T. Semple, Lancaster Univ., UK.
Bioremediation: Methods and Protocols. Springer, Berlin. Methods in Molecular Biology: Vol 599, ISBN: 978-1-60761-439-5, p 1-14 pp, 2009

Cyclodextrins are a group of macrocyclic compounds that can form inclusion complexes with organic xenobiotics. This occurrence can be exploited to measure the labile/rapidly desorbable compound fraction, which correlates with microbial degradation. This paper presents a rapid and easily reproducible HPCD shake extraction technique that has been experimentally demonstrated to predict microbial availability and degradation in soil. The method can provide practitioners with an indication of bioremediation endpoints and also could be valuable in the risk assessment of contaminated land.

Measurement of Total Site Mercury Emissions from Chlor-Alkali Plant Using Ultraviolet Differential Optical Absorption Spectroscopy and Cell Room Roof-Vent Monitoring
Thoma, E.D., C. Secrest, E.S. Hall, D.L. Jones, R.C. Shores, M. Modrak, R. Hashmonay, and P. Norwood.
Atmospheric Environment, Vol 43 No 3, p 753-757, 2009

This technical note describes an EPA measurement project to determine elemental mercury emissions from a mercury cell chlor-alkali facility in the southeastern United States during a 53-day monitoring campaign in the fall of 2006. The optical remote sensing area source measurement method EPA OTM 10 was used to provide Hg(0) flux data for the site. These results are reported and compared with cell room roof vent monitoring data acquired by the facility for similar time periods. The 24-hour extrapolated Hg emission rate estimates determined by the two monitoring approaches are shown to be similar with overall averages in the 400 g/day range with maximum values around 1,200 g/day. Results from the OTM 10 measurements, which include both cell room emissions and potential fugitive sources outside the cell room, are shown to be ~10% higher than cell room monitoring results, indicating that fugitive emissions from outside the cell room produce a small but measurable effect for this site.

Metagenomic and Proteomic Approaches to Site Characterization and Monitoring of Chlorinated Solvent-Contaminated Aquifers
Reiss, R. and P. Guerra.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-021, 2008

Recent advances in molecular techniques include high-throughput DNA sequencing and shotgun proteomics. These techniques eliminate the need to clone individual genes or purify specific proteins and rely on bioinformatics to identify sequences in a mixed sample. The major advantage of these techniques is that prior knowledge of DNA or protein sequence is unnecessary, facilitating the detection of novel microbes and genes without the need to culture specific microbes. Because the genome or proteome is analyzed in mass, a disadvantage is that the assignment of a specific protein to a single microbial species will be difficult. Techniques are discussed for obtaining and isolating adequate numbers of microbes for high-throughput DNA sequencing and shotgun proteomics from two sites, one contaminated with 1,2-DCA and the other with PCE. The potential of these high-throughput techniques to improve the understanding of biodegradation processes is discussed.

A Methodology to Reconstruct Groundwater Contamination History with Limited Field Data
Guan, J., M.L. Maslia, and M.M. Aral
World Environmental and Water Resources Congress 2009: Great Rivers, 17-21 May, Kansas City, Missouri. ASCE, Reston, VA. 7 pp, 2009

In the ongoing health study at U.S. Marine Corps Base Camp Lejeune, NC, no field data on groundwater contamination at water-supply wells are available prior to 1994. Limited contaminant concentration data at several observation wells are available during and after 1992, when remedial investigations of the contaminated aquifers began. To assist the epidemiological study in determining historical exposure scenarios, groundwater contaminant history needs to be reconstructed at base housing areas. This paper proposes a linear control model to reconstruct the contamination history at the site. The control model consists of two linear parts: the first part describes the system behavior of contaminant movement in aquifers in a natural environment, and the second part reflects the effect of pumping operations on contaminant concentrations. Both are expressed as matrices that are separately identified using optimization methods based on the available concentration records and pumping-schedule data. The Tarawa Terrace base housing area of Camp Lejeune, which has been modeled in detail, is used to demonstrate the effectiveness of the model and proposed algorithm.
http://www.atsdr.cdc.gov/edrp/pdfs/Guan_etal_EWRI2009_Final.pdf

Microbial Fuel Cell Biosensor for In Situ Monitoring of Bioremediation of Chlorinated Solvents and BTEX
Tront, J.M. (ETH Zurich, Switzerland), A. Puzrin, and J. Hughes.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

Recent advances in microbial fuel cell (MFC) technology suggest that MFC systems can be used as subsurface sensors and provide an advantage over conventional sampling by generating data that are directly related to the rate of contaminant reduction at a higher time resolution, with little increase in incurred costs. MFCs harness the ability of microorganisms to utilize an electrode directly as an electron acceptor, thereby oxidizing an electron donor and producing an electrical current. The electrical signal produced is proportional to the quantity of electron donor available and suitability of growth conditions, which means the MFC technology can provide information on the rate and nature of biodegradation processes and biogeochemical changes in the subsurface. Results demonstrated a correlation between concentration of electron donor (i.e., acetate, lactate, BTEX compounds) and the electrical signal produced for model MFC-biosensor systems inoculated with Shewanella spp. or Geobacter spp. The electricity output thus was a predictive tool for the concentration of electron donor available in situ. This paper describes a study focused on the adaptation of MFC systems into a fieldable MFC biosensor for biogeochemical monitoring of chlorinated solvents and BTEX. The results illuminated the potential of the MFC sensor system to provide real-time data for electron donor availability, biological conditions, and biomass productivity in soil systems for efficient and inexpensive monitoring of in situ bioremediation.

Microbial Fuel Cell Technology for Bioremediation
Tront, J.M., M. Ploetze, A. Puzrin, J.D. Fortner, and J. Hughes.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper B-020, 8 pp, 2008

A novel approach for in situ monitoring of electron donor concentration and microbial respiration rate involves the use of microbial fuel cells (MFCs) to measure respiration rate via the quantity of electricity produced. The ability of the MFC to provide meaningful information about in situ microbial respiration and analyte concentration was examined in column systems, where Geobacter sulfurreducens or Shewanella oneidensis used an external electron acceptor (an electrode) to metabolize acetate or lactate, respectively. Column systems were operated with influent media at varying concentrations of the electron donor acetate and monitored for current generation. Current generation was mirrored by bulk phase electron donor concentration, and correlations between electron donor concentration and current produced were developed. The electrical signal produced by the MFC system provided real-time data for electron donor availability and biological activity. These results have practical implications for development of a biosensor for inexpensive real-time monitoring of in situ bioremediation processes, where MFC technology provides information on the rate and nature of biodegradation processes.

The electricity produced during these processes could be stored or use for internal powering or other sensing application(s), thus expanding the applicability of the MFC-based sensor.

Microcosms as a Screening Tool for PCB Bioremediation

Krumins, V., J.-W. Park, L. Kerhkof, L. Totten, M. Haggblom, and D. Fennell, Rutgers Univ.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract I-023, 2008

Sediment microcosms were used to evaluate the potential for bioremediation of PCBs and chlorinated pesticides (CP) at two contaminated sites, a freshwater impoundment in the New Jersey Meadowlands (Kearny Marsh) and a tidal freshwater waterway in Washington, DC (the Anacostia River). Sediments at both sites contain a variety of organic and inorganic contaminants, including ~1 to 2 mg/kg dry weight total PCBs. Microcosms containing 200 mL site sediment were maintained under anaerobic conditions in the dark at 26 +/- 1 degrees C. Electron acceptors, haloprimers (25 uM tetrachlorobenzene or pentachloronitrobenzene), or bioaugmentation with Dehalococcoides ethenogenes strain 195 were introduced as amendments. These treatments are being evaluated for their effectiveness in increasing the population and activity of PCB dechlorinators for bioaugmentation as an in situ bioremediation option. The haloprimers were dechlorinated in the first 60 days. Pentachloronitrobenzene stimulated PCB dechlorination in the Anacostia sediment, with and without bioaugmentation. Tetrachlorobenzene stimulated dechlorination the Kearny Marsh sediment, but to a lesser extent. Polymerase chain reaction (PCR) primer sets were developed to detect 16S rRNA genes and functional genes from Dehalococcoides (-like) species in the sediments. Twelve primers sets targeted the genes that code for reductive dehalogenases (RDHs), the key enzymes for dechlorination. Various PCR-based techniques were used to detect and quantify the relative amounts of the RDH genes and thus their correlation to PCB dechlorination activity in the different sediments. Several RDH genes were detected in unamended sediment from both sites. Stimulation of the native populations with haloprimers increased incidence of several RDH genes.

Monitoring Groundwater Characteristics by Means of a Multi-Parametric Probe and Sampling Device

Conte, G., D. Scaradozzi, G. Vitaioli, M. Rosettani, S. Franca, A. Toccaceli, and A. Dell'Anno, Univ. Politecnica delle Marche, Italy.
EESMS 2009: IEEE Workshop on Environmental, Energy, and Structural Monitoring Systems, 25 Sep 2009, Crema, Italy. IEEE, ISBN: 978-1-4244-4847-0, p 50-57, 2009

A prototypal system for in situ analysis of groundwater bodies consists of a probe equipped with sensors, a water sampling device, and a control unit connected though an umbilical. This novel system has innovative features in the mechatronic design and control and data processing architecture. Owing to its modularity, the probe can be assembled in different configurations to fit the user's requirements and the dimensions of the inspection well. The system self-organizes itself according to the chosen configuration and can implement different auto-diagnostic procedures that improve reliability when analyzing the collected data. Using fuzzy reasoning, the system can provide a rough first evaluation of the quality of the monitored groundwater body to support system operation and decision making. From remote locations via the Internet, the system can be operated by two different m/m interfaces, a simpler one for routine use and a more powerful one for greater interactivity.

Monitoring of Leachate Recirculation in a Bioreactor Landfill by 2-D Electrical Resistivity Imaging
Grellier, S., R. Guerin, H. Robain, A. Bobachev, F. Vermeersch, and A. Tabbagh.
Journal of Environmental and Engineering Geophysics, Vol 13 No 4, p 351-359, 2008

Temporal variations of waste electrical resistivity during leachate recirculation in a bioreactor landfill are linked mainly to water and ionic content variations. Two-dimensional electrical resistivity imaging monitoring was carried out at a municipal solid waste landfill using a multi-channel resistivity meter to follow transient resistivity variations during leachate recirculation in the waste mass. Resistivity variations mainly corresponded to variations in water content and to temperature variations resulting from the injection of cold leachate into the warm waste mass. Laboratory experiments can be used to calibrate water content variations in the waste as a function of variations in electrical resistivity. Although such an approach is realistic for short measurement periods (hours), it is not reliable over longer time periods (months) because other parameters, such as biodegradation of the waste, can influence its electrical resistivity.

Monitoring the Removal of Phosphate from Ground Water Discharging through a Pond-Bottom Permeable Reactive Barrier
McCobb, T.D., D.R. LeBlanc, and A.J. Massey.
Ground Water Monitoring and Remediation, Vol 29 No 2, p 43-55, 2009

Installation of a permeable reactive barrier (PRB) to intercept a phosphate plume where it discharges to a pond provided an opportunity to develop and test methods for monitoring the barrier's performance in the shallow pond-bottom sediments. The barrier is composed of zero-valent iron mixed with the native sediments to a 0.6-m depth over a 1,100-m^2 area. Permanent suction, diffusion, and seepage samplers were installed to monitor phosphate and other chemical species along vertical transects through the barrier and horizontal transects below and near the top of the barrier. Analysis of pore water sampled at about 3-cm vertical intervals using multilevel diffusion and suction samplers indicated steep decreases in phosphate concentrations in groundwater flowing upward through the barrier. Samples from vertically aligned pairs of horizontal multiport suction samplers also indicated substantial decreases in phosphate concentrations and lateral shifts in the plume's discharge area as a result of varying pond stage. Measurements from Lee-style seepage meters indicated substantially decreased phosphate concentrations in discharging groundwater in the treated area; temporal trends in water flux were related to pond stage. The advantages and limitations of each sampling device are described. Preliminary analysis of the first two years of data indicates that the barrier reduced phosphate flux by as much as 95%.

Morphological Distribution of Hexavalent Chromium in the Soils Contaminated by Chromite Ore Processing Residue from Qingdao Hongxing Chemical Plant
Sun, Y. (Qingdao Technological Univ., Qingdao, China), S. Jing, and Z. Ruofan.
ESIAT 2009: Proceedings of the 2009 International Conference on Environmental Science and Information Application Technology, 4-5 July 2009, Wuhan China.
IEEE Computer Society, P3682, ISBN: 9780769536828, Vol 3, p 594-597, 2009

Soil samples contaminated with chromite ore processing residue (COPR) were analyzed using a modified BCR sequential extraction procedure to determine the chemical speciation of hexavalent chromium in soil from an industrial facility. Results indicated that the water-soluble species of hexavalent chromium was the chief component of total hexavalent chromium in the soil, which led the investigators to suggest remediation via a soil washing/flushing agent.

MTBE, TBA, and TAME Attenuation in Diverse Hyporheic Zones
Landmeyer, J.E., P.M. Bradley, D.A. Trego, K.G. Hale, and J.E. Haas II.
Ground Water, Vol 48 No 1, p 30-41, 2009

Four sites investigated on Long Island, NY, were characterized by groundwater contaminated with gasoline and fuel oxygenates (MTBE, TBA, and TAME) that ultimately discharge to fresh, brackish, or saline surface water. For each site, contaminated groundwater discharge zones were delineated using porewater geochemistry data from 15 ft (4.5 m) beneath the bottom of the surface water body in the hyporheic zone, and seepage-meter tests were conducted to measure discharge rates. These data when combined indicate that MTBE, TBA, and TAME concentrations in groundwater discharge in a 5-foot (1.5-m) thick section of the hyporheic zone were attenuated between 34 and 95%, in contrast to immeasurable attenuation in the shallow aquifer during contaminant transport between 0.1 and 1.5 miles (0.1 to 2.4 km). The attenuation observed in the hyporheic zone occurred primarily by physical processes, such as mixing of groundwater and surface water. Biodegradation also occurred as confirmed in laboratory microcosms by the mineralization of U-(14)C-MTBE and U-(14)C-TBA to (14)CO(2) and the novel biodegradation of U-(14)C-TAME to (14)CO(2) under oxic and anoxic conditions. The implication of fuel oxygenate attenuation observed in diverse hyporheic zones suggests that an assessment of the hyporheic zone attenuation potential (HZAP) merits inclusion as part of site assessment strategies associated with monitored or engineered attenuation.

A Multi-Sensor Approach for Monitoring River Chemical Tank Barge Emissions
Williams, D.J. and E. Thoma.
Defence, Security, and Sensing Conference, Orlando, FL, 13-17 April 2009. Proceedings of SPIE--the International Society for Optical Engineering, 2009

Monitoring for tank barge emissions to locate leaking barges and fix them, as well as determine or verify barge contents, must be cost effective and accurate. The use of field-deployable infrared spectrometers and open-path and passive devices, together with specialized thermal imaging cameras, has proven effective for locating leaking barges, determining the chemical(s) being released, and quantifying the emissions, defined as calculating the mass of the release per unit time. FTIR spectrometers were deployed in a radial plume mapping configuration to measure area emissions from the barges. Emissions also were measured at the source of the leak (e.g., barge hatch covers) using passive FTIR spectroscopy and specialized thermal imaging cameras that observed the plume as moving video. Verification of the remote sensing measurements was accomplished by measuring the leak flow rate using a leaking component encapsulation technique and by chemical analysis of canister samples in the laboratory. This presentation describes the findings of the study and the implications to port security applications.

Multidisciplinary Characterization of Chloroethene Subsurface Contamination in Sedimentary Bedrock

Machackova, J., Z. Wittlingerova, S. Trapp, and M. Larsen.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-008, 2008

The North Bohemia Carcass Disposal Plant (SAP) Mimon is one of the largest and most intensive areas of soil and groundwater chloroethene contamination in the Czech Republic. PCE was used in operations at the SAP Plant from 1963 to 1988 at the rate of 160 to 200 tons per year, and frequent leaks caused a large chloroethene plume in to form in the sandstone aquifer, spreading downgradient from the factory in the dominant groundwater flow direction. Plume migration was accelerated by pumping of water supply wells downstream from the source area. Contamination of these drinking water supply wells was discovered in 1988 as the first indication of contamination from the site. The total quantity of PCE released was estimated to range from 149 to 246 tons, with a confidence interval of 95%. The maximum contamination levels were identified between 2 and 20 meters depth in an area of about 10 hectares, in Quaternary sediments and weathered Cretaceous sandstones. The plume was found to be impacting the neighboring river. Ten years (1997-2007) of intensive pump and treat was applied at the site, which extracted ~100 tons of PCE, and reduced the plume extent to less than 1 hectare. A combination of investigative methods was applied at the site in 2005-2007 to obtain more detailed information about contamination stratification and DNAPL distribution in the sedimentary bedrock. The methods used were groundwater sampling from multi-level sampling points, soil probing with MIP, tree core sampling, geophysical methods, and soil core testing with hydrophobic dye. An innovative method of tree core sampling was used to detect chloroethenes in wood samples, which very precisely delineated groundwater contamination in the shallow aquifer. The survey revealed that sedimentary structures highly influenced DNAPL migration in the relatively homogenous sandstone bedrock. This finding led to creation of a new conceptual model of the site, which will be used in determining the final cleanup step.

Multisensor Approach to Operational Oil Pollution Monitoring in Coastal Zones

Olga, L., M. Marina, B. Tatiana, K. Andrey, and K. Vladimir, Space Res. Inst., RAS, Moscow.

IGARSS 2008: IEEE International Geoscience and Remote Sensing Symposium, 7-11 July 2008, Boston, MA. IEEE International, ISBN: 978-1-4244-2807-6, Vol 3, p III-1386 - III-1389, 2009

A new approach to operational oil pollution monitoring in coastal zones consists of the use of visual and infrared (IR) remote sensing data to supplement SAR data. This paper discusses results of satellite monitoring campaigns based on this approach and conducted in the framework of national and international projects in the Black, Azov, and Baltic Seas. The campaigns provided data for the study of hydrodynamic processes in the regions, particularly for the detailing of water circulation mechanisms. The effect of water circulation patterns on the dynamics of oil pollution is investigated.

Multiple-Increment TCE Vadose Zone Investigation
Hewitt, A.D. and S.R. Bigl (U.S. Army ERDC-CRREL); C.A. Ramsey (EnviroStat Inc.).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-012, 2008

A study was conducted at a site where an underground tank positioned above a concrete pad was used to store TCE for 12 years. An odor of TCE was evident during excavations when the original tank, a replacement tank used for fuel oil, and the concrete pad were removed from the site. The extent of contamination was quantified a few years later, using over 500 discrete samples to define the zone with the highest concentrations (sometimes exceeding 1% wt/wt of TCE). The highly contaminated zone was a 3,000 cubic m volume measuring 11 m x 22 m in surface area and 12 m deep. In 2006, both multi-increment and discrete sampling strategies were used to estimate the average concentration and the 3-D distribution of TCE in the zone of interest. A total of 188 discrete and 41 multi-increment samples were obtained for the evaluation. Each discrete sample was an individual 5-g (~3 cc) plug of soil. The majority of the multi-increment samples contained 40 of the 5-g soil plugs. The multiple increments were combined in two ways, within an individual borehole and within 0.6-m subsurface depth intervals. Both sampling strategies established similar average TCE concentrations, but the discrete sample average was heavily influence by a single sample with a concentration very different from the rest. More importantly, the discrete sampling strategy failed to identify two layers in a soil boring where the TCE concentrations exceeded 1% w/w. This omission could lead to a gross underestimation of the contamination mass (volume with >1% TCE), which could trigger a false negative action, or the improper design and subsequent low cost estimation for remedial technologies. The study also identified large economical advantages to using the multi-increment sample strategy and combining the increments in two directions, which inherently establishes two independent values, allowing for quality assurance data confirmation. The multi-increment sampling also allows for more increments (and sample mass) from the zone under investigation to be included in the analysis, for no additional cost other than that of the solvent. Results indicate that this sampling strategy is well suited for identifying the location of high concentrations of TCE and likely many other VOCs in subsurface zones.

Natural Attenuation Rates as part of Conceptual Model-Based Performance Monitoring for TCE and 1,2-DCA Plumes
Hall, B.L., K.A. Gorder, P.A. EerNisse, and D.S. Oliver.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-005, 2008

Hill AFB has developed a decision framework for evaluating treatment system performance that ties geosystem response to the evolution of the conceptual model for the site. For Operable Unit 8, this framework includes assessing the performance of two groundwater extraction systems and their impact on the plume dynamics for one on-Base TCE plume and two off-Base plumes, commingled TCE and 1,2-DCA. A process has been developed for verifying that the actual natural attenuation (NA) rates for the three plumes, in conjunction with mass removal from the extraction systems, are adequate to prevent expansion. The process is also useful for estimating cleanup timeframe. Estimates based on results from 2000 through 2007 suggest that the total dissolved-phase mass of all three plumes is decreasing and the position of the center of mass is not changing. The NA rates, estimated using Sen's method, and changes in mass between 2000 and 2006, are excellent indicators of the calculated mass in 2007. Total dissolved-phase mass (TotM) and center of mass (COM) estimates for the plumes were developed using a system of Theissen polygons, which assign a volume of the aquifer to each of a network of monitoring wells. The wells were selected to identify a polygon grid sensitive enough to measure changes in the plume, while minimizing sampling and analysis costs for the life of the plume. Once the polygon grid is defined, the exercise of estimating TotM and COM for any sampling event uses a simple spreadsheet calculation, with a Mann-Kendall test to identify any significant trend in the changes over time and Sen's method to estimate the rate of change of mass if there is a trend. The on-Base TCE plume is ~6,700 ft long, 300 acres, and represented by 29 polygons. The off-Base TCE plume is ~7,000 ft long, 300 acres, and represented by 26 polygons. The off-Base 1,2-DCA plume is ~9,000 ft long, 350 acres, and represented by 32 polygons. Estimated NA rates for the three plumes using Sen's method are 45, 68, and 37 kg/year, respectively. The performance monitoring plan for OU-8 includes tracking TCE degradation products and NA indicators to confirm that some of the attenuation can be attributed to chemical transformation, with the expectation that degradation products and indicators will be present and distributed across the plumes at consistent levels. The investigators have verified that NA rates, combined with groundwater extraction, are adequate to prevent expansion of the OU-8 plume, and they are using rate estimates to refine estimates of cleanup timeframe.

A Novel Method for In Situ Measurement of Oxidation Reduction Potential
Farone, W.A. and T. Palmer, Applied Power Concepts, Inc., Anaheim, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-041, 6 pp, 2008

Every chemical and biochemical reduction oxidation (redox) obeys the thermodynamic relationship that connects the concentration of the oxidized and reduced species with the oxidation-reduction potential (ORP), the pH, and the equilibrium constant for the reaction. In many sets of data for either chemical or biological remediation, this relationship is not used to test for the validity of data; consequently, much faulty data is used and accepted. In any solution, the ORP (pE) and pH are related to the various redox pairs of chemicals in the solution. One of the main problems with testing thermodynamic consistency is the difficulty of obtaining accurate and precise ORP measurements in situ. A method has been developed to measure ORP that appears to offer significant advantages over probes and extracted samples. The method uses organic dyes that can function as ORP indicators similar to way in which dyes function as pH indicators. The dyes are embedded in a gel matrix that can be placed in the system to be measured in either lab or field. The liquid being measured causes the change in the matrix, and the chemical reaction is slow to revert when the dye-gel is removed from the liquid, which allows stable readings to be made. For qualitative assessment similar to pH paper, the dyes are arranged such that the ones that change color provide an estimate of ORP. For more accurate measurements, the colors are read with a spectrophotometer. Many of the dyes exhibit changes in the intensity of the color as a function of ORP such that a routine absorbance measurement gives a precise value for the ORP. This system can be used to cover the entire range of ORP from below -500 mv to above +600 mv. Different dyes cover different ranges, and the results for different dyes are presented with the method for preparing and using the gel base to contain the dyes. For additional information, see U.S. Patent Application 20050112772, "Measurement of oxidation-reduction potential of a solution." http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=1&u=%2Fnetahtml%2FPTO%2Fsearch-bool.html&r=1&f=G&l=50&co1=AND&d=PG01&s1=20050112772&OS=20050112772&RS=20050112772

Novel Method for the Direct Visualization of in Vivo Nanomaterials and Chemical Interactions in Plants
Wild, E. and K.C. Jones.
Environmental Science & Technology, Vol 43 No 14, p 5290-5294, 2009

This paper describes how two-photon excitation microscopy coupled with plant, nanomaterial, or chemical autofluorescence can be used to detect and visualize multiwalled carbon nanotubes (MWCNTs), titanium dioxide, and cerium dioxide in living wheat tissues. The potential of the technique to track chemical/nanomaterial interactions in living tissues was demonstrated using phenanthrene as a model compound. MWCNTs were observed to pierce wheat root cell walls and enhance the transport of phenanthrene into the living cells. This paper highlights the ability of this technique to monitor in vivo nanomaterial behavior in real time, as well as the technique's potential applications and limitations for use in several disciplines.

Novel Sensor for the Identification and Quanitation of Engineered Nanomaterials
Sadik, O.A., S. Kikandi, Q. Wang, and K.E. Varner.
SETAC Europe 19th Annual Meeting, Goteborg, Sweden, 31 May - 4 June 2009

According to the U.S. National Nanotechnology Initiative (NNI), nanomaterials encompass a wide variety of materials that have at least one dimension in the 1- to 100-nm range. The NNI perceives a need to develop useful approaches to identify and categorize nanomaterials by size, composition, and morphology. Relevant properties that could be measured include characteristics such as purity, particle size and distribution, shape, crystal structure, composition, surface area, surface chemistry, surface charge, surface activity, and porosity. A broad array of analytical tools and methods is needed to perform such characterizations, including a variety of optical, microscopic, spectroscopic, chromatographic, and nuclear methods. Conventional methods for assessing the properties and characteristics of raw nanomaterial focus on the size distribution and effects, but they are unsuitable for environmental monitoring involving detection and quantification. The creation of new instruments or approaches or further development of existing tools is necessary to obtain these underlying data and the resulting effects on human health and the environment. This presentation focuses on the development of a novel Quartz crystal microbalance (QCM)-based sensor for fullerenes. The sensor should be capable of distinguishing between engineered nanomaterials (e.g., hybrid organic metal nanoparticles, carbon-based nanomaterials), and naturally occurring nanomaterials (e.g., dead bacteria, living bacteria, spores, viral components, or fungi) present in the environment.

Numerical and Experimental Mapping of Root Zone Using Surface and Borehole Resistivity Tomography
al Hagrey, S.A. and T. Petersen.
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

Better mapping of roots and monitoring of plant establishment is needed for a variety of uses, such as agriculture, environmental restoration, and phytoremediation. Generally, roots can be divided in soft, fine branches that cause electrically conductive anomalies and thick, isolated branches that produce electrically resistive anomalies within the soil material. Electrical resistivity tomography at the ground surface and in boreholes allows mapping root zones. The resolution generally increases by increasing number of measurements and accordingly the time and costs. The authors numerically tested different non-standard, standard, and a new approach of optimized electrode configurations in different survey designs. The resolution of the different configurations was studied to find the optimum dataset of practical size and high resolution. Forward and inverse modeling of different setups were applied on 2-D models of the root zone with conductive/absorbing and resistive/transporting roots, respectively. The best resulting models are discussed as a function of the different applied configurations and survey designs.

Object Oriented Oil Spill Contamination Mapping in West Siberia with Quickbird Data
Hese, S. and C. Schmullius, Friedrich-Schiller Univ., Jena.
Object-Based Image Analysis. Springer, Berlin. ISBN: 978-3-540-77057-2, Chapter 4.1: p 367-382, 2008

This paper presents concepts for an object-based mapping and classification system for terrestrial oil spill pollution in West Siberia using Quickbird data. An object-oriented classification system is created to map contaminated soils and vegetation using spectral information, shape, and context information. Due to the limited spectral resolution of Quickbird data, context information is used as an additional feature. The distance to industrial land use and infrastructure objects is utilized to increase the classification accuracy. Validation of the results is done with field data from the Russian partners at the Yugra State University in Khanty-Mansiyskiy.
http://www.commission4.isprs.org/obia06/Papers/19_Automated%20classification%20IC%20II%20-%20Geology,%20Soil,%20Natural%20Resources/OBIA2006_Hese_Schmullius.pdf

Off-Site Source Identification Using Modified Waterloo Profiler
Eccarius, B., U. Desery, G. Demers, and M. Ravella.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper F-015, 5 pp, 2008

Potential areas of concern at an active industrial site in Germany were investigated over a period of three years using various tools--soil borings, active soil gas samples, traditional groundwater monitoring wells, and membrane interface probe borings--in unsuccessful attempts to identify the source of the chlorinated volatile organic compounds (CVOCs) in the groundwater. Subsequently, a dynamic investigation employed an Modified Waterloo Profiler and a mobile on-site laboratory to investigate two groundwater transects perpendicular to groundwater flow. During the profiler investigation, high-resolution data were gathered through continuous index of hydraulic conductivity readings that were collected and interpreted in real time with discrete interval groundwater samples. Analyses for CVOCs in the on-site laboratory indicated that the contamination is divided into a shallow and a deep plume. The source of CVOC contamination could be located off site, on an upgradient property, supported by higher off-site CVOC concentrations than those on site. The percentage of the degradation products also increased toward the site. The cross-sectional site conceptual model developed using the Modified Waterloo Profiler showed more information and evidence than would have been possible with standard investigation approaches, in a fraction of the time.

Offshore Stand-Off Oil Spill Monitoring Using Passive Optical Imaging
Shih, W.-C., A.B. Andrews, and M. Clayton.
Advanced Environmental, Chemical, and Biological Sensing Technologies VI. Proceedings of SPIE--The International Society for Optical Engineering, Vol 7312, 2009

A dual-band optical imaging scheme has been implemented for offshore stand-off oil spill monitoring using visible and long-wave-infrared (LWIR) cameras. Based on differences in intrinsic optical properties, the visible cameral provides daytime images and monitoring capability as if observed by human personnel. The LWIR camera provides both day and night monitoring capabilities based on additional thermal and emissivity contrasts. The feasibility of the scheme has been demonstrated at various testing sites and under a variety of ambient conditions. An analytical model has been developed to explain observed oil/water contrast. Limitations in the dual-band scheme are noted using detection boundary analysis and experimental examples. This scheme can provide robust and cost-effective offshore stand-off oil spill monitoring.

Paper Strips Can Quickly Detect Toxin In Drinking Water
University of Michigan News Service, 8 Jan 2010

A strip of paper infused with carbon nanotubes can detect a toxin produced by algae in drinking water quickly and inexpensively. Engineers at the University of Michigan working in collaboration with scientists at Jiangnan University, Wuxi, in China have developed the new biosensor. The paper strips perform 28 times faster than the complicated method most commonly used today to detect microcystin-LR, a chemical compound produced by cyanobacteria (blue-green algae) commonly found in nutrient-rich waters. Microcystin-LR (MC-LR) and others like it are believed to be the culprits of mass poisonings going back to early human history. Water treatment plants--even in developed countries--can't always remove MC-LR completely, nor can they test for it often enough. The biosensor developed provides a quick, cheap, portable, and sensitive test that could allow water treatment plants and individuals to verify the safety of water on a more regular basis. The technology could easily be adapted to detect a variety harmful chemicals or toxins in water or food. The sensor works by measuring the electrical conductivity of the nanotubes in the paper. Before the nanotubes are impregnated in the paper, they are mixed with antibodies for MC-LR. When the paper strips come in contact with water contaminated with MC-LR, those antibodies squeeze between the nanotubes to bond with the MC-LR. This spreading apart of the nanotubes changes their electrical conductivity, which is measured by an external monitor. The whole device is about the size of a home pregnancy test, and results appear in fewer than 12 minutes. To adapt the biosensor for other toxins, scientists could simply replace the antibodies that bond to the toxin. The university is pursuing patent protection for the intellectual property, and is seeking commercialization partners to help bring the technology to market. A paper about the technique was published in Nano Letters 9(12):4147-4152(2009), "Simple, Rapid, Sensitive and Versatile SWNT-Paper Sensor for Environmental Toxin Detection Competitive with ELISA." Abstract and purchasing opportunity for the paper at http://pubs.acs.org/doi/abs/10.1021/nl902368r

Passive Flux Meter (PFM) Monitoring of Hydraulic and Contaminant Flux during NZVI Treatment of cVOCs

Baltz, K.J., R.S. Keenan, and N. Conrey.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-027, 2008

A pilot study was conducted at a former dry cleaning facility to evaluate the use of passive flux meter (PFM) technology for monitoring hydraulic and contaminant flux during nanoscale zero-valent iron (NZVI) treatment of chlorinated VOCs. Five monitoring wells were installed to house the PFMs within a treatment cell centered around an operating groundwater extraction well. Flux meters were deployed at the five locations prior to NZVI injection in June 2006 and ~3 months afterward, and subsequently were analyzed to determine hydraulic and contaminant flux. For comparison, pre- and post-injection groundwater monitoring also was completed at surrounding monitoring and injection wells using conventional groundwater sampling techniques. The use of the flux meters enabled the identification of zones of relatively low permeability in the treatment cell created by the NZVI injection and resulting changes in the contaminant flux in response to lower permeability zones. One flux meter actually intercepted DNAPL during the pilot study, a conclusion drawn from contaminant flux information. This presentation offers an overview of PFM technology; field application procedures, including deployment, retrieval, and flux meter analysis to determine hydraulic and contaminant flux; and interpretation of results. The flux meter monitoring results combined with point sampling data allowed a greater understanding of changes in the treatment cell hydrogeology following NZVI injection, contaminant migration, and NZVI treatment effectiveness than conventional groundwater monitoring alone would have provided. The PFM technology was developed and patented at the University of Florida.

Petroleum Vapour Model Comparison

Davis, G.B., M.G. Trefry, and B.M. Patterson, CSIRO Land and Water.

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment, Adelaide, Australia. Technical Report 9, ISBN: 978-1-921431-00-5, 32 pp, 2009

This paper offers a critical comparison of the attributes of two primary models used in vapor intrusion studies: Turczynowicz and Robinson (2003, etc.) and variants, and Johnson and Ettinger (1991, etc.) and variants. This paper describes the processes underlying vapor behavior and compares the two models for their utility in modeling petroleum vapors in soil profiles and as they move from the subsurface into built structures.
http://www.crccare.com/publications/technical_reports/index.html

The PHASED Micro Gas Analyzer (MGA): An Emerging Technology for Vapor Intrusion Monitoring

Hinchee, R.E., D. Burris, M. Rhodes, and K. Gorder.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-021, 2008

Effectively identifying and characterizing the migration of hazardous vapors from below ground into buildings is costly and at present inefficient. The current approach for obtaining vapor samples uses Summa canisters, which are sent to the laboratory for analysis by (typically) GC/MS. Samples usually are collected from only one location or a limited number of locations in a structure and, at most, on a quarterly basis, more commonly annually. This approach yields a small number of samples collected once or infrequently over an extended period of time. The PHASED MGA is an emerging technology for vapor intrusion monitoring that integrates a fully functional gas chromatograph with sample preparation, detection, and analysis. The heart of the system is the PHASED chip. Detection is accomplished using a micro-discharge detector, producing an optical discharge that is monitored with a simple spectrometer. Results of testing using the PHASED MGA have shown very good chromatographic resolution for TCE, even in complex mixtures such as gasoline vapor. A TCE detection limits of 2 ug/m3 (0.4 ppbv) has been demonstrated to date with a sample turnaround time of ~10 minutes. The authors are working to develop this technology, and results are presented.

Phytoremediation and Phytosensing of Chemical Contaminants, RDX and TNT: Identification of the Required Target Genes

Rao, M.R., M.D. Halfhill, L.G. Abercrombie, P. Ranjan, J.M. Abercrombie, J.S. Gouffon, A.M. Saxton, and C.N. Stewart Jr.

Functional & Integrative Genomics, Vol 9 No 4, p 537-547, Nov 2009

Although phytoremediation is viewed as a cost-effective means of decreasing the levels of high explosives, such as RDX and TNT, in contaminated soil, insufficient information has been gathered about how plants respond to explosives, especially in the steady state. Microarray analysis was conducted on *Arabidopsis thaliana* grown in Murashige and Skoog media containing steady-state levels of RDX (0.5 mM) or TNT (2.0 uM) to study the effect of these compounds on *A. thaliana*'s transcriptional profile. Results for both compounds were consistent with the existing theory for xenobiotic metabolism in plants. Oxidoreductases, cytochrome P450s, transferases, transporters, and several unknown expressed proteins were among the genes that were differentially expressed. The authors discuss the potential role of upregulated genes in plant metabolism, phytoremediation, and phytosensing. Phytosensing, the detection of field contamination using plants, is an end goal of this project.

Paper at http://plantsciences.utk.edu/pdf/stewart_rao_%20FIG_%202009.pdf

Pore-Scale Characterization of Residual Non-Aqueous Phase Liquids (NAPLs) in Fractional Wettability Porous Media
Al-Raoush, R.I.
World Environmental and Water Resources Congress 2009: Great Rivers. ASCE, Reston, VA. ISBN: 978-0-7844-1036-3, p 1-10, 2009

In an investigation of the impact of wettability of porous media on pore-scale characteristics of residual NAPLs, synchrotron X-ray microtomography was used to obtain high-resolution 3D images of fractional wettability sand systems. Pore-scale characteristics of NAPL blobs, such as volumes, lengths, interfacial areas, and shape factors, were computed from the 3D images. Four systems of different NAPL/wet-mass fractions containing the residual NAPL were imaged and analyzed. In systems comprising 100, 50, 25, and 0% NAPL/wet-mass fractions, residual NAPL saturations were 0.125, 0.067, 0.083, and 0.121; mean blob volumes normalized by the volume of a sphere with mean grain diameter were 0.97, 1.23, 1.93, and 2.39; normalized mean blob interfacial areas were 43.75, 35.86, 34.25, and 30.88/mm; and mean sphericity index values were 0.216, 0.262, 0.455, and 0.569, respectively. Findings showed that spatial variation in the wettability of porous media surfaces has a significant impact on pore-scale characteristics of residual NAPL blobs in saturated porous media systems.

The Power of Combining Rapid Screening Technologies with Environmental Visualization Software (EVS) to Guide Remediation
Rebele, L.M., Brown and Caldwell, Irvine, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-033, 8 pp, 2008

Rapid, in situ screening technologies for characterizing the lateral and vertical extent of contamination in the subsurface include the Rapid Optical Screening Tool (ROST) and the membrane interface probe (MIP). These powerful tools provide semi-quantitative data that can be used for lithologic and contaminant mapping purposes. While these technologies cannot be used exclusively for site characterization due to their semi-quantitative nature, the large amount of data collected from these cost-effective technologies can enhance knowledge of the subsurface beneath a project site, particularly when these data are calibrated using laboratory analytical results of site soil sampling. The value of rapid screening data can be enhanced through the use of EVS. EVS can visualize data in 3-D through dynamic rotation, translation, and zooming, thus emphasizing the characteristics of interest in the data set. More importantly, through data analysis, EVS can build "best fit" variograms on which the Kriging algorithm can be employed to interpolate and extrapolate between data points to produce 3-D maps of geologic structure and/or chemical constituents in the subsurface. The plume maps derived by EVS not only honor the measured data points, but also address the uncertainty associated with the estimated plume distribution. EVS can estimate plume areas, volumes, and contaminant mass, and is capable of integrating data from different formats, including tabular geographic information systems (GIS) shape files, computer aided design (CAD) files, and imagery data, as well as georeferencing data. The combination of these tools and software elements can enhance understanding of a project site. The outputs of EVS are often powerful visual aids for use in regulatory negotiations, litigation support, remedial technology selection, design, and performance monitoring.

Prediction of Groundwater Quality Improvement Down-Gradient of In Situ Permeable Treatment Barriers and Fully Remediated Source Zones: Estimation Tool [User's Manual]
Johnson, P.C., Arizona State Univ.
ESTCP Project ER-0320, 11 pp, Dec 2008

DGCHANGE v1.0 estimates dissolved contaminant concentration reductions with time in near-field monitoring wells downgradient of permeable reactive barriers (PRBs). In this spreadsheet-based tool, the aquifer is represented as a series of horizontal layers and the user enters layer-specific aquifer characteristics. The output is presented graphically in three main formats: a) a cross-section snapshot of dissolved concentrations along the groundwater flow path at some user-specified time, b) a table of dissolved concentrations vs. time in each layer at some user-defined downgradient location, and c) a plot of expected monitoring well dissolved concentration vs. time at some user-defined downgradient location for layer thickness- and layer discharge-weighted averages. The underlying fundamental basis and governing equations upon which DGCHANGE v1.0 is based are described in Appendix A of this document. The appendix provides a step-by-step user's guide for DGCHANGE v1.0 and is organized by each of the tool's four worksheets with a focus on model inputs, a cross-section snapshot, and changes with time at a monitoring well. DGCHANGE v1.0 was developed as part of ESTCP Project ER-0320, "Prediction of Groundwater Quality Down-Gradient of In Situ Permeable Treatment Barriers and Fully Remediated Source Zones," and its application is illustrated in the final report for that project. The following link is for both the brief User's Guide and the Estimation Tool: http://www.estcp.org/Technology/DGCHANGE/index.html

Preliminary Investigation of Perchloroethylene (PCE) Groundwater Plume Using a Passive Soil Gas Survey
Clarke, J.N., D. Goodwin, H. O'Neill, and J.E. Odencrantz.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-022, 5 pp, 2008

The costs to identify chlorinated solvent source and plume migration patterns can be extremely high. The costs for an investigation increase with the number and depth of borings and the number of samples that are collected and analyzed. Passive soil gas (PSG) surveys have been used cost effectively at several Arizona sites to investigate VOC impacts to groundwater and identify potential sources of impact. PSG surveys are minimally intrusive, and more samples can be collected for the same cost when compared to active soil gas surveys and conventional soil and groundwater sampling programs. This approach gains a surficial representation of the contaminant plume and the location of "hot spots," which are the potential sources, thus providing a better understanding of the nature and extent of the impact and allowing for a focused subsurface investigation, which subsequently reduces drilling and sampling costs.

Preliminary Results for Oil on the Bottom Detection Technologies
Hansen, K.A., J. Bello, S. Clauson, R. Camilli, B. Bingham, M.T. Eriksen, E. Maillard, J. Morris, and P. Loey.
Proceedings of the 31st Arctic and Marine Oilspill Program (AMOP) Technical Seminar on Environmental Contamination and Response (June 2008), p 713-740, 2008

The Coast Guard R&D center has embarked on a multi-year project to develop a complete approach for spills of submerged oils. This paper describes the preliminary assessment of using sonar, laser fluorometry, real-time mass spectrometry, and in situ fluorometry to locate oil sitting on the bottom. Evaluation of proof-of-concept devices was conducted at Ohmsett between November 2007 and February 2008. Preliminary data and assessments are provided in the paper. Additionally, the technologies are illustrated in 35 presentation slides at http://www.epa.gov/oem/docs/oil/fss/fss09/hansen.pdf
http://www.crrc.unh.edu/submerged_oil/amop_hansen_2008.pdf

Quantification of Vapour Intrusion Pathways into a Slab-on-Ground Building under Varying Environmental Conditions
Patterson, B.M. and G.B. Davis.
Environmental Science & Technology, Vol 43 No 3, p 650-656, 2009

Potential hydrocarbon-vapor intrusion pathways into a building through a concrete slab-on-ground were investigated and quantified under a variety of environmental conditions to elucidate the potential mechanisms for indoor air contamination. Vapor discharge from the uncovered open ground soil adjacent to the building and subsequent advection into the building was unlikely due to the low soil-gas concentrations at the edge of the building due to aerobic biodegradation of hydrocarbon vapors. When the building's interior was under ambient pressure, the investigators noted a flux of vapors into the building due to molecular diffusion of vapors through the building's concrete slab (cyclohexane 11 and methylcyclohexane 31 mg/m2 concrete slab/day) and short-term (up to 8 h) cyclical pressure-driven advection of vapors through an artificial crack (cyclohexane 4.2 x 103 and methylcyclohexane 1.2 x 104 mg/m2 cracks/day). The average subslab vapor concentration under the center of the building was 25,000 ug/L. Based on the measured building's interior vapor concentrations and the building's air exchange rate of 0.66/h, diffusion of vapors through the concrete slab was the dominant vapor intrusion pathway, and cyclical pressure exchanges resulted in a near-zero advective flux. When the building's interior was under a reduced pressure (-12 Pa), advective transport through cracks or gaps in the concrete slab (cyclohexane 340 and methylcyclohexane 1,100 mg/m2 cracks/day) was the dominant vapor intrusion pathway.

Quantifying DNAPL Compounds in the Subsurface as Affected by Sampling Method and Environmental Conditions
Oesterreich, R.C., R.L. Siegrist, and M.L. Crimi.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-007, 2008

Controlled lab-scale experimental work and statistical modeling is being done at the Colorado School of Mines to evaluate the effects of sampling method attributes (media disruption, atmospheric exposure, and preservation) and environmental conditions (e.g., contaminant type, concentration, media type and temperature) on the accuracy of measurements of DNAPL compounds in soil cores collected from the subsurface at contaminated sites. During an initial phase of experimental work, cores of sand were spiked with PCE and TCE. Then three sampling methods, with different levels of media disaggregation and atmospheric exposure (MDE), were used to sample soil from contaminated cores, which were at temperatures of 2, 20, and 38 degrees C. The results indicated that sampling of intact cores can yield negative bias, ranging from 0 to 98% or more, in concentrations of PCE or TCE detected; larger negative bias was associated with higher levels of MDE and higher temperatures. In the current experimental phase, steel cores lined with brass sampling rings are packed with soil and the cores are uniformly contaminated with a solution of PCE, TCE, and 1,1,1-TCA at concentrations ranging from below DNAPL saturation to above. Cores are sampled at temperatures of 5, 25, 40, 60, and 80 degrees C, and each brass ring is sampled using one of five different sampling methods. The intent of the expanded study is to determine how sampling method attributes and site conditions interact and what the accuracy of quantification is under typical field conditions. The study also includes statistical modeling to explore potential implications for site-wide characterization and remediation performance assessment. This presentation highlights the methods and results of this SERDP research effort and the implications for field practices used for site characterization and performance assessment.

Rapid Site Delineation Using Surface Geophysics and Soil Conductivity/Membrane Interface Probe

Utne, I., R. Lamb, and M. Eversman, Environmental Resources Mgmt., Overland Park, KS.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-025, 2008

A site-wide investigation consistent with the TRIAD approach used electrical resistivity imaging (ERI) and the Geoprobe System(r) soil conductivity/membrane interface probe (SC/MIP) to expedite the evaluation and subsequent redevelopment of a 13-acre property historically used as an oil refinery. In December 2006, a 1-week pilot SC/MIP program confirmed elevated VOC concentrations in areas of historical refinery operations as indicated by Sanborn Maps. ERI was used at the site on the basis that the tool would identity lithologic changes, map bedrock surfaces, distinguish the capacitance differences of hydrocarbons in native soils, and provide uninterrupted, graphical, 3-D representations of the subsurface conditions under survey areas. The geophysical survey collected resistivity and induced polarization data from the perimeter of the property and over the former refinery process areas. ERI results indicated several anomalous areas that were consistent with the location of apparent underground refinery structures and associated hydrocarbon plumes identified in the SC/MIP pilot program. ERI also identified several previously unknown potential source areas. On the basis of these results, an additional two weeks of SC/MIP work was performed to further delineate potential source areas. The two screening tools yielded over 13,500 lineal feet of ERI data and 150 SC/MIP soundings in less than five weeks in the field at the site. This data were corroborated by soil and groundwater data from mobile and fixed based laboratories. The soil results were used to correlate soil types and analytical results to the ERI and SC/MIP data. Graphical representation and visualization of data was available immediately for review to verify the conceptual site model and guide additional investigation activities. This TRIAD-based approach facilitated the completion of the investigational phase of the project in a fraction of the time and cost when compared to traditional drilling and analytical approaches.

Rapid New Methods for Paint Collection and Lead Extraction
Gutknecht, W.F., S.L. Harper, W. Winstead, K. Sorrell, D.A. Binstock, C.A. Salmons, C. Haas, M. McCombs, W. Studabaker, C.V. Wall, and C. Moore.
Journal of Environmental Monitoring, Vol 11 No 1, p 166-173, 2008

This paper presents a new, highly efficient method for paint collection that is based on the use of a modified wood drill bit. Also presented is a novel, one-step approach for quantitatively grinding and extracting lead from paint samples for subsequent Pb determination. The latter method is based on the use of a high-revolutions-per-minute rotor with stator to break up the paint into approximately 50 micron-size particles. Nitric acid (25%, v/v) is used to extract the Pb in <3 minutes. Recoveries are consistently >95% for real-world paints, NIST's standard reference materials, and audit samples from the American Industrial Hygiene Association's Environmental Lead Proficiency Analytical Testing Program. This quantitative extraction procedure, when paired with quantitative paint sample collection and Pb determination, can enable the development of a lead paint test kit that will meet the specifications of the EPA rule finalized in April 2008.

Rapid Site Characterization Utilizing the Membrane Interface Probe as a Field-Screening Tool for MTBE
Rueber, R. and A.D. Melody, SHN Consulting Engineers & Geologists, Inc., Eureka, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper K-033, 8 pp, 2008

The Geoprobe Systems(r) membrane interface probe (MIP) was used to provide real-time data for rapid determination of the relative vertical extent of MTBE contamination at an active automobile fueling facility. Five years of data for this site show persistence of MTBE in groundwater monitoring wells. Historic soil sampling for MTBE has also indicated low concentrations in site soils at shallow depths near the former fuel dispenser. The MIP probe results were used to determine the vertical extent of MTBE and assess the contaminant plume. The MIP was successful in screening the vertical extent of MTBE contamination in groundwater, and the MIP data were used to select locations for the collection of soil samples for laboratory analysis to confirm MIP response, as well as for an extensive ISCO bench-scale treatability study. The MIP coupled with targeted confirmation sampling provided a cost-effective means to obtain the lateral extent and thickness of the contaminated zone.

Remote Sensing LNAPL Characterization Using Laser-Induced Fluorescence (LIF)
Morris, K.A. (Environmental Resources Management), G. Smoot, K. Saum, and C. Hess.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

A release of #2 fuel oil at an industrial site in the late 1990s was discovered in 2000. Emergency responses included excavation and removal of impacted soils and installation of recovery wells and trenches to remove remaining product. When recovery from the wells and trenches diminished despite visual evidence of residual LNAPL at several locations throughout the site, several investigation methods were considered. After reviewing costs and site constraints, laser-induced fluorescence (LIF) with visual observation, field-screening, and minimal laboratory analysis were determined to be the most effective method to delineate extent and magnitude of the LNAPL plume. LIF (provided by Columbia Technologies) includes a fiber-optic cable advanced with direct push into the subsurface. The fiber optics project a laser with 4 different wavelengths--blue, green, orange, and red--to fluoresce hydrocarbons in the subsurface with blue for lighter PAH compounds to red for heavier PAH compounds. Prior to each boring, the LIF is calibrated with a standard fuel oil sample (provided by the LIF manufacturer) and then a blank response. All other responses are a percent response of the standard. A sample of product from the recovery tank was provided to determine response factor for the site-specific product. Seventeen investigation boring locations were identified on the site map to fill data gaps and cleared with site representatives. Ground penetrating radar (GPR) was used to identify potential subsurface utilities/structures for ~25 ft around each boring location. A LIF investigation was conducted at 16 of the boring locations in a 2-day period. Soil cores were collected at five of the boring locations immediately adjacent to the LIF locations. The investigators conducted visual observations and field screening using FID, and collected soil samples for laboratory analysis at the location of highest FID reading and at bottom of boring (20 to 25 ft) to verify LIF analysis. They also installed temporary piezometers in the 5 sampling locations, allowed piezometers to set for 24 hrs, and then checked for presence of LNAPL (interface probe and/or bailer). Based on LIF logs and the 3D conceptual model of the logs, LNAPL extends ~20 ft bgs in the heart of the plume. LNAPL thickness appears greatest in the area of the original release and then thins at the outer edges. Distinct differences in color response are observed in the same area. Visual observations, FID readings, piezometer monitoring and laboratory analysis at the 5 confirmatory boring locations provide agreement with LIF, indicating successful characterization of the LNAPL plume.

Results from the SABRE Field Pilot Test: Multilevel Sampler Network Assessment of Bioremediation

Rivett, M., R. White, G. Wealthall, M. Lelliot, P. Zeeb, S. Dwortzek, M. Harkness, M. Lee, D. Raymond, D. Ellis, and L. Houlden.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract B-015, 2008

A sub-project of the SABRE (Source Area BioREmediation) field reductive dechlorination pilot test, designated STREAMTUBE, investigated dechlorination activity along a multilevel sampler (MLS)-instrumented groundwater flow line (longitudinal transect) through a semi-contained area of the TCE DNAPL source. Comparison of detailed spatial data collected prior to and following aggressive bioremediation treatment allows an assessment of the effectiveness of DNAPL treatment via a combination of complete degradation and solubility enhancement. Comparison of the longitudinal transect data is made with transverse transect MLS and conventional monitoring well data collected under the SABRE project, thus allowing three independent means of assessing bioremediation effectiveness. Treatment (May 2007) involved injection of 2,900 L of SRS(tm), an emulsified (edible) soybean oil, diluted to 5% with extracted cell groundwater followed by bioaugmentation involving injection of a consortium of dechlorinating bacteria, the commercially available KB-1(r) culture. Early time data are presented from the ongoing bioremediation phase. The baseline MLS monitoring data reveals a complex site condition. The source zone DNAPL is highly heterogeneous, leading to significant variability in aqueous-phase concentrations. Although interpretation is complicated by DNAPL source heterogeneity and entry into the cell of cDCE from upgradient, the longitudinal transect confirms generation of daughter products within the source vicinity, particularly in shallower horizons where there is evidence of NAPL mineral oils possibly acting as an electron donor. Potential recontamination of the aqueous phase by TCE dissolving from DNAPL distributed along the cell flow line and some flow potentially oblique to the flow line further complicate data interpretation. Combination of the longitudinal and transect datasets hence provides an improved interpretation of the baseline condition. SRS(tm) was confirmed to be distributed throughout the cell via monitoring the longitudinal transect 60 d after remediation. Major sampling rounds are scheduled for 150 d, 240 d, and 330 d that will allow the effectiveness of remediation to be quantitatively evaluated via detailed comparison with the baseline datasets collected.

Rheology of Manufactured Gas Plant Tars
Birak, P.S., S.C. Hauswirth, and C.T. Miller, Univ. of North Carolina at Chapel Hill.
2009 Annual Meeting of the NIEHS Superfund Research Program: Emerging Issues, Emerging Progress, Columbia University, New York, NY, November 2-5, 2009. Book of Abstracts, 2009

The viscosity of MGP tars, which can vary by several orders of magnitude, plays an important role in affecting the migration and distribution of tarry DNAPLs in the subsurface. Understanding the flow or rheological behavior of a particular tar is critical for designing effective pumping strategies and for understanding the potential further migration of subsurface tar plumes. Researchers conducted a rheological analysis of tars recovered from two former MGPs, as well as a recently produced coal tar. Viscosity was measured using a rotational viscometer, where both temperature and shear rate can be controlled. Data from the rotational viscometer were fitted to standard functions to allow for the prediction of viscosity for various temperatures and shear rates. At low shear rates and temperatures relevant to subsurface systems, tars were found to be non-Newtonian such that the viscosity was no longer constant and increased with decreasing shear rate. Viscosity was also found to be very sensitive to temperature and decreased by orders of magnitude from 5 to 70 degrees C. This decreased viscosity could be useful for thermal approaches to remediation when the mobilization of trapped residual is a desired effect.

Same-Sample Determination of Ultratrace Levels of Polybromodiphenylethers, Polybromodibenzo-p-dioxins/Furans, and Polychlorodibenzo-p-dioxins/Furans from Combustion Flue Gas
Wyrzykowska, B., D.G. Tabor, and B.K. Gullett.
Analytical Chemistry, Vol 81 No 11, p 4434-4440, 2009

The analytical method used for determination of PCDD/F emissions from municipal waste combustors and other stationary sources was modified and validated to enable simultaneous analysis of ultra trace levels of PBDEs and PBDDs/Fs. Potential methodological problems related to physico-chemical properties of brominated compounds, including UV and

temperature-induced debromination and degradation, were addressed. The selection of solvents, optimization of extraction time, and adaptation of the cleanup and fractionation steps increased mean recoveries of 13C12-labeled PBDEs and PBDDs/Fs isotope dilution surrogates about 18% and 25%, respectively. The customary liquid chromatography isolation of PBDEs and PBDDs/Fs was replaced by optimization of high resolution gas chromatography to separate target PBDFs (2,3,7,8-Br-substituted) from potentially interfering PBDEs before mass spectroscopic identification. The optimized method allowed quantitative determination of 56 mono- through deca-bromodiphenylether congeners; 15 congeners of 2,3,7- and 2,3,7,8-Br-substituted tri- to octa-bromodibenzo-p-dioxins and -furans; and all 210 PCDDs/Fs present in the flue gas at levels of picogram to microgram per normalized cubic meter.
http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=200615&CFID=7246687&CFTOKEN=42307346&jsessionid=4a3058c6aa0d466868a750364527b547fe11

Sampling and Analysis of Asbestos Fibers on Filter Media to Support Exposure Assessment: Bench-Scale Testing
Vallero, D.A., J.R. Kominsky, M.E. Beard, and O. Crankshaw.
EPA 600-R-08-046 (NTIS PB2009-102750), 2009

Sampling efficiency is essential in exposure assessments of contaminants in air, as well as other matrices. In the measurement of airborne contaminants, it is critical to collect a sample of air containing representative contaminants in the air of concern, i.e., contaminant concentration and size distribution in the sampled air must be the same as that of the air of concern. A summary of this report has been published as a journal paper by the same four authors in Journal of Occupational and Environmental Hygiene 6(1):62-72(2009) under the title "Efficiency of sampling and analysis of asbestos fibers on filter media: Implications for exposure assessment." The paper is available at
http://www.eqm.com/eqmailers/2009/Asbestos_Filter_Efficiency.pdf
EPA has sent the report to NTIS, but it might eventually be available on line through NSCEP/NEPIS at www.epa.gov/nscep/.

Sampling and Analysis of Cranberries in an Area of Plume Discharge
Tindall, N., J. Davis, and P. de Groot.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-024, 2008

Detectable levels of chlorinated solvents (PCE and TCE) in surface water samples collected from a network of cranberry bog ditches led to concerns about the marketability of a 57-acre cranberry crop. These low-level detections in surface water resulted from the upwelling and discharge of the Ashumet Valley groundwater plume at the Massachusetts Military Reservation (MMR). To determine whether MMR's discharge of these contaminants had affected the marketability of the cranberry crop, a multi-stakeholder group was assembled to develop guidelines for sampling and analyzing cranberries for PCE and TCE. For sample analysis, U.S. EPA's SW-846 Method 8260B GC/MS Selected Ion Monitoring method was chosen. Advantages in using this method included lower method detections limits (MDL) over standard Method 8260 analysis and the ability to target specific compounds. A critical component was the performance of an MDL study for the non-traditional environmental media (i.e., homogenized cranberry fruit) that gained stakeholder approval. The results of the study established MDLs sufficiently low to meet the project data quality objectives. To date, neither PCE nor TCE have been detected above the MDL in any of the cranberry samples collected. Based on the sampling results collected following this procedure over the past several years, the cranberry crop has been considered suitable for market.

Screening of Potentially Hormonally Active Chemicals using Bioluminescent Yeast Bioreporters
Sanseverino, J., M. Eldridge, A. Layton, J. Yarbrough, J. Easter, T.W. Schultz, and G.S. Sayler.
Toxicological Sciences, Vol 107 No 1, p 122-134, 2009

Following the development of Saccharomyces cerevisiae bioluminescent bioreporter assays to assess a chemical's estrogenic or androgenic disrupting potential, S. cerevisiae BLYES, S. cerevisiae BLYAS, and S. cerevisiae BLYR were used to assess their reproducibility and utility in screening 68, 69, and 71 chemicals for estrogenic, androgenic, and toxic effects, respectively. Based on analysis of replicate standard curves and comparison to background controls, a set of quantitative rules has been formulated to interpret data and determine if a chemical is potentially hormonally active, toxic, both, or neither. The results demonstrated that these assays are applicable for Tier I chemical screening in EPA's Endocrine Disruptor Screening and Testing Program as well as for monitoring endocrine-disrupting activity of unknown chemicals in water.
http://toxsci.oxfordjournals.org/cgi/reprint/kfn229v1.pdf

Sediment Monitoring Bias by Autosampler in Comparison with Whole Volume Sampling for Parking Lot Runoff
Fowler, G.D., R.M. Roseen, T.P. Ballestero, Q. Guo, and J. Houle.
World Environmental and Water Resources Congress 2009: Great Rivers, 17-21 May, Kansas City, Missouri. ASCE, Reston, VA. 9 pp, 2009

A field study was conducted to assess biases of suspended sediment concentration analyses (ASTM standard D 3977-97) performed on discrete samples obtained by auto-sampler in comparison with actual sediment concentrations from whole volume sampling. Results indicate that the biases attributed to monitoring of sediment-event mean concentration (EMC) and particle size distribution (PSD) in parking lot runoff by automated samplers (non-isokinetic) can be insignificant. Large volume samples (~15,000 L) of the full pipe cross-section were taken from a stormwater sewer system for 18 storm events over 2 years to monitor for EMCs and PSDs. Concurrently, flow-weighted grab samples were obtained by automatic samplers throughout the entire large volume sampling period. Characteristics of sediments were compared from a "whole storm" sample with that of sub-samples obtained by an autosampler using non-isokinetic sampling. Suspended sediment concentrations and particle size distributions were compared for the two respective field sampling methods. The two methods showed a strong correlation for median sediment EMCs (R2=.9801, n=18). Biases to particle size distributions were found to be confined mainly to the large particles (>160 um) representing less than 25% of the load by mass. Sediment particles captured by the whole-volume sampling and autosampler were not significantly different (alpha=0.05) for D(50)'s=0.067 and 0.047 microns respectively (particle size at which 50% of the sample mass is less).
http://watertech.rutgers.edu/Publications/Member-Submitted(Not-Peer-Reviewed)/Robert_Roseen/Fowler_&_Roseen_et_al_Paper_EWRI_2009.pdf

Selecting Appropriate Analytical Methods to Characterize Asbestos in Various Media
Vallero, D.A. and M.E. Beard.
Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, Vol 13 No 4, p 249-260, Oct 2009

Methods for the measurement and analysis of asbestos and other fibers in air, water, dust, and bulk materials vary by type of scenario and according to applicable laws and rules. Two surveys and a focus group were undertaken to identify important information gaps in asbestos exposure assessments. The highest priority gaps were identifying analytical procedures and counting rules needed for asbestos detection, comparing the efficiency of 0.45-micron pore size filters versus 0.8-micron pore size filter media, rating the efficiency of polycarbonate versus mixed cellulose ester filters, and testing of filters at bench scale to evaluate fiber collection performance of these filter media. Other key responses included the need for consistency of analytical procedures and counting rules to determine suitable procedures for asbestos detection and quantitation in bulk samples, air, settled dust, and soil for field monitoring and risk analysis, as well as the need to identify underlying factors and physical dynamics that lead to aerosolization of fibers from bulk materials in various exposure pathways. The pore size of filters used in collecting fibers was identified as a key asbestos measurement uncertainty; therefore, a study is recommended to compare post-preparation asbestos fiber retention on mixed cellulose ester and polycarbonate filters.

The Self-Potential Method: Did the Ugly Duckling of Environmental Geophysics Turn into a Beautiful Swan?
Revil, A. and A. Jardani, Colorado School of Mines, Golden, CO.
SAGEEP 2009: Symposium for the Application of Geophysics to Environmental & Engineering Problems, March 29-April 2, Fort Worth, Texas. Environmental and Engineering Geophysical Society, Denver, CO. CD-ROM, p 795-800, 2009

The self-potential method involves passive measurement of the electrical potential response associated with in situ polarization mechanisms occurring in the earth. The two main mechanisms of polarization are the redox contribution (with applications concerning contaminant plumes and ore bodies) and the streaming potential associated with groundwater flow. Over the past 15 years, the self-potential method has been developed to the point where it can be considered as a powerful method in near-surface geophysics for non-intrusive inversion of the pattern of groundwater flow and the distribution of the redox potential in shallow contaminated aquifers. The authors provide a short history of the self-potential method, a discussion of recent quantitative developments and future trends (with particular attention to applications of the self-potential method in hydrogeophysics), and an overview of recent achievements on self-potential stochastic tomography and the joint inversion of self-potential signals with other geophysical datasets.

Semipermeable Membrane Devices to Quantify Effectiveness of Sediment Capping Strategies
Adriaens, P., M.-Y. Li, A. Michalak, J. Wolfe, and N. Barabas.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract O-009, 2008

A 3-year pilot study was implemented at the flume scale using sediments from the Anacostia River (Washington, DC) to obtain uncertainty-bounded fluxes of PAHs as a function of capping strategy (no cap, sand cap, clay cap) and ebullition/advection as inputs to a water quality model. The test bed consisted of a tank outfitted with a diffusion chamber for gas and water amendments on the bottom and a dedicated recirculating pump to generate surface water turbulence in each compartment (uncapped, sand cap, Aquablok(tm) cap). The ebullition simulation method is based on controlled air displacement by water (420 ml/d) to achieve an air flux on the low end of reported values for the natural system; the advective flow simulation method is based on communicating vessels in which a fixed volume of water (1,200 ml/day) is pushed through the diffusion bars at the bottom of the tank. Semipermeable membrane devices (SPMDs) were deployed to capture the spatial heterogeneity in PAH fluxes at the sediment bed/surface water interface and in air. Sufficient SPMDs were deployed for 10 triplicate measurements in air and water spanning a 10-week timeframe to capture the onset and saturation (if any) of PAH release in the system. At regular (1- to 2-week) intervals, SPMDs in both liquid and gaseous phase were collected, extracted with hexane, concentrated, and analyzed using GC-MS. In control sediments, the results showed the following trends: (1) PAH accumulation in SPMDs increased linearly between 2 and 6 weeks (r2 between 0.91 - 0.97); (2) the incubations needed a duration of at least 4 weeks in uncapped systems, and possibly twice this time in capped systems; (3) SPMDs showed evidence for selective partitioning, i.e., fluoranthene > phenanthrene > pyrene; (4) the bioaccumulation/partitioning kinetics of fluoranthene and phenanthrene was 8- and 4-fold higher than that of pyrene. The rate of PAH accumulation increased when ebullition was present, was reduced in the presence of a sand cap, and became negligible when an Aquablok(tm) cap was implemented. The differences in capping and ebullition impact decreased with increasing value of the partitioning coefficient. The estimated PAH fluxes in sediment, as derived from the SPMD flux calculations, ranged from 0.2 to 0.002 ppb/d/cm2 (depending on PAH compound) for uncapped sediments and decreased another 1 to 2 orders of magnitude in the presence of caps. These results indicate that SPMDs are a reliable tool to assess capping efficiency and impact of sediment stability at the pilot scale. The use of these data as input variables for water quality/capping models will improve available decision-making tools for in situ sediment remediation strategies.

Sensors as Tools for Quantitation, Nanotoxicity and Nanomonitoring Assessment of Engineered Nanomaterials
Sadik, O.A., A.L. Zhou, S. Kikandi, N. Du, W. Wang, and K. Varner, State Univ. of New York-Binghamton.
Journal of Environmental Monitoring, Vol 11 No 10, p 1782-800, Oct 2009

Nanosensors can be classified under two main categories: (1) nanotechnology-enabled sensors or sensors that are themselves nanoscale or have nanoscale materials or components, and (2) nanoproperty-quantifiable sensors or sensors that are used to measure nanoscale properties. Although the quantity of literature and reviews on category 1 sensors is large, few sensors are available to measure nanoscale properties or sensors belonging to category 2. This class of nanosensors is an area of critical interest to nanotoxicology, detection, and risk assessment, as well as for monitoring environmental and/or biological exposure. This paper discusses emerging fields of nanotoxicology and nanomonitoring, including the challenges of characterizing engineered nanomaterials and the potential of combining existing analytical techniques with conventional cytotoxicity methods. Two case studies are provided for development of category 2 nanosensors for fullerene nanoparticles and quantum dots. One highlights the uniqueness of portable, dissolved-oxygen electrochemical sensor arrays capable of detecting engineered nanomaterials (ENMs) and providing rapid nanotoxicological information. This review has shown that addressing the complex and critical issues surrounding the environmental transformation and toxicity of ENMs must be accompanied by the creation of new approaches or further developments of existing instrumentation.

Single Particle ICPMS for Characterizing Metal-Based Nanoparticles and Monitoring Transformation Processes in Surface Water
Heithmar, E.M.
American Chemical Society National Meeting, Salt Lake City, UT, 22-26 March 2009

Inductively coupled plasma mass spectrometry (ICP-MS) is a type of mass spectrometry that is highly sensitive and capable of the determination of a range of metals and several non-metals at concentrations below one part in 10 e+12. It is based on coupling together an inductively coupled plasma as a method of producing ions (ionization) with a mass spectrometer as a method of separating and detecting the ions. ICP-MS is also capable of monitoring isotopic speciation for the ions of choice. Monitoring trends in the concentration, size distribution, and metal content of nanoparticles in surface water over time can indicate potential exposure of ecosystems to engineered nanomaterials. These measurements have been made with hyphenated instrumental techniques, such as flow-field flow fractionation coupled with ICP-MS. Alternatively, metal concentrations of operationally defined size fractions have been estimated by filtration and ultrafiltration followed by elemental determination. ICP-MS in the single particle (SP) mode measures the intensity and frequency of signal pulses resulting from ion plumes of a metal from individual nanoparticles in the ICP. SP-ICP-MS can provide the number density of particles, as well as the mass of the measured metal in the particles, and therefore can estimate the size of particles, if composition is assumed, or it can provide information on possible compositions if particle size is known. SP-ICP-MS of several monodisperse suspensions of metal-based nanoparticles was evaluated to elucidate the factors that influence the sensitivity, accuracy, and precision. This presentation discusses SP-ICP-MS of several metals in native and nanoparticle-amended surface water.

Smart Dust Infrared Sensors for Standoff Explosives Detection
Kovalev, A.E., M.G. Bray E.A. Hernandez-Pagan, T.S. Mayer, and D.H. Werner, Pennsylvania State Univ.
Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing X. Proceedings of SPIE--The International Society of Optical Engineering, Vol 7304, 2009

A prototype sensor is based on a new eye-safe detection strategy with the potential to report the presence trace explosives from standoff distances of up to 100 m. The method detects the reflected infrared radiation from groups of micron-sized, chemically sensitized, metallodielectric nanostructures. Specifically, the sensors change from reflecting to absorbing nearly 100% of the incident probe beam radiation over a narrow band of mid-IR wavelengths when explosive vapor is present. This strategy is not limited to the detection of explosives, but also can be used to detect other threats by modifying the chemically sensitive layers of the nanostructure.

Spectral Induced Polarization for the Characterization of Free-Phase Hydrocarbon Contamination of Sediments with Low Clay Content
Cassiani, G., A. Kemna, A. Villa, and E. Zimmermann.
Near Surface Geophysics, Vol 7 Nos 5/6, p 547-562, Oct/Dec 2009

This paper discusses an investigation of the spectral induced polarization effect of changing fluid saturation in a well-characterized porous medium that involved an analysis of the difference between air and hydrocarbons at different degrees of water saturation. The experiments were conducted on fine aeolic sand samples from an experimental site near Turin, Italy. Octanol and benzene were used as NAPLs. Samples initially were saturated with water having controlled electrical conductivity and subsequently were de-saturated stepwise with injection of air at known pressure. The eolic sand samples were re-saturated with the same water contaminated with hydrocarbons and then a NAPL phase (either octanol or benzene) was injected in volumetric steps to compare the effects of air and NAPL invasion. At each saturation step, spectral induced polarization measurements were conducted in the 0.01 Hz to 1 kHz range using the ZEL-SIP04 impedance meter developed at the Forschungszentrum Juelich. The measurement setup guaranteed a 1 mrad-phase precision for the entire frequency measurement range. Measurements were conducted under temperature-controlled conditions at 20 (+/-0.5) degrees C. All spectral-induced polarization curves show a peak in the range 0.01 to 1 Hz that changes in intensity and frequency with varying saturation and a high-frequency phase shift increase dominated by capacitive coupling effects of the measuring system. When a multiple Cole/Cole model was fitted to the data, the effects of de-saturation on the low-frequency Cole/Cole parameters were as follows: (1) resistivity increased with decreasing water saturation but increased less with NAPL than with the same volume of air; (2) chargeability increased with decreasing water saturation, but in presence of NAPLs its value was sometimes lower, sometimes higher, and sometimes similar to the one observed in presence of air; (3) the time constant t increased with decreasing water saturation and was consistently larger with NAPL than with air. These differences between air and NAPL injection can be explained in terms of differences in nonaqueous-phase distribution within the porous medium as observed by X-ray micro-CT. While air is homogeneously distributed, NAPLs segregate under density effects. In summary, all spectral-induced polarization effects of air and NAPL injection in the considered porous medium are volumetric, i.e., are not due to interaction with grain surfaces or other electrical/chemical effects but are caused by pore obstruction by the electrically non-conductive phase.

Spectrophotometric Determination of Low Levels of Arsenic
Azad, M. and W.A. Farone, Applied Power Concepts, Inc., Anaheim, CA.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper H-033, 4 pp, 2008

As of January 2006, EPA regulations require drinking water arsenic levels not to exceed 10 ppb. This significant drop from the previously accepted level of 50 ppb has created a demand for highly sensitive and accurate analytical techniques for arsenic measurements in soil and water. This paper presents a new, innovative method of arsenic analysis using simple and inexpensive techniques. The procedure is a rapid, convenient method for determination of arsenic in a concentration range as low as 1 ppb. The method involves the oxidation of Rhodamine-B by iodine released by the reaction between potassium iodate and arsenic(III) in slightly acidic medium. The oxidation reaction of Rhodamine-B quantitatively quenches the pinkish-red Rhodamine-B that can be measured by any spectrophotometer at 553 nm. The measurement is repeated without arsenic(III) addition, and the increased color intensity gives arsenic(III) concentration with the help of a calibration curve. For increased sensitivity, the colorimetric technique was coupled with a standard addition technique, which allows for correction of matrix effects due to the presence of many impurities in samples of site water and soil. The method is very precise and accurate for the determination of arsenic as low as 0.5 ppb. The method can be applied successfully for arsenic determination in various complex matrices and environmental and biological samples.

Spectroscopic Analysis of Arsenic Uptake in Pteris Ferns
Slonecker, T., B. Haack, and S. Price.
Sensors, Vol 1 No 4, p 644-675, 2009

Two arsenic-accumulating Pteris ferns (Pteris cretica mayii and P. multifida) were grown with a non-accumulating control fern (Nephrolepis exaltata) in greenhouse conditions in clean sand spiked with 0, 20, 50, 100 and 200 ppm sodium arsenate. Spectral data were collected for each of five replicates prior to harvest at 4-week intervals. Fern samples were analyzed for total metals content and partial least squares and stepwise linear regression techniques were used to develop models from the spectral data. Results showed that P. cretica mayii and P. multifida are confirmed hyperaccumulators of inorganic arsenic and that reasonably accurate predictive models of arsenic concentration can be developed from the first derivative of spectral reflectance of the hyperaccumulating Pteris ferns. Both the arsenic uptake and spectral results indicate some species-specific variability, but the results compare favorably with previously published data, and additional research is recommended. http://www.mdpi.com/2072-4292/1/4/644/pdf

Stable Isotope Analysis to Determine Groundwater Contamination Source(s)
Goldman, D., B. Maidrand, J. Gabry, D. Newton, and W. Doctor.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-017, 2008

Stable isotopic analysis was used to identify and differentiate potential sources of TCE contamination in groundwater underlying a housing area in the San Francisco Bay area. 2-D compound-specific stable isotope analysis using the isotope ratios of carbon-13/12 and chlorine-37/35 provided definitive evidence to show the existence of mutiple off-site sources. No on-site TCE sources have been identified. TCE and daughter product cis-1,2-DCE were investigated in groundwater samples collected quarterly from the upper and lower portions of the uppermost aquifer. The stable isotope data have been interpreted as showing three isotopic ratio signatures from three TCE upgradient sources affecting the groundwater beneath the site. A conceptual site model (CSM) was developed using multiple lines of supporting evidence. The CSM includes short-time off-site release(s) of TCE south of the site that are responsible for the site TCE. The resulting groundwater TCE "slug(s)" migrated downgradient within the upper and lower portions of the aquifer, with residual contamination from the source and the tails of the slugs stretching back to the source area. Over time, the slugs have migrated through the site, leaving only the residual tail of the TCE plume and a slug remnant observed as a hot spot (sorption/desorption from finer-grained soils). Stable isotope analysis provided the only definitive line of evidence of three isotopic ratio signatures--indicating that three TCE sources affect the groundwater beneath the site. This analysis has provided the data necessary to defend to the regulatory agency that the contamination beneath the site originated off site.

Stable Isotope Probing and Molecular Analyses of Aerobic Oxygenate-Metabolizing Bacteria from Bio-GAC Reactors
Aslett, D., B. Haywood, M. Hyman, K. Salafrio, D. Trego, and J. Haas.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

MTBE and TBA are frequently found at gasoline spill sites or at gas stations that have leaking underground storage tanks. Research findings demonstrate that MTBE can be degraded substantially by organisms that grow on gasoline hydrocarbons, compounds that can be found at high concentrations in many MTBE-contaminated environments. Further characterization of these process is expected to provide novel routes for MTBE bioremediation, and these can be expected to translate into substantial costs savings throughout the U.S. This presentation discusses several molecular approaches that have been employed to characterize the TBA-oxidizing organisms in biological granular activated carbon (Bio-GAC) reactors designed to treat fuel oxygenate-contaminated groundwater. These molecular techniques (stable isotope probing, denaturing gradient gel electrophoresis, quantitative PCR) allow characterization of the organisms and key genes involved in MTBE and TBA biodegradation without the need to isolate and characterize individual microbial strains. Results suggest that oxygenate-oxidizing activity occurs within several definable bands within the reactor. The implications of the findings for the design of and operation of Bio-GAC reactors for treating oxygenate-contaminated groundwater are discussed.

Stable Isotope Probing with 13C-MTBE- and 13C-TBA-Amended Bio-Sep(r) Beads in Sulfate-Reducing Microcosms

Busch-Harris, J., K. Sublette, J.T. Wilson, C. Adair, X. Yang, T. Kuder, P. Philip, G. Davis, D. McElroy, W.E. Holmes, and D. Harris.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract K-036, 2008

Microcosm studies were conducted using different anaerobic sediments from MTBE-contaminated aquifers. All microcosms were amended with sulfate and Bio-Sep(r) beads containing one of four 13C-labeled substrates: 13C5-MTBE, 13C1-MTBE (methyoxy carbon labeled), 13C-MTBE (t-butyl group labeled), or 13C4-TBA. Pore water was sampled at 0, 2, and 4 months. After 4 months, beads and sediment were harvested and analyzed for phospholipid fatty acids (PLFA) and 13C-labeling of derived fatty acid methyl esters (FAMEs) by GC-IRMS. Five out of seven sediments showed sulfate depletion and MTBE degradation with TBA accumulation. Results are discussed for each sediment and substrate. This microcosm study indicates at least two mechanisms for MTBE and TBA biodegradation under sulfate-reducing conditions. Future work includes isolation of the TBA degrader(s) and isolation and analysis of 13CDNA from similar microcosms.

Standardization of Nanomaterials Characterization by Scanning Probe Microscopy for Societal Acceptance

Fujita, D., K. Onishi, and M. Xu.

Journal of Physics: Conference Series 159, 6 pp, 2009 [doi:10.1088/1742-6596/159/1/012002]

Novel nanomaterials are expected to play key roles for the promotion of innovations in various industrial products. For novel nanomaterials to be accepted by the general society and widely used, it is necessary to establish reliable nano-characterization methodologies for industrial nanomaterials under an authorized international scheme for standardization. Among the nano-characterization methods, scanning probe microscopy (SPM) is extremely versatile both in measurement functions and operational environments. Of the various nanomaterials of industrial application, fullerene nanomaterials (FNM) have attracted much attention due to their unique physical properties. The authors illustrate the potential of the quantitative analysis and characterization standardization available via SPM using FNM as an example.
http://www.iop.org/EJ/article/1742-6596/159/1/012002/jpconf9_159_012002.pdf

Standardized Procedures for Use of Nucleic Acid-Based Tools

Lebron, C., C. Acheson, P. Dennis, X. Druar, J. Wilkinson, E. Ney, D. Major, E. Petrovskis, N. Barros, C. Yeager, F. Loeffler, K. Ritalahti, J. Hatt, E. Edwards, M. Duhamel, and W. Chan.

Strategic Environmental Research and Development Program (SERDP), Project ER-1561, 82 pp, Aug 2008

A survey of peer-reviewed and technical literature was conducted with a focus on the methods used in disciplines that utilize the quantitative polymerase chain reaction (qPCR) technique, encompassing the medical, agricultural/food, forensics, and environmental fields. The review identified unique challenges associated with environmental remediation samples (with a focus on groundwater), including the potential for high variability, challenges associated with

representativeness, biomarker losses in sample processing, and extraction and matrix interference leading to PCR inhibition. Recommendations for assessing and addressing these challenges are provided in the report and include the development of Dhc reference standards and internal microbial controls (i.e., microbial surrogates) to a) assess current approaches to sampling, shipping, storage, biomass concentration, nucleic acid extraction, and data analysis and interpretation, and b) identify promising areas where methodological improvements might be required. [Note: the report was prepared under an alternate working title: "An Overview of Current Approaches and Methodologies to Improve Accuracy, Data Quality and Standardization of Environmental Microbial Quantitative PCR Methods."]
http://www.serdp.org/Research/upload/ER-1561_LR_PMA_Final.pdf

A Study of Quenching Procedures for VOC Sampling at ISCO Sites
Pac, T., R.A. Brown, M. Lee, A. Gladwell, R. Pajooh, J. Kelly, C. Armbruster, S. Klusey, and R. Kocsis.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper Q-040, 8 pp, 2008

One of the problems encountered during in situ chemical oxidation (ISCO) projects is that groundwater samples collected after injection of the oxidant for laboratory analysis of VOCs can contain unreacted oxidant in addition to VOCs. If collected together, the oxidant can continue to react with the VOCs during shipment and hold time, potentially causing an inaccurate or false-negative result or damaging laboratory equipment during the testing process. The authors tested field procedures for quenching the excess oxidant by addition of a reductant, with attention to the following factors: (1) does the presence of excess quenching agent affect the analysis of VOCs? and (2) which reductant avoids unintended reaction with VOCs? To develop the quenching procedure, the investigators analyzed a series of unquenched and quenched VOC-spiked samples were over time, such as VOC samples containing excess permanganate or excess persulfate, to see how rapidly the excess oxidant would react with VOCs. Ferrous iron, sodium dithionite, and ascorbic acid were tested. Samples also were run where the oxidant was added to dissolved VOCs and then quenched, with subsequent analysis of the quenched samples. Based upon the results, the authors recommend quenching unreacted (excess) oxidant in VOC samples collected from ISCO sites with ascorbic acid before submitting the sample to the laboratory for analysis. Quenching provides for more reliable data for accurate assessment of cleanup progress, while providing safer material handling for transporters and laboratories.

Subsurface Characterization in Support of an In Situ Bioremediation Pilot Study in Fractured Granitic Bedrock
Boysun, M.A., R.H. Mora, and S. Grossi (Earth Tech); P. Hallman (USAF, Edwards AFB, CA).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper F-042, 9 pp, 2008

At Site 162, Edwards Air Force Base, California, Phase I of an in situ bioremediation (ISB) pilot study to address PCE and TCE groundwater contamination consisted of injection of Emulsified Oil Substrate (EOS(r)) in a biobarrier formation. Phase II will consist of EOS(r) injection and bioaugmentation. Results from Phase I showed that PCE dechlorination stalled at cis-1,2-DCE. To evaluate the results of Phase I further and collect supplementary information to design the Phase II EOS(r) injection, additional lithologic and hydrogeologic studies of the site's fractured granitic bedrock were conducted to assess groundwater flow velocity, effective porosity, preferential pathways, connectivity of monitoring wells, vertical extent of the water-bearing zone, and fracture orientation and aperture. This paper discusses the study results from a tracer test using three different tracers, reverse circulation air rotary drilling, optical and acoustic televiewing, and installation of observation wells, including one multilevel well.

Taproot(tm) Technology: Tree Coring for Fast, Noninvasive Plume Delineations
Burken, J.G., S. Bailey, M. Shurtliff, and J. McDermott.
Remediation Journal, Vol 19 No 4, p 49-62, 2009

A laboratory experiment and a field sampling effort were undertaken to evaluate the potential of plants as forensic tools for delineating contaminated soil and groundwater. In the first field application of Taproot(tm) technology, a large, heavily forested site was sampled in one day, and a more accurate delineation of contamination was obtained than had been generated at the site in over a decade, despite installation of more than 26 monitoring wells. New source zones were detected on the site, and the presence of new waste depositions was uncovered for the first time, showing the great value of tree coring as a contaminant detection tool. The findings of this study show that plants can be used as a tool to evaluate a variety of subsurface contaminants, in either the vadose or the saturated zone.

TarGOST(r) Delineation of Coal Tar in Site Soils and River Sediments: Remediation Implications
Finney, D., S. Saroff, T. Metcalf, L. Tseng, and K. Goldenberg.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-030, 2008

Tar-specific Green Optical Screening Tool (TarGOST(r)) laser-induced fluorescence (LIF) surveys were conducted on 100-foot grids at a former roofing material manufacturing and petroleum bulk storage Superfund site in New Jersey at upland and river sediment operable units (OUs) to characterize the spatial extent of coal tar in the subsurface soils and sediments. At the upland OU, 93 TarGOST(r) profiles were conducted to depths of ~37 ft bgs to the confining layer using a Geoprobe(r) 6010 direct-push rig. At the river sediment OU, 49 TarGOST(r) profiles were installed to depths of 50 ft below sediment surface using the Geoprobe(r) rig mounted on a sampling barge. The TarGOST(r) results facilitated revision and refinement of the conceptual site model. The TarGOST(r) instrument (Dakota Technologies, Inc.) is a laser-based unit that utilizes light-energy in the form of a green PSX-100 Excimer Laser(r) (wavelength 532 nm) to energize and excite coal tar and creosote-range hydrocarbons to fluoresce a characteristic wavelength of light. The light is detected by the probe tip optical assembly. Confirmatory soil and sediment samples from ~30% of the TarGOST(r) profile locations were visually inspected and chemically analyzed. False positives (4.3% soils, 13% sediments) and false negatives (1.1% soils, 26% sediments) were evaluated and factored into the site interpretation. The minimum response for TarGOST(r) that indicated the presence of coal tar was determined to be 49.1% RE (normalized TarGOST(r) response) for upland soils and 6.7% RE for river sediments (fluoresce signal only). Due to the considerable light scatter in the sediments, only the raw fluorescence signal, not the normalized (raw fluorescence/scatter signals), were used for interpretation. The TarGOST(r) results and geologic surfaces were modeled to create 3D images of the site that illustrate the spatial extent of coal tar in the subsurface within the stratigraphic framework. Results indicate that coal tar is not present as a single contiguous mass, but instead occurs in distinct isolated areas lying above and on top of the upland silty clay confining unit, and thin isolated layers in sediment in a smaller extent than had been previously interpreted.

Technology Performance Summary: Proengin AP2C Handheld Detector for Toxic Industrial Chemicals
Voder, C., U.S. EPA, Washington, DC.
EPA 600-S-08-015, 3 pp, Oct 2008

The Proengin AP2C is a hand-held flame spectrometer that detects characteristic emissions from hazardous chemicals as they are consumed in a flame. The device burns hydrogen supplied from a compact low-pressure cylinder inside the instrument. Sample air is drawn through continuously by an internal pump. Detection of a target chemical triggers an alarm from the AP2C, and the instrument provides identification and semi-quantitative readings for the detected chemical. The readings take the form of a series of five bars that successively turn orange depending on the intensity of response. Sulfur compounds, nitrogen compounds, phosphorus compounds, and arsenic compounds are each identified by separate sets of bars. The AP2C can also indicate the presence of hydrocarbons. An attachment device allows liquid samples (either neat samples or solutions) to be picked up by the device and vaporized into the inlet of the AP2C by a heating circuit. The reviewers found that the Proengin AP2C reliably detected the presence of hydrogen cyanide, arsine, and hydrogen sulfide in vapor samples but did not have reliable responses for indicating cyanogen chloride in vapor form or cyanide in liquid samples. The instrument gave an incorrect response to hydrogen cyanide in vapor form at the low temperature and relative humidity condition; therefore, it was determined to have an overall accuracy of 75% for detecting hydrogen cyanide, with false negative rates of 25%. The unit uses a relatively simple procedure and typically responded within a few seconds. Less than one minute was required both to install the attachment for liquid sampling and to obtain instrument response. The unit would require low-pressure hydrogen supply replacements periodically, if used regularly; however, the 12-hour supply life can be maximized by turning the instrument on and off. http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=488512

Time Domain Electromagnetic Soundings to Delineate Hydrocarbon Contamination of Ground Water
Hallbauer-Zadorozhnaya, V.Y. and E. Stettler.
SAGEEP 2009: Symposium for the Application of Geophysics to Environmental & Engineering Problems, March 29-April 2, Fort Worth, Texas. Environmental and Engineering Geophysical Society, Denver, CO. CD-ROM, p 242-251, 2009

There are two principal indicators for the presence of hydrocarbons in groundwater: an increase in the electrical resistivity of the groundwater-saturated layer and an induced polarization (IP) effect. The electro-osmosis type IP superimposes an effect on the time-domain electromagnetic (TDEM) soundings that distorts the signals. The parameter affecting the electro-osmosis IP is the polarizability, which is the ratio of surplus electrical conductance and electrical conductance of the pore fluid. The value of the decay constant is controlled mainly by the radii of pores. Theoretically, the process of electro-osmosis type-IP can occur in different types of sediments, but in reality, the IP-effect can be observed only in fluid-saturated sediments, with an imperfect relationship between the components if the pore size is in the range 1x10(-5) to 5x10(-4) m. The interpretation of TDEM soundings was carried out using the S version as an indicator of the IP effect, and mathematical modeling provided the forward calculation of the electromagnetic field in multilayered polarizable media. The TDEM sounding results were used successfully to delineate hydrocarbon contamination of groundwater in a few areas of South Africa and Russia. Follow-up drilling results confirmed that the contaminant plume could be mapped by identifying the IP effects.

The Trace Analysis of DEET in Water Using an On-line Preconcentration Column and Liquid Chromatography with UV Photodiode Array Detection
Adams, W., V.V. Namboodiri, and C. Impellitteri.
Abstracts of the Proceedings of the 237th American Chemical Society National Meeting, Salt Lake City, UT, 22-26 March 2009

A method for the detection of trace levels of N,N-diethyl-m-toluamide (DEET) in water utilizes an on-line preconcentration column in series with high-performance liquid chromatography (HPLC) and UV photodiode array detection. Current methods of analysis for DEET, a common insect repellent, involve solvent extractions and solid-phase extraction (SPE), which can be labor intensive and require a considerable amount of sample handling. Extraction and concentration steps are necessary for the analysis of DEET at very low concentrations. In addition, potentially costly mass spectrometry or tandem mass spectrometry might be needed for low detection limits of DEET. This study allows for the quantification of DEET at low part-per-billion (ppb) and part-per-trillion (ppt) levels using common HPLC UV detection.

Two-Dimensional Compound-Specific Isotope Analysis to Assess Remediation System Effectiveness
Buscheck, T., T. Kuder, P. Philp, R. Kolhatkar, and L. Klinchuch.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

Two-dimensional carbon and hydrogen compound-specific isotope analysis (CSIA) was applied at a California remediation site with an air sparging/soil vapor extraction (AS/SVE) system in place. Carbon and hydrogen CSIA was conducted for dissolved benzene in four or more monitoring wells over three sampling events. Modest carbon fractionation occurred, suggesting limited biodegradation. Inverse hydrogen fractionation was observed, i.e., depletion of the heavy isotope associated with decreasing benzene concentration (reverse of the fractionation expected during biodegradation). Depletion of the heavy hydrogen isotope resulting from volatilization is consistent with isotope effects in volatilization of benzene and MTBE NAPL. The signature for volatilization was strongest in a monitoring well influenced by the AS/SVE system.

Two Rapid Site Characterization Strategies: Intensive DPT Groundwater Characterization and the MIP

Peacock, D.R., A. Kunkel, and D. Li.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-032, 2008

Combinations of chlorinated ethenes, ethanes, and BTEX constituents were released during the operation of a former chemical distribution facility in Wichita, Kansas. After an initial period of traditional monitoring, investigators undertook a rapid site characterization approach in which soil and groundwater samples collected via direct-push technology (DPT) and analyzed by a field laboratory, with confirmation via fixed-base laboratory. Obtaining results in the field allowed investigators to make daily decisions regarding additional sampling. With laboratory confirmation of the field-generated data, investigators were able to qualify results and gain regulatory approval to use the data for extent determination in the remedial investigation report. Data collected over time from monitoring wells were used to document temporal contaminant trends and were presented in concert with the lateral and vertical spatial understanding determined via the DPT study. Several "plumelets" of different combinations of source contaminants were found to emanate from several source areas on the relatively small site, and resultant dissolved-phase plumes traveled off site onto other properties. Where BTEX was discovered on and off site, historical evidence showed that reductive dechlorination had occurred, substantially reducing concentrations of chlorinated and BTEX constituents. The topography of the lower confining unit declines by over 20 ft in elevation over a distance of just 70 ft, with the result that contaminant distribution was affected by gravity flow in a direction opposite to groundwater flow. A membrane interface probe (MIP) was used to investigate the volumes of saturated soil sources that remain on site and further define the lower confining unit. The study was remediation-driven, but it provided an opportunity to evaluate the previous conceptual site model generated by the DPT study. Thirty MIP pushes were advanced with a truck-mounted Geoprobe 6600. Over 800 ft of continuous data were generated, including temperature fluctuation, conductivity, and chemical analysis via three detectors: electron capture (ECD), flame ionization (FID), and photoionization (PID). The combination of these measurements provides information regarding the presence and concentration of chlorinated solvents (ECD and PID), BTEX components (FID and PID), overall soil conductivity to ascertain the lower confining unit, and presence of groundwater (temperature fluctuation). The MIP allowed investigators to delineate the lower confining layer more effectively, determine in several cases that chlorinated solvent contamination was present at the base of the aquifer, and observe BTEX contamination coexisting or lying above solvent contamination. While the MIP provided excellent vertical and lateral characterization, the detailed DPT study allowed distinct sources to be discerned. For this complicated site, a combination of lithologic, MIP, and geochemical data was needed to establish a spatial understanding of chlorinated solvent contamination. Using remediation-driven investigative techniques allow residual saturated soil sources in areas where BTEX was not present to be targeted to enhance reductive dechlorination.

Understanding the Use of Models in Predicting the Effectiveness of Proposed Remedial Actions at Superfund Sediment Sites
U.S. EPA, OSWER Directive 9200.1-96FS, SAMS #2, 36 pp, 2009

This product is a primer for those not experienced in the development and use of models at sediment sites. It explains the typical objectives of modeling, how models are built, how they are used to predict the effectiveness of remedies, and how the uncertainty in model predictions can be addressed.
http://www.epa.gov/superfund/health/conmedia/sediment/pdfs/Modeling_Primer.pdf

Use of Bio-Traps with Multiple Substrates and Electron Acceptors to Optimize Remediation
Fiorenza, S. (BP, Houston, TX); A.C. McClary and S. Lummus (S&ME, Inc., Spartanburg, SC).
Remediation Journal, Vol 20 No 1, p 69-85, 2009

Bio-Traps(r) were used to investigate biodegradation of benzene, MTBE, and TBA under different conditions at a fractured rock site to aid the selection of a bioremediation approach. The Bio-Traps were amended with the 13C-labeled constituent of interest and sampled sequentially at 15-, 30-, 60-, and 90-day intervals. The conditions tested were biodegradation during operation of an air sparging (AS) system, amendment with nitrate during AS operation, anaerobic biodegradation with the system turned off, and anaerobic biodegradation with nitrate amendment. Nitrate amendment appeared to increase biomass whether the AS system was on or off for all the constituents of interest; however, the diversity of the microbial community as determined by phospholipid fatty acid analysis decreased with nitrate amendment as more specialized degraders were selected. The most negative indicators of potential biodegradation performance were observed with the anaerobic control. There was less biomass overall, less incorporation of 13C into biomass, and decreased membrane permeability. As testing with additional amendments continues at the site, it is not yet certain which treatment might be selected for bioremediation, but the Bio-Trap tests thus far have identified that the in situ natural attenuation condition is least favorable for biodegradation.

Use of CPT/MIP Data to Optimize Remedial Design of a Zero-Valent Iron Permeable Reactive Barrier
Bjorklund, B., J. Warner, A. Chemburkar, K. Lake, J. Moe, M. Grant, and J. Ortman.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract A-046, 2008

At the site of a former railroad right of way, industrial tenants had used TCE as a degreaser in a production process. Upgradient commercial sites also contributed solvents (e.g., PCE and TCE) to the subsurface, and a neighboring fuel facility had released hydrocarbons to the groundwater. The commingled groundwater plumes migrated from these industrial properties toward a residential neighborhood. VOCs have migrated into indoor air in adjacent homes, and crawl-space vapor intrusion prevention systems have been installed in several homes. Long-term vapor intrusion exposure reduction will be achieved by treating the shallow groundwater using an injected zero-valent iron (ZVI) PRB. The PRB will be placed close to the residential receptors to minimize the time necessary to achieve indoor air cleanup goals. Deeper groundwater restoration will be achieved using in situ chemical oxidation (ISCO) in an upgradient near-source location. Normally, ISCO and ZVI are mutually exclusive technologies to employ within the same groundwater plume; however, the use of high-resolution in situ data collection methods using cone penetrometer testing (CPT) coupled with a membrane interface probe (MIP) has led to a design that will safely couple both oxidative and reductive technologies for groundwater restoration, allowing for varying PRB thickness to match upgradient VOC flux to achieve downgradient VOCs concentrations meeting site remedial goals. A bench-scale treatability study was performed to evaluate the effectiveness of ZVI to treat VOCs and obtain site-specific reaction rates using site groundwater. A hydraulic pulse interference test will be completed to determine localized flow velocities through two distinct zones of the upper silty aquifer targeted for treatment. The PRB thickness for the site-specific application will be calculated using probabilistic methods based on site-specific reaction rates, groundwater flow velocities, and the cross-sectional distribution of VOCs in groundwater as determined using the CPT/MIP tools.

Use of Hydraulic Profiling Tool to Identify Preferential Pathways for Chloride-Impacted Groundwater Migration
Binder, J.L., Burns & McDonnell Engineering Company, Kansas City, MO.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Paper F-011, 9 pp, 2008

A study was conducted to demonstrate the effectiveness of the Geoprobe(r) Hydraulic Profiling Tool (HPT) for the identification of preferential pathways relative to migration of chloride-impacted groundwater. The method was used in combination with conventional investigative methods to characterize subsurface conditions by comparing HPT response curves for background conditions with the responses recorded in the chloride-contaminated zone. The comparison of these data aided in the identification of the extent of the chloride impact and the eventual location of a hydraulic containment system to control the migration of the chloride plume off site.

Use of In-Planta Solid Phase Sampling Devices to Delineate VOC Plumes
Burken, J., K. Waltermire, and E. Sheehan.
World Environmental and Water Resources Congress 2009: Great Rivers. ASCE, Reston, VA. ISBN: 978-0-7844-1036-3, 7 pp, 2009

Plants interact directly with water, air, and soil to collect and store chemicals and elements from the surrounding environment. Two new and innovative sampling methods have been developed in which valuable plant-based data can be accessed to replace as well as supplement investigations at a contaminated site. These methods include the use of commercially available solid-phase microextraction (SPME) fibers and newly developed solid-polymer samplers (SPS) developed specifically for in-planta sampling. When determining the extent of the plume on a contaminated site, groundwater sampling can be limited due to time, site access, and expense. Using the new techniques to place sampling devices inside trees naturally occurring on a contaminated site or planted in phytoremediation or redevelopment efforts enables evaluation of the plume size and even monitoring of changes in concentration. The phytoforensic methods will have a minimal footprint and can be accomplished with little materials cost, time, or labor. These quick and innovative sampling techniques can provide an array of data within a short amount of time to improve efficiency in placement of groundwater monitoring wells.

Use of Large-Scale Aquifer Dye Tracer Test for Design of Vegetable Oil Injection for In Situ Bioremediation
Jacob, C.L., B. Jonsson, C.B. Kimmel, K.G. Chaput, J.A. Parsons, and M.D. Kent.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

A large-scale aquifer tracer test was implemented to support design of electron donor substrate injection for stimulation of bioremediation at an aerospace manufacturing facility in Portland, Oregon. Trichloroethene (TCE) is present in an upper unconfined aquifer and lower confined aquifer where a groundwater pump and treat system has operated since 1997 to provide hydraulic containment and for mass removal. Dye tracer testing was performed to obtain design parameters for donor injection and to determine the influence of extraction wells that will continue to operate for hydraulic containment. The target treatment zone is 30 to 70 ft of saturated clean-to-silty sandy gravel in the unconfined aquifer, over an area of ~150,000 ft^2 (i.e., 280,000 yd^3 aquifer). Tracer injection was performed in March 2008 using 95,000 gallons of rhodamine WT dye solution and 26,000 gallons of fluorescein dye solution into two wells planned for donor injection. Results discussed include estimates of maximum dye extent, groundwater seepage velocity, radius of injection, and effective porosity for flow. The bioremediation design utilizes six existing wells (to be decommissioned due to facility expansion) and two new temporary wells for a one-time electron donor injection. The total design injection volume is 240,000 gal, consisting of a 20% oil-in-water emulsion utilizing 10 tanker truck loads (400,000 lb/53,290 gal) of vegetable oil/surfactant mixture. Extraction wells will be operated selectively during injection to distribute emulsion in the target treatment zone and to minimize transport toward extraction wells that will operate following injection. Contingency measures will address groundwater treatment system fouling and unacceptable concentrations of biological oxygen demand and dissolved metals in the system discharge, conditions that could occur due to extraction of reduced groundwater from extraction wells operated for containment following donor injection.

Use of LNAPL-Soluble Tracer to Resolve LNAPL Stability
Smith, T. and T. Sale, Colorado State Univ., Fort Collins, CO.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-052, 2008

This presentation focuses on demonstration of periodic mixing tests (PMTs) for resolving LNAPL stability during tracer tests. The principle underlying PMTs is that change in tracer concentration over the interval between periodic mixing is proportional to volume of LNAPL displaced from the well, and correspondingly, the rate of LNAPL flow in the adjacent geologic formation. Tools employed in conducting LNAPL PMTs include an LNAPL-soluble fluorescing tracer, spectrometer, down-hole fiber-optic cable, and mixing tool. Initially, the tracer is introduced into LNAPL in a well, the tracer is uniformly distributed in the LNAPL in the well via low-energy mixing, and the tracer concentration is measured using a fiber-optic cable and a spectrometer. Next, a period of time (delta-t) is allowed to pass, the tracer in the LNAPL is remixed, and the tracer concentration is re-measured. Lastly, the rate of LNAPL flow is calculated using the changes in tracer concentration and the period delta-t as the inputs to an analytical solution. A primary advantage of PMTs for resolving LNAPL stability is that a large number of concurrent tests can be conducted without the need for dedicated mixing equipment at each well. The PMT method for LNAPL stability has been tested via mathematical, laboratory, and field studies. Mathematically, the PMT solution converges to the continuously mixed reactor solution as delta-t or LNAPL flow goes to zero. At lab scale, results from PMTs conducted in a large sand tank agree closely with known LNAPL flow rates over a range of LNAPL thicknesses and flow rates. At field scale, LNAPL flow rates measured in monitoring wells near active recovery wells show close agreement with well production rates. Ongoing efforts with PMTs for LNAPL stability are focused on optimizing field equipment through beta tests at large petroleum facilities.

Use of Microbial Tools during Source Delineation and Natural Attenuation Evaluation
Swift, D.L. J.E. Gallegos, M.H. Lee, T.W. Macbeth, J.L. Weidhaas, and J. Skog.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-029, 2008

The use of microbial tools that directly document the location and extent of microbial degradation processes is becoming more common in assessing the feasibility of implementing a natural attenuation (NA) remedy. A remedial investigation for the F.E. Warren Air Force Base, former Atlas D Missile Site 1 located near Cheyenne, WY, was conducted to characterize the vertical and horizontal extent of TCE contamination in groundwater in a deep (~200 ft to groundwater), complex subsurface system in a remote location and to evaluate whether NA of contaminants was taking place. Collection of groundwater samples for microbial analyses was performed in conjunction with analyses for chemical contamination and geochemical characteristics. Anaerobic biodegradation was evaluated through analysis of groundwater geochemical parameters indicative of anaerobic biodegradation potential and quantitative polymerase chain reaction (qPCR) to quantify the number of Dehalococcoides spp. present. Both geochemical and microbial results demonstrated that anaerobic reductive dechlorination (ARD) of TCE likely is not very active in groundwater as evidenced by low concentrations of Dehalococcoides spp. at a well with relatively high TCE concentrations (~2,450 ug/L) and two wells with low TCE concentrations (<5 ug/L). No detections of Dehalococcoides spp. were made at any other wells. Only limited detections of ARD daughter products of TCE degradation were made. The geochemistry data supported the limited ARD of TCE in that sulfate was present at all wells and dissolved oxygen primarily ranged between 4 to 6 mg/L. Aerobic biodegradation was evaluated using enzyme probes to detect the presence and activity of enzymes capable of TCE aerobic cometabolism in groundwater. Results indicated that aerobic cometabolism of TCE likely is naturally occurring in the groundwater as significant enzyme activity was reported at two wells (one with TCE ~2,400 ug/L and the other with TCE <5 ug/L); some enzyme activity was detected at five wells where TCE concentrations were <5 ug/L or non-detect; and little to no enzyme activity was detected at the well where low concentrations of Dehalococcoides spp. were present and three other wells where TCE concentrations were non-detect. This conclusion was also supported by the lack of intermediate TCE degradation products.

Use of Narrow-Diameter, Direct-Push Wells to Characterize and Remediate Carbon Tetrachloride in the 200 West Area, Hanford Site, Washington
Moser, K., W. Bratton, and V. Rohay.
Program and Abstracts: The 7th Annual Washington Hydrogeology Symposium, 28-30 April 2009, Tacoma, Washington. Washington Department of Ecology and the U.S. Geological Survey, p 92 [poster], 2009

Carbon tetrachloride (CT) was discharged to three liquid waste disposal sites in the 200 West Area of the Hanford Site from 1955 to 1973. The sites received CT in mixtures with other organics (e.g., tributyl phosphate) and also entrained/dissolved in aqueous-phase liquids. Soil vapor extraction (SVE) through perforated or screened wells was initiated in 1992 to remediate the vadose zone underlying these waste sites. A soil sample collected in 2003 from ~ 19.4 to 20.1 m depth in well 299-W15-46, which was being drilled near the 216-Z-9 Trench waste site, was found to contain a relatively high concentration of CT (380 mg/kg). This high concentration is believed to be associated with a silt layer present from 19.8 to 20.4 m depth that had not been remediated by the existing SVE wells. The high concentration suggests that the CT is present as a DNAPL. In 2006, a comprehensive field study culminated with direct-push technology to investigate the extent of this silt layer and associated CT soil concentrations in the vicinity of the waste site. Similar CT concentrations (390 mg/kg) were detected in a soil sample from 19.5 to 20.1 m depth at P66, the push location ~3.1 m east of well 299-W15-46. CT was not detected in samples from this depth at the other nearby push locations. This presentation discusses monitoring results following SVE as well as the results of pressure testing at three narrow-diameter wells to evaluate the zone of influence. If analysis of the data indicates that the wells have adequate zones of influence to support shallow (less than 30 m deep) SVE, a direct-push technology will be considered in the future for SVE well installation as part of the remedial action for CT in the vadose zone. http://www.osti.gov/bridge/product.biblio.jsp?osti_id=951762

Use of Natural Gamma Logging to Evaluate Well Construction
Raphael, J., D. Boehnker, O. Ogbebor, B. Fishwild, and B. Kanzler.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-042, 2008

Use of older groundwater monitoring wells with improperly documented construction details can present a challenge to stakeholders. Factors that could result in wells with uncertain construction details include poor document management, project transition from one consultant to another, and inadequate logging and documentation during well installation. One issue resulting from improperly documented well construction is uncertainties associated with the integrity of the well, e.g., the relationship of sand pack and bentonite seal to the screened interval, or in the most poorly documented cases, the presence of a bentonite seal. Another limitation is uncertainties related to the soil lithology and knowing if the screen interval is appropriately placed within the aquifer. These items can result in incomplete delineation and/or improper analysis of remedial options. It is feasible to replace the well if the wells are few and shallow, but this option could be too expensive in the case of numerous deep wells. Several techniques can be used to evaluate well construction, including dye testing, DPT/CPT drilling immediately adjacent to the well, and natural gamma geophysical logging. Some of the techniques can be difficult to implement, inconclusive, and/or further compromise the integrity of the well. The natural gamma geophysical logging method is a widely used down-hole logging method to evaluate soil stratigraphy. Down-hole gamma logging provides a record of the total natural gamma radiation detected. In unconsolidated soils, natural gamma radiation is associated with clay minerals, so fine-grained clayey soils and grout containing bentonite typically have higher gamma radioactivity levels than coarse-grained (e.g., sand, gravel soils) materials. Natural gamma logging can be used to identify changes in lithology and to identify material (particularly bentonite seals) in constructed monitoring wells. This presentation discusses the cost/benefit analysis of various well construction assessment techniques; details of the natural gamma logging approach; examples of gamma logs generated on wells of known and unknown construction at a site in the upper midwest; usefulness of the gamma logging technique to also help evaluate soil stratigraphy; and limitations associated with the gamma logging technique.

Use of Passive Flux Meter (PFM) Technology to Refine a Conceptual Site Model for Chlorinated Solvent Nature and Extent Characterization, MCRD Parris Island, South Carolina: A Field Demonstration

Hackett, L., R. Howe, and Y. Burhan, Tetra Tech Inc.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-002, 17 slides, 2008

Generally, a passive flux meter (PFM) is composed of a fabric sock sized to the diameter of the groundwater monitoring well and filled with a sorbent and tracer mixture. The sorbent and tracer can be varied to address specific site contaminants and groundwater flow conditions. PFMs can be used to estimate groundwater and contaminant flux rates, provide a better understanding of geologic conditions that influence contaminant distributions, and evaluate the effectiveness of remedies at the site. This field demonstration was conducted to verify the usefulness of PFM technology for characterization of DNAPLs at contaminated sites. During the demonstration at the Marine Corps Recruit Depot, Parris Island, SC, 26 PFMs were deployed in 14 2-inch diameter wells in the Southern Site in November 2006 for 21 days to investigate chlorinated solvents associated with dry cleaning operations. PFMs were deployed along transects A-A' and B-B', which were oriented perpendicular and parallel, respectively, to the primary direction of groundwater flow, with transect locations intentionally placed to bisect the known extent of contaminant distribution. All 26 PFMs were retrieved successfully. Data collected from wells where PFMs were deployed support previous conclusions made about the geologic, hydrologeologic, and contaminant conditions present at the site, while newly collected PFM data have provided information on site conditions that were previously unknown, including contaminant distributions, the competence of the confining layer underlying the site, and the potential presence of hydrologic high-permeability pathways for preferential contaminant transport. http://www.tetratech.com/tetratech/download-document.html?gid=34

The Use of Satellite Remote Sensing and Helicopter TEM Data for the Identification and Characterization of Contaminated Land
Viezzoli, A., A. Edsen, E. Auken, S. Silvestri
Near Surface 2009: 15th European Meeting of Environmental and Engineering Geophysics, 7-9 Sep 2009, Dublin, Ireland. European Association of Geoscientists and Engineers, EAGE Publications BV, ISBN: 978-90-73781-72-6, CD-ROM, 2009

In previous studies, satellite remote sensing has been used successfully to identify numerous candidate sites that are likely to host waste materials. This result was the basis for further monitoring activities carried out at end of April 2009 using a helicopter transient electromagnetic (TEM) system. Extended results of the modeling of this survey are presented. Based on initial modeling results along with actual data acquired earlier over a disposal site in Denmark, it is anticipated that SkyTEM will be capable of identifying the contaminated sites and of mapping the contaminant plumes. The data will be processed to decouple them from man-made infrastructures and then inverted using spatially constrained inversion to recover a quasi-3D model of the subsurface. The integration of proximal and remote sensing methods represents a useful instrument for environmental management.

Using a Flux-Based Approach to Evaluate the Treatment Efficiency of a Permeable Reactive Barrier
Muchitsch, N., M.P. Jensen, and P. Kjeldsen, Technical Univ. of Denmark, Kgs. Lyngby.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract A-050, 2008

At a PRB installed in 1999 to address a plume of dissolved-phase solvents (TCE, PCE, TCA and daughter products), a 2006/2007 study was conducted to evaluate the PRB's efficiency by a flux-based analysis and calculation of the removal of chlorinated aliphatic compounds (CAHs) by comparing mass discharge through cross sections up- and downstream of the barrier. The research was based on calculations of mass flux through different cross sections located parallel to the PRB and perpendicular to the groundwater flow. The flux analysis focuses on 2 pairs of well fences that each contained a cross section before and after the barrier. The first pair of well fences consists of 24 well screens, while the second pair consists of 196 well screens bundled in 14 multilevel samplers. All screens were sampled and analyzed for the subject CAHs. To estimate the groundwater velocity, slug tests were performed in or adjacent to all 220 screens to determine the local permeability. To determine local gradients, two maps of the groundwater potential in the area have been made: one for a larger area around the site (based on 33 piezometers) and one for a smaller area around the barrier (based on 48 piezometers). The spatial variability in mass flux was determined by use of the computer program Mass Flux Toolkit(r) based on the measured concentrations, permeabilities, and gradients. The local mass fluxes were integrated to determine the total plume mass flux both upstream and downstream from the PRB. The study showed a heterogeneous plume distribution: 11% of the PRB treats more than 90% of mass flux. The mass flux determined using high level of detail gave higher fluxes due to the narrowness of the plume because the high level of detail gave a better chance of sampling the plume cores. In general, the PRB was very efficient, except for DCE, due to high upstream mass flux and further formation of DCE from breakdown of PCE/TCE within the PRB. The concentration-based removal efficiencies generally were slightly higher than the flux-based efficiencies.

Using Advanced Analysis Approaches to Complete Long-Term Evaluations of Natural Attenuation Processes on the Remediation of Dissolved Chlorinated Solvent Contamination
Brauner, J.S., D.C. Downey, and R. Miller, Parsons Infrastructure and Technology Group.
Strategic Environmental Research and Development Program (SERDP), Project ER-1348, 462 pp, Oct 2008

This report 1) presents a strategy and framework for quantitatively assessing the sustainability of MNA-based remedies for groundwater at chlorinated solvent-impacted sites, 2) provides case study reviews using existing long-term monitoring (LTM) data sets from multiple U.S. Air Force sites where chlorinated solvents exceed closure criteria, and 3) summarizes observations and recommendations developed when working through the case study examples. While the original intent of the current study was to apply the methods described in this report solely to sites where MNA was the primary remedy, it was recognized during the implementation of the plume stability evaluation process that these methods can also be used for the assessment of active remedies. A case study example that applies the suggested plume stability analysis methods to data from a pump-and-treat remedy is provided to illustrate the flexibility of the proposed approach for evaluating active remedy performance. Application of these methods to other sites where active remedies (e.g., chemical oxidation, chemical reduction, enhanced bioremediation) have been implemented is a recommended next step for evaluating the robustness of the methods described in this report.
http://www.serdp.org/Research/upload/ER-1348-FR.pdf

Using an Integrated Approach to Investigate Natural Biodegradation of Coal-Tar Compounds in a Deep Groundwater Aquifer Under Anaerobic Conditions
Christophersen, M., H. Skou, M.M. Broholm, D. Hunkeler, D.L. Baun, L. Andersen, C. Westergard, H.C.L. Hansen, and P.L. Bjerg.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-003, 2008

The natural degradation of coal-tar compounds under anaerobic conditions was investigated in a deep aquifer downgradient of a former tar and asphalt plant in Ringe, Funen, Denmark. The investigators employed integrated plume characterization, including isotopic fractionation and specific degradation products, laboratory batch degradation tests for selected compounds, and transport modeling to determine whether natural degradation of the coal-tar compounds is sufficient to protect the local drinking water resource. A plume of dissolved coal-tar compounds, including monoaromatic hydrocarbons, naphthalenes, phenols and NSO-compounds, spreads from a source area with DNAPL coal-tar >17 m bgs at the site. The plume follows a buried stream channel in the sand aquifer and has traveled >120 m downgradient and to a depth of 25 to 35 m bgs. Benzene, 2,6-dimethylphenol, thiophene, benzothiophene, and 2-methylbenzofuran are the primary, most persistent constituents. The isotopic fractionation for benzene, toluene, ethylbenzene and m-/p-xylene confirms the degradation of the latter three compounds in the near vicinity of the source-area by 13C-enrichment. In contrast, no 13C-enrichment is observed for benzene in the source area or within the part of the plume, where concentrations of benzene suffice for isotopic fractionation analysis. Specific anaerobic degradation products of TEX are found within the source area only, confirming that the degradation of these compounds takes place predominantly in the near vicinity of the DNAPL. In the downgradient end of the plume where compound concentrations are lower and the redox conditions are somewhat less reduced, benzene and thiophene concentrations are reduced compared to the other problem compounds. This suggests that these two compounds are degraded in the farthest downgradient part of the plume. This presentation emphasizes the line of evidence provided by the integrated approach.

Using Fish Tissue Data to Monitor Remedy Effectiveness

U.S. EPA, OSRTI, OSWER Directive 9200.1-77D, SAMS #1, 14 pp, 2008

Fish tissue contaminant concentrations are often the key measures that need to be monitored to document the success of a cleanup; however, many factors can influence the measured concentrations of contaminants in biota tissues. This directive provides technical guidance to U.S. EPA staff on developing monitoring plans for contaminated sediment sites. It also provides information to the public and to the regulated community on how EPA intends to exercise its discretion in implementing monitoring plans.
http://www.epa.gov/superfund/health/conmedia/sediment/pdfs/fish_sams.pdf

Using Geochemical Characterization to Determine Sources of Unexpected Organic Contaminants

Downey, T.N. and J. Zbozinek, GeoTrans, Inc., Phoenix, AZ.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-018, 2008

A confidential study site in Yuma, AZ, is the source of known PCE and cyanide releases that have co-mingled with a diesel plume emanating from a neighboring site. Under standard reductive conditions, PCE is dechlorinated to form TCE. The second dechlorination step forms the three isomers of DCE: cis-DCE (95%), trans-DCE (~5%), and 1,1-DCE (<1%). The presence of high relative concentrations of 1,1-DCE and the lack of cis-DCE in an area of the plume triggered the need for further investigation of the 1,1-DCE source(s). The three primary 1,1-DCE formation pathways are via the abiotic degradation of PCE in the presence of high sulfide concentrations, microbial biodegradation of PCE in the presence of petroleum hydrocarbons, and the dominant abiotic degradation of 1,1,1-TCA. The first two possibilities were eliminated because the low concentrations of sulfide present were insufficient to promote the abiotic degradation of PCE to 1,1-DCE, and extensive research at a similar PCE-diesel co-contaminated site found that only the cis-DCE isomer was created in the presence of various Dehalococcoides species. The only remaining 1,1-DCE formation pathway is via the release and subsequent degradation of 1,1,1-TCA. The ratio of 1,1-DCE to PCE historically detected at the source property and immediately downgradient was less than 1.5%, roughly consistent with the ratio of 1,1,1-TCA present in PCE as a manufacturing impurity; however, the current 1,1-DCE/PCE ratio detected in one set of wells downgradient of the study area is roughly 15%. The marked change in the chemical fingerprint of the plume points to an additional source of 1,1,1-TCA within the existing PCE plume. Although the half-life of 1,1,1-TCA is on the order of days, the source of a 1,1,1-TCA release can be traced by the presence of 1,4-dioxane, typically present in 1,1,1-TCA at 10 to 15% by weight. 1,4-Dioxiane is recalcitrant and persists in groundwater indefinitely, thus confirming the occurrence of a 1,1,1-TCA release as well as pin-pointing the source. Review of the site-specific data allowed potential 1,1-DCE source(s) to be determined. This presentation elaborates on the practical geochemical analyses required to differentiate the sources of the various daughter products, including the ramifications of these analyses on the choice of remedial technologies selected for the site.

Using GTS as a Tool for LTM Optimization at Government and Military Sites
Hunter, P.M. (AFCEE); K. Cameron (MacStat Consulting Ltd.); R. Stewart (SAIC).
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract N-047, 2008

AFCEE is upgrading and improving its software implementation of the geostatistical temporal-spatial (GTS) long-term monitoring (LTM) optimization scheme under ESTCP Project ER-0714. By enhancing the current beta version of the software, GTS will be integrated into a full-featured software technology. GTS is a statistical and geostatistical decision-logic groundwater monitoring optimization algorithm. It uses a novel combination of statistical techniques to answer two questions given an existing LTM network: (1) what is the optimum number and placement of wells in that network (i.e., is there spatial redundancy and/or is there lack of coverage within the spatial network)? and (2) what is the optimal sampling frequency for wells in the network (i.e., is there temporal redundancy)? GTS is designed to balance some of the practical and scientific difficulties inherent in optimization schemes, i.e., how to perform a scientifically defensible optimization analysis without requiring substantial involvement from hydrogeologic and/or statistical or mathematical experts. The software has several state-of-the-art statistical and geostatistical analytical routines built-in, all tailored to LTM optimization, yet woven into a user interface designed to guide the user through a complex series of analyses. GTS will be used to optimize monitoring networks at three study sites: (1) Air Force Plant 44 (Tucson, AZ), (2) Former Nebraska Ordnance Plant (Mead, NE), and (3) DOE's Fernald Site (Cincinnati, OH). This poster covers some of the improvements being made to GTS as well as the progress and challenges ongoing with the three case studies.

Using Perchlorate to Estimate Site-Specific Recharge for Groundwater Pathway Evaluation
Regmi, S., J. Stovall, T. Fox, T. Battenhouse, and L. Deschaine.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-034, 2008

An innovative approach for quantifying site-specific recharge rates was developed using partially saturated flow modeling and observed perchlorate distribution in soils at the Burning Ground at the Pantex Plant, Amarillo, TX. Perchlorate has been confirmed in shallow soils at the Burning Ground at depths to 6 ft. The finite element heat and mass transfer (FEHM) code was use to evaluate partially saturated flow through a column model. Hydraulic parameters and layer structure for the column model were developed from site investigation data. The timing of perchlorate release is known to be limited to a 1-year period beginning in 1967. Soil sampling results provided the depth of perchlorate migration at different locations ~30 years later at the time the samples were collected. A range of recharge rates was evaluated through particle tracking to determine travel times corresponding to the observed depths of perchlorate migration. The resulting range of recharge rates was 0.09 to 0.35 in/yr. An independent assessment of recharge rates was completed using EPA's HELP model. Results from this assessment produced a net recharge rate of 0.1 in/yr (2.5 mm/yr). The estimated recharge rates are within the ranges provided from previous studies using different lines of evidence and provide further constraints on the recharge rate used in predictive simulations to assess the groundwater pathway. Predictive simulations using the recharge rates in conjunction with observed sampling results have demonstrated that the groundwater pathway beneath much of the Plant is incomplete.

Using Simple Field Instruments to Monitor for Biological Production of Methane at Gasoline Spill Sites

Jewell, K.P., J.T. Wilson, and K. Barron.

Prepared for presentation at the 21st Annual National Tanks Conference and Expo, Sacramento, CA, March 30 - April 01, 2009

When gasoline containing ethanol is spilled to groundwater, natural anaerobic biodegradation of the ethanol can produce copious quantities of methane gas, which bubbles out of the groundwater and enters the unsaturated zone. Depending on local circumstances, the concentration of methane can exceed the lower explosive limit. In addition, the methane can exclude oxygen or provide a substrate for the biological consumption of oxygen in the soil gas. As a result, the methane can diminish the role of aerobic biodegradation in limiting the intrusion of benzene vapors into structures. The authors evaluated a simple and inexpensive meter that is marketed to screen for methane vapors in coal mines. The meter was used to determine methane concentrations in the soil gas of tank fill at gasoline service stations in Oklahoma. Sites were selected where the tank fill is monitored with conventional two inch PVC monitoring wells that are screened above the water table. The well plug was replaced with a sampling cap, and soil gas was pumped at 10 liters per minute from the well for twenty minutes. The pump effluent was delivered to the meter, which recorded the concentrations of oxygen and the concentrations of methane as determined by an infrared cell. To evaluate the accuracy of the field meter, gas samples were collected and returned to the laboratory for analysis by gas chromatography. The lower explosive limit of methane in air is 5%. A concentration of 5% methane was taken as an arbitrary indication for concentrations of concern. The field meter indicated that concentrations of methane met or exceeded 5% at seven of nine sites. Based on GC analysis, the concentrations of methane exceed 5% at only three of the nine sites. An analysis of the composition of stable isotopes indicated that the methane at two of the three sites was produced by anaerobic biodegradation of the petroleum constituents of the fuel. At the other site, the methane came from a leak of natural gas.

Using Specific Conductance Data to Support Characterization of DNAPL Sites

Fiacco Jr, R.J., M. Duquoc, and M.C. Leahy, Environmental Resources Management.

Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract Q-030, 2008

DNAPL or matrix diffusion source areas typically are characterized by complex architectures that will continue to generate dissolved-phase plumes for decades or longer. Source longevity will be controlled by mass transfer and/or back diffusion rates. To mitigate the risks associated with chlorinated solvent plumes, it is critical to characterize the complex source area architecture. Analysis of groundwater chemistry data from several known or suspected DNAPL sites has revealed a general correlation between chlorinated VOCs (CVOC) concentrations and specific conductance. Common factors observed at these sites include significantly elevated dissolved-phase CVOC concentrations, evidence of intrinsic abiotic and/or biological degradation, and relatively low background specific conductance values. In these cases, the CVOC source area can be defined or monitored simply through measurement of specific conductance in groundwater. This approach is significant in that surface geophysical survey methods, such as 2-D resistivity surveys, can be used to support rapid and cost-effective definition of source area and proximal plume architecture. Surface geophysical methods have been used for years to locate and delineate landfill leachate plumes but have not been applied to chlorinated solvent DNAPL sites. At sites where a strong correlation is established between CVOC concentration and specific conductance, in situ specific conductivity probes can be used to monitor changes in groundwater quality over time, rather than more expensive laboratory analyses. Analysis of data from additional sites will be conducted to estimate what percentage of sites could be evaluated using this approach.

Utilization of Background Fluorescence Analysis (BFA) and Fluorescent Dyes to Evaluate Contaminant Distribution and Groundwater Flow
Mohlin, J. and M.H. Otz.
Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH, ISBN 1-57477-163-9, Abstract F-031, 2008

At a site in Long Island, New York, wastes resulting from the production of inks, carbon paper, and typing ribbon were disposed of in open pits. A remedial investigation identified BTEX as the primary site contaminants in groundwater over an area of 1.4 acres. After 5 years of dewatering and SVE, the treatment system achieved a point of diminishing returns, although a 0.3 acre area of elevated BTEX concentrations in groundwater remained. As the contractor considered some form of chemical injection to oxidize and/or promote aerobic degradation of the BTEX, recent groundwater samples suggested groundwater contamination was unexpectedly migrating upgradient from the remediation area and off site. Because BTEX compounds fluoresce intensely, the background fluorescence analysis (BFA) technique was tried to determine if the intrinsic fluorescence of the BTEX compounds is characteristic enough to identify areas of higher BTEX contamination quickly and cost-effectively (the analysis is ~one-fifth the cost of BTEX analysis). Groundwater samples were collected from 35 monitoring wells and analyzed using a spectro-fluorometer for fluorescence emission intensity. Spectrofluorometers are capable of detecting organic substances down to the ng/L (ppt) range--orders of magnitude more sensitive than any chemical analysis. Several emission wavelength values were chosen, their values plotted to their corresponding wells and then contoured. These contour maps were compared to the BTEX distribution to evaluate if the BFA could serve as an alternative. The close matches with the chemical BTEX fingerprint suggested that BFA can be beneficial for site characterization and plume delineation. After a thorough BFA, several fluorescent dyes were injected and analyzed between October 2005 and May 2006 to evaluate groundwater flow paths and seepage velocities to obtain pre-design information in the complex geology. The fluorescent dye tracing (FDT) study revealed the presence of dyes in several wells that were not in the generally accepted direction of groundwater flow, indicating preferential flow paths and also providing data on seepage velocity. The BFA/FDT techniques can offer an effective means to address hydraulic connections and preferential flow paths. The case study BFA helped to confirm that a part of the plume had extended upgradient and off site due to very localized groundwater flow patterns. The FDT provided data on seepage velocity and flow paths that can be used to improve the design and ultimate dispersion of chemicals during a final injection-based remedy.

Utilization of Nondisruptive, Molecular Analyses to Expedite Closure of an MTBE-Contaminated Retail Facility
Jennings, E.M. (URS, Gaithersburg, MD), T. Ryan, H. Van Elburg, and D. Clark.
In Situ and On-Site Bioremediation 2009: Proceedings of the 10th International In Situ and On-Site Bioremediation Symposium, 5-8 May, Baltimore, Maryland. Battelle Press, ISBN: 9780981973012, 2009

In 1985, both benzene and MTBE were detected in concentrations above drinking water standards at a retail gasoline station. By 1994, benzene concentrations were reduced to acceptable levels, but MTBE rebounded at the site after a release from a nearby unrelated retail facility. Preliminary remediation methods, including SVE and a mobile dual-phase extraction system, were followed by weekly air sparging and in situ remediation. Despite these efforts, MTBE remained in the groundwater. To restimulate bioremedial activity, a site-specific profile of the bacterial community responsible for MTBE degradation was needed. Analytical methods such as stable-isotope probing analyses and phospholipid fatty-acid (PLFA) analyses often require a site to be left undisturbed for extended periods of time, but on-site and nearby remediation activities made it inappropriate to implement those methods. A customized approach was designed that coupled the use of denaturing gradient gel electrophoresis (DGGE) to other geochemical analyses. The resulting information provided a detailed profile of the groundwater microbial community and supported the design of a site-specific in situ remediation protocol. The modified and more efficient bioremediation methods subsequently resulted in an increased rate of MTBE biodegradation, allowing concentrations to approach acceptable regulatory levels more quickly. This project illustrates the importance of using molecular microbial analyses that have a minimal impact on ongoing site activities when evaluating remedial options.

Vadose Zone Monitoring of the T-Tank Farm Interim Surface Barrier
Zhang, Z.F.,C.E. Strickland, J.G. Field, and D.L. Parker.
Program and Abstracts: The 7th Annual Washington Hydrogeology Symposium, 28-30 April 2009, Tacoma, Washington. Washington Department of Ecology and the U.S. Geological Survey, p 46, 2009

A temporary surface barrier was constructed over a portion of the Hanford's T Tank Farm as part of the T Farm Interim Surface Barrier Demonstration Project. The surface barrier is designed to minimize the infiltration of precipitation into the contaminated soil zone created by the Tank T-106 leak and reduce the rate of movement of the contamination. Vadose zone moisture is being monitored to assess the effectiveness of the barrier at reducing soil moisture. A solar-powered and remotely controlled system was installed for continuous monitoring of soil water conditions at four locations (i.e., instrument Nests A, B, C, and D) beneath the barrier and outside the barrier footprint as well as site meteorological conditions. Each instrument nest is composed of a capacitance probe with multiple sensors, multiple heat-dissipation units, and a neutron probe access tube. The principal variables monitored for this purpose are soil-water content and soil-water pressure. Soil temperature, precipitation, and air temperature are also measured. Nest A is placed in the area outside the barrier footprint and serves as a control, providing subsurface conditions outside the influence of the surface barrier. Nest B is placed at the western edge of the surface barrier and just beneath it. Nest B provides subsurface measurements to assess surface barrier edge effects. Nests C and D are placed in the area covered by the barrier and are used to assess changes in soil-moisture conditions beneath the interim surface barrier. Monitoring began on September 2006 and is planned to continue for two years after barrier emplacement. Data collected and stored in the dataloggers can be retrieved remotely any time. To date, the monitoring system has provided continuous high-quality data. The monitoring data in FY 2007 and early FY2008 reflect the baseline of the soil-water condition. The data in late FY 2008 and after show the impacts of the surface barrier on soil-water conditions.

Validation of Sampling Protocol and the Promulgation of Method Modifications for the Characterization of Energetic Residues on Military Training Ranges: ESTCP Cost and Performance Report
Environmental Security Technology Certification Program (ESTCP), Project ER-0628, 62 pp, Apr 2009

The objectives of this demonstration/validation project were to promote scientifically defendable sampling and sample-processing protocols for the characterization of energetic residues on military training ranges. The principal mechanism for meeting this objective has been to inform potential users of the sampling and sample processing protocols developed under the Strategic Environmental Research and Development Program (SERDP) projects ER-1155 and ER-1418. These objectives were promoted by the posting of U.S. EPA Method 8330B on the Web in 2006, performance of two field demonstrations, and development of guidance for implementing Method 8330B. The Method 8330B guidance is available on line at www.navylabs.navy.mil/Archive/Final%208330B%20Implementation%20Guide%20070708.pdf Workshops have been held to promote the attributes of MULTI INCREMENT(r) sampling (MIS) and to highlight the laboratory modifications required for representative subsampling and analysis, and commercial laboratories have been actively assisted to prepare for certification in Method 8330B. http://www.estcp.org/Technology/upload/ER-0628-C&P.pdf

Vertical Distribution of VOCs in Soils from Groundwater to the Surface/Subslab
Elliot, J. and G. Swanson.
EPA 600-R-09-073, 326 pp, 2009

Field work was conducted at Installation Restoration Program (IRP) Site 14 on Naval Air Station Lemoore, CA, to assess the vertical and horizontal distribution of VOCs (PCE, TCE, DCE, 1,2-DCE, 1,1-DCA, and 1,2-DCA, with commingled fuel residuals) in the subsurface from groundwater to the surface/subslab environment and to develop a database of paired macro-purge and micro-purge soil gas sample measurements. In addition, sampling was conducted to evaluate

the performance of a variety of soil gas probe construction materials (tubing types) and to test passive diffusion samplers (PDSs). Statistical analyses of the paired micro-purge and macro-purge soil gas samples indicate a correlation between the results obtained from the two sampling methodologies; however, the range of relative percent differences (RPDs) for the macro-purge samples was 50%, which is largely within analytical error, whereas the range of RPDs for the micro-purge samples was 260%, suggesting there are some as yet undetermined issues with this sampling method that are limiting its reproducibility. The results of analysis of samples obtained from collocated probes constructed with different tubing types indicate that for most materials, the observed variability in measured concentrations is within analytical error. Polyethylene tubing consistently yielded lower VOC concentrations than the other tubing types except for copper. Copper tubing VOC concentrations were significantly lower than the other tubing types and their concentrations were inconsistent with one sample being a non-detect and the other having 170 ug/m3 of TCE. After converting the PDS sample results to gas equivalent concentrations using Henry's Law, the TCE and PCE concentration results for the PDSs generally were higher than in the collocated macro-purge probes. Additional data are needed to assess sampler performance more completely. The results of the investigation into the distribution of soil gas VOCs near a slab indicate that, as expected, VOC concentrations in soil gas decrease with increasing vertical separation from the groundwater source and with increasing horizontal distance away from the edge of the slab. These findings are consistent with physical principles of subsurface vapor distribution from a groundwater source and the impact of a slab as a physical barrier; however, the decline in soil gas VOC concentrations moving horizontally away from the edge of the slab was more rapid than expected. Limited groundwater data show a corresponding large decrease in VOC concentrations moving away from the slab. These observations indicate that the presence of the slab can have a significant and abrupt impact on VOC concentrations in soil gas and the upper-most groundwater, and have important implications for sample location selection in vapor intrusion studies.
http://www.epa.gov/nerlesd1/cmb/pdf/EPA600-R-09-073.pdf

SBIR and Other Grant Awards

U.S. Department of Energy

Determining Spectral Properties of Rocks and Sediments from Broadband Electrical/Electromagnetic Data Processing (DOE 2009 SBIR Phase 1)
Multi-Phase Technologies, LLC, Sparks, NV

This project will design a method that can characterize subsurface conditions (i.e. permeability) of environmental remediation sites to better design remediation systems.

Development of Packaging and Integration of Sensors for On-Line Use in Harsh Environments (DOE 2009 SBIR Phase 1)
MesoScribe Technologies, Inc., Stony Brook, NY

This project will develop improved sensor packaging techniques for use in advanced power systems. The technology will enable steam turbines, boilers and other critical components to be monitored and operated efficiently to prevent unforced shutdowns, reduce maintenance costs, and reduce emissions.

Disposable MEMS-Based Raman Micro-Spectrometer for Improved Characterization of Waste in Tanks and Ancillary Piping (DOE 2009 SBIR Phase 1)
Tanner Research, Inc., Monrovia, CA

As a legacy of the Cold War, toxic waste from nuclear munitions fabrication has been buried in now aging tanks in dozens of locations across the US. This project will develop a novel miniature chemical sensor to enable safe and successful remediation of this environmental hazard.

Enabled VOC Sensor for Energy-Efficient Building Ventilation (DOE 2009 SBIR Phase 1)
TIAX, LLC, Cambridge, MA

This project will develop a sensor technology that allows for efficient management of building ventilation, while maintaining a healthy environment for occupants. With widespread adoption, it has the potential to save billions in energy costs with a relatively short payback period.

Fiber Optically Coupled Raman Telescope for the In Situ Standoff Characterization of Residual Wastes (DOE 2009 SBIR Phase 1)
EIC Laboratories, Inc., Norwood, MA

This project will develop a fiber optically coupled Raman probe telescope that will be able to detect and identify chemicals at a standoff distance. The telescope Raman probe will be used as a characterization tool for residual wastes in nuclear waste storage tanks.

Harsh Environment Sensor Packaging (Sensor Pack) (DOE 2009 SBIR Phase 1)
Luna Innovations Incorporated, Roanoke, VA

Housing of fiber-optic harsh environment sensors is proposed for universal power generation compatibility. These sensors, once applied to the power industry will enable U.S. energy independence by enabling efficient clean coal and by improving other fossil fuel based power production efficiency.

HgTe/CdTe Superlattice FTIR Detectors Optimized for the 300-to-1000 cm-1 Region (DOE 2009 SBIR Phase 1)
EPIR Technologies, Inc., Bolingbrook, IL

This project will use unique new methods in a new technology to develop the first sensitive, high-resolution focal plane arrays to image in the very long wavelength infrared needed for reliable remote sensing of weapons of mass destruction and of chemical and biological agents.

In-Situ Monitoring of Iodine-129 in Groundwater Using a Minicolumn (DOE 2009 STTR Phase 1)
Burge Environmental, Inc., Tempe, AZ

This project will develop a field-deployable monitoring system for the cost-effective and rapid determination of radioactive substances in the groundwater at federal sites, such as Hanford Site, Washington. The development of the system will decrease the future cost of site remediation.

An Integrated In Situ Raman and Turbidity Sensor for High Level Waste Tanks (DOE 2009 STTR Phase 1)
EIC Laboratories, Inc., Norwood, MA

This project will develop an integrated Raman/turbidity sensor for in situ characterization of nuclear waste. The sensor will provide chemical characterization of the waste and yield information concerning the amount of suspended particles in the waste.

Label-Free In-Situ Biofilm Analysis (LIBA) System (DOE 2009 SBIR Phase 1)
ChromoLogic, LLC, Pasadena, CA

This project will develop an instrument that will revolutionize our understanding of biofilms - leading to their management to better protect the national infrastructure and the engineering of novel biofilms that could reduce global warming (carbon sequestration) and heal the environment (soil remediation).

Long-Wave Infrared Photonic Band-Gap Fiber (DOE 2009 SBIR Phase 1)
Agiltron, Inc., Woburn, MA

Infrared optical fibers are a long sought goal of optical technology, useful for a broad range of military and commercial applications ranging from antimissile countermeasures to laser surgery. The proposed research will lead to the first practical, manufacturable low-loss infrared optical fiber for the wavelength band of greatest importance.

Long-Wave Infrared Transmitting Single Mode Fiber (DOE 2009 SBIR Phase 1)
AdValue Photonics Inc., Tucson, AZ

This project will develop a new class of advanced infrared transparent single mode fiber to meet DOE's demand on new fibers for remote sensing systems currently under development. The remote sensing program has been a cornerstone in the national capability for the detection of proliferation facilities and activities for decades. Such a fiber can also be used for chemical monitoring and deliver IR power for medical application.

Low Cost Optrodes for Chemical Sensor Development of Tethered PET-Fluorophores (DOE 2009 SBIR Phase 1)
Resodyn Corporation, Butte, MT

This project will produce a novel sensor technology that enables the production of a low-cost optical sensor to determine the level of acidity or alkalinity (pH) over a broad range for industrial, military, and environmental applications. Expected benefits include improved performance, energy savings, enhanced efficiency, and security.

Nanoparticle Enhanced Resonator Sensor for Trace Radionuclide Detection (DOE 2009 SBIR Phase 1)
Novawave Technologies, Inc., Redwood City, CA

This project will develop a real-time metal enhanced fluorescence detection system that has the potential to impact significantly the ability scientists to track sub-surface radionuclide and metal migration to prevent widespread ecological contamination from aging radiological stores. In addition, the technology can be adapted for homeland security applications, particularly safe buildings where office buildings, hospitals, hotels, malls, and schools can be monitored with a distributed sensor network.

Novel Sensor for Industrial Process Monitoring (DOE 2009 SBIR Phase 1)
Los Gatos Research, Mountain View, CA.

This project will support the development and demonstration of a novel instrument with unprecedented speed, specificity and reliability for monitoring and control of combustion emissions and of power plants and industrial processes; and for measurements of atmospheric pollutants, trace gases and greenhouse gases.

Novel Wireless Sensor Integration in Process Control (DOE 2009 SBIR Phase 1)
Crossfield Technology, LLC, Austin, TX

This project seeks to develop a standard package that will enable the use of advanced chemical sensors in harsh environments, such as present in emerging clean coal technology power systems. The standardized package will enable quick implementation of newly developed sensors.

Standardized Sensor Packaging for Harsh Environment (DOE 2009 SBIR Phase 1)
Makel Engineering, Inc., Chico, CA

This project seeks to develop a standard package that will enable the use of advanced chemical sensors in harsh environments, such as present in emerging clean coal technology power systems. The standardized package will enable quick implementation of newly developed sensors.

Ultrasonic In-Situ Characterization of Tank Waste (DOE 2009 SBIR Phase 1)
Luna Innovations Incorporated, Roanoke, VA

This project will develop ultrasonic measurement technologies to enable the cleanup of liquid waste stored in underground tanks for the DOE without the generation of secondary waste by existing technologies.

Environmental Security Technology Certification Program (ESTCP)

Use of Compound-Specific Stable Isotope Analysis to Distinguish Between Vapor Intrusion and Indoor Sources of VOCs (ESTCP 2010 Grant)
Project ER-1025.
Thomas McHugh, PI, GSI Environmental, Inc.

Distinguishing between vapor intrusion and indoor sources of volatile organic compounds (VOC) is a significant challenge during site assessments, greatly increasing the cost and complexity of investigations. The objective of this project is to validate compound-specific stable isotope analysis (CSIA) as a tool to distinguish between vapor intrusion and indoor sources of VOCs. Validation of this technique will reduce the effort and cost of testing indoor air at vapor intrusion sites.

Validation of a Novel Bioassay for Low-Level Perchlorate Determination (ESTCP 2010 Grant)
Project ER-1030
John Coates, PI, University of California, Berkeley.

The objective of this project is to demonstrate and validate a novel perchlorate-specific bioassay with field samples collected from sites with groundwater known to contain perchlorate. This technique has the potential to provide a rapid, specific, and sensitive method for the detection of perchlorate that obviates the need for expensive equipment and highly trained personnel.