Measurement & Monitoring:
16th Quarterly Literature Update

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Accelerated Solvent Extraction (ASE) of Environmental Organic Compounds in Soils Using a Modified Supercritical Fluid Extractor
Li, K. (Environment Canada, Environmental Technology Centre, Ottawa, ON, Canada); M. Landriault; M. Fingas; M. Llompart.
Journal of Hazardous Materials, Vol 102 No 1, p 93-104, 15 Aug 2003

Two conventional supercritical fluid extraction (SFE) systems, the Suprex Prep Master and SFE/50 systems have been modified to function as accelerated solvent extraction (ASE) systems. Using solvent, instead of supercritical fluid, extraction in an enclosed system proceeded under high pressure and temperature. Parameters such as extraction temperature and effect of modifiers were investigated. Though limited by a 150 degrees C maximum oven temperature, effective extraction could be carried out in less than 25 minutes for all the compounds studied. The technique was applied to a variety of real matrices contaminated with hydrocarbons, PAHs, and phenols. Validations of the technique were performed using standard reference materials. Recoveries for these matrices were good (>75%) and precision (R.S.D.) was generally less than 10%. Primarily a rapid field extraction technique, comparison with other rapid extraction such as sonication and microwave assisted extraction (MAP(TM)) were made. Recoveries were found to be comparable to MAP(TM) and superior to sonication. On the present ASE system, only sequential extraction can be carried out but given the rapid nature of the process, about 15 samples can be carried out in a working day.

Accelerated VOC Source Investigation Pairing SCAPS/MIP with EPA Triad to Save Time and Money, Marine Corps Base Camp Pendleton, California
Collins, Karen G. (U.S. Navy Public Works Center San Diego); M. Bilodeau; G. Buckner; A. Saboya; P. Underwood. Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization, 15-17 June 2004, Dallas, Texas.

A dynamic work strategy was implemented to expedite a preliminary assessment/site inspection (PA/SI) for an uncharacterized volatile organic compound (VOC) release at Marine Corps Base Camp Pendleton. Using the U.S. EPA's Triad approach for site characterization, the investigation implemented a Navy Site Characterization and Penetrometer System (SCAPS) outfitted with a membrane interface probe (MIP). The SCAPS/MIP is an emerging sensor technology used to optimize characterization of sites affected by VOCs. Using a customized probe, cone penetrometer soil property data are coupled with near-continuous VOC vertical profile data to enable the detailed interpretation of preferential pathways for contaminant migration and the construction of a robust conceptual site model (CSM). Real-time VOC and lithologic data were input to on-board computer models to continuously expand and refine the CSM. Data acquisition and analyses was conducted in real time by a core technical team of geologists, hydrogeologists, chemists and regulatory partners, which supported expedited decision-making with the goal of complete source area characterization in a single mobilization. Implementation of the Triad approach using the SCAPS/MIP on this project provided a high-density data set, identification of preferential pathways for contaminant migration, and a detailed CSM and resulted in expedited site closure with agency concurrence. Cost savings estimated at $2.5 M were realized, and the site characterization and cleanup schedule was reduced by approximately 3 years.
http://207.86.51.66/siteopt/ataglance.htm

Accelerating the Availability of Monitoring Data Through Electronic Data Management Tools
Carey, T. and J. Ovia (CH2M HILL, Navarre, FL); M. Rodriguez (Eglin AFB); J. Bossart (CH2M HILL). Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, 15-17 June 2004, Dallas, Texas.

Data management and evaluation were streamlined at several Air Force Bases in the southeast through the use of electronic tools, software, and hardware that allowed project team members faster access to the monitoring data. During extensive field efforts, monitoring data must be collected, evaluated, and disseminated quickly. Contractors (i.e., drillers) and field technicians may be on site waiting for further work instructions related to excavation or remediation system operation based on these data results. Because project team members are often not in the same location, it is challenging to ensure that all members have access to the most current field and analytical data. To expedite data availability, electronic data management tools were developed in conjunction with the analytical database and maintained on a company server. Field data were entered in one location, analytical data loaded from another location, and queries of all data were generated from a third location. The project team members were able to access and evaluate field and analytical data much quicker, often within hours of data receipt. This database was also routinely queried to update other applications such as the project Geographic Information System (GIS) files. In this data management process, samples are identified, collected, and submitted to an outside laboratory for analysis. The laboratory provides preliminary data in a prescribed electronic format within 24 hours following sample receipt. The project chemist or database manager then loads the electronic data into the database. A preliminary evaluation of the data is performed using custom queries, and necessary data qualifiers are applied. The data are then evaluated against project criteria using custom queries. Criteria exceedance tables are generated and distributed to the project team within 2 hours following data receipt from the laboratory. Based on these data results, maps are generated and field activities redirected as needed. To expedite data evaluation, all final data reports are received from the laboratory reports electronically as portable document files, eliminating the paper copy and shipping delays. Data are validated electronically and the data files are posted to project folders for project team members to access.
http://207.86.51.66/siteopt/ataglance.htm

Accelerating Waste Site Cleanup at the Savannah River Site Using Geostatistics
Shoffner, Lisel R., Bechtel Savannah River Inc., Aiken, SC.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 241, 2004

There are many tools available to expedite characterization, but one of the most effective tools is the use of statistics in sample planning. At the Chemicals, Metals, and Pesticides (CMP) Pits waste site at the Savannah River Site, statistical methods were used to expedite site characterization while maintaining data quality and cost effectiveness. Determining how many samples are required to complete characterization of a waste site is typically subjective and can involve large numbers of samples, long durations of time, and large budgets. The use of DOE's Visual Sample Plan (VSP) statistical software improved the efficiency and effectiveness of the CMP Pits characterization. VSP allows users to choose from a variety of statistical methods to best determine the number of samples needed to properly characterize a site. A site map can be loaded into the VSP program and statistical parameters can be tailored to the particular site. Once the appropriate number of samples has been determined, VSP will randomly generate locations, which can be exported to a GIS program and incorporated into the sample and analysis plan. At the CMP Pits, VSP was used to plan verification sampling for an area where contaminated soil had been removed. By performing statistically based

sampling of the area rather than traditional grid sampling, the number of samples was reduced by 50%, which reduced the cost of sampling by $8,000. The federal and state regulators accepted the statistical basis for the sampling plan and required no additional sampling for verification of the remedial goal objectives. This use of a geostatistics tool for characterization planning incurred no additional labor cost, was scaleable for project needs, reduced characterization costs and time, resulted in statistically valid sample plans with reduced subjectivity, and produced increased regulator confidence.

Acid Lake Identification Using GIS and Remote Sensing
Shi, Peichang, Songlin Cheng, and Steven B. Smith, Wright State Univ., Dayton, OH.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 300, 2004

The authors studied the feasibility of using GIS and remote sensing to identify acid lakes. The initial attempt to identify lakes by image classification using LANDSAT 7 imageries did not produce a unique cluster of lakes. Digital line graph (DLG) of lakes was then used to isolate lakes to produce a lake layer. It was anticipated that a lack of phytoplankton in acid lakes should have a uniformly low Normalized Difference Vegetation Index (NDVI) value, while normal lakes should show a high value in the summer and low in the winter. IDRISI32 was used to generate NDVI from LANDSAT 7 bands 3 and 4 of the study site between March and December. The limitation of suitable data made it necessary to use LANDSAT 7 data taken between 1999 and 2002. Boolean operation using lake layer to multiply the NDVI isolated the NDVI of lakes from non-lake areas. The result clearly shows that the NDVI of normal lakes is high during the growing season (> 0.4) and approaches zero during the winter, while NDVI of acid lakes is about -0.2 in each month. The authors conclude that this approach can effectively differentiate normal lakes from the acid lakes via the NDVI during the growing season.

Activation of Phosphorothionate Pesticides Based on a Cytochrome P450 BM-3 (CYP102 A1) Mutant for Expanded Neurotoxin Detection in Food Using Acetylcholinesterase Biosensors
Schulze, H., R.D. Schmid, T.T. Bachmann, Univ. of Stuttgart, Stuttgart, Germany.
Analytical Chemistry, Vol 76 No 6, p1720-5, 14 Mar 2004

A novel enzymatic in vitro activation method for phosphorothionates has been developed for their detection with acetylcholinesterase (AChE) biosensors. Activation is necessary because in the pure non-metabolized form, this group of insecticides shows nearly no inhibitory effect toward AChE. After oxidation as it takes place by metabolic activation in higher organisms, however, the insecticides exert a strong inhibitory effect on AChE. A genetically engineered triple mutant of P450 BM-3 (CYP102 A1) could convert two frequently used insecticides (parathion and chlorpyrifos) into their oxo variants as confirmed by GC/MS measurements. For chlorpyrifos, the enzymatic activation was as good as the chemical oxidation. For parathion, the P450 activation was more efficient than the oxidation by NBS, but neither activation method yielded an AChE inhibition that was as high as with paraoxon. The application of the method to food in combination with a disposable AChE biosensor enabled detection of chlorpyrifos and parathion at concentrations down to 20 ug/kg within 95 min.

An Adaptive Long-Term Monitoring and Operations System (aLTMOs) for Optimization in Environmental Management
Rizzo, D.M., D.E. Dougherty, and M. Yu.
ASCE 2000 Joint Conference on Water Resources Engineering and Water Resources Planning and Management (July/Aug 2000, Minneapolis, MN). American Society of Civil Engineers, Reston, VA.

The growing costs of long-term monitoring and operations at groundwater cleanup sites present a significant opportunity for system optimization. Optimization techniques have been used to suggest ways to operate pump-and-treat remediation systems at effectively reduced costs. Contemporaneously, characterization methods based on kriging methods, artificial neural networks, and Extended Kalman Filtering have been developed and deployed. In addition to mapping property values, the characterization methods detect and describe spatial and temporal correlations among aquifer properties and are used in uncertainty assessments. These technologies are reusable and form the core of the adaptive Long Term Monitoring and Operations system (aLTMOs(TM)) to assess and optimize long term monitoring network performance and costs. This paper presents the preliminary application of an aLTMOs(TM) optimization to the Army SSCOM in Massachusetts.

The Advanced Monitoring System Initiative: Optimizing Delivery and Application of New Sensor and Monitoring Solutions
Jones, John B. (U.S. DOE, Nevada Site Office); William Haas, Jr. (Ames Laboratory, Iowa State Univ.).
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, 15-17 June 2004, Dallas, Texas.

The Advanced Monitoring System Initiative (AMSI) is a new approach to overcome technical and institutional obstacles to the development and application of advanced sensor and monitoring systems. AMSI is a vertically integrated development, testing, and evaluation (DT&E) enterprise that searches aggressively for promising new sensors and monitoring system elements, for development, integration, and application addressing DOE's Office of Environmental Management (DOE EM) end-user needs. AMSI provides rapid prototyping, systems integration, and field testing, including initial deployment assistance. It has easy access to unique facilities and capabilities available at the Nevada Test Site, which is also home to the Hazardous Materials Spill Center, a one-of-a-kind facility built and permitted for releases of hazardous materials for training purposes, field-test detection, plume dispersion experimentation, and equipment and materials testing under controlled conditions. This presentation describes AMSI operating characteristics and activities with examples of vadose zone and groundwater tritium monitoring, strontium-90 monitoring, technetium-99 monitoring, a wireless moisture monitoring system, and Cr(VI) monitoring.
http://207.86.51.66/siteopt/ataglance.htm

Advances in Analytical Technologies for Environmental Protection and Public Safety
Sadik, O.A., A.K. Wanekaya, and S. Andreescu.
Journal of Environmental Monitoring, Vol 6 No 6, 513-522, 2004

This paper discusses challenges to meet in developing monitoring technologies for warfare agents and other toxins. It provides an overview of how advances in environmental analytical methodologies could be adapted to design reliable sensors for public safety and environmental surveillance. The paths to designing sensors that meet the needs of today's measurement challenges are analyzed using examples of novel sensors, autonomous cell-based toxicity monitoring, lab-on-a-chip

devices, and conventional environmental analytical techniques. Guidelines are provided for assessing data quality and quality assurance using the U.S. EPA methodologies to ensure that the public and legal authorities are provided with quality data to make informed decisions.

Analysis of 1, 4-Dioxane: Technical Challenges and Observed Results
Occhialini, James F., James Todaro, Scott Enright, & Joseph Watkins, Alpha Analytical Labs, Westborough, MA. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

The presence of 1,4-dioxane as a ground water contaminant has been the subject of increasing concern. In industry, the compound has often been used as a stabilizer for chlorinated solvents, which suggests that it may be present at chlorinated solvent sites. The compound is highly mobile in water, which makes it difficult to remediate. The same physical characteristics that make it a threat to ground water also present analytical challenges, particularly with regard to the analytical sensitivity required to address 1,4-dioxane at risk-based concentration levels. This paper presents modifications to EPA Methods 8260B and 8270C to maximize the analytical performance for this compound. Accuracy, precision, and sensitivity data are presented for each method with recommendations for obtaining the best performance.

Analytical Equations for Predicting Concentration and Mass Flux from Composite Landfill Liners
Foose, G., C. Benson, and T. Edil.
Geosynthetics International, Vol 8 No 6, p 551-575, 2001

In this paper, equations are presented for predicting the discharge of contaminants from composite liners and for designing alternative liners. Some of these equations are shown to provide predictions of mass flux and contaminant breakthrough that are similar to predictions made with more complex 1- and 3-D numerical models for composite liners having perfect contact, circular defects, a constant source concentration, and relatively simple boundary conditions.
http://www.uwgeotech.org/publications3.htm

The Application of Ground Penetrating Radar Attenuation Tomography in a Vadose Zone Infiltration Experiment
Chang, Ping-Yu and David Alumbaugh (Univ. of Wisconsin-Madison, Madison); Jim Brainard (Sandia National Labs, Albuquerque, NM); Laila Hall (New Mexico Tech, Socorro).
Journal of Contaminant Hydrology, Vol 71 Nos 1-4, p 67-87, July 2004

Cross-borehole ground-penetrating radar (XBGPR) is being used to examine contaminant transport in the vadose zone via the monitoring of a long-term vadose zone infiltration experiment at a test site in Socorro, NM. The study indicates that XBGPR attenuation tomograms provide high-resolution images of clay distribution in the vadose zone. Time-lapse attenuation tomograms of water infiltration show that attenuation increases by approximately 0.3 Np/m during the water infiltration, and indicate a snowplow effect may be occurring where salts are dissolved by the water and concentrated at the front of the plume. Seasonal temperature changes may also cause changes in electromagnetic attenuation images and mask the evidence of water infiltration. Caution must be taken when using time-lapse attenuation images to interpret the movement of a water plume during a long-term experiment as temperature changes.

Application of Microbial Enumeration Technique to Evaluate the Occurrence of Natural Bioremediation
Kao, C.M., S.C. Chen, J.K. Liu, and Y.S. Wang, National Sun Yat-Sen Univ., Taiwan.
Water Research, Vol 35 No 8, p 1951-1960, June 2001

The feasibility of applying the microbial enumeration technique was assessed for natural biodegradation evaluation at three selected gasoline spill sites. At each site, two monitor wells were installed along the groundwater flow, and one multilevel sampler (MLS) was installed to delineate the vertical distribution of the contaminant plume. Two continuous soil cores were collected at each site to evaluate the horizontal distribution of the microbial activity. Soil samples were used for microbial enumeration, grain-size distribution analysis, and sediment extraction. 1,2,4-Trimethylbenzene was released as a tracer to study the efficiency of contaminant biodegradation. The study results show agreement between microbial enumeration and other evaluation techniques for natural bioremediation (e.g., geochemical indicator analysis, tracer study) and indicate that microbial enumeration can be useful in assessing the occurrence, efficiency, and status of bioremediation. This technique could provide a supplemental method for natural bioremediation evaluation at petroleum-hydrocarbon spill sites.

Assessing the Toxicity of Neuse River Sediments with BioTurbTox: a new Chironomid Bioturbation Test
Cho, E.-A., D. Shea, and W. Cope, North Carolina State Univ., Raleigh, NC.
Fourth SETAC World Congress, 25th Annual Meeting in North America, 14-18 November 2004, Portland, Oregon. Society of Environmental Toxicology and Chemistry, Pensacola, FL. Poster PM114, 2004

The authors used the newly developed sediment toxicity test method, BioTurbTox, a chironomid bioturbation test, with other standardized sediment toxicity tests to evaluate the toxicity of Neuse River sediments during the summers of 2003 and 2004. They also simultaneously collected water and sediment samples and deployed passive sampling devices (PSDs) at the six study sites in the upper-, mid-, and lower-Neuse River and analyzed them for polycyclic aromatic hydrocarbons (PAHs), metals, and pesticides. Atrazine was the most frequently detected pesticide, which was measured at relatively high concentrations (0.12 ng/mL) in the upper Neuse River watershed. The two PAHs, pyrene and fluoranthene, were measured at relatively high concentrations (3553.8 and 3267.6 ng/2 strips) in PSDs deployed in the upper river. Fluoranthene was also frequently detected at sites from the mid- and lower-river. Concentrations of fluoranthene were correlated with the C. dubia porewater toxicity results. Sediment toxicity test methods were evaluated for similarity of response among assays. The BioTurbTox test generated results similar to the standard assays and was useful as a rapid screening method for sediment toxicity information, but it required normalization to the clay content of field-collected sediments.

Assessment of Hydraulic Capture through Interpolation of Measured Water Level Data
Tonkin, Matthew J. Tonkin (S.S. Papadopulos & Associates, Inc.); Steven Larson, Univ. of Queensland). Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization, 15-17 June 2004, Dallas, Texas.

A quick assessment of measured water level data indicates that the second-order stationarity requirements for kriging are rarely satisfied, and that the principal cause is an underlying trend, which indicates that the water level data must be de-trended. Common trend models such as linear and nth-order polynomials are a pragmatic approach for estimating (or removing) regional trends typically seen in water level data; however, more specific trend models are required to explain the effects of

pumping and hydraulic boundaries, and these should be based upon the physical processes that produce the trend. The motivation behind developing these specific trend models is to increase the amount of inference that can be drawn from the measured data. Two examples demonstrate the increased inference possible when using these trend models with measured water levels to assess the performance of pump-and-treat groundwater remedies in achieving capture. The long-term objective is to familiarize the groundwater community with the theory behind these methods, develop the methods further through application and technical review, and make available documented and tested approaches and supporting programs to the groundwater community.
http://207.86.51.66/siteopt/ataglance.htm

Assessment of Subsurface Chlorinated Solvent Contamination Using Tree Cores at the Front Street Site and a Former Dry Cleaning Facility at the Riverfront Superfund Site, New Haven, Missouri, 1999-2003
Schumacher, J.G. and G.C. Struckhoff (U.S. Geological Survey); J.G. Burken (Univ of Missouri, Rolla).
U.S. Geological Survey Scientific Investigations Report 2004-5049, 41 pp, 2004

The sensitivity of tree-core sampling to detect subsurface contamination was estimated using measured PCE concentrations in trees growing along contaminated tributaries at the Riverfront Superfund Site and from field hydroponic experiments. Data collected from trees growing along PCE-contaminated streams and hybrid poplar cuttings planted in these streams indicate that tree-core sampling can be used to detect PCE concentrations as small as about 8 to 30 ug/L in shallow ground water at this site. This range assumes that the tree roots are in direct contact with the contaminated ground water, and that the depth to ground water is less than a few feet deep. The sensitivity of tree cores to detected PCE contamination in soils is difficult to estimate because PCE concentrations in soils at the Front Street site typically are large (tens of thousands of micrograms per kilogram or more), and because a mixture of contaminated soil, soil vapor, and ground water is present at most locations at the Front Street site. The data indicate that PCE should be present in core samples from trees growing in soils containing PCE concentrations of several hundred micrograms per kilogram or less.
http://mo.water.usgs.gov/Reports/sir2004-5049-schu/

Automated Analysis of Chromium(VI) for Long-Term Monitoring of Ground and Surface Waters
Burge, Scott (Burge Environmental, Inc., Tempe, AZ); Richard Venedam (Bechtel Nevada).
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

A colorimetric method of detection for chromium(VI) has been interfaced to a 'universal' sampling/analytical module capable of automating the monitoring of chromium(VI) in shallow groundwater and surface-water systems. The universal system was designed to serve as a field-deployable platform of several types of analytical sensors. Previous deployments have included the monitoring of trichloroethene in aquifers. The universal sampling/analytical system is capable of sample collection from either surface or groundwater, sensor calibration, duplication, and spikes and calibration checks without the requirement of an operator. The system can perform up to 500 analyses without changing solutions or other maintenance. The method limit of detection of the monitoring system is .5 ppb. Data are presented from field trials at a site in the state of Washington where a chromium(VI) groundwater plume is suspected of discharging into the Columbia River. The monitoring system was used to determine chromium(VI) concentrations in the gravel bed of the river to ascertain if the concentrations were high enough to impact the development of the embryos of salmon and other aquatic species.

Bacteria in Gel Probes: Comparison of the Activity of Immobilized Sulfate-reducing Bacteria with in Situ Sulfate Reduction in a Wetland Sediment
Edenborn, Harry M. and Lynn A. Brickett, U.S. DOE, National Energy Technology Lab, Pittsburgh, PA.
Journal of Microbiological Methods, Vol 46 No 1, p 51-62, 2001

A novel method was used to examine the microbial ecology of iron-rich wetland sediments receiving neutral-pH coal mine drainage. Gel probes inserted into the sediments allowed analysis of the distribution and activity of bacterial sulfate reduction (BSR). A mixed population of sulfate-reducing bacteria enriched from anoxic wetland sediments was immobilized in low temperature-gelling agarose held in grooved rods or probes. The probes were inserted vertically into sediments and allowed to incubate in situ for 48 h. After their retrieval, the gels were sectioned and analyzed for residual BSR activity and compared to in situ BSR rates and chemical porewater profiles. The depth distribution of residual BSR activity in the immobilized cell gel probes differed significantly from the BSR measured in situ. The method has numerous potential environmental applications, especially in delineating the depths over which well-defined geomicrobial populations are active or in determining the potential toxicity of specific environments at sites to be treated via in situ bioremediation. Despite the contrast in the observed activity between natural sediments and immobilized bacteria incubated in situ, the method demonstrates that it should be possible to use model bacteria with known metabolic activity to assess the likely distribution of bacterial activity within the environment or the distribution of biologically toxic compounds.
http://www.netl.doe.gov/products/r&d/techpapers/techpapers.htm

Biconical Tapered Fiber Optic Sensors for Pathogen Detection in Aqueous Samples
Leung, A., K. Rijal, P.M. Shankar, and R. Mutharasan, Drexel Univ., Philadelphia, PA.
AIChE 2004 Annual Meeting, November 7-12, Austin, TX.
American Institute of Chemical Engineers, New York, NY. Presentation 41c, 2004

This paper addresses detection of two model low-level pathogens, E. coli 0157:H7 (EC) and a Strep Group A (SA) using tapered fibers that enables access to an evanescent field. Single-mode tapered fiber sensors were fabricated by heat pulling, with tapered waist diameters of 3 to 10 microns and taper length of 0.7 to 7 mm. The glass surface (tapered fiber or cantilever glass tip) was silanized with a reactive alpha amine end. Using zero length crosslinker EDC and N-Sulfohydroxy succinamide (Sulfo NHS), monoclonal antibody (MAb) specific to the antigen, EC or SA, was covalently bonded to the surface amine. The two sensors were exposed to known concentrations of EC and SA or to a non-pathogenic wild strain. The tapered fiber sensor shows high sensitivity for detecting the model bacterial pathogen when the sensor surface is modified with an antibody specific to the pathogen. Very low concentrations of 70 to 700 #/mL are conveniently measured using this approach. While weakly adsorbed cells interfere with measurement with tapered fiber sensors, the application in a flow cell model is currently under investigation.

Biogeochemical Mapping in Estonia: Mg and Heavy Metals (Cu, Zn, Cd, U) in Dropwort Root Ash
Enel, M., Univ. of Tartu, Tartu, Estonia.
Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-IV, p 508-509, 2003

Biogeochemical mapping based on the roots of dropwort and sedge has been used in Sweden to identify soil pollution. In Estonia, pilot studies to examine the method further were carried out in three

relatively small areas, with different landscape, geochemical and anthropogenic pollution conditions. Though the number of samples analyzed and list of elements determined were small, the results were sufficient to permit the assertion that both natural and anthropogenic pollution are reflected in dropwort root ash.

The Biomonitoring Approach as a Tool of Trace Metal Assessment in an Uncontaminated Marine Ecosystem: the Island of Ustica (Sicily, Italy)
Conti, M.E. (Univ. "La Sapienza," Roma, Italy); M. Iacobucci & G. Cecchetti (Univ. degli Studi di Urbino, Urbino, Italy). Geo-Environment, WIT Press, ISBN: 1-85312-723-X, Ecology and the Environment Series Vol 75, 10 pp, 2004

Marine organisms were tested as possible biomonitors of heavy metal contamination in a reference marine ecosystem. The goal of this preliminary work is to evaluate concentrations of Cu, Zn, and Pb using two gastropod molluscs, Monodonta turbinata Born and Patella caerulea L. Samples were collected in the tidal zone at five locations, one of which is an uncontaminated site. To gain additional information on both the environmental conditions of the area and possible bioaccumulation patterns, seawater samples were also collected at each site to assess soluble metal concentrations. Statistical analyses (one-way ANOVA and multiple comparison tests) were applied to test the differences between metal concentrations in different sites and species. High concentration factors (CFs) were seen with respect to the concentrations in marine waters (soluble fraction), confirming the suitability of these species for biomonitoring purposes.

Biosensors for the Determination of Environmental Inhibitors of Enzymes
Evtugyn, G.A., H.C. Budnikov, and E.B. Nikolskaya.
Russian Chemistry Review, Vol 68 No 12, p 1041-1064, 1999

The authors discuss characteristic features of functioning enzyme-based biosensors and practical application for the determination of environmental pollutants. The pollutants act as enzyme inhibitors. Emphasis is placed on the influence of the methods used for the measurement of the rates of enzymic reactions, the enzyme immobilization procedure, and the composition of the reaction medium on the analytical characteristics of inhibitor assays. This text contains a summary of a survey of published data on the development of biosensors for detecting pesticides and heavy metals. Special attention is given to the use of cholinesterase-based biosensors in environmental and analytical monitoring. The authors review approaches to the estimation of kinetic parameters of inhibition and analyze the factors determining the selectivity and sensitivity of inhibitor assays in environmental objects.

A Case Study of Traditional and Alternative Monitoring Techniques for Solvent Contamination within Fractured Bedrock
Pearson, Scott (Parsons Corporation); Brian Murphy (Camp Stanley Storage Activity).
Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 239-252, 2004

Multiple plumes of chlorinated organic compounds (PCE, TCE, and cis-1,2-DCE) are present above drinking water standards in groundwater beneath the Camp Stanley Storage Activity (CSSA). One plume has migrated off post, impacting more than 20 drinking water wells within the aquifer. The off-post groundwater plume is defined by a series of traditional monitoring wells. The presence of

faulting, fractures, and minor karstic features has resulted in a sometimes erratic and fluctuating distribution of contaminants. The hydrogeologic model is further complicated by a seasonal groundwater-level swing of more than 150 feet and the presence of a 60-foot thick confining unit within the Middle Trinity Aquifer. CSSA adopted a unique monitoring strategy to optimize the amount of both geologic and contaminant data available from standard boreholes. The most recent study incorporated the traditional methods of continuous rock coring, borehole geophysical and video surveys, and discrete interval packer testing along with less traditional characterization tools such as optical televiewers, borehole flow zone determinations, and multi-port wells. These tools were integrated to design and implement a Westbay(TM) multi-level monitoring system at both on- and off-post locations. This system maximized data collection at each point location, accelerated the characterization process, and saved money. The effects of the open borehole completion typically used by groundwater consumers were investigated at an off-post location of known contamination. The characterization approach identified structural features and intervals of preferential flow that conduct contaminants away from the source area. The study results indicate that simple changes in the construction of off-post drinking water wells might significantly improve groundwater quality and reduce or eliminate contaminant exposure. http://www.clu-in.org/products/siteprof/2004fracrockconf/cdr_pdfs/indexed/group1/239.pdf

Cathodic Stripping Voltammetric Speciation of ug/L Level Arsenic in Water Samples
He, Yi, Yan Zheng, and David C. Locke, Queens College, Flushing, NY.
NEMC 2004: The 20th Annual National Environmental Monitoring Conference, 19-23 July 2004, Washington, DC. Book of Abstracts, No. 40.

Two arsenic speciation methods based on differential pulse cathodic stripping voltammetry (DPCSV) have been developed. The methods are simple, fast, sensitive, and inexpensive, with a detection limit at sub ug/L level and applicable in both lab and field. The methods employ a hanging mercury drop electrode (HMDE), on which As(III) is deposited in the presence of Cu and Se in HCl medium. As(III) is determined by direct measurement. In the first method, determination of total As is performed by reducing As(V) to As(III) using sodium meta-bisulfite/sodium thiosulfate reagent stabilized with ascorbic acid. As(V) is quantified by difference. This method has been successfully applied for on-site analysis of groundwater at a Superfund site in Vineland, NJ, and Bangladesh. The second method further improved the reducing procedure by using a new reducing reagent, L-Cysteine, and has the capability to differentiate organic arsenic and inorganic arsenic. By using L-Cysteine reducing As(V) in batch mode, which is difficult to perform by using sodium meta-bisulfite/sodium thiosulfate reagent, sample analysis throughput can be greatly improved. Organic arsenics are photooxidized to inorganic As(V) and total arsenic (inorganic plus organic) are consequently determined. The instruments, Eco Chemie Autolab voltammetric apparatus (Brinkmann Instruments, Westbury, NY) equipped with a Metrohm 663VA electrode stand and controlled by a notebook computer, are compact and portable. The HMDE electrode effectively eliminates the memory effect of solid state electrode, such as a gold electrode, by generating fresh mercury drop for each analysis. The instruments are priced at US$10K to 20K, depending on specific model, and operation and maintenance cost are low.

Characterization of Bacteria Using Micro-Fabricated Differential Mobility Spectrometry with Pyrolysis Gas Chromatography
Schmidt, H., F. Tadjimukhamedov, I.V. Mohrenz, G. Smith, G.A. Eiceman, New Mexico State Univ., Las Cruces, NM. Proceedings of the 13th International Conference on Ion Mobility Spectrometry, Gatlinburg, TN, July 25-29 2004

Abstract not available.

Characterization of Soil Contamination at Former Small Arms Training Ranges Utilizing a Triad Work Strategy
Chien, Elizabeth, Gwyn Puckett, and Kym Takasaki, US Army Corps of Engineers, Seattle District, Seattle, WA. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

This paper describes the application of a Triad site characterization approach at Fort Lewis, WA. Fort Lewis is a major military facility located approximately six miles south of Tacoma, Washington. USACE was tasked with determining the nature and extent of contaminated soils in three former small arms training ranges, i.e, a former pistol range, an infiltration range, and a skeet range. The characterization was designed to determine if surface soils contain significant concentrations of metals, with the focus on collecting sufficient data for potential future actions (i.e., risk analysis or soil remediation). A Triad work strategy was developed to conduct sampling in one mobilization and to manage uncertainty around site-specific remediation decisions. Concurrent analysis of soil samples during the demonstration of method applicability using both field portable X-ray Fluorescence (FPXRF) and laboratory methodologies for the initial sampling period established a correlation between FPXRF and laboratory data. Subsequently, the site characterization data were collected in the form of FPXRF data and fixed-laboratory soil collaborative sample results to refine the conceptual site model for each site. During the site characterization process, additional sample locations were determined from the analysis and interpretation of real time data, which identified the extent and distribution of contamination. Communication strategies were developed to inform the project delivery team, customer, and regulator of real-time data, ensure the effectiveness of the sampling communication, and allow real-time decisions.

Characterizing Uptake Kinetics of PAHs from the Air Using Polyethylene-Based Passive Air Samplers of Multiple Surface Area-to-Volume Ratios
Bartkow, M.E. (National Research Centre for Environmental Toxicology (ENTOX), Univ. of Queensland, Coopers Plains, Australia), D.W. Hawker, K.E. Kennedy, and J.F. Muller. Environmental Science & Technology, Vol 38 No 9, p 2701-2706, 2004

Polyethylene passive sampling devices (PSDs) were deployed to investigate how passive samplers of multiple surface area-to-volume ratios could be used to characterize uptake kinetics for polyaromatic hydrocarbons (PAHs). Theoretically, uptake profiles for different thickness PSDs of the same surface area should show that where uptake is linear, the amount of compound accumulated in the different PSDs will be the same, and where equilibrium is approached, the amount accumulated by the different PSDs will be proportional to sampler thickness. Polyethylene sheets of the same surface area and approximately 100 and 200 m thickness were collected after 30, 60, and 90 days of exposure alongside samples from a co-deployed high volume sampler. Twelve PAHs could be routinely quantified in replicate PSDs. Reproducibility between replicate PSDs was satisfactory overall, with

normalized differences rarely exceeding 25%. The test results suggest that a single deployment of PSDs with multiple surface area-to-volume ratios can be sufficient to determine whether uptake is linear or approaching equilibrium for a range of PAHs.

Chemical Artifacts of Sampling Methods in Groundwater
Boylan, John A., URS Corporation, Denver, CO. Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 242, 2004

Groundwater monitoring at DOE's Rocky Flats facility northwest of Denver is done predominantly in wells constructed of PVC or stainless steel, some of which are equipped with dedicated stainless steel pumps. This paper summarizes correlations between elevated trace metal concentrations in groundwater samples with sampling equipment and purging and sampling methods. Concentrations of nickel (Ni) and chromium (Cr) in groundwater samples from a PVC well began to increase after a dedicated stainless steel pump was installed in 1997, and they exceeded site-specific action levels in 2003. Recent data from PVC monitoring wells located closer to the possible source, which had all been sampled using a bailer, were examined and showed no similar contamination. Groundwater samples were then collected from the well in question, using a dedicated pump, both before and after the routine purge. The pump was removed, the well was redeveloped, and after 12 days it was sampled using a teflon bailer. Concentrations of Ni and Cr were significantly higher in pumped samples of stagnant (pre-purge) than normally-sampled (post-purge) groundwater, indicating a possible borehole source, and were significantly lower in bailed samples collected following redevelopment. Ni and Cr in unfiltered samples were higher than in filtered samples, indicating the metals were present in particulate form. Pump surfaces showed visible iron oxyhydroxides. Contamination was therefore attributed to Ni and Cr sorbed on iron oxyhydroxide precipitates on the stainless steel pump surfaces and particulates in the well. Purging at this site had been considered complete upon stabilization of continually measured field parameters; however, this evaluation shows that purge volume can be inadequate in the collection of representative samples, and stainless steel materials, even in neutral, uncontaminated waters, can serve as a geochemical sink and contribute significant concentrations of some trace metals.

Comment on "Evaluation of the Diffusive Gradient in a Thin Film Technique for Monitoring Trace Metal Concentrations in Estaurine Waters"
DiGiano, F.A., Univ. of North Carolina, Chapel Hill.
Environmental Science & Technology, Vol 37 No 22, p 5268-5268, 2003

Dunn et al. have shown the application of a passive technique to measure low ambient concentrations of trace metals. They use the terminology-Diffusive Gradient Technique (DGT)-and state that it has generated considerable interest over the past decade. The commenter contends that DGT is the same as "passive dosimetry," a general method for measuring ambient concentrations that has been used for decades to measure exposure of workers to chemicals in the work place. The application of passive dosimetry analyze trace organic contaminants in water occurred in the late 1980s with results published in this Journal. The initial design used a 1-cm diffusion barrier (holes drilled in Plexiglas barrier) with GAC placed behind it as the adsorbent. A second generation of dosimeter was constructed with a Nucleopore filter to shorten the diffusion barrier to 10 m, greatly increasing the sensitivity of the dosimeter. The application of passive dosimetry to measurements of contaminants in water has also found its way into a textbook.

Comparison of a Genetic Algorithm and Mathematical Programming to the Design of Groundwater Cleanup Systems
Aly, Alaa H. and Richard C. Peralta, Utah State Univ., Logan.
Water Resources Research, Vol 35 No 8, p 2415-2425, 1999

The authors present and apply a new simulation/optimization approach for single- and multiple-planning period problems in groundwater remediation. Instead of the traditional control locations for contaminant concentrations, they use a global measure of aquifer contamination (CMAX), and response-surface constraints to represent CMAX within the optimization model. The performance of formal mixed integer nonlinear programming and a genetic algorithm are compared for several optimization scenarios.

Comparison of Three Methods to Measure Acidity of Coal-Mine Drainage
Means, Brent (U.S. Office of Surface Mining); Tiff Hilton (WOPEC, Inc.). The 6th Annual Abandoned Mine Reclamation Conference, 9-12 June 2004, Indiana Univ. of Pennsylvania, Indiana, PA.

Though the Standard Methods 2310 hot peroxide acidity procedure is widely used for measuring the acidity of mine drainage, little work has been done to determine if 'hot acidity' data actually describe the base requirement for neutralization of mine drainage. Three methods were compared for estimating the acidity of net-acidic waters emanating from four Pennsylvania coal mines: Standard Methods 2310 hot acidity titration to pH 8.2 endpoint, cold acidity titration to treatment endpoint pH as high as 11.0, and calculated acidity. The results showed poor agreement between hot acidity and calculated acidity for three of the four waters. This paper details the results of the study and the researchers' subsequent hypotheses. (1) Mg hydrolysis and the formation of base-consuming complexes are the reason why acidity measured by treatment titrations at high pH is often greater than that measured by hot acidity titrations to pH 8.2 or 8.3. (2) The neutralization of carbonic acid is the reason why the acidity measured by 'cold' titrations at low to mid pH is often greater than that measured by hot acidity titrations. The study results suggest that hot acidity titrations should not be used to universally describe the acidity of mine drainage, especially when estimating the acidity produced when Mg-rich mine drainage is chemically treated to high pH. The work also showed that over-treating Mg-rich mine drainage not only increases chemical costs but also increases sludge production.

Complexation and Solubility Reactions Controlling Cyanide Environmental Behavior: Literature Review and Speciation/Solubility Calculations
Electric Power Research Institute (EPRI), Palo Alto, CA. Report No: 1000588, Nov 2000

This report presents information obtained from an extensive literature search on the geothermal behavior and thermodynamic properties of cyanide compounds. It also presents information on bioremediation technologies for degradation of cyanide. Available data on groundwater concentrations of cyanide compounds from several manufactured gas plant (MGP) sites indicate that free cyanide is a minor fraction of the total dissolved cyanide complexes. Equilibrium constants were compiled for cyano aqueous species and solids to identify those that might be important to the mobility and solubility limits of cyanide in soil and water. The researchers completed a limited set of equilibrium thermodynamic calculations using the MINTEQA2 code to illustrate the possible importance of different cyanide aqueous species and solids in soil/water systems. The literature search resulted in the compilation of equilibrium constants for numerous cyanide aqueous species and solids. Available thermodynamic data indicate that cyanide anion readily forms metal complexes in aqueous phase as well as in solid phase, which means a suite of easily dissociable, weak acid-dissociable, and strong acid-dissociable metal

cyanide complexes may exist in groundwater. Thermodynamic calculations indicate that the speciation of dissolved cyanide complexes is a function of pH and pE (oxidation/ reduction conditions). At pH values between 7 and 10, the Fe-CN complexes are the dominant CN species both under oxidizing and moderately reducing conditions. Thermodynamic calculations further suggest that HCN(o) (aq) is the dominant aqueous phase species in the acidic pH range. At pH values greater than 9 under oxidizing conditions and very low concentrations of dissolved cyanide, free CN(-) may become dominant relative to the aqueous Fe-CN complexes; however, field data on cyanide in groundwater at MGP sites show the preponderance of the Fe-CN complexes at environmental pH values. This discrepancy is likely a result of slow kinetics for the decomposition of dissolved Fe-CN complexes. Further research is needed.

Composite Sampling for Soil VOC Analysis.
Schumacher, Brian A. and John H. Zimmerman, U.S. EPA, Las Vegas, NV.
NEMC 2004: The 20th Annual National Environmental Monitoring Conference, 19-23 July 2004, Washington, DC. Book of Abstracts, P2.

There is a high degree of spatial variability in the measurement of volatile organic compounds (VOCs) in soil at contaminated waste sites. The use of a small sample aliquot (5 g) in the standard low-level, purge-and-trap sample extraction method (i.e., SW-846 Method 5035) decreases the representativeness of the sample. To optimize sample representativeness, the number of samples collected at the site is generally increased; however, this greatly increases project costs. Compositing soil samples has been suggested as a cost-effective alternative means to obtain data that are representative of the overall conditions at a site. To explore the feasibility of composite sampling for soil VOC analysis, core samples were collected and cut into sections at 20, 30, 40, 50, 60, 70, and 80 cm below the ground surface. After each cut, approximately 5 g of soil was removed from the newly exposed surface (top end of the cut) using a truncated syringe and placed in a preweighed 40-mL septum-sealed vial containing 5 mL of methanol. A second 5 g sample was removed from each core at the 20, 40, 60, and 80 cm intervals and combined in a preweighed 40-mL septum-sealed vial containing 20 mL of methanol. Samples were analyzed following SW-846 methods 5035/8260. The results show both cis-1,2-dichloroethene (DCE) and trichloroethene (TCE) were ubiquitous at the site. Nearly 50% of the composite sample concentrations were greater than that of the individual sample means for DCE, while 80% were greater for TCE. The composite sample provided a representative sample of the vertical heterogeneity within the soil column. Within a sampling plot, the mean of the composite samples was typically greater than the mean of all the individual samples, but the relative percent differences among the composite and individual sample means were generally less than 35% indicating that the composite samples provided data representative of the horizontal heterogeneity within the plot. In comparing the overall grand mean of all 70 individual samples to the mean of the composite samples for the entire site, a similar pattern was identified, indicating that composite samples provided a valid means to effectively characterize the site with an associated cost savings.

Conceptual Model Development and Identification of Groundwater Pathways for Monitoring System Design at a Nuclear Materials Processing Facility Using 3D Geospatial Models
Stirewalt, G.L. (Mandex, Inc., Fairfax, VA); J.C. Shepherd (U.S. Nuclear Regulatory Commission, Washington, DC). Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 567, 2004

Knowledge of groundwater flow and transport pathways is essential for designing optimal monitoring systems, yet detailed pathway data usually are not collected during initial site characterization and therefore are not incorporated into early conceptual models. The presented approach for identifying site-specific groundwater pathways involves construction of alternative conceptual 3D geohydrologic framework and property models for a former nuclear materials processing facility in Oklahoma. The models formed a basis for monitoring system design at the site. As a result of this detailed delineation, the pathways were more carefully characterized by trenching and resistivity, and new monitoring wells installed. The site conceptual model developed by hydrologic modelers was also modified.

Construction of Geotechnical Boreholes and Groundwater Monitoring Systems Handbook
Louisiana Department of Environmental Quality and Louisiana Department of Transportation and Development, 36 pp, Dec 2000

This document is intended to provide a reliable and uniform reference of the preferred materials, procedures, and practices for the construction and plugging and abandonment of groundwater monitoring and recovery systems and boreholes. It is not intended to present any specific regulation or regulatory program; however, it will guide the user in meeting regulatory requirements. The user should always consult the specific regulation or contact the appropriate regulatory authority.
http://www.dotd.state.la.us/intermodal/wells/handbook.pdf

Cost Effective Groundwater Quality Sampling Network Design
Herrera de Olivares, Graciela, Doctoral dissertation, Univ. of Vermont, Burlington. 172 pp, 1998

This report presents a methodology for the design of cost-effective groundwater-quality sampling networks in which sampling locations and sampling times are decision variables. The sampling networks obtained with this method are cost-effective in the sense that an efficient use of the information provided by each contaminant concentration sample leads to sampling programs that can get accurate estimates with a small number of samples. As a first step to manage the data information in an efficient way, an estimation method was developed that accounts for space-time correlations of the transport model error. The method is equivalent to a space-time kriging method in which the concentration mean and covariance matrix are obtained from a stochastic transport model. The method can accommodate several sources of variability. Taking advantage of current modeling practices, the estimation method uses a deterministic model developed for a given groundwater quality problem and adds uncertainty to it.
http://www.rcgrd.uvm.edu/herrera_dissertation.pdf

Cost-Effective Sampling Network Design for Contaminant Plume Monitoring under General Hydrogeological Conditions

Wu, Jianfeng and Chunmiao Zheng (Univ. of Alabama, Tuscaloosa), Calvin C. Chien (DuPont Company, Wilmington, DE). Journal of Contaminant Hydrology, Vol 77, p 41-65, 2005

A new simulation/optimization methodology developed for cost-effective sampling network design associated with long-term monitoring of large-scale contaminant plumes is similar in concept to the one presented by Reed et al. in 2000 in that an optimization model based on a genetic algorithm is coupled with a flow and transport simulator and a global mass estimator to search for optimal sampling strategies. This new approach introduces the first and second moments of a 3-D contaminant plume as new constraints in the optimization formulation and demonstrates the proposed methodology through a real-world application. The new moment constraints significantly increase the accuracy of the plume interpolated from the sampled data relative to the plume simulated by the transport model. The plume interpolation approaches employed in this study are ordinary kriging (OK) and inverse distance weighting (IDW). The methodology was applied to the monitoring of plume evolution during a pump-and-treat operation at a large field site, showing that potential cost savings up to 65.6% can be achieved without any significant loss of accuracy in mass and moment estimations. The IDW-based interpolation method is computationally more efficient than the OK-based method and results in more potential cost savings, whereas the OK-based method leads to more accurate mass and moment estimations. A comparison of the sampling designs obtained with and without the moment constraints points to their importance in ensuring a robust long-term monitoring design that is both cost-effective and accurate in mass and moment estimations.

http://hydro.geo.ua.edu/hydro/wu_zheng_chien.pdf

Critical Studies for Predicting Ground Water Quality by Integrating Remote Sensing and GIS: a Novel Approach

Asadi, S., P. Vuppala, A. Mareddy, Jawaharalal Nehru Technological Univ., Hyderabad, Andhra Pradesh, India. 24th Annual Meeting of the Society of Environmental Toxicology and Chemistry, 9-13 November 2003, Austin, Texas. SETAC, Abstract PT066, 2003

An attempt was made to evaluate the impact of landuse and landcover on groundwater quality of Zone VII under the Municipal Corporation of Hyderabad (MCH) area. Thematic maps were prepared from the Survey of India toposheet using AutoCAD and ARC/INFO GIS Software. The landuse/landcover map of the study area was prepared from the linearly enhanced fused data of IRS-1D PAN and LISS-III imagery using Visual Interpretation Technique. Groundwater samples were collected at pre-determined sampling locations based on satellite imagery of the study area. All the samples were analyzed for various physico-chemical parameters, adopting standard protocols for the generation of attribute data. Based on these results, maps showing spatial distribution of selected water quality parameters were prepared using curve-fitting method in GIS software. The variations in the concentrations of water quality parameters indicated high concentrations of TDS, fluoride, hardness, and nitrates while other parameters like sodium, potassium, and phosphorous were with in permissible limits except in few areas, which may be attributed to seepage of domestic and industrial wastes. Different ratings of water quality indicate deteriorating quality of groundwater. Control and remedial measures for the improvement of groundwater quality in the study area are suggested.

Cryogenic Laser Induced Fluorescence Characterization of U(VI) in Hanford Vadose Zone Pore Waters
Wang, Zheming (Pacific Northwest National Laboratory, Richland, WA), John M. Zachara, Wassana Yantasee, Paul L. Gassman, Chongxuan Liu, and Alan G. Joly.
Environmental Science & Technology, Vol 38 No 21, p 5591-5597, 2004

Ambient and liquid helium temperature laser-induced, time-resolved uranyl fluorescence spectroscopy was applied to study the speciation of aqueous uranyl solutions containing carbonate and phosphate. Two porewater samples obtained by ultracentrifugation of U(VI)-contaminated sediments. The significantly enhanced fluorescence signal intensity and spectral resolution found at liquid helium temperature allowed direct fluorescence spectroscopic observation of the higher aqueous uranyl complexes with carbonate. The porewater samples were nonfluorescent at room temperature, but at liquid helium temperature, both porewater samples displayed strong, well-resolved fluorescence spectra. Comparisons of the spectroscopic characteristics of the porewaters with those of the standard uranyl-carbonate complexes confirmed that U(VI) in the porewaters existed primarily as UO2(CO3)34- along with a small amount of other minor components consistent with thermodynamic calculation. The U(VI)-carbonate complex is apparently the mobile species responsible for the subsurface migration of U(VI).

Data Mining to Improve Management and Reduce Costs Associated with Environmental Remediation
Farrell, Dara Mary, Master's thesis, Univ. of Illinois, 50 pp, 2004

In this study, data from 105 soil and groundwater remediation projects at British Petroleum gas stations were mined for lessons to reduce cost and improve management of remediation sites. A data mining tool called D2K was used to train decision tree, stepwise linear regression, and instance-based weighting models that relate hydrogeologic, sociopolitical, temporal, and remedial factors in the site closure reports to remediation cost. The most important factors influencing cost were found to be the amount of soil excavated and the number of wells installed, suggesting that better management of excavation and well placement could result in significant cost savings. The best model for predicting cost classes (low, medium, and high cost) was the decision tree, which had a prediction accuracy of approximately 73%. The mis-classification of approximately 27% of the sites in even the best model suggests that remediation costs at service stations are influenced by other site-specific factors that may be difficult to accurately predict in advance.
http://cee.uiuc.edu/emsa/documents/farrell_thesis_final.pdf

Demonstration of Two Long-Term Groundwater Monitoring Optimization Methods
Yager, Kathleen M. (U.S. EPA, OSRTI); John Anthony (Mitretek Corp.); Dave Becker (U.S. Army Corps of Engineers); Julia Aziz (Groundwater Services, Inc.); Carolyn Nobel (Parsons).
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization, 15-17 June 2004, Dallas, Texas.

The U.S. EPA and the Air Force Center for Environmental Excellence sponsored a project to showcase two optimization techniques to improve the design of long-term groundwater monitoring programs. Two different methods of optimizing groundwater monitoring programs were used in the project: the Monitoring and Remediation Optimization System (MAROS) software tool, developed by Groundwater Services, Inc., and a 3-tiered monitoring network optimization (MNO) approach applied by Parsons Corporation. The two methods were applied to three sites with existing groundwater monitoring networks to determine if temporal or spatial redundancies exist. Results of the application of the two methods at the three sites are discussed along with lessons learned regarding differences

between the two methods, advantages and limitations of the methods, important pre-optimization steps, and challenges associated with implementing recommended changes. Potential cost savings and the estimated costs to perform a monitoring network optimization are also discussed.
http://207.86.51.66/siteopt/ataglance.htm

Deployment of Smart 3D Subsurface Contaminant Characterization at the Brookhaven Graphite Research Reactor
Sullivan, T.; J. Heiser; P. Kalb, Brookhaven National Lab., Upton, NY.
NTIS: DE2004-833317, 24 pp, 2002

The Brookhaven Graphite Research Reactor (BGRR) Historical Site Assessment in the late 1990s identified contamination inside the below grade ducts (BGD) resulting from the deposition of fission and activation products from the pile on the inner carbon steel liner during reactor operations. Due to partial flooding of the BGD since shutdown, some of this contamination may have leaked out of the ducts into the surrounding soils. The baseline remediation plan for cleanup of contaminated soils beneath the BGD involves complete removal of the ducts, followed by surveying the underlying and surrounding soils, then removing soil that has been contaminated above cleanup goals. Alternatively, if soil contamination around and beneath the BGD is either non-existent/minimal (below cleanup goals) or is very localized and can be 'surgically removed' at a reasonable cost, the BGD can be decontaminated and left in place. DOE undertook an Accelerated Site Technology Deployment project to determine the extent of soil contamination surrounding the BGD as part of the engineering evaluation/cost analysis (EE/CA) process. A suite of innovative tools was used to complete the soil characterization: (1) a tracer gas leak detection system was used to define the gaseous leak paths out of the BGD and guide soil characterization studies; (2) a small-footprint Geoprobe was used to reach areas surrounding the BGD that were difficult to access; and (3) two novel, field-deployed, radiological analysis systems (ISOCS and BetaScint) and a 3D visualization system facilitated data analysis/interpretation. All of the technologies performed as well or better than expected, allowing the characterization to be completed in less time and at lower cost than could have been achieved without this approach.

Designing a Competent Simple Genetic Algorithm for Search and Optimization
Reed, P.M., B.S. Minsker, and D.E. Goldberg.
Water Resources Research, Vol 36 No 12, p 3757-3761, 2000

The purpose of this technical note is to summarize the theoretical relationships for population sizing and time scale analysis and to illustrate their practical utility in a long-term groundwater monitoring design application. These relationships, which model the effects of the primary operators of a simple genetic algorithm (selection, recombination, and mutation), provide a highly efficient method for ensuring convergence to near optimal or optimal solutions. Application of the method to a monitoring design test case identified robust parameter values using only 3 trial runs.

Detection of Diesel Fuel Plumes Using Methane Data in Guadalajara, Mexico
Gandoy-Bernasconi, W., A. Rojano Aguilar, and O. Palacios Velez.
Ground Water Monitoring & Remediation, Vol 24 No 4, Fall 2004

This paper examines the detection of diesel fuel in the subsoil by measurements of biogenerated methane. Once a link between methane and diesel fuel was established at the lab scale, the authors applied the concept in the field. A flame ionization detector was used to measure hydrocarbon vapors in

the field. The work showed methane concentrations ranging from 0 to 220,000 ppmv, and diesel fuel thickness ranging from 0 to 83 cm. BTEX were also measured in soil gas with maximum concentration of 4000 ppmv. Statistical analysis showed the correlation between methane and diesel fuel was 0.89, with no correlation with other measured vapors. The methane distribution showed spatial variability, and geostatistical techniques were applied to produce maps that described zones with different gas concentrations. The positive high correlation between methane and diesel fuel allows plume, sources, and sinks of diesel fuels to be located.

Detection of Potential Estrogenic Endocrine Disruptor Chemicals Using The LUMI-Cell(TM) ER Recombinant Bioassay

Gordon, J.D., A.C. Chu, C.L. Taylor, G.C. Clark, and M. Chu (Xenobiotic Detection Systems Inc., Durham, NC); M.S. Denison (Univ. of California, Davis). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Identification of endocrine disruptor chemicals (EDCs) requires a relevant bioassay to both detect these chemicals and provide a relevant estimate of their endocrine-disrupting potency. Xenobiotic Detection System (XDS) Inc. has developed the LUMI-Cell(TM) ER bioassay to detect EDCs using a high-throughput bioassay system in which BG-1 cells are stably transfected with an estrogen-responsive luciferase reporter gene plasmid (pGudLuc7ere). The resulting cell line responds to estrogenic chemicals in a time- and dose-dependent and chemical-specific manner with the induction of luciferase gene expression. The bioassay system has tested over 110 chemicals of which 69 demonstrated estrogenic activity, while 41 showed no activity. The bioassay has an EC50 detection of 1.48x10-11 for b-estradiol, which level of detection is far lower than any limit likely to be imposed by any regulatory agency.

Determination of Free Copper Concentrations in Natural Waters by Using Supported Liquid Membrane Extraction under Equilibrium Conditions

Romero, Roberto and Jan Ake Jonsson, Lund Univ., Lund, Sweden.

Analytical and Bioanalytical Chemistry, Vol 381 No 7, p 1452-1459, Apr 2005

The authors present a method for measurement of freely dissolved copper concentrations in natural water samples using supported liquid membrane (SLM) extraction under equilibrium conditions, a technique known as equilibrium sampling through membranes. 1,10-Dibenzyl-1,10-diaza-18-crown-6 as neutral carrier and oleic acid were used in the membrane phase. The main variables optimized were the carrier used to form the metal complexes, the organic solvent used in the membrane, the countercation, pH, the ligand used in the acceptor phase, the extraction time, and the flow rate of the donor phase. After the optimization process, an enrichment factor of 18.5 was obtained. Equilibrium conditions were reached after extraction for 60 min if a flow rate of 1.0 mL/min or greater was used. When different ligands such as humic acids, phthalic acid, and EDTA were added to the sample solution, and sample pH ranged from 6 to 8, the results obtained for freely dissolved copper concentrations were in a good agreement with results from speciation calculations performed with Visual Minteq V 2.30, Cheaqs V L20.1, and WinHumic V. The technique was applied to analysis of stream and leachate water.

Determination of Manganese Stability in a Constructed Wetland Sediment Using Redox Gel Probes
Edenborn, H.M. and L.A. Brickett.
Geomicrobiology Journal, Vol 19 No 5, p 485-504, 2002

Redox gel probes containing immobilized particulate manganese compounds (MnO2, MnCO3, and MnS) were placed on a surveyed grid in the sediment of a wetland receiving coal mine drainage. The stability of these compounds in the wetland was shown to be highly variable both temporally and spatially, indicating that apparent manganese removal based on water quality data did not result in long-term manganese retention in sediments. Contour maps of the gel probe data revealed the importance of local environmental conditions, such as surface water velocity, on geochemical conditions influencing manganese compound stability in sediments, as well as seasonal changes in the ability of the wetland to retain MnO2 in sediments. Estimates of in situ MnO2 reduction rates using gel probe data agree with earlier published estimates based on laboratory studies. Though the factors influencing particulate metal stability in sediments are extremely complex and difficult to study, the redox gel probe method provided a cost-effective means of obtaining an areal and depth-related picture of that stability during a particular period of time.
http://www.netl.doe.gov/products/r&d/techpapers/techpapers.htm

The Determination of Perchlorate Anion in High Total Dissolved Solids Water Using LC/MS/MS
Krol, Jim, Senior Applications Chemist, Waters Corp., Milford, MA.
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

The current EPA method 314.0 (Determination of Perchlorate Using Ion Chromatography…) uses anion exchange chromatography with suppressed conductivity detection. This method works well but becomes limiting as the total dissolved solids concentration increases, especially sulfate. Sample preparation to remove chloride and sulfate is necessary and the most difficult problem, because it requires the use of an O18 perchlorate internal standard to account for recovery. This presentation describes an LC/MS/MS method for perchlorate without the requirement for sample preparation. The key is the chromatography of perchlorate relative to sulfate. As organic modifier concentration increases, perchlorate elutes faster than sulfate, allowing the chromatograph perchlorate baseline to be separated between high chloride and high sulfate. MS/MS detection can obtain a perchlorate detection limit (3:1 S/N) of 0.2 ppb with the direct injection of 100 mL of a solution containing 1000 ppm each of bicarbonate, chloride, and sulfate. Larger injection volumes can be used to increase sensitivity.

Determination of Trace Element Stability in Sediments using Redox Gel Probes: Probe Construction and Theoretical Performance
Edenborn, H.M.; L.A. Brickett; R.F. Chaiken.
Geomicrobiology Journal, Vol 19 No 5, p 465-483, 2002

The authors present a simple and inexpensive technique that can be used to assess the stability of redox-sensitive compounds in the sediments of wetlands and other shallow water environments. Solid redox-sensitive compounds, such as manganese dioxide (MnO2), are incorporated into agar gels held in rigid plastic holders. One surface of the gel remains exposed along the length of the resulting probe. The probes are pushed vertically into sediments and are left in situ for a period of time (days to weeks), after which they are visually inspected and chemically analyzed. The diffusion of nonreactive solutes (e.g., sulfate) in 2% (wt/vol) agar was unaffected by the presence of immobilized MnO2 particles. The rate of dissolution of particulate MnO2 in agar gels in the presence of an external diffusing reductant (L-ascorbic acid) could be quantified by digital analysis of pixel density on gel images. Redox gel

probes incubated in the sediment of a wetland built to remove manganese from circumneutral pH coal mine drainage demonstrated different patterns of depth-dependent MnO2 stability along a 15-m transect. MnO2 gel probe results were consistent with data obtained using sediment cores and porewater diffusion samplers.
http://www.netl.doe.gov/products/r&d/techpapers/techpapers.htm

Development and Application of a near Real-Time In-Situ Analyzer to Determine Na, Mg, and Ca in Streams Affected by Coal Bed Methane Discharge Waters
Chapin, Thomas P., C.J. Patton, and R.B. Wanty, U.S. Geological Survey, Denver, CO.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 536, 2004

Coal-bed methane (CBM) extraction generates large volumes of water with high Na levels (~100-500 mg/L) and these waters are routinely spread over the ground surface, stored in impoundments, or discharged into surface drainages. Sodium adsorption ratio (SAR) is a measure of the suitability of irrigation water for sustained soil and crop health and a SAR limit of 3 has been established for the Tongue River during the summer irrigation period. USGS has initiated a comprehensive monitoring program to examine any changes or trends in surface water quality in the Tongue River and provide real-time information to resource managers. Traditional water quality studies involve field collection followed by laboratory analysis, typically resulting in 10 to 20 sample analyses per year. This low-frequency sampling cannot provide real-time information and often misses important episodic events, such as rainstorms and dam releases that can dramatically affect SAR values and irrigation water quality. USGS is developing a relatively low-cost (less than $3,000) in situ automated SAR field analyzer for hourly analysis of Na, Mg, and Ca. The SAR field analyzer measures Na by ion selective electrode and determines Mg and Ca by spectrophotometry. The analyzer is self-calibrating, and an onboard computer performs instrument control, data storage, and transfers data to an existing USGS gage station telemetry system. In contrast to traditional sampling, the SAR field analyzer reduces sampling costs, dramatically increases the number of samples analyzed, and provides near real-time data. Preliminary in situ field results are presented.

Development and Application of a Simple Scheme to Determine the Aquatic Toxicity of Mine Wastes
Wildeman, Thomas R. and James F. Ranville, Colorado School of Mines, Golden.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 465, 2004

A simple approach has been developed to determine the aquatic toxicity potential of solid mine wastes using leachate tests developed by USGS and the Colorado Division of Minerals and Geology and a modified version of EPA's 1311 TCLP test. The multi-element power of modern inductively coupled plasma, atomic-emission spectroscopy (ICP-AES), is also part of the scheme. At two sites in Colorado, approximately 25 sediment samples and the water flowing over the sediments were collected and the water and extracts from the three leachate tests were analyzed for 31 elements by ICP-AES. When the pHs of the water and the leachate from the CDMG were below 5.0, the element concentration patterns of all four solutions were quite similar. When the pHs of the water and the leachate from the CDMG test were above 5.5, the element concentration patterns from the four solutions were often different. The results suggest that when the paste pH of a mine waste is below 5.0, the element concentration patterns from the three tests will give an excellent indication of the metals being released from a mine waste and thus a good estimate of the aquatic and human toxicity of water flowing over that mine waste.

Development of a Genome-Wide Screening Method to Identify Gene Candidates Involved in the Degradation of Halogenated Hydrocarbons Using Ion Chromatography
Strycharz, Sarah and Lee Newman, Univ. of South Carolina, Columbia, SC.
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

As the use of phytoremediation for cleanup of halogenated hydrocarbons becomes increasingly widespread, it is imperative to determine the route of metabolism of such chemicals in plants to increase effectiveness and efficiency of degradation. Potential enzymes that might be involved in trichloroethene (TCE) degradation in plants include cytochrome P450s, peroxidases, dehalogenases, laccases, and reductases. Scientists have developed an assay to screen for multiple enzyme types in which bacterial cultures expressing a commercially purchased tobacco leaf (Nicotiana tabacum) cDNA library can be examined for the ability to degrade a halogenated hydrocarbon, ethylene dibromide (EDB). EDB is being used instead of TCE because the bromide ion (Br-) is not prevalent in culture media, whereas chloride ion (Cl-) can be found at high levels. Following 72 hours of growth to high density, cultures are concentrated and resuspended in a phosphate buffer containing glucose and 100 ppm EDB. Degradation of EDB is measured by detection of Br- release using an ion chromatograph. The researchers hope to narrow the number of possible candidate genes by comparing the ability of cDNA library cultures to degrade EDB with the ability of a control culture expressing a gene known to degrade EDB.

Development of an Optical and Spectroelectrochemical Sensor for Copper and Cadmium
Shtoyko, Tanya, Ph.D. dissertation, Univ. of Cincinnati, 157 pp, 2003.

A spectroelectrochemical sensor with three modes of selectivity has been developed in recent research. This sensor consists of a planar optical electrode coated with a selective film. The analyte must partition into the selective film, be electroactive at an applied potential, and change the optical properties at reduced and oxidized states. Enhancing the sensitivity of the spectroelectrochemical sensor for a metal complex by ligand exchange within the sensing film during spectroelectrochemical modulation has been demonstrated in the first part of the research with a sensor for Cu(en)22+, where en = ethylenediamine, in aqueous solution. The ligand exchange reaction increases the difference in the molar absoptivities of the two species involved in spectroelectrochemical modulation, giving a larger optical response. The sensor consists of cation-selective Nafion-SiO2 composite film spin-coated on indium tin oxide (ITO) glass optically transparent electrode (OTE). The film was loaded with 2, 9-dimethyl-1,10-phenanthroline (neocuproine) for the ligand exchange reaction. The electrodeposition and subsequent stripping of copper and cadmium on the ITO OTE were monitored by attenuated total internal reflectance in the second part of this research. Light passing through the ITO OTE is attenuated proportionally to the concentration of metal ion and deposition time. The wavelength dependence of the optical responses of deposited copper and cadmium were determined and compared with calculations. The morphology of the resulting metallic films on ITO surface was examined by scanning electron microscopy. Calibration curves for copper and cadmium were obtained over the range of 1 x 10-7 M 1 x 10-4 M and 1 x 10-9 1 x 10-5 M for Cu and Cd, respectively. The simultaneous determination of copper and cadmium was also demonstrated.
http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1060364622

Development of A Remote Spectroelectrochemical Sensor for Technetium as Pertechnetate
Monk, David James, Ph.D. dissertation, Univ. of Cincinnati, 263 pp, 2003

Subsurface contamination by technetium is of particular concern in the monitoring, characterization, and remediation of underground nuclear waste storage tanks, processing areas, and associated surroundings at Hanford and other DOE sites. Technetium's most common isotope, Tc-99, has an extremely long lifetime, and its most common chemical form in environmental conditions, pertechnetate (TcO4-), migrates quickly through soils, posing a threat to groundwater. Standard procedures of sampling and analysis in a laboratory are slow and costly in the case of subsurface contamination by radioactive materials. In situ sensors are needed for these materials for continuous monitoring or immediate analysis of collected samples. These sensors need to possess adequate detection limit and selectivity, rapid response, reversibility (many measurements with one sensor), remote function, and ruggedness. This dissertation describes several areas of the continued work toward a sensor for Tc-99 as TcO4-. Research initially focused on developing spectroelectrochemical instrumentation and a disposable sensing element engineered to address the need to perform remote measurements. In the most recent work, the development of metal templating techniques using complexes synthesized with rhenium (Re) was investigated as one means to circumvent irreversibility. In an extension of the metal templating research, custom ligands were designed to impart structural rigidity and fluorescence to the template complexes, thereby facilitating selectivity and sensitivity at levels previously unprecedented for optical techniques.
http://www.ohiolink.edu/etd/view.cgi?acc_num=ucin1052761078

Development of Arsenic Testing Field Kit--a Tool for Rapid On-Site Screening of Arsenic Contaminated Water Sources
Deshpande, Leena S. and Sunil P. Pande, National Environmental Engineering Research Inst., Nagpur, India. Environmental Monitoring and Assessment, Vol 101 Nos 1-3, p 93-101, Jan 2005

A simple, efficient, user-friendly, indigenous field kit has been developed for rapid on-site screening of arsenic-contaminated water sources. It is capable of detecting arsenic concentration as low as 0.01 mg/L, the guideline value for arsenic set by the World Health Organization. The kit has been subjected to extensive laboratory and field testing. The authors present the kit's development details and its salient features.

Development of Conductive Polymer Analysis for the Rapid Detection and Identification of Phytopathogenic Microbes
Wilson, A.D.; D.G. Lester; C.S. Oberle.
Phytopathology, Vol 94, p 419-431, 2004

Conductive polymer analysis, an electronic aroma detection (EAD) technology, was evaluated for its efficacy in the detection, identification, and discrimination of plant-pathogenic microorganisms on standardized media and in diseased plant tissues. The method is based on the acquisition of a diagnostic electronic fingerprint derived from multisensor responses to distinct mixtures of volatile metabolites released into sampled headspace. Protocols were established to apply this technology specifically to plant disease diagnosis. This involved development of standardized cultural methods, new instrument architecture for sampling, sample preparation, prerun procedures, run parameters and schedules, recognition files and libraries, data manipulations, and validation protocols for results interpretation. The collective output from a 32-sensor array produced unique electronic aroma signature patterns diagnostic of individual microbial species in culture and specific pathogen-host combinations

associated with diseased plants. The level of discrimination applied in identifications of unknowns was regulated by confidence level and sensitivity settings during construction of application-specific reference libraries for each category of microbe or microbe-host combination identified. Applications of this technology include diagnosis of specific disease systems, including bacterial and fungal diseases and decays of trees, determinations of levels of infection and relatedness between microbial species, and host identifications, as well as identification of toxins affecting the plant. The rapid analysis possible with this technology could prove useful in the detection of plant and human pathogens for homeland security applications as real-time identifications become feasible using portable EAD devices.
http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=6432

Direct Monitoring of Soil and Water Nitrate by FTIR Based FEWS or Membrane Systems
Shaviv, A. (Technion-IIT, Haifa, Israel), A. Kenny, I. Shmulevitch, L. Singher, Y. Raichlin, and A. Katzir. Environmental Science & Technology, Vol 37 No 12, p 2807-2812, 2003

Samples containing nitrate in water, soil extracts, and pastes were used for the determination of nitrate concentration with a common ATR (attenuated total reflectance) ZnSe crystal and with silver halide fibers (fiberoptic evanescent wave spectroscopy, or FEWS). Spectra of soil pastes and suspensions and those of phosphate, carbonate, sulfate, ammonium, and soil organic constituents were collected to study possible interference with nitrate determination. The standard error of estimate (SEE) and R2 values obtained with flat fibers using the simple single-point correlation method were superior to those obtained for cylindrical FEWS and ZnSe ATR crystals in pure water. Improvement in the SEE and R2 was achieved in most soil pastes by applying the simple mode of the cross-correlation method. Direct transmission of MIR radiation through ion-exchange membranes, partially loaded with nitrate or carbonate, was found an effective alternative for MIR-FTIR determination of these ions. Further development and modification of the FEWS devices should allow in situ and on-line determination of nitrate in soil and environmental systems.

A Direct Passive Method for Measuring Water and Contaminant Fluxes in Porous Media
Hatfield, K., M. Annable, Jaehyun Cho (Univ. of Florida, Gainesville); P.S.C. Rao (Purdue Univ., West Lafayette, IN); Harald Klammler (Graz Univ. of Technology, Austria).
Journal of Contaminant Hydrology, Vol 75 Nos 3-4, p 155-181, Dec 2004

This paper introduces a new direct method for measuring water and contaminant fluxes in porous media. The method uses a passive flux meter (PFM), which is essentially a self-contained permeable unit properly sized to fit tightly in a screened well or boring. The meter is designed to accommodate a mixed medium of hydrophobic and/or hydrophilic permeable sorbents, which retain dissolved organic/inorganic contaminants present in the groundwater flowing passively through the meter. The contaminant mass intercepted and retained on the sorbent is used to quantify cumulative contaminant mass flux. The sorptive matrix is also impregnated with known amounts of one or more water-soluble 'resident tracers.' These tracers are displaced from the sorbent at rates proportional to the groundwater flux; hence, in the current meter design, the resident tracers are used to quantify cumulative groundwater flux. Theory is presented and quantitative tools are developed to interpret the water flux from tracers possessing linear and nonlinear elution profiles. The same theory is extended to derive functional relationships useful for quantifying cumulative contaminant mass flux. The passive flux meter was tested in multiple box-aquifer experiments with 2,4-dimethyl-3-pentanol (DMP) used as a surrogate groundwater contaminant.

A Direct Quantitative Analysis Method for Monitoring Biogenic Volatile Organic Compounds Released from Leaves of Pelargonium hortorum In Situ
Deng, Xiaojun, Jinyin Peng, Bin Luo, Ming Wei, Wenli Hu, and Jiawei Du, Chinese Academy of Sciences, Shanghai, China.
Analytical and Bioanalytical Chemistry, Vol 380 Nos 7-8, p 950-957, Dec 2004

A direct quantitative method for monitoring biogenic volatile organic compounds (BVOCs) released from a living leaf of Pelargonium hortorum in situ is based upon the use of multiple headspace solid phase microextraction (HS-SPME). Seventeen BVOCs were detected by GC-MS after a single SPME extraction using a CAR/DVB/PDMS fiber. An internal standard was employed to determine the absolute amounts of seven terpenoid compounds released from a P. hortorum leaf. The quantitative analysis was performed over two days, with extraction preformed for 20 min every 3 h. The amount of volatiles extracted varied with the time of day. The results indicate that multiple HS-SPME in combination with an internal standard is a simple, quick, and quantitative technique for analyzing BVOC emissions from a live plant sample.

A Dynamic Meta-Model Approach to Genetic Algorithm Solution of a Risk-Based Groundwater Remediation Design Model
Yan, S. and B.S. Minsker, Univ. of Illinois, Urbana.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2003 & Related Symposia, Philadelphia, PA, 2003

For optimizing risk-based groundwater remediation approaches, the authors propose a dynamic meta-modeling approach in which artificial neural networks (ANN) and support vector machines (SVM) are embedded into a genetic algorithm (GA) optimization framework to replace time-consuming flow and contaminant transport models. Data produced from early generations of the GA are sampled to train the ANN and SVM, and the numerical models are periodically called to dynamically update the ANN and SVM. This allows the meta model to adapt to the area in which the GA is searching and provide more accuracy. Preliminary results show that a well-trained ANN or SVM can achieve satisfactory accuracy. Different approaches to dynamic training are presented.
http://cee.uiuc.edu/emsa/conference/smyan-2003-01.pdf

A Dynamic Meta-Model Approach to Genetic Algorithm Solution of a Risk-Based Groundwater Remediation Design Model
Yan, S. and B.S. Minsker, Univ. of Illinois, Urbana.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2004 & Related Symposia, Salt Lake City, UT, 2004

The authors propose a dynamic meta-modeling approach in which artificial neural networks (ANN) are embedded into a genetic algorithm (GA) optimization framework to replace time-consuming flow and contaminant transport models. Data produced from early generations of the GA are sampled to train the ANN. A dynamic learning approach is proposed that periodically resamples new solutions both to update the ANN and correct the GA's converging route. This allows the meta model to adapt to the area in which the GA is searching and provide more accuracy. The results show that a proper sampling strategy can benefit both GA searching and ANN retraining. In a test case, more than 90% of the numerical model calls were saved with no loss in accuracy of the optimal solution.
http://cee.uiuc.edu/emsa/conference/smyan-2004-03.pdf

Effect of P-Wave Scattering on Velocity and Attenuation in Unconsolidated Sand Saturated with Immiscible Liquids
Seifert, P.K., J.T. Geller, and L.R. Johnson, Lawrence Berkeley National Lab, Berkeley, CA.
Geophysics, Vol 63 No 1, p 161-170, 1998

Seismic wave tomography is a potentially powerful tool for detecting and delineating nonaqueous phase liquid (NAPL) contaminants in the shallow subsurface. The authors conducted laboratory and numerical studies to understand the mechanisms of P-wave transmission through NAPL/water/sand systems. To simulate the laboratory measurements, numerical calculations of P-wave propagation through a 1-D medium were performed. The results show that the main behavior of travel time and amplitude variation can be explained by P-wave scattering. This represents an alternative explanation to the theories that describe local fluid flow as the dominant mechanism for seismic wave attenuation and velocity dispersion.

Effects of Different Extraction and Analysis Techniques on the Determination of Arsenic Species in Soils
Gurleyuk, Hakan and Jeni Garcia, Frontier Geosciences, Seattle, WA.
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Speciation data may be accepted by some regulators, but there seem to be no set laws or regulations on this matter. The lack of species-specific regulations is mostly due to the absence of methods that can reliably measure the analytes of interest at the regulatory levels. The most common method for the extraction of As species from soils and sediments is the use of phosphate-based solutions. A 0.1 M phosphoric acid solution is used to extract As(III) and a 0.1 M sodium phosphate solution for As(V) and methylated arsenic species. After extraction, the first extract is analyzed for As(III), while the second is analyzed for total inorganic arsenic and methylated arsenic species by hydride generation / cryo-trapping / atomic absorption spectrometry (HG-CT-AAS), which provides detection limits below 0.001 mg/Kg. It is important to use a method that can differentiate between As(III), As(V), and organic arsenic species in the extracts, instead of total inorganic As analysis. An alternative to HG-CT-AAS is ion chromatography coupled to an ICP-MS (IC-ICP-MS). This technique can determine each As species in a single run and allows determination of arsenosugars that are present in fish tissue. Various cases are presented where the use of different analytical techniques resulted in unreliable data.

Electrochemical Detection of Halides by Monoatomic Layers of Silver on Gold Thin Film Electrodes
Laibinis, Paul E. (Rice Univ., Houston, TX); Hyun-Goo Choi and Richard Michalitsch (MIT, Cambridge, MA). AIChE 2004 Annual Meeting, November 7-12, Austin, TX.
American Institute of Chemical Engineers, New York, NY. Presentation 40i, 2004

An electrochemical method for the detection of chloride and other halide ion is based on the spontaneous adsorption of these ions onto under-potentially deposited (upd) silver adlayers on gold substrates. The upd process generates a well-defined monoatomic layer of silver atoms, with the atomically thin film providing the active species for sensing. Upon contact with a halide-containing solution, the halides form a layer on top of the silver upd adlayer and change its electrochemical adsorption and stripping potential. At submonolayer coverage of the halides, cyclic voltammetry shows distinct stripping and deposition peaks that can be assigned to the surface population of native silver upd

atoms and the silver-halide species. Changes in the stripping signature for the silver adlayer are readily correlated with the amounts of adsorbed halide on the upd layer and can be used for measuring halide concentrations in test solutions. The sensor was particularly well suited for detecting halides at low (ppb) concentrations. Competing ions such as nitrate, sulfate, and phosphate showed no interference; however, the presence of other halides at similar or greater concentrations to the halide of interest did complicate determination of halide concentrations. The tolerance for higher atomic weight halides and for coordinating ions such as sulfide and thiocyanide surpassed abilities of ion-selective electrodes. This presentation addresses initial efforts using single macroscopic single crystal Au(111) electrodes, its ability to be developed for use with polycrystalline Au electrodes, and current efforts toward implementation on polycrystalline gold microelectrodes interfaced with microfluidic channels and delivery systems.

Electrochemical Sensors for Environmental Monitoring: Design, Development and Applications
Hanrahan, Grady, Deepa G. Patil, and Joseph Wang.
Journal of Environmental Monitoring, Vol 6 No 8, p 657-664, 2004

Electrochemical sensing devices have a major impact on the monitoring of priority pollutants by allowing the instrument to be taken to the sample, rather than bringing the sample to the laboratory. Such devices can perform automated chemical analyses in complex matrices and provide rapid, reliable, and inexpensive measurements of a variety of inorganic and organic pollutants. This review addresses some of the important advances in electrochemical sensor design and development for environmental monitoring purposes, with particular attention to analytical improvements (e.g., detection limits), microfabrication, and remote communication. Modern environmental applications are discussed and future perspectives considered.

Elucidating Mechanisms of Benzene Biodegradation in Subsurface Environments Using Carbon and Hydrogen Isotope Analysis
Mancini, S.A., A.C. Ulrich, M. Elsner, G. Lacrampe-Couloume, B. Sleep, E.A. Edwards, and B. Sherwood Lollar, Univ of Toronto, Toronto, ON, Canada. Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 189, 2004

Characterization of carbon and hydrogen isotopic fractionation during anaerobic benzene biodegradation using enrichment cultures under sulfate-reducing, nitrate-reducing, and methanogenic conditions suggested that the initial steps in the benzene biodegradation pathway may determine the extent of isotopic fractionation. Enrichment factors (e) calculated for carbon and hydrogen isotopic fractionation showed significant differences between cultures using the three terminal electron accepting processes (TEAP). These differences were not related to initial biomass levels or rates of biodegradation. Linear regressions of the carbon versus the hydrogen isotope ratios for each of the cultures with different TEAPs revealed that the nitrate-reducing cultures produced fractionation with a distinct slope for the regression compared to the methanogenic and sulfate-reducing cultures that had similar slopes. These results suggest that the methanogenic and sulfate-reducing cultures used a similar initial mechanism for benzene biodegradation, while the initial reaction in the nitrate-reducing cultures was different. Results from this study show that carbon and hydrogen isotope analysis can be used to provide evidence of benzene biodegradation in the field and to help elucidate biodegradation pathways and mechanisms.

En Core® Sampler Performance for Storage of Soil Samples at -7 to -21 Degrees C
Sorini, S.S., J.F. Schabron, and J.F. Rovani, Jr.
Remediation Weekly, Vol 1 No 7, 226 July 2004

Preservation of sample integrity during storage and shipment of soil samples to the laboratory is a major concern in sampling soil for volatile organic analysis. The En Core® sampling/storage device provides a simple means for sampling soil and holding a soil sample during shipment to the laboratory for VOC analysis. The sampler consists of a coring body/storage chamber, O-ring sealed plunger, and O-ring sealed cap. It is designed to collect and store soil samples in a manner that minimizes loss of contaminants due to volatilization and/or biodegradation. After a sample is collected in the En Core sampler, the coring body is sealed with a slide-on cap and immediately becomes a sample storage chamber. ASTM standard D 6418, 'Standard Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis' (ASTM 2004), describes use of the EnCore® sampler to collect and store a soil sample for VOC analysis.
http://www.RemediationWeekly.com

Enhanced Data-Driven Assessments of Hydraulic Capture Zones
Dougherty, David E. (Subterranean Research, Inc.); David Wilson (U.S. EPA).
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, 15-17 June 2004, Dallas, Texas.

Hydraulic capture zones of saturated groundwater systems are inferred from head measurements. Once a contour map of heads is available, directions of groundwater flow are inferred using Darcy's law, enabling capture zones to be determined. Typically, synoptic head observations are used assuming instantaneous groundwater response, i.e., quasi steady-state. If the flow system includes singularities, such as groundwater extraction wells, or other sources of significant curvature in the head fields, then the standard methods of interpolation will be inadequate. In practice, observation data very near these locations are censored or are incorporated using professional judgement. This paper considers some extensions of the Tonkin and Larson kriging methodology, such as incorporating the effects of partial penetration, well losses, and unconfined conditions. It describes an approach in which residue kriging is combined with numerical simulation to obtain head estimates under complex flow conditions, such as heterogeneous aquifer materials. Because the goal is to interpret head observations, not to devise or improve a simulation model, there is no need to recalibrate or tweak a simulator to develop enhanced data-driven assessments of heads and capture zones.
http://207.86.51.66/siteopt/ataglance.htm

Environmental Isotope Forensics of Perchlorate Contamination
Horita, J. (ORNL, Oak Ridge, TN); J.F. Bohlke (USGS, Reston, VA): N.C. Sturchio (Univ. Of Illinois, Chicago); B. Gu and G.M. Brown (ORNL): J.R. Batista (Univ. of Nevada, Las Vegas).
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 241, 2004

The stable isotope ratios of Cl and O can potentially be used to distinguish the source(s) of perchlorate in a given location and to evaluate the extent of biodegradation. The stable isotope ratios of Cl and O in anthropogenic perchlorate salts can be readily measured in milligram amounts, but it is difficult to extract and recover isotopically measurable amounts of perchlorate from natural waters in which the perchlorate concentrations may be on the order of ppb. The recent development of a new class of bifunctional anion exchange resins for efficient sorption and removal of perchlorate, along with

a new resin regeneration technique for recovering sorbed perchlorate, provides a means for nearly quantitative recovery of perchlorate from water samples collected in the field for isotopic analysis. Using these innovative separation-recovery technologies, both developed at Oak Ridge National Laboratory, researchers have begun a systematic characterization of the stable isotope ratios of Cl and O in perchlorate from different sources, including anthropogenic perchlorate reagents, natural perchlorate-bearing salt deposits, salt-derived fertilizers, and waters from contaminated military and industrial sites. Preliminary results indicate that there are isotopic differences between various anthropogenic and natural perchlorate sources. When the data set of isotopically characterized perchlorate sources becomes sufficiently representative, stable isotope forensics of perchlorate may become useful for issues of source apportionment, natural attenuation, or remediation monitoring.

Environmental Sampling and Analysis for Metals
Csuros, Maria and Csaba Csuros, Univ. of PECS, Hungary.
CRC Press, Boca Raton, FL. ISBN: 156670572X, 408 pp, 2002

Determination of metals is a major part of the work of environmental testing laboratories. EPA and DEP methodology releases provide information only for selected areas of metals sampling and analysis, and their language makes them unsuitable for teaching and training purposes. This book is a comprehensive and easy-to-read text for laboratory technicians and analytical chemists who need a guide for analyzing metals in environmental samples and a reference for analytical and quality control procedures. The book provides both theoretical and practical applications in metals analysis of environmental samples and incorporates the latest in analytical techniques, instrumentation, and regulations. Topics include sample collection and preservation, step-by-step analytical procedures, complete QA/QC requirements, and data validation. It also provides an overview of the occurrence, source, and fate of metallic substances in the environment, as well as their control by regulations and standards.

Estimating Pre-Mining Water Quality Using Ferricrete
Furniss, George (Montana Dept. of Environmental Quality, Helena); Joe Gurrieri (USDA Forest Service, Butte, MT). Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 414, 2004

Mine remediation efforts in mountainous watersheds affected by sulfide mineralization and historic disturbance ultimately encounter the question of background (pre-mining) water quality. Ferricrete terraces mapped and radiocarbon-dated as Holocene age, discovered along many of these streams appear to be the result of acid rock drainage from sulfide mineral weathering, and suggest that streams in these watersheds may not have met aquatic or human health water quality criteria prior to mining. The authors present a method developed at a site near Cooke City, MT, that uses the geochemical characteristics of ferricrete coupled with the geochemistry of modern metal precipitates to predict pre-mining water chemistry in streams. For each hydrochemical variable (Cu, Zn, Al, Fe, Fe/Cu), an equation is generated that describes the longitudinal relationship between aqueous metal concentration or pH and modern precipitate metal concentration along a stream reach. Curves representing water column/precipitate metal and pH relationships, primarily exponential and power functions, show reasonable R2 values. For each ferricrete sampling location along the stream, the precipitate metal value is substituted by the ferricrete value in the equation to calculate the composition and pH of the paleo-stream. The pre-mining water quality estimation methods presented have the potential for use in monitoring the progress of remedial efforts at mine sites associated with ferricrete

deposits. A reasonable remediation objective for impacted streams would be realized when trace metals in streams correspond to patterns found in the adjacent ferricrete geologic record or when stream pH corresponds to the predicted pH.

Estimating Spatial Moments with Electrical Resistivity Tomography: Effect of Spatially Variable Resolution During a Saline Tracer Test
Singha, Kamini and Steven M. Gorelick, Stanford Univ, Stanford, CA.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 328, 2004

Crosswell electrical resistivity tomography (ERT) was used to monitor the migration of a saline tracer in a two-well tracer test conducted at the Massachusetts Military Reservation on Cape Cod. After injecting 2200 mg/L of sodium chloride for 9 hours, ERT data sets were collected from 4 wells every 6 hours for 20 days. Each ERT data set was inverted to produce a sequence of 3D maps that track the plume. Using modified moment analysis of the resistivity tomograms, the mass, center of mass, and spatial variance of the imaged tracer plume were estimated. Though the tomograms provide valuable insights into field-scale tracer migration behavior and aquifer heterogeneity, standard tomographic inversion and application of Archie's Law to convert electrical conductivities to solute concentration result in underestimation of tracer mass. Underestimation can be attributed to reduced measurement sensitivity to electrical resistivity values with distance from the electrodes and differential smoothing (regularization) from tomographic inversion. The center of mass calculated from the ERT inversions coincides with that estimated by migration of the tracer plume using 3D advective-dispersive simulation. The 3D plumes imaged using ERT exhibit greater apparent dispersion than the simulated plumes and greater temporal spreading than observed in field data of concentration breakthrough at the pumping well.

Evaluation of Advanced Genetic Algorithms Applied to Groundwater Remediation Design
Hayes, M.S. and B.S. Minsker, University of Illinois at Urbana-Champaign.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2005 & Related Symposia, Anchorage, AK, 2005

Optimal design of a groundwater pump and treat system is a difficult task, especially given the computationally intensive nature of field-scale remediation design. Genetic algorithms (GAs) have been used extensively for remediation design because of their flexibility and global search capabilities, but computational intensity is a particularly difficult issue with GAs. This paper discusses a new competent GA, the hierarchical Bayesian Optimization Algorithm (hBOA), which is designed to reduce the computational effort. GAs operate by assembling highly fit segments of chromosomes (potential solutions), called building blocks. The hBOA enhances the efficiency of this process by using a Bayesian network to create models of the building blocks. The building blocks are nodes on the network, and the algorithm uses the network to generate new solutions, retaining the best building blocks of the parents. This work compares the performance of hBOA to a simple genetic algorithm (SGA) in solving a case study to determine if any benefit can be gained through the use of this approach. This work demonstrates that hBOA more reliably identifies the optimal solution to a groundwater remediation design problem.
http://cee.uiuc.edu/emsa/conference/mhayes-2005-01.pdf

Evaluation of a Simple, Inexpensive Dialysis Sampler for Small Diameter Monitoring Wells
Harter, Thomas and Samer Talozi.
Ground Water Monitoring & Remediation, Vol 24 No 4, Fall 2004

The authors report on the development and testing of a simple, inexpensive dialysis sampler design for in situ measurement of nitrate and salinity in monitoring wells. The dialysis sampler is made with regenerated cellulose membrane tubing placed in an open cage, 18.5 mm in diameter and constructed of commonly available, inexpensive hardware. The design was tested in a monitoring well network installed in shallow, relatively warm groundwater of a sandy aquifer affected by animal waste discharge and agricultural fertilizer. Three dialysis samplers were placed near the bottom, center, and below the top of 20-ft-long well screens in an otherwise open well casing. In lab tests, 1 to 4 days was sufficient equilibration time to collect a representative sample, yet short enough to ensure the integrity of the membrane samplers, which began to degrade after about 1 week. Significant density-stable salinity gradients were detected in 25% of 40 wells. Non-uniform, heterogeneous nitrate profiles were much more common (80%). Despite the nonuniformity in the open profile, the average of the three samplers was generally within 10% of the electrical conductivity and nitrate concentrations obtained by standard purging and well sampling using a pump. At initial hardware costs of approximately $1 per reusable open multilevel sampling string and at sampling costs of $1 to $3 per open multilevel sampling string for disposable membrane material, dialysis samplers are a good candidate for a low-cost, low-tech sampling device to determine major water quality parameters in small diameter groundwater monitoring wells.

Evaluation of Kriging Methods for Assessing the Spatial Distribution of some Soil Trace Elements Contamination
Bourennane, H., D. Baize, and D. King (INRA, Olivet, France); F. van Oort and I. Lamy (INRA, Versailles). Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-III, p 252-253, 2003

Interpolation algorithms such as ordinary kriging tend to smooth out local details of the spatial variation of the attribute. Small values are typically overestimated, whereas large values are underestimated. Such conditional bias is a serious shortcoming when trying to detect patterns of extreme attribute values, such as zones high in metals. Another common situation in the environmental sciences is that the data are markedly skewed and non-normal. The variogram is sensitive to strong positive skewing because a few exceptionally large values contribute to so many squared differences and the estimation has bias. Skewing can often be removed and the variances stabilized by taking logarithms. This approach leads to log-normal kriging, and the logarithms must be transformed back in original unit. This paper evaluates four prediction methods for the spatial distribution of total contents of zinc, cadmium, copper, and lead soil contamination that have a positively skewed distribution with a few extreme values. The final objective was to accurately map the spatial distribution of trace elements. This step is necessary for risk assessment and soil remediation studies carried out simultaneously with the study.

Evaluation of Solvent Plume Discharge to a Wetland Stream using an Innovative Passive Diffusion Sampling Methodology

Hellerich, L.A. and J.L. Albrecht (Metcalf & Eddy, Inc., Wallingford, CT); R.C. Schwenger (Noranda Inc., Bathurst, NB, Canada). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

This presentation describes the first phase of a multi-phase project to delineate a chlorinated solvent (primarily trichloroethene, or TCE) plume in groundwater downgradient of a former industrial site. The plume extends from the on-site source to a wetland/stream complex, the primary discharge point for groundwater migrating from the site. The plume has been delineated from the source to the upgradient edge of the wetland via quarterly groundwater sampling through a network of monitoring wells. At the upgradient edge of the wetland, TCE concentrations in groundwater remain elevated, while products of reductive dechlorination are present. Surface water sampling indicates that the solvent plume is discharging to a stream that drains the wetland. The first phase of the plume delineation project consisted of a solvent plume discharge evaluation (SPDE) designed to evaluate the locations of solvent plume discharge to the wetland stream. This cost-effective SPDE was conducted by deploying passive diffusion samplers (PDSs) in the wetland stream sediments at 45 locations along a 1,900-foot length of the stream. Once equilibrium between the PDSs and the sediment pore water was attained, the concentrations of chlorinated ethenes in the PDS samplers were measured. The analytical results were mapped as a function of stream length and indicate a definitive point of plume discharge to the stream and a possible plume fringe. The ratios of degradation products to TCE were greater in the PDS samplers than ratios observed at upgradient monitoring locations, indicating an increasing natural attenuation potential as the plume migrates through the wetland.

Evaluation of the Diffusive Gradient in a Thin Film Technique for Monitoring Trace Metal Concentrations in Estuarine Waters

Dunn, R.J.K., P.R. Teasdale (Griffith Univ. Gold Coast Campus, Queensland, Australia), J. Warnken, and R.R. Schleich. Environmental Science & Technology, Vol 37 No 12, p 2794-2800, 2003

A study of trace metal concentrations in dynamic estuarine waters demonstrated that important information could be obtained from intensive sampling of physicochemical parameters and trace metal concentrations. A regular pattern of variation in Cu and Ni concentrations was related to the movement of water passed point sources with tidal flows, rather than due to conventional estuarine mixing of end-member waters. The initial approach was logistically demanding and expensive. The diffusive gradients in a thin film (DGT) technique was used as an alternative method due to its continual time-integrated response to changes in trace metal concentrations. Significant correlations were found between 24 h DGT-labile measurements and 0.45-m filterable measurements on time-averaged composite samples for Cu, Pb, Zn, and Ni. Though DGT measurements were confirmed as being highly operationally defined, DGT was still found to be very promising as a monitoring approach with speciation capabilities, particularly for dynamic estuarine waters.

Evaluation of the Quick, Easy, Cheap, Effective, Rugged, and Safe (QuEChERS) Approach to Pesticide Residue Analysis

Schenck, F.J. and J.E. Hobbs, Southeast Regional Lab, U.S. FDA, Atlanta, GA.
Bulletin of Environmental Contamination and Toxicology, Vol 73 No 1, p 24-30, July 2004

QuEChERS (pronounced 'catchers') is the name for a new approach to analyzing pesticide residues in fruits and vegetables. Steven J. Lehotay, an Agricultural Research Service chemist, and a

visiting scientist, Michelangelo Anastassiades, from a government laboratory in Stuttgart, Germany, developed the QuEChERS method, which stands for quick, easy, cheap, effective, rugged, and safe. It can be used with a wide range of pesticides and food types. Using QuEChERS, a single chemist can prepare a batch of 10 previously chopped samples in about 30 minutes with $1 worth of materials per sample. This gives at least four-fold lower material costs and fourfold greater sample throughput per analyst than traditional methods. The method combines different steps, which means there is less chance for error. A single, easy-to-clean Teflon tube is the only item to be washed and reused, eliminating all the glassware used in conventional methods. Furthermore, less than 10 milliliters of solvent waste is generated--much less than the 75-450 milliliters generated by other methods. Key to the new approach is the development of a rapid procedure called dispersive solid-phase extraction. This technique quickly removes water and nontarget compounds with magnesium sulfate and a primary-secondary amine sorbent.

Evaluation Report with Appendix: Certification Statement for HAPSITE® Portable Gas Chromatograph Mass Spectrometer Manufactured by INFICON® Inc.
California Environmental Technology Certification Program (CAL/EPA). 75 pp, Mar 2004

The Field-Portable Gas Chromatograph Mass Spectrometer is one of the innovations for on-site measurement of organic pollutants in environmental media. This report was prepared to show the performance of a portable gas chromatograph, mass spectrometer system HAPSITE® manufactured by INFICON®, Inc. for on-site measurement of volatile organic compounds in air, water, soil, and gas samples. The evaluation is based on a detailed review of information and data packages submitted by the technology proponent, field data generated by independent parties, and new data collected under the oversight of the DTSC.
http://clu-in.org/download/char/calepa_hapsite_cert_report.pdf

Evidence of Biodegradation at a DNAPL Contaminated Fractured Bedrock Field Site Using Stable Carbon Isotopes
Chartrand, M.M.G., P.L. Morrill, and G. Lacrampe-Couloume (Univ. of Toronto); K.T. Finneran, P. Chang, and P. Zeeb (Geosyntec Inc.); B. Sherwood Lollar (Univ. of Toronto).
Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 385-387 [abstract only], 2004

Stable carbon isotope analysis of chlorinated ethenes and ethene was performed at a site where the TCE DNAPL source and dissolved plume are located in fractured bedrock. Previous attempts to biostimulate the pilot test area (PTA) at the site resulted in the accumulation of cis-1,2-dichloroethene (cis-DCE). Since there was no appreciable production of vinyl chloride (VC) or ethene (ETH), there was no evidence for further reductive dechlorination beyond cis-DCE. Subsequently, the PTA was bioaugmented with KB-1, a natural microbial consortium shown in laboratory experiments to completely reduce TCE to non-toxic ETH. While the appearance of breakdown products (VC, ETH) suggested that bioaugmentation was successful to some extent, due to the continuous source of TCE from the DNAPL in the fractured bedrock and variability in the hydraulic gradient, concentration profiles of TCE and degradation products cis-DCE, VC and ETH were unable to unambiguously verify bioaugmentation. Compound specific carbon isotope analysis of the chlorinated ethenes was able to confirm biodegradation. At any given sampling well, the isotopic signatures of the breakdown products were more depleted than that of their parent compound. The isotopic signatures of cis-DCE and VC became increasingly enriched over the four sampling events consistent with the effects of

biodegradation. The isotopic profile of TCE remained relatively consistent due to the continuous input of undegraded TCE from DNAPL dissolution. Stable carbon isotope measurements can provide an important line of evidence for biodegradation in complex hydrogeologic systems.

Expert Knowledge in Long-Term Groundwater Monitoring Optimization Process: The Interactive Genetic Algorithm Perspective
Babbar, M., B.S. Minsker, and H. Takagi, Univ. of Illinois, Urbana-Champaign.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2005 & Related Symposia, Anchorage, AK, 2005

In most practical water resources optimization applications, some important subjective issues exist that cannot be represented in numerical optimization procedures. An innovative approach, the Interactive Genetic Algorithm (IGA) involves the expert directly in the online search process to steer the genetic algorithm to a solution or set of solutions that address both quantitative and qualitative criteria. This paper investigates the effect on the overall search process when a single user interacts with the IGA system. Some of the salient control parameters that affect performance of such a framework are algorithmic control parameters (the GA settings, visualization interfaces), human control parameters (the user's cognitive perception, degree of risk aversion, human fatigue, etc.), and external control parameters (environmental noise and uncertainty). This work begins a rigorous assessment of the effects of different control parameters on the IGA search process by simulating the human decision making process using fuzzy logic models of human preferences as 'pseudo humans.' Comparison of such a system with a conventional optimization framework (that lacks progressive user feedback) is made for a long-term groundwater monitoring optimization problem, and related ramifications are highlighted.
http://cee.uiuc.edu/emsa/conference/mbabbar_ASCE2005_final.pdf

Expert Systems and Geographic Information Systems for Impact Assessment
Rodriguez-Bachiller, Agustin and John Glasson, Oxford Brookes Univ., England, UK.
CRC Press, Boca Raton, FL. ISBN: 0415307252, 408 pp, 2004

Environmental impact assessment is plays a part in an increasing number of development proposals in the UK and Europe. As the approach matures, it becomes more standardized and good practice starts to be defined. This text discusses the potential of integrating two well-known computer technologies--GIS and Expert Systems--to help with the process of impact assessment. The proposition behind the work is that all three areas are potentially complementary and that mutual benefits can be gained from bringing them together in the field of planning.

Explosive Residue Detection Using Polypeptide-Based Biosensors
Lannigan, D.A.; H, Qian; B. Nguyen; D. Kitt; D. Clark, Virginia Univ.
DTIC: ADA430817, 6 pp, Mar 2005

Polypeptide-based biosensors are being developed and targeted against 2,4,6-trinitrotoluene (TNT) or its breakdown products. To identify the receptors, the researchers developed an in vitro evolution and selection (IVES) process that leads to a greatly accelerated cycle of receptor modification and diversification. Their work has substantially optimized the IVES process by increasing the sensitivity and reducing the false positive rate of the assay, developed a signal-generation system that uses fluorescence resonance energy transfer for the detection of small organic compounds, and

identified a TNT receptor that specifically binds TNT compared to its metabolite DNT. The EC50 for the TNT receptor in the yeast-based one-hybrid assay is about 3 M (0.7 ppm). The amount of TNT present in soil samples above a TM-62P mine buried 4 inches below the surface has been measured to be about 2 ppm. Thus, theoretically, a 2-ppm concentration of TNT should be detected by the TNT receptor developed through the IVES process.
http://handle.dtic.mil/100.2/ADA430817

Fault and Fracture System Delineation of Bedrock Aquifer
Truskowski, M. and J. Warner (ERM); J. Clark (Bay Geophysical); D. Tisoncik (United Airlines).
Society of Exploration Geophysicists (SEG) Technical Program Expanded Abstracts, p 1393-1396, 2004

Chlorinated solvents were released into the ground at an active aircraft maintenance facility 35 to 50 years ago during engine maintenance. Solvents, predominantly 1,1,1-TCA, 1,1-DCE, and 1,1-DCA, have been detected at the site in concentrations ranging from dense nonaqueous phase liquids (DNAPL) to non-detect over a small distance. The bedrock topography is complex, and the degree and distribution of the fracturing has been identified within the boreholes with optical and acoustic borehole televiewer logging. A high-resolution/high frequency vibroseis reflection seismic survey was conducted to identify faulting, bedrock topography, and bedrock fracture systems. The survey identified a complex fault system, including three primary faults, each with a complicated set of antithetic faults. The locations of the primary faults corresponded to areas of increased fracture density, and hence fluid and contaminant flow. Using the seismic survey as a predictive tool allowed focused placement of monitoring wells to define the extent of the plume. Subsequent work has confirmed the predicted bedrock topography, fault positions, and extent of the contaminant plume.

Field Sampling: Principles and Practices in Environmental Analysis
Conklin, Alfred R., Jr. with Rolf Meinholtz.
Marcel Dekker, ISBN: 0824754719, Books in Soils, Plants, and the Environment, Vol 104, 300 pp, 2004

This reference outlines procedures for taking air, water, soil, biological, and other samples that will yield a representative and accurate measurement of the conditions and concentrations of components present in the field. The practical textbook explains the importance of developing a field sampling plan and keeping a project notebook, describes geostatistical and GPS tools, suggests protocols for transporting and storing the samples, and overviews the basic principles of analytical methods.

Field Uptake Rates of Hydrophobic Organic Contaminants by Semipermeable Membrane Devices: Environmental Monitoring Considerations
Sanchez-Hernandez, Juan C., F. Borghini, A. Corral, and J.O. Grimalt.
Journal of Environmental Monitoring, Vol 6 No 11, 919-925, 2004

The uptake rates of selected hydrophobic organic contaminants (HOCs) by semipermeable membrane devices (SPMDs)--a polyethylene layflat containing the lipid triolein--were investigated under natural conditions in industrial, urban, and agricultural areas. The organochlorines 4,4-DDT, 4,4-DDE, alpha-HCH, gamma-HCH, pentachlorobenzene, hexachlorobenzene, and polychlorinated biphenyls (PCBs) and 16 priority pollutant polycyclic aromatic hydrocarbons (PAHs) were detected in

the SPMDs deployed in the three sampling sites. The results indicate that SPMD kinetic uptake studies in the natural environment are suitable for identifying point-pollution sources, and that shorter times of SPMD exposure (1 week) are desirable to minimize one of the main problems of field SPMD deployment, i.e., biofouling, which negatively affects the estimation of the dissolved HOC concentrations.

Fluid Transport Monitoring During Percolation Pond Infiltration and Recharge to a Complex, Deep, Heterogeneous Vadose Zone at the Idaho National Engineering and Environmental Laboratory
Baker, Kristine E., L.C. Hull, T.L. McLing, and L.V. Street (INEEL, Idaho Falls, ID); R.C. Roback and C.L. Jones (Los Alamos National Lab, Los Alamos, NM). Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 392, 2004

Predicting fluid and contaminant transport in the vadose zone at the Idaho National Engineering and Environmental Laboratory (INEEL) has been problematic due to the complex geology underlying the site. In an attempt to better understand the controlling mechanisms of subsurface fluid transport, a system of monitoring instruments was installed in boreholes around the perimeter of newly constructed percolation ponds and along an ephemeral river approximately one kilometer to the north. This instrumented region has been designated the Vadose Zone Research Park (VZRP). Facility-water discharge to the new percolation ponds at a rate of approximately a million gallons per day began in October 2002. Continuous monitoring of subsurface hydraulic properties at the VZRP since May 2002 coupled with periodic tracer injections suggest that subsurface flow is controlled by the presence of preferential flow paths and extreme contrasts in hydraulic conductivity between sedimentary interbeds and fractured basalt flows. Perched water does not dissipate rapidly in the absence of local recharge and may extend tens of meters both laterally and vertically from the source area. In contrast to these observations, the current conceptual model for fluid transport in the vadose zone at the INEEL adopts diffuse type flow and assumes that perched water dissipates rapidly in the absence of local recharge. Continued monitoring and transport studies at the VZRP can contribute significantly to the understanding of fluid transport at the INEEL and similar sites throughout the country. Efforts are currently underway to establish the VZRP as a collaborative, multidisciplinary field research center for developing an improved conceptual model for fluid and contaminant transport in heterogeneous, complex vadose zones.

The FLUTe Multilevel Groundwater Monitoring System Used for Study of a Contaminated Dolostone Aquifer
Cherry, J.A. and B.L. Parker (Univ. of Waterloo); C.M. Turner (Haley & Aldrich, Inc.); L.S. Burns and J.H. Plett (Univ. of Waterloo); C.E. Keller (Flexible Liner Underground Technologies Ltd.). Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 778-779 [abstract only]

The FLUTe system for multilevel groundwater monitoring is being used to determine the nature of the groundwater flow system and groundwater contamination in a fractured dolostone aquifer in Cambridge, Ontario. The FLUTe system consists of a continuous flexible urethane-coated nylon fabric liner that seals the borehole by pressure created by loading the inside of the liner with water. Discrete segments of the liner are equipped for monitoring at the borehole wall. A FLUTe system with 15 monitoring ports distributed over a 65-m interval in the upper part of the aquifer was used for 12 months of monitoring in 2001, followed by removal (without difficulty) to make the borehole available for other uses. Fifteen ports was the maximum that could be fitted into this 5.7 inch diameter vertical core hole

and still retain the free flow of the larger tubing normally used in this system. The second FLUTe system was installed in a 4.8 inch diameter vertical cored hole that allowed a maximum of 10 ports. This system monitored to a depth of 145 m below ground surface, with the bottom port in the shale below the dolostone. Each port in each system was equipped with a pressure transducer for continuous pressure measurement and also a long stroke double-valve pump for groundwater sampling. This is the first application of the FLUTe groundwater system in which such a large number of monitoring ports were used in a hole. Each system provided detailed depth-discrete vertical profiles of head and water chemistry. Important features were identified that would have gone undetected with conventional monitoring approaches. For example, the many monitoring intervals in each system were essential for determining the depths at which maximum concentrations of the major contaminants (NO3-, CL-, TCE, metolachlor) occur. This study demonstrates the value of detailed, depth-discrete multilevel monitoring in investigations of contamination in fractured rock.

Forecasting the Number of Soil Samples Required to Reduce Remediation Cost Uncertainty
Demougeot-Renard, H. (Inst. for Raumplanung und Landschaftsentwicklung, Zurich, Switzerland); Chantal de Fouquet; Philippe Renarda.
Journal of Environmental Quality, Vol 33, p 1694-1702, 2004

In practice, sampling is seldom designed to comply with a given level of remediation cost uncertainty. The authors present a new technique for estimating the number of samples that should be taken at a given stage of investigation to reach a forecasted level of accuracy. The uncertainty is expressed both in terms of volume of polluted soil and overall cost of remediation. This technique provides a flexible tool for decision-makers to define the amount of investigation worth conducting from an environmental and financial perspective. The technique is based on nonlinear geostatistics (conditional simulations) to estimate the volume of soil that requires remediation and excavation and on a function allowing estimation of the total cost of remediation (including investigations). The geostatistical estimation accounts for support effect, information effect, and sampling errors. The cost calculation includes mainly investigation, excavation, remediation, and transportation. The application of the technique on a former smelting work site (lead pollution) illustrates how the tool can be used.

Further Evaluation of SPMDs as Passive Air Samplers of Semivolatile Organic Compounds
Bartkow, M. and K. Kennedy (Univ. of Queensland, Brisbane, Queensland, Australia); J. Huckins (US Geological Survey, Columbia, MO); J. Mueller (Univ. of Queensland).
Fourth SETAC World Congress, 25th Annual Meeting in North America, 14-18 November 2004, Portland, Oregon. Society of Environmental Toxicology and Chemistry, Pensacola, FL. Platform Presentation IP044, 2004

Though previous work has shown that SPMDs are useful as passive air samplers of semivolatile organic compounds (e.g., PCBs, PAHs, and dioxins), some aspects of sampler performance required further investigation. For example, are photosensitive compounds accumulated in the SPMD subject to photodegradation during the sampling period? If so, what sampler deployment device could limit this effect? Are particles sampled by the SPMD? If so, is uptake via a linear, first-order process? The authors designed a field-based experiment using SPMDs and HiVol air sampling systems at 2 sites to investigate these factors. This paper describes the progress and results of the study.

GC-MS LC-MS and LC-MS/MS of Soil Samples from a Former Mustard Storage Site for the Presence of Mustard Thiodiglycol and Related Compounds
D'Agostino, P.A.; J.R. Hancock; C.L. Chenier, Defence Research and Development Suffield, Alberta, Canada. Report No: DRDC-TR-2004-021, NTIS: ADA426439, 38 pp, July 2004

Soil samples were taken for the first time near a former mustard storage site as part of an environmental assessment. A portion of the site soil samples were selected for mass spectrometric analysis. Mustard was not detected in the dichloromethane extracts of the soil samples during capillary column GC-MS; however, three of the soil sample extracts were found to contain thiodiglycol and/or related mustard hydrolysis products. A recently developed low-resolution LC-ESI-MS method was applied to the identification of mustard hydrolysis products in aqueous extracts of soil. Thiodiglycol was detected by LC-ESI-MS in the aqueous extracts of two soil samples at the 200 ug/mL and 300 ug/mL levels, along with three longer chain diols associated with the hydrolysis of munitions grade mustard. Identification of several other related compounds was not possible by LC-ESI-MS. Acquisition of a high resolution LC- ESI-MS/MS at DRDC Suffield provided an opportunity to accurately determine elemental composition during analyses, a considerable advantage when confirming compound presence or when dealing with the identification of previously uncharacterized compounds in complex environmental samples. High-resolution LC- ESI-MS/MS methods were developed for the determination of thiodiglycol and longer chain diols and applied to the analysis of these compounds in the aqueous extracts of the soil samples collected from the former mustard storage site. Detailed analysis of these aqueous extracts by high resolution LC-ESI-MS/MS resulted in the confirmation of thiodiglycol and three longer chain diols and the characterization of five new longer chain diols that could not be characterized during low-resolution LC-ESI-MS analyses.
http://handle.dtic.mil/100.2/ADA426439

Geoelectrical Characterization of a Site with Hydrocarbon Contamination as a Result of Pipeline Leakage
Delgado-Rodríguez, Omar, Vladimir Shevnin, and Jesus Ochoa-Valdes (Inst. Mexicano del Petroleo); Albert Ryjov (Moscow State Geological Prospecting Academy).
Society of Exploration Geophysicists (SEG) Technical Program Expanded Abstracts, p 1448-1451, 2004

This work presents the results of the geoelectrical characterization of a hydrocarbon-contaminated site. Low levels of contamination were mapped in two contaminated zones in a sandy aquifer using a resistivity method. Petrophysical parameters were estimated by recalculation of ground and water resistivity values in clay content, porosity, and CEC values. Anomalous values of clay content, porosity and CEC indicate the presence of hydrocarbon contaminants. The correlation between geoelectrical results, petrophysical parameters, and hydrocarbon contamination was verified in laboratory by electrical measurements made in pure and contaminated sand samples.

Geophysics-Based, Contaminated Land Research Provides New Insights into the Characterisation of Hydrocarbon Pollution
Cassidy, Nigel. GeoSchool Newsletter, Vol 6 No 4, p 6, Autumn 2004

The author has recently completed a successful NERC-funded study that is providing new insights in to the fate and evolution of in situ NAPL contaminants (i.e., nonaqueous phase liquids such as petrol and diesel). The preliminary findings of the research were presented at the 10th International conference on Ground-Penetrating Radar, Delft, Netherlands. The findings show that natural, in situ

biodegradation of hydrocarbon contaminants (in this case a liquid benzene-toluene-styrene mix in clean dune sands) can result in elevated levels of groundwater conductivity that can be detected and, more importantly, quantified through the use of noninvasive, surface-based geophysical techniques such as ground-penetrating radar, electromagnetic conductivity, and resistivity. The phenomenon has been identified before, but in this study, geochemical and dielectric testing were used in conjunction with geophysical techniques to characterize the nature of the biodegradation products. The results indicate that natural microbial activity produces a range of complex, organic-related acids and bases that in turn attack the lithics present in the dune sands. As consequence, free ions are released into the pore and groundwaters (e.g., Fe, Ca, K), increasing the electrical conductivity of the fluids. By analyzing the frequency-dependent attenuation and velocity response of these fluids to a propagating electromagnetic wave, it has been possible to discriminate between areas of varying contamination with noninvasive geophysical methods. This work has important implications for the assessment and characterization of contaminated sites with the possibility of providing ongoing pollution monitoring at a fraction of the cost of traditional invasive methods.
http://www.esci.keele.ac.uk/newsletters/latest.pdf

GPR Application for Mapping Toluene Infiltration in a Heterogeneous Sand Model
Attia al Hagreya, Said, Kiel University, Kiel, Germany.
Journal of Environmental and Engineering Geophysics, Vol 9 No 2, p 79-85, June 2004

A high resolution radar technique was applied for monitoring infiltrated light, nonaqueous-phase hydrocarbon liquids (toluene) in a partially saturated heterogeneous sand medium as a function of time. Radar measurements of the laboratory model using 1.5 GHz antenna showed that mapping toluene was possible in the fully and partially saturated zones of objects, but failed in the other parts. The weak reflections within the low-saturation region may be related to the weak electromagnetic impedance contrast at the interface between the toluene (which replaced the pore water) and air.

Ground Water Chlorinated Ethenes in Tree Trunks: Case Studies, Influence of Recharge, and Potential Degradation Mechanism
Vroblesky, D.A., B.D. Clinton, J.M. Vose, C.C. Casey, G.J. Harvey, and P.M. Bradley.
Ground Water Monitoring and Remediation, Vol 24 No 3, Summer 2004

Trichloroethene (TCE) was detected in cores of trees growing above TCE-contaminated ground at three sites: the Carswell Golf Course in Texas, Air Force Plant PJKS in Colorado, and Naval Weapons Station Charleston in South Carolina. This was true even when the depth to water was 7.9 m or when the contaminated aquifer was confined beneath approximately 3 m of clay. Additional groundwater contaminants detected in the tree cores were cis-1,2-dichloroethene at two sites and tetrachloroethene at one site. Tree cores collected over time were useful in identifying the onset of groundwater contamination, and the method can be a rapid and effective means of locating shallow subsurface chlorinated ethenes and possibly identifying zones of active TCE dechlorination.

Groundwater Redox Conditions and Conductivity in a Contaminant Plume from Geoelectrical Investigations
Naudet, V.; A. Revil (CNRS-CEREGE, Aix-en-Provence, France); E. Rizzo; J.-Y. Bottero; P. Begassat.
Hydrology and Earth System Sciences, Vol 8 No 1, p 8-22, 2004

A map of redox potential in an aquifer is indicative of biodegradation of organic matter and of concentrations of redox-active components; a map of electrical conductivity provides information on the mineralization of the groundwater. Together, the maps can be used to optimize the position of pumping wells for groundwater remediation. This paper describes an application of the self-potential (SP) method and electrical resistivity tomography (ERT) to the contaminant plume associated with a landfill in France. The SP depends on groundwater flow (electrokinetic contribution) and redox conditions ('electro-redox' contribution). Using the variation of the piezometric head in the aquifer, the electrokinetic contribution is removed from the SP signals. A good linear correlation is obtained between the residual SP data and the redox potential values measured in monitoring wells. This relationship is used to draw a redox potential map of the overall contaminated site. The electrical conductivity of the subsoil is obtained from 3D-ERT analysis. Good linear correlation between the electrical conductivity of the aquifer determined from the 3D-ERT image and the conductivity of the groundwater measured in boreholes indicates that the formation factor is nearly homogeneous in the shallow aquifer at the scale of the ERT. A map of the pore-water conductivity of the aquifer is obtained from this correlation. Accurate mapping of the electrical conductivity and redox potential of groundwater is important in delineating the shape of a contaminant plume.

Groundwater Remediation Strategies Tool
Newell, Charles J. (Groundwater Services, Inc., Houston, TX); John A. Conner; Dana L. Rowen.
American Petroleum Institute, Pub No 4730, 80 pp, Dec 2003

This guide provides strategies for focusing remediation efforts on the change in contaminant mass flux in different subsurface transport compartments (e.g., the vadose zone, smear zone, or a zone within an aquifer of interest), and the change in remediation time frame. The approach combines ground-water flow and contaminant concentration data to estimate the rate of contaminant mass transfer past user-selected transects across a contaminant plume. The method provides the user with a means to estimate the baseline mass flux and remediation time frame for various transport compartments and then evaluate how different remedies reduce the mass flux and the remediation time frame in each transport compartment. Results from one or more transects can be used to evaluate (1) potential water quality impacts on downgradient water supply wells, (2) the natural attenuation of the contaminant mass with distance downgradient of the source, and (3) the relative benefits of remedies based on their anticipated reductions in mass flux from the source to the receptor. In addition to step-by-step instructions for the strategies, several utilities are provided, including worksheets for estimating baseline mass flux and remediation time frame and evaluating potential remedies, tools for calculating mass flux, resources on estimating remediation lifetime and evaluating remedy flux reduction/mass removal factors, and tools for evaluating how long it takes for an upgradient remedial action to affect a downgradient ground-water transect zone.
http://api-ec.api.org/filelibrary/4730_Final.pdf

Guidance for Evaluating Soil Vapor Intrusion in the State of New York
New York State Dept. of Health, Bureau of Environmental Exposure Investigation, Troy, NY. Feb 2005

This document provides guidance on identifying and addressing current and potential human exposures to contaminated subsurface vapors associated with known or suspected volatile chemical contamination. While vapor intrusion may also occur with "naturally-occurring" subsurface gases (e.g., radon, methane and hydrogen sulfide), the document discusses soil vapor intrusion in terms of environmental contamination only. The document is organized into five sections. Section 1 introduces the concept of soil vapor intrusion, associated human exposure issues, factors affecting soil vapor intrusion, factors affecting indoor air quality, and the general approach to evaluating vapor intrusion. Section 2 provides guidance on collecting appropriate and relevant data that can be used to identify current or potential human exposures. Section 3 discusses how the investigation data are evaluated, recommends actions based on the evaluation, and presents tools that can be used when determining appropriate actions to address exposures. Section 4 provides an overview of soil vapor intrusion mitigation methods and basic requirements pertaining to their selection for use, installation and design, post-mitigation testing, operation, maintenance and monitoring, termination of operation, and annual certification. Section 5 describes outreach techniques commonly used to inform the community about soil vapor intrusion issues.
http://www.health.state.ny.us/nysdoh/gas/svi_guidance/

Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air. Interim Final
California Environmental Protection Agency, Dept. of Toxic Substances Control, 105 pp, Feb 2005

The intrusion of subsurface vapors into buildings is one of many exposure pathways that must be considered in assessing the risk posed by releases of hazardous chemicals (i.e., volatile organic compounds) into the environment. This guidance document recommends an approach for evaluating vapor intrusion into buildings and its subsequent impact on indoor air quality. Approaches for the mitigation of vapor intrusion are also discussed.
http://www.dtsc.ca.gov/ScienceTechnology/HERD_POL_Eval_Subsurface_Vapor_Intrusion_interim_final.pdf

Heat Stabilized Ganglioside Films for Biotoxin Sensing
Stine, R., C.-L. Schengrund, and M.V. Pishko, Pennsylvania State Univ., University Park.
AIChE 2004 Annual Meeting, November 7-12, Austin, TX.
American Institute of Chemical Engineers, New York, NY. Presentation 41b, 2004

Researchers have developed a means of producing thin, oriented lipid monolayers that are stable under repeated washing and may be useful in biosensing or surface-coating applications. A mixed, hydrophobic, self-assembled monolayer was produced on a gold surface and brought into contact with a thin lipid film assembled at the liquid/air interface of a solution. The lipid layer was then heated to cause intermingling of the fatty acid and alkanethiol chains. Presence and stability of the film was confirmed via ellipsometry, FTIR, and QCM, with an average overall film thickness of about 3.5 nm. This method was used to produce GM1 layers on gold-coated QCM crystals for affinity sensing trials with cholera toxin, ricin, and other biotoxins. Potential sites for non-specific adsorption were blocked using serum albumin without sacrificing toxin specificity.

Heavy Metals Monitoring using Bivalves from Mediterranean Sea and Red Sea
El-Sikaily, Amany, Azza Khaled, and Ahmed El Nemr, National Inst. of Oceanography and Fisheries, Kayet Bay, Alexandria, Egypt.
Environmental Monitoring and Assessment, Vol 98 Nos 1-3, p 41-58, Nov 2004

Heavy metal (Cd, Co, Cu, Fe, Mn, Ni, Pd, and Zn) concentrations were measured in bivalves collected from the Egyptian coasts of the Mediterranean Sea (Modiolus auriculatus and Donax trunculus) and from the Egyptian coasts of the Red Sea (Brachiodonates sp.). The average concentrations of the metals analyzed were Fe > Zn > Cu > Mn > Ni > Co > Pb > Cd for both the Mediterranean and Red Sea. The analyses of Cd, Co, Ni, Pb, and Zn showed higher average concentrations for samples collected from the Red Sea than that collected from the Mediterranean Sea, while Fe, Cu, and Mn showed the reverse. Fe was used as a normalizing agent for all studied metals. The study results suggest that the coastal area along both the Mediterranean and Red Sea of Egypt is relatively unpolluted by heavy metals.

High Speed Explosives Monitoring Using UPLC(TM)
Benvenuti, Mark, Andy Aubin, Joe Romano, and Jim Krol, Waters Corporation, Milford, MA.
NEMC 2004: The 20th Annual National Environmental Monitoring Conference, 19-23 July 2004, Washington, DC. Book of Abstracts, P5.

Rapid identification of explosive residues whether for pollution or terrorist concerns has become increasingly important. These residues contain nitroaromatic and nitramine compounds, which pose significant health risks. EPA Method 8330 describes the separation of fourteen analytes and degradation products of explosive compounds. This poster describes a new separation technology that allows separation of these compounds in under ten minutes. This technology, known as Ultra Performance LC (UPLC(TM)) relies on columns with a particles size of 1.7 microns, leading to extremely high efficiency separations in very short run times. Applicability to real samples is shown.
http://www.waters.com/watersdivision/pdfs/720000950EN.pdf

Hydrogeologic Investigation of VOC Contamination in Bedrock Using Mass Flux Analysis: a Case History
Eby, R.K. (ARCADIS G&M Inc., Lowell, MA); R.E. Zimmermann (Roadway Express Inc., Akron, OH); M.T. Paczkowski (ARCADIS); T. Regan (TR Associates, Newburyport, MA).
Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, 13-15 September 2004, Portland, Maine. p 372-382, 2004

A fractured bedrock system was investigated using a combination of hydrogeologic methods to minimize the number and depth of bedrock wells installed during an investigation of the vertical and horizontal extent of chlorinated organic compounds in the groundwater. A fracture-trace analysis was used to identify potential fracture zones downgradient of the site to determine potential migration pathways and assist in locating monitoring wells. An electrical resistivity survey was conducted to ground truth results of the fracture-trace analysis. Vertical profiles of hydraulic conductivity and VOC concentrations were developed using packer testing and groundwater sampling of discrete intervals within each borehole. Mass-flux analyses were conducted using the discrete hydraulic conductivity and VOC-concentration data to determine the vertical extent of VOC contributions from the relatively low permeability bedrock encountered with increasing depth at the site. The mass-flux approach provided a practical and cost-effective alternative to installing and sampling additional deep bedrock wells in relatively low-permeability bedrock. Results of the discrete VOC sampling and packer pressure testing provided hydraulic conductivity values and VOC concentrations of 10-foot test intervals within well

boreholes. Mass flux was calculated using the hydraulic conductivity and VOC concentrations to quantify the relative contributions of VOCs from each test interval. Total mass flux for an entire well bore was calculated by adding the individual mass flux values for each interval. The ratio of the mass flux calculation of each test interval to the mass flux calculation of the entire well bore was used to quantify the relative percent of the total mass flux contributed by the corresponding bedrock test interval. Profiles of mass flux calculations for each well bore demonstrated a significant decrease in mass flux with depth. These data were used to limit the number and depth of additional deep bedrock well clusters installed during the investigation.
http://www.clu-in.org/products/siteprof/2004fracrockconf/cdr_pdfs/indexed/group1/372.pdf

Impact of GPS Technology on Reclamation in Texas
Brandt, Jon and Bill Reimer, Railroad Commission of Texas.
National Association of Abandoned Mine Land Programs (NAAMLP) Newsletter, Vol 26 No 1, p 5, Spring 2004

The Texas Abandoned Mine Land Program has reclaimed 11 uranium mines since 1988. Global Positioning System (GPS) equipment and software has substantially reduced the time and manpower needed to delineate these sites. The work formerly involved at least two people to accomplish all the surveying using traditional equipment. In 2000, a Leica Geosystems SR530 RTK DGPS system was purchased, and since then all of the survey work has been accomplished with one person. The use of GPS equipment has had a great impact on collecting and managing environmental data (e.g., soils and radioactivity), which previously involved the use of topographic maps, aerial photos, and a compass to approximate a location. Data locations were less than accurate unless additional people were available to survey locations in greater detail. Uranium sites can be difficult to characterize because of variability where spoil has been regraded and top-dressed with soil, which can mask the presence and extent of radioactive materials. Soil depth inconsistencies further complicate efforts to quantify salvageable soil. A ProXRS GPS unit allows a worker to quickly record field data and track them through the time soil is salvaged or radioactive materials are removed. The system can display data points, contours, or any other feature of interest in the field, allowing the user to monitor reclamation work at various levels of detail, within the unit's accuracy constraints. Radioactive hot spots can be assessed in the field and material volumes estimated 'on the fly' by obtaining areas with the GPS unit. It also is used to collect bathymetric data by linking a depth finder to the data collector. GPS has become one of the department's best and most versatile tools for assessing and managing environmental information for reclamation. A ProXRS GPS handheld unit paid for itself ($11,000) in less than a year by the time and labor saved.

Implementation of a New Technology for Point Detection
Petinarides, J., R.A. Miller, E.G. Nazarov, A.D. Bashall.
The 2nd Joint Conference on Point Detection for Chemical and Biological Defense, 1-5 March 2004, Williamsburg, VA.

General Dynamics ATP (GDATP) and Sionex Corporation are carrying out a cooperative development for a handheld chemical agent detector called JUNO. The unit will have lower false positives, higher sensitivity, and improved interference rejection compared with presently available detectors. This enhanced performance is made possible by the use of a principle of ion separation known as differential mobility spectrometry (DMS). Enhanced selectivity is provided by the field-tunable nature of the Sionex differential mobility technology, microDMx(TM), which forms the analytical heart of the JUNO system and enables fingerprinting of molecules by characterization of the ionized molecular

behavior under multiple electric field conditions. This enhanced selectivity is valuable in addressing not only the traditional list of chemical warfare agents (CWA) but also a substantial list of toxic industrial compounds and toxic industrial materials. Experimental results show the ability of the microDMx to reject interferences and to detect and resolve live agents. An additional breakthrough in the technology was realized by operating the device at a reduced pressure of around 0.5 atmospheres. This reduced pressure operation resulted in roughly doubling the spectrometer's resolution over what has previously been reported. Advances also have been made in power consumption and packaging, leading to a device suitable for portable, handheld, applications.

An Improved Flow System for Phenols Determination Exploiting Multicommutation and Long Pathlength Spectrophotometry
Lupetti, K.O. (Univ. Federal de Sao Carlos, Sao Carlos-SP, Brazil); F.R.P. Rocha; and O. Fatibello-Filhoa. Talanta, Vol 62 No 3, p 463-467, 27 Feb 2004

This paper presents a sensitive procedure for spectrophotometric determination of phenols based on a multicommuted flow system with a 100-cm optical path flow cell. The method exploits the oxidative coupling of phenolic compounds with 4-aminoantipyrine in an alkaline medium containing potassium hexacyanoferrate(III). Sensitivity was 80-fold higher than that achieved with a 1-cm flow cell, enabling the determination of phenols in the 10 to 100 g/L range with a detection limit estimated as 1 g/L phenol. The multicommutation approach allowed a 200-fold reduction of reagent consumption compared with the reference batch method. The increase in sensitivity renders chloroform extraction for analyte concentration unnecessary. Recoveries within 93.3 and 106% were achieved for phenol determination in natural and wastewater samples. Results agreed with those obtained by a reference method at the 95% confidence level.

The Inner Workings of SEDD: Everything You Wanted to Know but Were Afraid to Ask
Solsky, Joseph F. and Anand R. Mudambi, U.S. Army Corps of Engineers, Omaha, NE.
NEMC 2004: The 20th Annual National Environmental Monitoring Conference, 19-23 July 2004, Washington, DC. Book of Abstracts, No. 61.

The SEDD (Staged Electronic Data Deliverable) specification provides a common structure and data element dictionary to report a wide variety of data to multiple customers. The SEDD specification allows for reporting of data in a single deliverable format that contains results ranging from simple sample concentrations all the way to a CLP-type data package and beyond using an open data standard (XML). SEDD is implemented in stages. Stage 1 only uses a small part of the overall SEDD structure and contains a minimum number of data elements to transmit results only data. Stage 2 contains all of the Stage 1 structure and data elements but adds additional structural and data elements to report method quality control (Stage 2a) and instrument quality control (Stage 2b) information. Stage 3 contains all of the Stage 2 structure and data elements but adds additional structural and data elements to allow for the independent recalculation of the reported results (e.g., as required by CLP). Stage 4 is under development that would build on stage 3 and allow for the reporting of all raw instrument data files. This presentation gives an overview of each stage with example files for common environmental analytical methods, plus a demonstration of linkages between samples, method and instrument quality control, and addition of instrument files.

An Innovative Approach to Investigation of an MTBE Plume in Fractured Bedrock
Burke, Timothy S., Sarah A. Czajka, and David C. Raymes, Geologic Services Corporation. Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 350-351 [abstract only]

Innovative technologies and traditional investigative techniques were combined in the investigation of a methyl tert-butyl ether (MTBE) plume in a fractured bedrock aquifer. The aquifer serves as the sole potable water source for a residential neighborhood and has been contaminated by historical releases from gasoline stations in the study area. An exploratory 150-foot deep open borehole bedrock well was installed adjacent to a potential source area, and borehole geophysical logging was performed to evaluate the properties of the bedrock aquifer. Based on the predominant orientation of the fractures identified by packer tests, additional open borehole bedrock wells were installed down to 100 ft up dip, 250 ft down dip, and 100 ft along strike from the potential source area.
Geophysical logging of these wells was conducted, and two were fitted with multi-level sampling liners developed by Flexible Liner Underground Technologies, LLC (FLUTe(TM)) to facilitate discrete groundwater sampling over a multi-year monitoring program. A prototype Conductivity Profiler developed by FLUTe(TM) was field-tested as an alternative method of evaluating fracture conductivity. Results from the Conductivity Profiler testing correlated favorably to those from traditional pump testing using inflatable packers. Use of the Profiler and Water FLUTe(TM) technologies represents a significant long-term cost savings over traditional investigative methods. The approach demonstrates the technical and financial benefit of combining new, innovative technologies with traditional investigative methods.

Innovative Use of a Modified Risk-Based Sampling Approach to Investigate a National Priority Site
Scholfield, J.C. (Brown and Caldwell, Honolulu, HI); R.M. Pawlowicz (Bechtel National, Inc., San Diego, CA); S.W. Blanchard (Brown and Caldwell, San Diego, CA); D.L. Peeler; L.L. Urizar. Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 241, 2004

A case study is presented to illustrate the success of a dual sampling approach for characterizing a 5-acre CERCLA site with wastes whose characteristics were unknown. A sodium valve disposal area at an NPL site in southern California was investigated in 1994. The preliminary assessment concluded that valves and areas of soil contamination were not present. The site was eliminated from further investigation. Subsequently, several sodium-filled valves, miscellaneous metal debris, and unidentified metal canisters were discovered in a borrow area near the suspected site. A remedial investigation (RI) was initiated as a result of the discovery. Because the costs of sampling, analyses, and investigation using a traditional RI approach were prohibitive, a modified risk-based sampling approach was developed to characterize the site. After a geophysical survey identified anomalous areas, the site was subdivided based on signature, i.e., areas where anomalies were not identified, anomalous areas identified using EM-31 in-phase (metal detection) data, and anomalous areas identified using EM-31 quadrature (conductivity) data. Portions of the site where anomalies were not identified were characterized using a statistical approach. Eight anomalies were evaluated via trenching. Trenches oriented approximately perpendicular to each other in the anomalies exposed long sidewalls for improved description of subsurface conditions, enabled detailed identification of soil characteristics (or waste, if present) responsible for each anomaly, and allowed representative samples to be collected from known soil horizons, thereby reducing the sampling and analytical requirements.
Implementation of this dual approach resulted in a more efficient characterization and significant cost and schedule savings compared to a traditional RI approach.

In Situ Analysis of the Reactions of Heavy Metal Minerals in Soils
Birkefeld, A., R. Schulin, and B. Nowack, Swiss Federal Inst. of Technology (ETH Zurich).
Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-IV, p 506-507, 2003

To assess the risks associated with heavy metal-contaminated soils, it is important to know the chemical speciation of the metals. The long-term behavior of the metals initially deposited in soils affects their mobility, bioavailability and toxicity, hence knowledge of the dissolution reactions and the phase transformations of the metal phases is very important. A new method was developed to investigate in situ the changes of minerals in soils and other systems. Heavy-metal minerals were mounted onto epoxy resin-coated Plexiglas(TM) polymer supports. The supports can be directly inserted in soils, sediments, or water. This method allows direct contact of the minerals with the soil and the soil solution without losing the material and with easy recovery. The reported study used lead oxide, zinc oxide, and copper sulfides, but the method is applicable to many other mineral phases.
The polymer supports were inserted into soil columns under laboratory conditions and in the field. After specific time intervals, the supports were recovered and analyzed for concentration and mineralogical phase changes.

In-Situ Assessment of Active Thiobacillus Species in Corroding Concrete Sewers using Fluorescent RNA Probes
Hernandez M., E.A. Marchand, D.J. Roberts, and J. Peccia.
International Biodeterioration and Biodegradation, Vol 49, p 271-276, 2002

Culture-dependent studies have implicated sulfur-oxidizing bacteria as the causative agents of concrete corrosion in sanitary sewers. Thiobacillus species are often considered the major representative of the acid-producing bacteria in these environments, and members of the genus Acidiphilium have been implicated to support their growth. Active populations of selected Thiobacillus, Leptospirillum, and Acidiphilium species were compared to total bacterial populations growing on the surfaces of corroding concrete using three oligonucleotide probes that have been con6rmed to recognize unique sequences of 16S rRNA in the acidophilic bacteria. With these genetic probes, fluorescent in situ hybridizations (FISH) were used to identify and enumerate selected bacteria in homogenized biofilm samples taken from the corroding crowns of concrete sewer collection systems
operating in Houston, TX. Direct epifluorescent microscopy demonstrated the ability of FISH to identify significant numbers of active acidophilic bacteria among concrete particles, products of concrete corrosion (e.g., CaSO4), and other mineral debris. As judged by FISH analyses with the species-specific probe Thio820 and a domain-level probe that recognizes all bacteria (Eub338), T. ferrooxidans and T. thiooxidans comprised between 12% and 42% of the total active bacteria present in corroding concrete samples.
http://equinox.unr.edu/homepage/marchand/PDF%20Documents/IBB_Paper_2002.pdf

In-Situ Monitoring of Heavy Metal Availability in River Flood Plain Soils
Schroder, T.J. and J.P.M. Vink.
Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-IV, p 498-499, 2003

The authors investigated the influence of redox processes on the speciation of heavy metals in contaminated floodplain areas. Temporary waterlogging leads to a dynamic behavior of floodplain systems. For essential parameters that control metal speciation, such as dissolved organic carbon (DOC),

little is known about the variation of these parameters in time and depth. The researchers monitored pore water in situ covering aerobic to sulfidic potentials to study metal availability and temporal dynamics under different redox conditions.

Integrating Data Sources to Improve Long-Term Monitoring and Management: A Hierarchical Machine Learning Approach
Michael, William Joseph, Master's thesis, University of Illinois at Urbana, 39 pp, 2002

The purpose of this paper is to demonstrate how integrating all available site data using a hierarchical machine learning approach can improve decision-making and provide cost savings for long-term monitoring and management of groundwater remediation systems. This study proposes a new hierarchical modeling framework and successfully tests that framework for integrating historical and current data from the 317/319 Area phytoremediation site at Argonne National Laboratory-East. Site data used in this study include hourly head measurements from a subset of seven monitoring wells and quarterly head measurements from the remaining wells. The learning machine uses these data and daily weather data (to account for the impact of recharge on the groundwater regime) to forecast groundwater head levels. The performance of the model built by the learning machine is assessed by comparing predictions from previous monitoring periods to the most recently available data. By comparing predictive performance using different combinations of datasets, the most relevant data are identified to guide future sampling efforts. The best data-driven predictions resulted in an average error of 1.5 feet, compared with average errors of 7.5 feet from an existing Modflow numerical flow model. The data-driven predictions were obtained from all of the historical quarterly data; the hourly head measurements were not as useful for prediction, most likely because of their poor spatial coverage. The Modflow model was also incorporated into the framework to test the framework's capabilities for updating numerical models to improve predictions as new data are collected. A combined data-driven and Modflow model had an average error 75% lower than the Modflow model, even when the Modflow model was updated to reflect more recent flow conditions. These results demonstrate that the proposed framework holds substantial promise for improving predictive performance of existing numerical models in areas with good data coverage.
http://cee.uiuc.edu/emsa/documents/wmichael-2002-01.pdf

Integrating Data Sources to Optimize Long-Term Monitoring, Operation, and Stewardship
Michael, W. J., D. K. Tcheng, B. S. Minsker, A. J. Valocchi, J. J. Quinn, and G. P. Williams.
The 3rd International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, 2002. Battelle Press, Columbus, OH.

Due to technical limitations and the high cost of hazardous waste site clean up, it seems there has been a shift toward risk-based long-term management of sites, where contamination is left in place. This study demonstrates how integrating all available site data can improve long-term monitoring, operation, and stewardship (LTMOS) decision-making and provide cost savings. A learning machine is used to integrate historic and current data from the 317/319 Area phytoremediation site at Argonne National Lab-East. The learning machine uses these data and daily weather data to build a model to forecast groundwater head levels. Development of the learning machine framework provides a method for integrating the diverse data sources available at the site and using that information to determine the importance of each data source in achieving monitoring objectives. Future work will determine how long the historical record will retain its accurate predictive capability and whether the value of the surrogate data (continuous samples and rainfall) increases over time. In this preliminary study, the entire historical

quarterly dataset was shown to be the most important data source; it could be used to predict future water levels with far more accuracy than the most recent quarterly dataset alone.
http://cee.uiuc.edu/emsa/conference/wmichael-2002-02.pdf

Introduction to Microwave Remote Sensing
Woodhouse, Iain.
CRC Press, Boca Raton, FL. ISBN: 0415271231, 208 pp, 2005

This book provides an introduction to the subject for professionals unfamiliar with microwave remote sensing. It begins with a look at the physical principles and properties of microwaves and how they behave in the real world. It provides a study of microwave systems: passive systems, basic principles of radar, conceptual issues of radar, and radar imaging and its applications, then moves on to the advanced topics of radar modeling, interferometry, and polarimetry before concluding with an appendix giving some useful mathematics, notably trigonometry, logs and exponentials, complex numbers, vectors, and matrices.

Investigation of Leachate Plumes at Two Landfill Sites in South Africa Using Resistivity Techniques
Rosqvist, H., T. Dahlin, A. Bengtsson, M. Larsson, A. Fourie, and L. Rohrs.
Proceedings: NGM 2004, 18-20 May 2004, Ystad, Sweden, 12 pp.

Leakage from municipal solid waste landfills is generally associated with high ion concentrations and hence very low resistivities. This makes geoelectrical imaging techniques particularly interesting for mapping the 3-D extent of contamination around landfills. The migration of contaminants out of the landfill formation was studied at the Coastal Park landfill near Cape Town and the Waterval landfill near Johannesburg to develop a methodology for detection of leachate contamination of the geo-hydrological system close to a landfill. The geoelectrical measurements compared well to the results of conventional groundwater sampling at the field sites and to results from previous investigations.
http://www.ngm2004.nu/addon/LinkedDocuments/073-C.pdf

Isotopes as Tracers in a Contaminated Fractured Chalk Aquitard
Adar, Eilon (Ben-Gurion Univ. of the Negev, Beersheba, Israel); Ronit Nativ (Hebrew Univ. of Jerusalem, Israel).
Journal of Contaminant Hydrology, Vol 65 Nos 1-2, p 19-39, Aug 2003

Clustered industrial plants often generate contaminant plumes in groundwater with several potential sources. In a study area in an industrial complex in the Negev desert, contaminants could not serve as indicators for the contamination sources because of their extensive spatial distribution across the site; however, stable isotopes of oxygen, hydrogen, and sulfur, as well as tritium, proved to be efficient tools for this task. The isotopic characterization of the potential end members provided the criteria for constraining a contaminating source when several alternative sources appeared viable. The isotopic fractionation of oxygen and hydrogen isotopes could be tied to the various disposal phases of the industrial wastewater. The three case studies presented illustrate the important role of isotopes as tracers in contaminated sites.

It's a Bug's Life: Biosensors for Environmental Monitoring
Sharpe, Mike.
Journal of Environmental Monitoring, Vol 5 No 6, p 109N-112N, 2003

After many years of development, biosensors have begun to move out of the laboratory and into commercial applications. Combining advances in biotechnology, nanotechnology and information processing, these novel devices promise to open the door to many exciting new environmental monitoring solutions.

Laboratory Investigation into the Contribution of Contaminants to Ground Water from Equipment Materials Used in Sampling
Gilmore, Tyler J., Alexandre V. Mitroshkov, P. Evan Dresel, and Deborah S. Sklarew.
Ground Water Monitoring and Remediation, Vol 24 No 3, Summer 2004

Benzene contamination was detected in well water samples from the Ogallala Aquifer beneath and adjacent to DOE's Pantex Plant near Amarillo, TX. Researchers assessed whether or not the materials used in multilevel sampling equipment at the site could have contributed to the contaminants found in well water samples. Lab results from static leach tests of the sample equipment conducted during an 8-week period indicated that three different materials from two types of multilevel samplers did contribute volatile and semivolatile organic compounds to the ground water samples. The nylon-11 tubing contributed trace concentrations of benzene (1.37 ug/L) and relatively high concentrations of the plasticizer N-butylbenzenesulfonamide (NBSA) (764 mg/L) to the water; a urethane-coated nylon well liner contributed relatively high concentrations of toluene (278 ug/L) and trace amounts of NBSA; and a sampling port spacer material made of nylon/polypropylene/polyester-composite contributed trace amounts of toluene and NBSA. While the concentrations of benzene and toluene measured in the laboratory tests were below the concentrations measured in actual groundwater samples, the concentrations of organics from these equipment materials were sufficient to call into question the reported sample results.

Laser Remote Sensing
Fujii, Takashi and Tetsuo Fukuchi.
Marcel Dekker, ISBN: 0824742567, Optical Engineering, Vol 97, 712 pp, 2005

Providing an up-to-date, comprehensive review on LIDAR, this book focuses on applications to current topics in atmospheric science. It includes coverage of laser remote sensing of the atmosphere, including measurement of aerosols, water vapors, clouds, winds, and trace constituents. In addition, the book addresses interesting applications such as vegetation monitoring and altimetry. LIDAR systems include ground-based, airborne, and spaceborne systems, and emphasis is placed on instrumentation and measurement techniques to enable the reader to understand what kind of LIDAR system is necessary for a certain application. Each chapter is self-contained and written by experts in each field.

Less is More: Induction Based Fluidics, and the Nanoliter-Microliter "Syringe"
Sauter, A.D. Jr. (Nanoliter, Henderson, NV) and L. Williams.
NEMC 2004: The 20th Annual National Environmental Monitoring Conference, 19-23 July 2004, Washington, DC. Book of Abstracts, No. 46.

Induction-based fluidics (IBF), a technology introduced in 1997 and patented in 2000, is a simple, electrokinetic technology that allows the transport of liquids across a very large dynamic range

from uL/sec to pL/sec without moving parts, joule heating, or adverse electrochemistry. With a single source of energy, IBF can move liquids through N channels with high accuracy and precision. This technology has wide application in environmental laboratory work, including analysis of chemical or biological agents. Reducing the amount of reagents from the microliter (or higher) to the nanoliter regime can directly and dramatically reduce the cost of purchasing reagents. Working at nanoliter levels can also reduce the likelihood and amount of risk posed to workers in the laboratory and dramatically reduce the production of hazardous wastes (and associated disposal costs). By freezing nanoliter quantities of chemical reagents, exact amounts of these can be prepackaged and aspirated with a dielectric, minimizing waste and limiting contamination. For IBF to be widely used, specific tools must be developed. This presentation discusses data generated from a very simple IBF tool, the "Nanoliter-Microliter Syringe," which is used for dispensing nanoliter quantities of liquids onto surfaces and into receivers such as beakers, vials, or micro-titer plates. The data are obtained via pixel counting and other techniques.

Long Term Monitoring of Natural Attenuation Processes by Thermal Measurements
Klaas, Norbert and Ralf Wege, Univ. of Stuttgart, VEGAS - Research Facility for Subsurface Remediation. Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

Using natural attenuation processes for contaminated sites requires a monitoring concept that can assess the stability of these processes for decades. With standard sampling techniques and laboratory analyses, monitoring is a considerable financial factor and often the reason why natural attenuation is not considered feasible. In a study of natural attenuation processes affecting PAH contamination, a novel monitoring strategy was developed and tested. The concept involved the placement of several thermal sensor arrays in the aquifer along the contaminant plume. The PT1000 sensors can detect the reaction energy produced by microorganisms, and hence the sensor arrays can measure vertical temperature profiles. Calculations showed that the complete oxidation (mineralization) of the dissolved total organic carbon should result in an increase of the groundwater temperature of about 1 degrees C. Sixteen sensors were installed during the installation of groundwater monitoring wells between 8 and 40 meters below ground for each of the 6 sensor arrays along the plume. The resolution of the PT1000 sensors is about 0.01 degrees C. Specially developed, battery-operated, stand-alone electronics positioned within the soil provide data collection and storage. The batteries and data cables are accessible through the groundwater wells. Each box can operate without service for about half a year. After operating for one year, the study systems have accumulated a data pool of more than 20,000 measurements. The results indicate that there is a significant change in the temperature profiles along the distance from the source.

Mapping of Trace Element in Soil at the Aggregate Scale by Electronic Microprobe and Synchrotron X-Ray Microfluorescence
Cousin, I. and S. Cornu (INRA Orleans, Olivet, France); J. Rose (CEREGE, Aix-en-Provence, France); B. Clozel (BRGM, Orleans, France); P. Chevallier (Laboratoire Pierre Sue, CEA Saclay, France). Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-IV, p 426-427, 2003

The authors present a study aiming to characterize trace element spatial distribution within soil aggregates at the micrometric scale by electron microscopy, electron microprobe, and X-ray microfluorescence.

Measuring Bioavailability and Chronic Exposure of POPs with Passive Sampling Devices
Heltsley, R., K. White, and D. Shea, North Carolina State Univ., Raleigh, NC.
Fourth SETAC World Congress, 25th Annual Meeting in North America, 14-18 November 2004, Portland, Oregon. Society of Environmental Toxicology and Chemistry, Pensacola, FL. Platform Presentation IP047, 2004

Measuring chronic exposure to persistent organic pollutant chemicals at trace levels is a continual challenge due to inadequate sensitivity of existing analytical methods and fluctuations in environmental concentrations not captured with traditional grab sampling. The authors have developed a novel passive sampling device that provides in situ analyte enrichment of non-polar chemicals from water and serves as an infinite sink over several weeks of exposure. The method allows simple linear uptake kinetics to be used to estimate chronic exposure at ultra-trace concentrations. The device consists of polydimethysiloxane (PDMS) as a polymeric sorption material compatible with solvent extraction and thermal desorption. Calibration experiments were conducted to determine the uptake and elimination rates and partition coefficients for a broad suite of chlorinated compounds into PDMS disks to investigate the potential of the device as an environmental in situ sampler for hydrophobic organic contaminants. Uptake rates ranged from 0.03 to 0.7 L/g d. Compounds with log Kow values greater than 4.5 remained in the linear uptake phase for the duration of the experiment (25 days), demonstrating the ability of PDMS to function as a time-integrated sampling device. Elimination rates and log KPDMS values had a linear relationship with log Kow. The PDMS device shows great potential as an effective alternative to conventional sampling and other passive sampling techniques.

Metabolic Biomarkers for Monitoring in Situ Anaerobic Hydrocarbon Degradation
Young, Lily Y. and Craig D. Phelps, Rutgers, New Brunswick, NJ.
Environmental Health Perspectives, Vol 113 No 1, p 62-67, Jan 2005

Researchers have made great progress in understanding the metabolism of hydrocarbons by anaerobic bacteria. Organisms capable of utilizing benzene, toluene, ethylbenzene, xylenes, alkanes, and polycyclic aromatic hydrocarbons have been isolated and described, and the mechanisms of degradation for these compounds have been elucidated. This basic research has led to the development of methods for detecting in situ biodegradation of petroleum-related pollutants in anoxic groundwater. Knowledge of the metabolic pathways used by anaerobic bacteria to break down hydrocarbons has allowed the identification of unique intermediate compounds that can be used as biomarkers for in situ activity. One of these unique intermediates is 2-methylbenzylsuccinate, the product of fumarate addition to o-xylene by the enzyme responsible for toluene utilization. Laboratory studies show that this compound can be used as a reliable indicator of anaerobic toluene degradation. Field studies confirmed that the biomarker is detectable in field samples and its distribution corresponds to areas where active biodegradation is predicted. Three biomarkers [2-naphthoic acid (2-NA), tetrahydro-2-NA, and hexahydro-2-NA] were identified for naphthalene that can be used in the field to identify areas of active in situ degradation.
http://ehp.niehs.nih.gov/members/2004/6940/6940.html

A Metal Detector Study to Locate Inactive, Un-Maintained Small Arms Firing Range Impact Areas
Martin, W.A. (Applied Research Associates, Inc., Vicksburg, MS); V.F. Medina (U.S. Army Corps of Engineers, Vicksburg, MS); J.R. Marsh and K. Takasaki (U.S. Army Corps of Engineers, Seattle District, WA). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

An environmental forensics study of a 25-acre site at a large military facility was conducted to

locate impact areas of a Thompson sub-machine gun range last used over 50 years ago. Following a review of a historical map and aerial photography, site visits, and interviews with range control personnel, investigators used a Garrett Infinium metal detector to successfully locate several small impact areas. The impact rounds were identified, marked, and the location coordinates were identified using GPS. The study was completed in 4 days, and at a fraction of the cost of a conventional approach.

A Method for Evaluating Horizontal Well Pumping Tests
Langseth, David E., Andrew H. Smyth, and James May.
Ground Water, Vol 42 No 5, Sep-Oct 2004

Predicting the future performance of horizontal wells under varying pumping conditions requires estimates of basic aquifer parameters, notably transmissivity and specific yield. There are well-established methods for estimating these parameters in vertical wells, typically based on either the recovery from induced head changes in a well or from the head response in observation wells to pumping in a test well, but comparable aquifer parameter estimation methods for horizontal wells have not been presented in the groundwater literature. This paper presents a simple and versatile method by which pumping test procedures developed for vertical wells can be applied to horizontal well pumping tests. Using the principle of superposition to represent the horizontal well as a series of partially penetrating vertical wells, the method allows estimation of a distance from an observation well at which a vertical well that has the same total pumping rate as the horizontal well will produce the same drawdown as the horizontal well. This equivalent distance can then be associated with an observation well for use in pumping test algorithms and type curves developed for vertical wells. The method has produced good results for confined aquifers and unconfined aquifers in the absence of delayed yield response. For unconfined aquifers, the presence of delayed yield response increases the method error.

Methodology for Integrating Direct Sensing Tools with In-Situ Remediation Injection Technology to Facilitate Effective Treatment of Groundwater
Cooper, Eliot, Tod Hanna, and Frank Stolfi, Vironex, Inc. Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization, 15-17 June 2004, Dallas, Texas.

The effectiveness of in situ groundwater remediation technologies is a function of the delivery of reagents into direct contact with contaminants located in the dissolved, desorbed, and NAPL phases. Many in situ remediation projects move to full-scale implementation without a good understanding of the radius of influence and distribution of reagents that can be achieved. To deliver reagents effectively, the location of contaminant mass in relation to lithology must be determined. The membrane interface probe (MIP) is a direct push-applied sensing tool that simultaneously measures soil conductivity and volatile organic compounds. Once contaminant mass has been identified, a reagent delivery strategy is developed to maximize reagent distribution, radius of influence, and injection rates, as well as to optimize project costs. The authors present a new methodology that utilizes site characterization data obtained with the MIP and integrates this soil conductivity and contaminant mass information into injection strategies, delivery techniques, and equipment selection for a wide range of chemical oxidation and bioremediation reagents, contaminants, and site subsurface conditions.
http://207.86.51.66/siteopt/ataglance.htm

Methods for Removing Signal Noise from Helicopter Electromagnetic Survey Data
Al-Fouzan, F. (King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia); W. Harbert and R. Dilmore (Univ. of Pittsburgh, PA); R. Hammack, J. Sams, G. Veloski, and T. Ackman (NETL, Pittsburgh, PA). Mine Water and the Environment, Vol 23 No 1, p 28-33, Mar 2004

A geophysical analysis was conducted over the abandoned T&T subsurface mines and portions of the Muddy and Roaring Creek watersheds in northeastern Preston County, WV. The data were collected using helicopter-borne measurements of frequency-domain electromagnetic (FDEM) conductivity. Noise was a significant issue in the lowest frequency EM conductivity data, especially the 390 Hz and 1555 Hz data. Noise removal was accomplished by standard spatial frequency filtering, using homomorphic filters and Fourier filtering along individual flight lines. The filtered FDEM apparent conductivities and apparent resistivities are interpreted as showing regions of potential mine pools and regions of contrasting groundwater conductivity related to discharge.

Microbial Population and Degradation Activity Changes Monitored During a Chlorinated Solvent Biovent Demonstration
Pfiffner, Susan M., Anthony V. Palumbo, Gregory D. Sayles, and David Gannon.
Ground Water Monitoring and Remediation, Vol 24 No 3, Summer 2004

At Dover Air Force Base in Delaware, microbial populations and degradation activity increased significantly during a chlorinated solvent bioventing effort using propane. Propane injection resulted in the degradation of a mixture of chlorinated solvents, e.g., trichloroethene (TCE), cis-dichloroethene (c-DCE), and 1,1,1-trichloroethane (TCA). In only 20 days, the propane injection resulted in decreases of TCE and c-DCE of greater than 98%, and a decrease in TCA in soil gas by about 70%. These decreases in chlorinated solvent concentrations were accompanied by large increases in propane-utilizing bacteria, ranging from below detection levels prior to the injection to 1% of the ending total aerobic heterotrophic population by the end of the propane injection. A proportional increase occurred as heterotrophic counts increased a hundredfold. Microbial TCE degradation activity, as measured in microcosms, also increased with the propane injection. The highest rates of degradation were observed in microcosms with propane and nutrients, indicating the potential for higher field rates of degradation with nutrient additions.

Micro-Chemical Sensors for In-Situ Monitoring and Characterization of Volatile Contaminants
U.S. DOE, Sandia National Laboratories website.

This website provides information about Sandia's Laboratory-Directed Research and Development (LDRD) project that investigates and develops micro-chemical sensors for in situ monitoring of subsurface contaminants. The page contains background information, identifies partners and collaborators, and links to documents, presentations, and field test reports.
http://www.sandia.gov/sensor/

Miniature Chemical Sensor Combining Molecular Recognition with Evanescent Wave Cavity Ring-Down Spectroscopy
Pipino, Andrew C.R. and Curt W. Meuse, National Inst. of Standards and Technology (NIST).
EMSP-73844, 21 pp, Dec 2004

DOE-sponsored EMSP Projects 60231 and 73844 have realized a new chemical detection technology based on a variant of the sensitive optical absorption technique, cavity ringdown spectroscopy (CRDS). Termed evanescent-wave cavity ring-down spectroscopy (EW-CRDS), the

technology employs a miniature solid-state optical resonator having an extremely high Q-factor as the sensing element, where the high-Q is achieved by using ultra-low-attenuation optical materials, ultra-smooth surfaces, and ultra-high reflectivity coatings, as well as low-diffraction-loss designs. At least one total-internal reflection mirror is integral to the resonator permitting the concomitant evanescent wave to probe the ambient environment. Several prototypes have been designed, fabricated, characterized, and applied to chemical detection. Moreover, extensions of the patent-protected sensing concept have been explored to enhance selectivity, sensitivity, and range of application. Operating primarily in the visible and near IR regions, the technology inherently enables remote detection by optical fiber. The EW-CRDS technology has the potential to fulfill many DOE sensing needs by ultimately providing a sensitive, selective, and rugged in situ chemical sensing technology. While the development of EW-CRDS is in its infancy, application to TCE detection using a monolithic folded resonator has the greatest potential for near-term field trials. The resonator could be coating with a polysiloxane polymer to yield a sensitive, selective, and robust sensor for both remediation and long-term monitoring applications, where the polymer protects the sensing surface and enriches the TCE concentration in the evanescent wave region. While chemically selective films employing molecular recognition do not yet appear to be sufficiently robust for field applications, polysiloxane polymers provide an enrichment mechanism based on simple partitioning and are currently used in many rugged environments. Polysiloxane polymers have been applied previously for near-IR TCE detection with a waveguide sensing platform.
http://www.osti.gov/em52/final_reports/73844.pdf

The Mobile Biofilm Unit (MBU): a Technological Innovation in Geomicrobial Studies
Cady, Sherry L. (Portland State Univ, Portland, OR); Paul Stoodley (Allegheny-Singer Rsch Institute, Pittsburgh, PA); Paul Gentile and Peter Suci (Montana State Univ, Bozeman).
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 474, 2004

The authors have designed, constructed, and tested a Mobile Biofilm Unit (MBU) for characterizing biofilms microscopically and spectroscopically in their natural setting. An integral component of the MBU is a portable flow cell system coupled to a microscope, a digital camera, and a prototype microscope-coupled imaging spectrometer. This configuration allows real-time examination of the development of biofilms inoculated and fed from hydrothermal fluid channeled into the flow cells from a hot spring. A lab-based unit with the same hardware configuration as the MBU permits parallel experiments with populations of dominant members of thermophilic and hyperthermophilic consortia. The lab-based unit is also being used to conduct abiotic mineralizing experiments. The comparison of indigenous microbial biofilm communities grown under hydrodynamically controlled conditions in fluids extracted from the natural environment and biofilms of cultured relatives of populations in the indigenous communities grown under similar hydrodynamic conditions improves significantly the ability to recognize the role of microbial biofilms in biofabric formation in mineralizing ecosystems. This paper reports the results of a set of field experiments carried out using the MBU in a hot spring ecosystem.

Molecular Characterization of Microbial Mats from Alkaline Lakes in Warner Valley, Oregon
Gupta, Nabanita, David B. Finkelstein, and Lisa M. Pratt, Indiana Univ, Bloomington.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 170, 2004

Alkaline brackish lakes and wetlands are the dominant environments in the northern part of

Warner Valley. Water chemistries in the lakes are dominated by Na-Cl-SO4. From early summer through fall, most of the lakes are covered by fibrous algal-cellulose mats overlying bacterial mats and anaerobic muddy sediments. Both algae and bacteria in these lakes are tolerant of arsenic. Algal and bacterial mats were characterized using solvent extraction of both untreated and pyrolyzed samples separation of the saturated hydrocarbons and gas chromatograph/mass spectrometry. Saturated hydrocarbons from untreated mat samples are dominated by n-C23, n-C25, n-C27, and n-C29, and have a carbon preference index (CPI) equal to 4.6. Saturated hydrocarbons from pyrolyzed mat samples are dominated by branched alkanes eluting in the range of n-C18 to n-C20, with a CPI of 1.5. Hydrous pyrolysis yields 250 to 900 mg of extractable organic matter per gm of mat, suggesting a high potential for preserving microbial biomarkers and for sourcing petroleum from alkaline lake deposits in extensional tectonic settings.

Morphological Design of Nanoparticle Assemblies: Application to Environmental Sensing
Tarabara, Vladimir V. (Michigan State Univ., East Lansing); Mark V. Wiesner (Rice Univ., Houston, TX). AIChE 2004 Annual Meeting, November 7-12, Austin, TX. American Institute of Chemical Engineers, New York, NY. Presentation 41e, 2004

The potential of ionic strength mediated silver nanoparticle deposition was examined for the morphological design of optically active substrates for water quality monitoring. The critical dependence of the effect of surface-enhanced Raman scattering on the morphology of enhancing substrate was quantified as a basis for developing sensors with tunable sensitivity. Research demonstrated that Ag nanoparticle deposits with a range of morphologies can be designed using ionic strength as a control variable. Fractal and multifractal formalisms can provide an appropriate framework for the characterization of deposit morphologies. The critical dependence of the effect of surface-enhanced Raman scattering on the morphology of enhancing substrate was quantified as a basis for developing sensors with tunable sensitivity.

Multi-Method Geophysical Approach for Characterizing a Deep Fractured Bedrock Aquifer, Anniston Army Depot, Anniston, Alabama
Murray, Brian S. and Matthew B. Vest, Science Applications International Corporation. Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 464-478, 2004

The correct positioning of deep wells to monitor groundwater and entrained contaminants is greatly aided by using remote sensing methods. The geologic setting at the Anniston Army Depot (ANAD) consists of a sequence of fractured dolostones and clastic rocks that have been thrust-faulted, creating a highly complex and heterogeneous aquifer. Dense nonaqueous-phase liquids (DNAPLs) are present in the shallow residuum and underlying fractured bedrock. The drilling of deep bedrock groundwater monitoring wells at this site is expensive due to depth, the nature of the rock, and the required use of casing-advancement drilling techniques, which means that well positioning is critical. A geophysical program consisting of seismic reflection, seismic refraction, magnetotellurics (MT), and electrical imaging (EI) has been used to position groundwater monitoring wells at locations selected to intercept fractured bedrock, and borehole geophysical and hydrophysical logging has been completed to assess flow conditions and to calibrate the geophysical survey measurements. The results of the seismic reflection, refraction, and EI resulted in drilling rock with permeability too low for construction of monitoring wells. An MT survey was completed, and the results were used to identify a well location that intersected a high-permeability fractured bedrock interval, thus allowing completion of a deep

monitoring well. MT surveying is now used to locate deep bedrock wells at ANAD, as correlation of survey results to drilling results is quite high, costs for this type of survey are relatively low, and the completion of a survey can be performed in a short field effort. Borehole logging of each hole, using a suite of downhole geophysical tools, was followed by HydroPhysical(TM) testing to determine the correct placement of well screen intervals at depths correlative to fracture flow zones. Borehole logs also allowed transect-to-transect correlation of subsurface formations to allow extension of the subsurface geology beyond an individual borehole and transect. This multi-method approach of remote sensing was successful in providing characterization data for the Jacksonville fault zone and the nature of the fractured rock aquifer. The collection of similar data using only drilled wells would have been prohibitively costly and inefficient.
http://www.clu-in.org/products/siteprof/2004fracrockconf/cdr_pdfs/indexed/group1/464.pdf

Multiscale Island Injection Genetic Algorithm for Ground Water Remediation
Sinha, E., B.S. Minsker, and M. Babbar, Univ. of Illinois at Urbana-Champaign.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2004 & Related Symposia, Salt Lake City, UT, 2004.

Genetic algorithms can serve as powerful tools for solving a wide variety of water resource optimization problems. Applying these approaches to complex, large-scale applications, which is usually where these methods are most needed, can be difficult due to computational limitations. Large grid sizes are often needed for solving field-scale groundwater remediation design problems. Fine grids usually improve the accuracy of the solutions, but they are also computationally expensive. Multiscale parallel genetic algorithms have been shown to improve the performance of engineering design problems that use spatial grids. This paper presents multiscale island injection genetic algorithms (IIGAs), in which the optimization algorithm has different multiscale populations working on different 'islands' (group of processors). Each island has a fraction of its population on the coarse grid and a fraction on the fine grid. Different islands exchange the best individuals, at the same scale, after a fixed number of generations and thus drive the GA towards better and more accurate solutions faster. The performance of this approach is compared to a single population multi-scale approach developed previously, using a field-scale pump-and-treat design problem at the Umatilla Army Depot.
http://cee.uiuc.edu/emsa/conference/sinha-2004-02.pdf

Multiscale Parallel Genetic Algorithms for Optimal Groundwater Remediation Design
Babbar, Meghna, Master's thesis, University of Illinois, 57 pp, 2002

Applying genetic algorithms to complex, large-scale applications, which is usually where these methods are most needed, can be difficult due to computational limitations. In groundwater remediation design problems, computational limits are often driven by the spatial grids required to simulate the performance of candidate designs. Fine grids usually improve the accuracy of the solutions, but they also pose major bottlenecks in the computational efficiency of the algorithms. This work presents multi-scale parallel genetic algorithms that can be used to improve the performance of water resources management problems that have spatial grids. Two management techniques that use the advantages of parallel computing are employed to test the significance of spatial grid sizes on optimization search. The first technique uses a simple master-slave parallel setup to change to different grid sizes at different stages of the simple genetic algorithm (SGA), whereas the second technique uses an island injection parallel SGA (IIGA) to investigate the performance effects when the optimization algorithm has different populations

working on different spatial grids on different processors, allowing frequent communication between the processors. Results for the two techniques highlight two important observations. First, objective functions that use numerical models can drive the GAs towards different sub spaces of the optimum solution space, depending upon the spatial grid size. Second, tradeoff between solution quality improvement and computational time invested by using such techniques is crucial for numerical modelers, who use such optimization algorithms, to understand. The master-slave multiscale approach reduced computational time by 67% with only a 2% increase in the optimal cost. The IIGA proved to be an inefficient approach for this problem as it is currently configured, despite success with this approach in other fields. Further research is needed to explore whether other IIGA configurations would be more efficient.
http://cee.uiuc.edu/emsa/documents/mbabbar-2002-01.pdf

National Security Via Analytical Chemistry: Escalating Threats of Chemical Warfare Drive Scientists to Bolster Detection Methods
Mitch Jacoby, C&EN Chicago.
Chemical and Engineering News, Vol 81 No 13, 31 Mar 2003

As military and security experts devise strategies to reduce risks of chemical attacks on civilians and military personnel, scientists are developing materials and procedures for detecting and quantifying hazardous substances that might be used in those attacks. A host of scientists active in that area of research gathered at the 2003 Pittcon symposium to discuss the latest findings. A symposium on detection methods for chemical warfare agents was one segment of a three-part session focusing on detection of biological and chemical weapons and explosive materials. There is a push to take laboratory instrumentation, make it smaller, and move it out of the lab and into the field for hand-portable use. Miniaturizing sophisticated instruments for use in detecting chemical weapons in the field poses significant challenges; a number of new instruments offer high sensitivity but not all of them are field-tested and readily available in compact size. This article provides an overview of some of the research represented at the conference. At Colorado State University, chemistry professor Steven H. Strauss measures parts-per-billion quantities of hazardous materials in water with Fourier transform infrared (FTIR) spectroscopy methods. At Edgewood Chemical Biological Center, Aberdeen Proving Ground, Maryland, research chemist Steven D. Christesen is working with Raman spectroscopy to detect nerve agents, mustard gas (a blister agent), and cyanide (a blood agent) in water samples. At Washington State University, Pullman, chemistry professor Herbert H. Hill is investigating the use of ion mobility spectrometry (IMS) for detecting chemical warfare agents. At the University of Pittsburgh, chemistry professor Sanford A. Asher and his research group prepare crystalline colloidal arrays of various particles that can respond to specific chemical species in an easy-to-recognize manner. The ordered materials are a type of photonic crystal.
http://pubs.acs.org/cen/coverstory/8113/8113pittcon4.html

New Developments with HPLC-ICP-MS and GC-ICP-MS Instrumentation for Routine Speciation Analysis
Nash, Martin, Phil Shaw, Bill Spence, and Simon Nelms, Thermo Electron Corporation, Winsford, Cheshire, UK. NEMC 2004: The 20th Annual National Environmental Monitoring Conference, 19-23 July 2004, Washington, DC. Book of Abstracts, No. 12.

This presentation highlights new developments with HPLC-ICP-MS and GC-ICP-MS instrumentation for routine speciation analyses and describes methodologies to enable rapid separations

of some topical elemental species (e.g., organo-tin and organo-mercury species) in selected environmental and biological samples. Topics covered will include the actual hardware and software required as well as aspects important to a routine laboratory, such as ease of use, flexibility to do other work, and productivity. The latter is influenced not only by the sample throughput but also the expected change-over and setup times for the majority of laboratories lacking a dedicated speciation ICP-MS.

A New Method for In-Situ Sampling of Colloids in Anaerobic Groundwater Wells
Wolthoorn, A., E.J.M. Temminghoff, and W.H. van Riemsdijk, Wageningen Univ., Wageningen, the Netherlands.
Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-IV, p 488-489, 2003

Iron colloids, which are common in groundwater systems, are dynamic particles with diameters between 1 nm and 1 um. Colloids with a diameter of 0.1 to 1 um can be considered potentially mobile. Mobile colloids, in turn, can play a key role in colloid-facilitated transport of contaminants. It is necessary to sample colloids in order to study the process of colloid-facilitated transport; however, such sampling can be difficult because many factors can affect the process, and often the sampling procedures are suspected of creating artefacts. A new method is presented for sampling iron colloids in situ in an anaerobic groundwater system. This method was developed to study the effects of subsurface aeration during the in situ removal of iron from groundwater to produce drinking water. When subsurface aeration is used, oxygen-containing water is added to an anaerobic groundwater well. As a result of subsurface aeration, ferrous iron (Fe2+) oxidises via ferric iron (Fe3+) into iron(hydr)oxides. At a pH higher than 7, the oxidation of Fe2+ becomes a heterogeneous process that can result in the in situ formation of iron colloids in the groundwater well.

New Strategies for the Development of Environmental Biosensors
Koenigsberg, S. and L. Laing (Regenesis, San Clemente, CA); David Weinkle, (Eran Associates).
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

The environmental industry is now being affected by a paradigm shift in analytical measurement that is essentially a "bench to biosensor" shift due to the recent biotechnology revolution that promises a host of better, faster, and cheaper means of obtaining data in the field. Biosensors at their most fundamental level are small-scale binding reactions between a sensor molecule and the target analyte. The term biosensor is invoked here because the sensor molecule in the described system is a DNA-protein complex that can react with the target analyte. These reaction chemistries are then coupled to special detection and signaling platforms. Regenesis has completed proof-of-concept work that shows it is possible to detect inorganic species, such as arsenic, at very low levels with minimal interference and with an output measured in a few minutes. This technology can be extended to other inorganic species, as well as organic molecules. Ultimately, these devices will be conveniently field-portable and hand-held. The presentation includes a discussion of basic binding, specific detection, and signaling interactions. The goal is to multiplex the system to give a suite of results at one time in the field as an alternative to expensive and time-delayed results that require off-site laboratory services.

Novel Cyanobacterial Biosensor for Detection of Herbicides
Shao, C.Y. (Univ of Aberdeen, Aberdeen, UK); C.J. Howe (Univ of Cambridge, UK); A.J.R. Porter; L.A. Glover. Applied and Environmental Microbiology, Vol 68 No 10, p 5026-5033, Oct 2002

In work undertaken to generate a bioluminescent cyanobacterial biosensor for the detection of herbicides and other environmental pollutants, researchers genetically engineered the cyanobacterium Synechoscystis, adding a gene from a firefly to make it glow in the presence of a broad range of herbicides and other pollutants, including heavy metals. Expression of the luc gene in the novel Synechocystis sp. strain PCC6803 cultures was characterized by measuring optical density and bioluminescence. Bioassays demonstrated that a novel luminescent cyanobacterial biosensor has been developed that responds to a range of compounds, including different herbicides and other toxins. This biosensor is expected to provide new opportunities for the rapid screening of environmental samples or for the investigation of potential environmental damage.
http://pubmed-central.nih.gov/articlerender.fcgi?artid=126403

Observations from Several Bedrock Remediation Programs in EPA Region 1 (New England): A Monitoring Perspective
Brandon, W., M.J. Daly, and C. Franks (US EPA Region 1); J.A. Lough (Lakeport GIS and Hydrology); S. Mangion and E. Waterman (US EPA Region 1).
Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 128 [abstract only]

This paper reviews bedrock investigation and remediation programs completed in New England under U.S. EPA Region 1 RCRA, CERCLA, and Solid Waste programs. Representative projects include in situ chemical oxidation projects, steam-enhanced recovery pilot tests, landfill investigations, various hydraulic containment remedies, and several investigations related to bedrock water-supply wells. Efforts taken to optimally locate monitoring wells in the bedrock environment are a particular focus of this review, which shows that much of the work to date suffers from an 'overburden mindset' that does not adequately consider the heterogeneous nature and inherent uncertainties associated with bedrock aquifers. This misconception is compounded by the fact that resource allocation decisions for bedrock remedial programs are commonly skewed toward 'technology' at the expense of monitoring. Moreover, despite the fact that boreholes provide the necessary access points to the bedrock aquifer from which most characterization and remediation data are ultimately derived, the borehole locations are often selected without the benefit of a systematic approach. The goal of the case study review is to identify common themes, lessons learned, and an improved overall approach to bedrock site characterizations. Emphasis is placed on establishing preliminary guidelines for conceptual site model development at bedrock sites, with an eye to how particular characterization techniques can be combined or sequentially employed to this end. Weight is given to recent efforts where improvements to a conceptual site model have supported efforts to reconfigure or optimize monitoring networks.

On-Line Monitoring for Control of a Pilot-Scale Sequencing Batch Reactor Using a Submersible UV/VIS Spectrometer
Langergraber, G., J.K. Gupta, A. Pressl, F. Hofstaedter, W. Lettl, A. Weingartner, and N. Fleischmann. Water Science & Technology, Vol 50 No 10, p 73-80, 2004

A submersible UV/VIS spectrometer was used to monitor a pilot-scale sequencing batch reactor (SBR). The instrument utilizes the whole UV/VIS range between 200 and 750 nm. With just one single instrument, nitrate, organic matter, and suspended solids can be measured simultaneously. The

spectrometer is installed directly in the reactor, measures in real time, and is equipped with an auto-cleaning system that uses pressured air. This paper shows the calibration results for measurements in the SBR tank and time series for typical SBR cycles, and proposes possible ways optimizing the operation with these measurements.

On-Line Monitoring of Mercury and Arsenic Below Regulatory Levels
Hensman, C., H. Gurleyuk, P. Kilner (Frontier Geosciences, Seattle, WA); W.T. Dietze and V. Dozortsev (TraceDetect, Seattle, WA). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Most natural water systems and process and waste streams are monitored using periodic grab sampling and analysis. This type of spot monitoring results in a low-resolution understanding of a stream's chemistry. With a limited number of data points, brief high- or low-concentration spikes may not be detected, or when they are detected, these brief spikes may bias an analyte's average concentration. Frontier Geosciences has developed an innovative continuous mercury monitoring system to monitor temporal variability of mercury in complex matrices. The system has online sample preparation involving chemical, thermal, and UV digestion. Detection is achieved by cold vapor atomic florescence spectrophotometry. The analyzer is run using either EPA method 1631 or 245.7 to achieve a detection range of sub-ppt to 100 ppb levels. Modifications to the physical instrument, to the analyzer chemistry, and to the analytical method have been made, optimizing the system to run matrices ranging from drinking water to organic-rich process water from a natural gas plant. Frontier Geosciences has also built an on-line monitoring instrument for arsenic with a similar sample pre-treatment system suitable for As. Continuous monitoring allows geochemical trends that are not apparent under spot monitoring to come to light. Dischargers can better tailor treatment systems and insure proper operation in rapidly changing situations. The instrument can be built to collect samples from various parts of a process for continuous mass balance determinations. This presentation details the method and the results of field studies.

Open-Path Tunable Diode Laser Absorption Spectroscopy for Acquisition of Fugitive Emission Flux Data
Thoma, E.D., R.C. Shores, E.L. Thompson, D.B. Harris, and S.A. Thorneloe (U.S. EPA, Research Triangle Park, NC); R.M. Varma, R.A. Hashmonay, M.T. Modrak, and D.F. Natschke (ARCADIS Inc., Research Triangle Park, NC); H.A. Gamble (Unisearch Assoc. Inc., Concord, ON, Canada).
Journal of the Air and Waste Management Association, Vol 55 No 5, May 2005

U.S. EPA has developed a ground-based optical remote-sensing method that enables direct measurement of fugitive emission flux from large area sources. Open-path Fourier transform infrared spectroscopy (OP-FTIR) has been the primary technique for acquisition of pollutant concentration data used in this emission measurement method. For various environmentally important compounds, such as ammonia and methane, open-path tunable diode laser absorption spectroscopy (OP-TDLAS) is shown to be a viable alternative to Fourier transform spectroscopy for pollutant concentration measurements. Near-IR diode laser spectroscopy systems offer significant operational and cost advantages over Fourier transform instruments, enabling more efficient implementation of the measurement strategy. The authors reviews the EPA's fugitive emission measurement method, describes its multipath tunable diode laser instrument, and discusses validation testing of the system. OP-TDLAS versus OPFTIR correlation testing results for ammonia and methane are reported.

Optimal Groundwater Remediation Design Using Trust Region Based Meta-Models within a Genetic Algorithm
Yan, S. and B.S. Minsker, Univ. of Illinois at Urbana-Champaign.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2005 & Related Symposia, Anchorage, AK, 2005.

Computational cost is a critical issue for large-scale water resource optimization problems that often involve time-consuming simulation models. Less accurate approximation ("meta") models can be used to improve computational efficiency. The authors propose a novel trust-region-based metamodel framework in which hierarchically trained metamodels are embedded into a genetic algorithm (GA) optimization framework to replace time-consuming numerical models. Numerical solutions produced from early generations of the GA, along with solutions dynamically sampled from later generations, are used to retrain the metamodels and correct the GA's converging route. A bootstrap sampling technique is used to cluster the collected numerical solutions into hierarchical training regions, and then multiple metamodels are trained based on these clustered regions. The hierarchically trained metamodels are then used to approximate the numerical models. A trust region testing strategy selects the most appropriate metamodels for prediction. This allows the local regions (particularly those near the optimal solution) to be approximated by smoother and smaller metamodels with higher accuracy. This can speed up GA's convergence when the population moves into local regions. The technique was tested with artificial neural networks (ANNs) and support vector machines (SVMs) on a field-scale groundwater remediation case in a distributed network computation environment. Preliminary results show that the adaptive meta-model GA (AMGA) with the trust region based training technique converges with higher accuracy with the same computation effort.
http://cee.uiuc.edu/emsa/conference/smyan-2005-01.pdf

Optimal Sampling of a Chemical Hazard Area
Plourde, Jennifer R., Master's thesis, Air Force Inst. of Technology, Wright-Patterson AFB, OH.
Report No: AFIT/GOR/ENS/05-15, DTIC: ADA433471, 108 pp, Mar 2005

This thesis proposes a methodology for optimally sampling a chemical hazard area subsequent to a chemical weapons attack. The objective is to identify the maximum number of areas that no longer require protective gear for safe operations. The area is modeled as an undirected graph, and network analysis techniques provide a methodological framework for identifying an optimal sampling sequence within a fixed time limit. Four models are proposed that characterize the secondary vapor concentrations: i) static and deterministic, ii) static and stochastic, iii) dynamic and deterministic, and iv) dynamic and stochastic. Comparisons of the static cases and their dynamic counterparts demonstrate the impact of temporal evolution of vapor concentrations on the optimal sampling path. The number of safe areas may be either under- or over-estimated depending on the assumed nature of the secondary vapors. Available in pdf format through the DTIC search engine at http://stinet.dtic.mil/str/tr_fields.html

An Optimization of a Bioassay for Toluene Analogs Using Bioluminescence Reporter Strain KG1206
Kong, In Chul, Y. Jung, H.K. Ko, and M. Kim, Yeungnam Univ., Kyungbuk, Korea.
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

The recombination of the TOL plasmid of Pseudomonas putida with bioreporter genes, such as the lux (encoding luciferase) and the lacZ (encoding b-galaxtosidase), presents great potential for the development of biomonitors for contaminated environments. A constructed genetically engineered strain

of P. putida mt-2 KG1206 containing the intact TOL plasmid and a plasmid with the Pm-lux gene has been used to bioassay toluene analogs and intermediates in a soil system. This strain can be used for biomonitoring environments contaminated with specific pollutants, and can establish a correlation between specific pollutant concentration and produced bioluminescence from the reporter strain. The characteristics and the effects of culture conditions on this constructed strain were investigated in the presence of toluene analogs and intermediates, and a pollutant quantification protocol was developed for standardization. The absence of standardization and the existence of mixtures is still a major problem for this work.

Optimization of a Long-Term Monitoring Program at an Arizona Superfund Site
Schladweiler, C., S. Alter, N. Kresic, and D. Lang (Malcolm Pirnie, Inc.); J. Biggs (Tucson Water); F. Brinker (Tucson Airport Authority). Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

As sites affected by groundwater contamination progress through the characterization phase and into the operation and maintenance phase, the objectives of the groundwater monitoring program change from plume delineation and characterization to tracking the performance of the implemented remedy. Too often, the groundwater monitoring program is not reevaluated in the context of the new objectives, leading to long-term monitoring that is excessive and costly. The groundwater monitoring program at a Superfund Site in Arizona was developed during site characterization activities in the mid-1980s. Additional monitoring and production wells and a groundwater pump-and-treat system have been incorporated into the network since 1994. The current monitoring network includes 61 wells, 36 of which are monitored on a quarterly basis. An optimization evaluation was conducted to determine the most efficient distribution of sampling points for the site's pump-and-treat system, while remaining in compliance with the Consent Decree. The optimization method developed for the site comprised (1) a general data review to identify optimization potential, (2) statistical analyses to identify temporal and spatial redundancies in the monitoring network, and (3) a review of the results of the statistical analyses in the context of site-specific conditions. The spatial analyses were conducted using multiple regression and geostatistics, including variogram analyses and kriging. The statistical analysis indicated that 12 wells could be eliminated from the monitoring network and sampling frequency could be reduced at 48 wells. The final step of the optimization study included developing a revised monitoring program that considered operational, regulatory, and community relations, in addition to the results of the statistical analysis. A decision tree for the site considered well type (i.e., monitor, extraction, or municipal water supply), well location, and well use (i.e., sentinel well). The final evaluation recommended the elimination of 10 wells and a reduction in sampling frequency at 28 wells. Implementation of the optimization recommendations would lead to a 51% reduction in samples collected and analyzed on an annual basis.
http://207.86.51.66/siteopt/ataglance.htm

Optimization of an Extraction Well Using Three-Dimensional Capture Zones
O'Reilly, M. (CH2M HILL, Otis ANG Base, MA); J. Glass (CH2M HILL, Herndon, VA); S. DeHainaut (CH2M HILL, Otis ANG Base, MA); R. Forbes (AFCEE, Otis ANG Base, MA).
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Optimization of aquifer remediation at several groundwater contamination sites on the Massachusetts Military Reservation (MMR) may involve adjustment of pumping and reinjection rates,

addition or removal of wells, or packing off sections of well screens to focus remediation efforts on the most critical depth intervals. Because groundwater flow is fully three-dimensional, system modifications are guided by a combination of groundwater monitoring and 3-D modeling. For example, a single-well hydraulic containment system was installed to intercept a long, narrow trichloroethene (TCE) plume that passes beneath a 1000 foot land mass between two ponds before the plume discharges into the downgradient pond. Based on monitoring results from 1999, the TCE plume was delineated with a width of 50 to 75 feet, a thickness of less than 50 feet, and concentrations ranging up to 2200 micrograms per liter (ug/L). Since startup of the extraction well in January 2000, the plume trajectory has shifted, and TCE has not been detected at concentrations exceeding the maximum contaminant level of 5 ug/L in the upgradient monitoring network. Influent concentrations at the extraction well, however, remain consistent with the original plume delineation, with concentrations ranging up to 90 ug/L at a pumping rate of 150 gallons per minute (gpm). To optimize the performance of the well and locate the shifted plume, a field investigation program was based on the results of 3-D hydraulic capture-zone delineation using the groundwater flow model. Investigation results and additional modeling of optimization scenarios re-focused the extraction stress on the most contaminated portion of the aquifer while maintaining hydraulic containment of the plume.

Optimization of Costs and Time for Site Characterization and Remediation Measures Using Innovative Sensor Technologies

Muller, Martin, Univ. of Stuttgart, VEGAS - Research Facility for Subsurface Remediation, Stuttgart, Germany. Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

Instruments for cost-effective on-site or in situ field screening measurements are currently under development at VEGAS. These remotely operated, small, rugged tools can be applied directly inside the drilling rod of a percussion penetrometer. A 4-sensor array of metal oxide semiconductor sensors has been developed for the measurement of volatile organic compounds (VOC) in soil vapor. The array can distinguish if chlorinated (PCE, TCE) or unchlorinated (BTEX) compounds are present and provides concentration data in terms of PCE or benzene equivalents. Fluorometric measuring devices are being applied to detect polycyclic aromatic hydrocarbons (PAHs) in groundwater. A miniature Xenon flash lamp is used to excite a groundwater sample in DUV-light (220-300 nm) and an avalanche photodiode detects the fluorescent light (300-400 nm). Differentiation between single PAHs is not possible--no spectrum is recorded and therefore a total fluorescent signal is put out. For the detection of liquid-phase contaminants (e.g., NAPL), the large refraction index of most liquid organic compounds is determined using either glass fiber optics or a solid state optics. This instrument yields just binary information as to whether NAPL is present or not and can neither distinguish between different compounds nor tell anything about the total mass. The operator of the system uses a simple and intuitive interface, either on a laptop or a PDA featuring wireless data transfer and thus ensuring full mobility during the measurements. The use of these methods to plan and control remediation measures delivers much more detailed information about remediation progress and results in a significant cost reduction over conventional approaches.

Optimization of LTM Networks Using GPS: Statistical Approaches to Spatial and Temporal Redundancy
Cameron, K. (MacStat Consulting, Ltd.) and P. Hunter (AFCEE).
Proceedings from the 2000 Spring National Meeting of the American Institute of Chemical Engineers: Remedial Process Optimization Topical Conference, Atlanta, GA.

The Air Force has developed a spatial and temporal optimization algorithm based on statistical methods to manage long-term monitoring (LTM) of groundwater. Data from two ground-water plumes (the FS-12 and Eastern Briarwood plumes) at the Massachusetts Military Reservation on Cape Cod were used to test and develop the statistical approaches. The database consisted of 173 distinct well locations for FS-12 and 363 distinct well locations for Eastern Briarwood. Both of these plumes were sampled over a period of years. Contaminants analyzed include ethylene dibromide (EDB), benzene, trichloroethene (TCE), and tetrachloroethene (PCE). Other contaminants either rarely or never exceeded applicable drinking water standards (MCLs) and so were excluded from the analysis; almost 90% of the measurements were non-detect. The Air Force sought to determine to what degree resources dedicated to field sampling, laboratory analysis, and/or well construction can be pared without significant loss of key statistical information about the plumes being monitored. In particular, it was assumed that the goal of any LTM effort is to provide an accurate assessment over time of groundwater quality, with the ultimate objectives of enabling construction of an interpolated map of the current concentration levels across the site area and accurately assessing trends or other changes in individual monitoring wells. Interpolated maps are used to assess whether or not a plume of contaminated ground water exists, and, if so, its extent and characteristics. Changes in the maps over time can indicate either improvement or decline in ground-water quality across the plume area. Changes in concentration patterns or the identification of trends at individual 'sentinel' wells can serve the same purpose. At the root level, the optimization algorithm consists of three basic steps: 1) identification of temporal redundancies in currently monitored wells; 2) identification of spatially redundant wells; and 3) projection of cost savings gained by eliminating wells and/or reducing sampling frequencies.
http://www.afcee.brooks.af.mil/products/rpo/docs/GTSOptPaper.pdf

Optimizing Long Term Monitoring at a BP Site Using Multi-Objective Optimization
Minsker, B.S., P. Groves, and D. Beckmann, Univ. of Illinois at Urbana-Champaign.
American Society of Civil Engineers (ASCE) Environmental & Water Resources Institute (EWRI) World Water & Environmental Resources Congress 2005 & Related Symposia, Anchorage, AK, 2005.

BP (formerly British Petroleum) incurs significant costs associated with the monitoring of subsurface remediation. A project was undertaken to evaluate whether these costs could be reduced by identifying and eliminating both spatial and temporal redundancies in the monitoring data at a BP site without significantly increasing monitoring errors. The project also aimed to demonstrate the potential for multi-objective optimization approaches to improve monitoring decision-making at the many sites at BP and elsewhere with long-term monitoring records. The first step in the optimization process is to identify monitoring objectives and constraints and express them in mathematical form. The initial objectives were to minimize the number of samples collected and to minimize relative BTEX interpolation error. The BTEX interpolation error for trial sets of sampling plans was calculated by comparing the concentrations interpolated using all sampling locations and times with those interpolated using only reduced sampling frequencies or locations. Historical data from the wells that are currently being sampled were used to develop a suite of interpolation models, which were then tested using a cross-validation approach. Adaptive Environmental Monitoring System (AEMS) software, developed by the University of Illinois and RiverGlass, Inc., was used to search through the billions of sampling plans to identify the optimal tradeoffs between the number of samples collected and the relative error.
http://cee.uiuc.edu/emsa/conference/minsker-2005-01.pdf

Optimizing LTM Networks with GTS: Three New Case Studies
Cameron, Kirk (MacStat Consulting, Ltd.); Philip Hunter (AFCEE).
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

The Air Force spends millions of dollars annually on groundwater long-term monitoring (LTM) networks at installations around the country. Because LTM is costly and its well networks so extensive, the Air Force is actively pursuing testing and implementation of optimization strategies for many of its LTM networks. One such strategy developed in coordination with the Air Force Center for Environmental Excellence (AFCEE) is a decision-logic statistical optimization scheme termed the geostatistical temporal-spatial algorithm or GTS. GTS uses known statistical and geostatistical techniques in a novel manner to answer two questions concerning an existing LTM network: 1) what is the optimum number and placement of wells in that network (i.e., is there spatial redundancy within the spatial network)?, and 2) what is the optimal sampling frequency for wells in the network (i.e., is there temporal redundancy)? Optimized networks in previous applications of GTS have resulted in estimated cost savings off the total LTM budget of over 30%. To measure spatial redundancy, GTS has applied kriging and robust spatial modeling techniques in an iterative fashion to identify optimal subsets of the existing monitoring network. Optimality is measured by balancing the costs of sampling, analyzing, and maintaining the LTM network against 1) deterioration in estimated site maps compared to the baseline, 2) increases in global uncertainty associated with map estimates, and 3) increases in localized areas of uncertainty. The purpose of this paper is to provide case-study examples of the flexibility and advantages provided by the GTS algorithm. Overall, results from these three sites demonstrate that the optimization approach built into GTS nets substantial savings in LTM costs, with percentage savings ranging from 30 to 63%, depending on the base.
http://207.86.51.66/siteopt/ataglance.htm

OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)
U.S. EPA, Office of Solid Waste, Washington, DC. 177 pp, Nov 2002

This draft guidance examines a single exposure pathway--the vapor intrusion pathway. It is intended to be a screening tool to aid users in determining whether a vapor intrusion pathway is complete and, if so, whether the completed pathway poses an unacceptable risk to human health. A complete pathway means that humans are exposed to vapors originating from site contamination. The draft guidance begins with simple and generally reasonable conservative screening approaches and gradually progresses toward a more complex assessment involving increasingly greater use of site-specific data. For those sites determined to have an incomplete vapor intrusion pathway, further consideration of the current site situation generally should not be needed. For those sites determined to have a complete pathway, guidance is provided to evaluate whether the pathway does or does not pose a potential significant risk to human health. This draft guidance is not intended to provide recommendations to delineate the extent of risk or eliminate the risk. Its sole purpose is to determine if there is a potential for an unacceptable risk. EPA generally recommends reevaluation of those sites that are screened out if site conditions or land use changes in a way that might alter a decision to screen out, or other new information suggests greater conservatism is appropriate in assessing the vapor intrusion pathway.
http://www.epa.gov/epaoswer/hazwaste/ca/eis/vapor.htm

Overview and Comparison of Lipid-Containing Semipermeable Membrane Devices (SPMDs) and Oysters (Crassostrea gigas) for Assessing Organic Chemical Exposure

Huckins, J.N., H.F. Prest, J.D. Petty, J.A. Lebo, M.M. Hodgins, R.C. Clark, D.A. Alvarez, W.R. Gala, R. Gale, C.I. Ingersoll, and A. Steen, U.S. Geological Survey, Columbia, MO.

Environmental Toxicology and Chemistry, Vol 23 No 7, p 1617-1628, 2004

Researchers performed 20-d, flow-through exposures of lipid-containing semipermeable membrane devices (SPMDs) and Pacific oysters to three concentrations (10, 100, and 250 ng/L) of a diverse mixture of polycyclic aromatic hydrocarbons (PAHs). The exposure water was seawater free of particulates larger than 0.1 microm. The results of these controlled laboratory studies demonstrated that SPMDs and oysters concentrate the same chemicals, but accumulate them at different rates in different amounts. For oysters, the 20-d mean (across treatments) concentration factors (CFs) of test compounds were much lower than those of the same compounds in SPMDs. In contrast, the 20-d CFs of PAHs in oysters from low-level treatment were higher than the corresponding CFs for SPMDs. The CFs of these compounds in oysters from the low-level treatment ranged from approximately 3.0- to 13-fold higher than those in oysters from the high-level treatment. This physiologically mediated difference in oyster CFs appears to be linked to active feeding in the low-level treatment and to apparent toxicity-induced cessation of feeding (i.e., valve closure) in the high-level treatment. Because CFs for these compounds in oysters were not independent of exposure concentrations, it follows that tissue levels were not proportional to exposure concentration. Both sampling approaches have advantages and disadvantages, and the appropriateness of their use depends on the goals of a given study.

Paraxylene Spill at a Petroleum Depot: Using 3D Visualization Results to Design Optimal Remedial Measures

Blanchet, Jacques (Biogenie SRDC Inc., Sainte Foy, Quebec); Marc Guillemette (Jean-Gaulin Valero/Ultramar Refinery, St-Romuald, Quebec); Pierre Ouellette (Biogenie SRDC Inc., Lachenaie, Quebec). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

In winter and spring of 2003, a major spill (more than 336,000 gallons) of paraxylene (p-xylene) occurred at a petroleum depot located on the shoreline of the St. Lawrence River in Montreal. The spill was discovered when p-xylene was observed leaking into the river, and immediate measures were needed to recover the pollutant and reduce the leakage into the river. This paper documents how 3D visualization was strategically applied, initially to understand the extent of the contamination in the subsurface and then to design optimal interim remedial measures. The first step was to integrate existing site data onto the 3D tool to assess the extent of soil and groundwater contamination and define the boundaries of the free-product plume. Lab studies were performed to conceptualize the behavior of the p-xylene in the soil as this chemical has the unusual property of solidifying at about 13 degrees C. The results provided by the 3D tool were a primary factor in the design and implementation of optimal mitigation measures. A 100-meter cement-bentonite wall was strategically installed to eliminate free product migration into the river, and recovery equipment was installed in a trench constructed hydraulically upgradient of the wall to recover free product. Recovery of the p-xylene represented a unique challenge because of the physical properties of this product and the complex subsurface characteristics revealed by 3D visualization. The interim measures are the first steps of a more comprehensive remediation project that will likely extend over several years.

Partitioning of Zn, Pb and Cd in River Sediments from a Lead and Zinc Mining Area Using the BCR Three-Step Sequential Extraction Procedure
Svete, Peter, Radmila Milai and Boris Pihlar.
Journal of Environmental Monitoring, Vol 3 No 6, p 586-590, 2001

The extent of pollution was investigated in sediments collected along the course of a river and its tributaries in a lead and zinc mining area. To evaluate the heavy metal burden, total concentrations of Zn, Pb and Cd were determined, and the partitioning of these metals between the easily and sparingly soluble sediment fractions was performed with a slightly modified BCR sequential extraction procedure. Good agreement was obtained between the determined and certified or indicative metal concentrations. Normalization to Al was applied to estimate the natural and anthropogenic inputs of Zn, Pb, and Cd in the sediments. The results of the partitioning study indicate that Zn prevails in the most sparingly soluble fraction and is distributed between organic matter and sulfides, while a smaller proportion is found in the easily soluble fraction. Pb is distributed mainly between organic matter and sulfides, whereas Cd is predominantly associated with the most sparingly soluble fraction. Data from the normalization procedure indicate that the anthropogenic inputs of Zn, Pb, and Cd correlate with the very high total metal concentrations determined in sediments. These data indicate severe pollution of the terrestrial and aquatic environment.
http://pubs.rsc.org/ej/EM/2001/b106311c.pdf

Passive Gas Diffusion Sampling at Monitored Natural Attenuation Sites
McLeish, K.L., M.C. Ryan, and A. Chu (Univ. of Calgary, Calgary, AB, Canada); J.E. Armstrong (Univ. of Alberta, Edmonton, AB, Canada). Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 470, 2004

Monitored natural attenuation (MNA) is an increasingly popular cleanup strategy at sites contaminated with oil and gas. Accurate data that demonstrate that biodegradation is occurring are critical to MNA assessment. Regulators look for both a decrease in contaminant concentrations and evidence that these contaminants are degrading, ideally to CO2 and CH4 degradation end-products. Measurement of these gases is also valuable for interpreting subsurface biogeochemical processes and calculating mass balance. Dissolved gas concentrations from passive gas diffusion samplers can provide strong supportive evidence of MNA. Passive diffusion sampling in combination with measurement of total dissolved gas pressure (TDGP) is an attractive alternative to conventional dissolved gas sampling techniques (e.g., headspace extraction). Atmospheric contact is minimized, and gas samples are collected under in situ TDGP. Traditional gas sampling provides relative dissolved gas concentrations, while passive gas sampling in combination with TDGP can provide absolute concentrations of dissolved gases in groundwater. Diffusion samplers were deployed in groundwater monitoring wells with varying degrees of hydrocarbon contamination at several MNA research sites in Alberta and compared with dissolved gas concentrations acquired using traditional headspace extraction techniques. Samples collected by conventional means often underestimated the consumption (O2) and production (CO2 and CH4) of dissolved gases during biodegradation reactions. Elevated CO2 and CH4 concentrations provided strong evidence that MNA was occurring at these sites and insight into the spatial extent of biodegradation. Seasonal temperature fluctuations had notable effects on the production of dissolved gases in shallow groundwater.

Passive Sampling and/or Extraction Techniques in Environmental Analysis: a Review
Namienik, Jacek, Boena Zabiegaa, Agata Kot-Wasik, Monika Partyka, and Andrzej Wasik, Gdansk University of Technology, Gdansk, Poland.
Analytical and Bioanalytical Chemistry, Vol 381 No 2, p 279-301, Jan 2005

Passive dosimeters have been successfully used to monitor organic and inorganic contaminants in air, water, sediments, and soil. This review summarizes the main milestones in the development of passive techniques for sampling and/or extraction of analytes and in biomonitors used in environmental analysis. The authors address the application of new approaches to the determination of pollutants at the sampling stage and compare the use and performance of passive samplers and biomonitors.
http://www.diffusionsampler.org/Documents/Passive%20Sampling%20-%20Namienik.pdf

Performance Monitoring of MNA Remedies for VOCs in Ground Water
Pope, D.F. (Dynamac Corp., Ada, OK); S.D. Acree (U.S. EPA, Ada, OK); H. Levine (U.S. EPA Region 9, San Francisco, CA); S. Mangion (U.S. EPA Region 1, Boston, MA); J. van Ee (U.S. EPA, Las Vegas, NV); K. Hurt and B. Wilson (Dynamac Corp., Ada, OK).
Report No: EPA 600-R-04-027, 92 pp, Apr 2004

Monitoring is the major component of any cleanup approach that relies on natural attenuation processes. This document identifies data needs and evaluation methods useful for designing monitoring networks and determining remedy effectiveness. Effective monitoring of natural attenuation processes involves a 3-D approach to network design and clearly defined performance criteria based on site-specific remedial action objectives. Objectives for the monitoring program will be met through routine measurements of contaminant, geochemical, and hydrologic parameters. These data are used to evaluate changes in 3-D plume boundaries, contaminant mass and concentration, and hydrological and geochemical changes that may indicate changes in remedy performance. Data interpretation focuses on detection of spatial and temporal changes and assessment of their impacts on the achievement of site-specific goals. Notable changes include (1) progress toward contaminant removal objectives, indications of new releases, and changes in the rate of release from any residual source materials, (2) contaminant detections at the horizontal and vertical plume boundaries that may indicate plume expansion, and (3) geochemical changes (e.g., oxidation-reduction (redox) conditions) indicative of possible changes in contaminant transformation rates, (4) changes in ground-water flow rates or directions such that contaminants may move into previously unimpacted areas, and (5) changes in land use that threaten the effectiveness of institutional controls. Decisions regarding remedy effectiveness and the adequacy of the monitoring program will generally result in either continuation of the program, program modification, implementation of a contingency or alternative remedy, or termination of the performance monitoring program.
http://www.epa.gov/ada/download/reports/600R04027/600R04027.pdf

Permeation Liquid Membrane Approach for Measuring Bioavailable Dissolved Trace Metal Species: Role of Lipophilic Complexes in the Metal Transport
Parthasarathy, N., M. Pelletier, and J. Buffle, Univ. of Geneva, Geneva, Switzerland.
Proceedings of the 7th International Conference on the Biogeochemistry of Trace Elements (7th ICOBTE), 15-19 June 2003, Uppsala, Sweden. Book of Abstracts. Vol 1-II, p 45-46, 2003

Trace metal ions (e.g., Cu, Pb, Cd, and Zn) exist in various chemical forms in natural waters. The form in which it occurs has relevance to metal bioavailability and toxicity to organisms. The free metal ions, lipophilic and labile metal complexes play a particularly important role in the biogeochemical

cycles of trace elements. Methods for measuring the concentration of free metal ions, the bioavailable metal fraction, and the total metal ion concentration are required to understand the role of a metal in natural waters. These metal ions are found at very low levels, and measurement of such trace amounts of bioavailable fraction remains a challenging task. Species-selective carrier-mediated permeation liquid membrane (PLM), an emerging technique based on liquid-liquid extraction, seems to be a promising technique to achieve good measurement. The method allows species-selective separation and preconcentration to be done in one step. This presentation addresses the transport of lipophilic Cu(II) complexes.

Photonic Nose for Chemo- and Bio-Agent Detection: A Novel Surface Enhanced Raman Approach
Davis, Scott, Vescent Photonics, Denver, CO.
DTIC: ADA426905, 25 pp, Sep 2004

In Phase I of this project, critical feasibility concerns and objectives were (1) transfer of the photonic nose technology from an academic lab (JILA) to industry (Vescent), (2) thin film characterization and definition of a manufacturing protocol to provide reproducible SERS active sites, and (3) demonstration of the Raman enhancement via recording the spectrum of a known analyte. All of the phase I objectives were met. Vescent Photonics worked within the JILA laboratory to learn both the synthesis techniques and the metrology methodology associated with photo-generated SERS films. This experience facilitated the design of a Vescent experimental apparatus, which enabled production and analysis of SERS films at the Vescent facility. The polymer films were scrutinized by stylus profilometry and atomic force microscopy, and the process tolerances for uniform film generation were refined.
http://handle.dtic.mil/100.2/ADA426905

A Physical-Chemical Screening Model for Anticipating Widespread Contamination of Community Water Supply Wells by Gasoline Constituents
Arey, J. Samuel and Philip M. Gschwend, Massachusetts Inst. of Technology, Cambridge, MA.
Journal of Contaminant Hydrology, Vol 76 Nos 1-2, p 109-138, Jan 2005

A screening model has been developed to estimate well-water concentrations and transport times for gasoline components migrating from underground storage tank (UST) releases to typical at-risk community water supply wells. Representative fuel release volumes and hydrogeologic characteristics were used to parameterize the transport calculation. Subsurface degradation processes were neglected in the model to make risk-conservative assessments. The model was tailored to individual compounds based on their abundance in gasoline, gasoline/water partition coefficients, and organic matter/water partition coefficients. Transport calculations were conducted for 20 polar and 4 nonpolar compounds found in gasoline, including methyl tert-butyl ether (MTBE) and other ether oxygenates, ethanol, methanol, and some aromatic hydrocarbons. With no calibration, the screening model successfully captured the reported magnitude of MTBE contamination of at-risk community supply wells. Stochastic analysis of field parameter variability concluded that community supply well contamination estimates had order-of-magnitude reliability. This tool could be used for analyses to anticipate environmental problems and/or inspire focused investigations into chemical properties (e.g., biodegradability) prior to industrial adoption of new fuel formulations.

Physics-Based Radiometric Signature Modeling and Detection Algorithms of Land Mines Using Electro-Optical Sensors
Liao, Wen-Jiao, Ph.D. dissertation, Ohio State University, 255 pp, 2003

Airborne electro-optical (EO) sensors possess several desirable properties for finding surface-laid anti-vehicle mines: they are capable of stand-off operation and can quickly survey a large area. This work focuses on signature modeling and detection algorithms, two topics that are useful in realizing a real-time minefield detector using EO imagery. Signature modeling helps to provide insight for sensor deployment. The model addresses relevant issues in sources, targets, and sensors. Natural sources such as thermal emission, solar radiation, and solar scattering were considered and incorporated using empirical models. A BRDF model that defines scattering and emission from rough surfaces was developed that integrates geometric relations with intrinsic surface properties. Stokes' vectors are used throughout this work to describe incident and scattered radiances, which permits a polarimetric study of the signatures. The simulated signatures are compared with several measured data sets from different scenarios and exhibit strong quantitative agreement. Mine detection algorithms are a critical system component. The existing baseline RX algorithm makes little use of signature information. An alternative to the RX algorithm is constructed using an estimator-correlator formulation and uses spatial target information to enhance the clutter rejection rate. A filter-bank configuration was proposed to fuse results from multiple references to boost the mine detection rate. A locally adaptive implementation was developed to obtain a reliable detection in nonhomogeneous backgrounds. The proposed detectors were used to process a large measured data set. Substantial gains were observed for the proposed techniques. The advancements described throughout this work will serve to improve real-time mine detection.
http://www.ohiolink.edu/etd/view.cgi?acc_num=osu1064252075

Planning of a Groundwater Monitoring System with the Use of Pattern Recognition Techniques
Lisenkov A.B., V.M. Shvets, and E.V. Popov, Moscow State Geological Survey Academy, Moscow, Russia.
Water Resources, Vol 30 No 5, p 480-485, Sep 2003

This paper describes general principles of establishing the boundaries of hydro-lithosphere space within which regular groundwater monitoring should be planned. The application methodology of the information theory apparatus for partial formalization of the implementation of monitoring system is presented with an example of a groundwater monitoring plan.

Point-Source Energetics Detection: Initial Sensor Evaluation
Van Wyck, Neal E. and Philip G. Thorne.
Report No: ERDC/CRREL Technical Report 04-10, 2004

The development of real-time detection capability for explosives and propellants in high-concentration point sources is an important objective for comprehensive test and training range management. This report documents efforts to identify and characterize sensors that are both sensitive and selective to high-concentration point sources and can operate in a standoff mode by detecting the vapors released by energetics. Other factors under study included portability, speed of analysis, and overall system ruggedness. Initial evaluations identified 28 potential detection systems. Based primarily on sensitivity requirements, the initial list was reduced to five candidate detectors. The subset of detectors was then subjected to further evaluation, including extensive laboratory testing. Based on the results of laboratory testing and evaluations, a single detector was identified that warrants further investigation: the GE Ion Track Vapor Tracer2. The Vapor Tracer2 is the most sensitive of the detectors

tested and has the greatest freedom from interferences. Follow-on laboratory and field investigations are recommended to determine the potential of this detector for high-concentration point-source detection. To request a copy of this report, apply via email to sales.homelandprotection.us@ge.com

Practical Applications of Tracers in Environmental Hydrogeology and Groundwater Remediation
Divine, Craig E., ARCADIS, Highlands Ranch, CO. Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 395, 2004

Applied tracers have been widely used to characterize groundwater flowpaths and estimate velocities, particularly in karst regions. Advances in chemical measurement technology have led to a significant increase in the diversity of constituents used as tracers, permitted quantification of significantly lower tracer breakthrough concentrations, and made high-frequency sampling economically feasible. Consequently, the practical (i.e., non-research) use of tracers in environmental hydrogeology and groundwater remediation is quickly increasing. For example, the spatial distribution of basic aquifer information can be inexpensively obtained using simple single-well tracer tests. Conservative and reactive tracers can greatly aid in the design and evaluation of enhanced bioremediation strategies by providing a reliable way to measure in situ contaminant decay, electron acceptor/donor utilization rates, and zones of influence. The long-term application of tracers can used to evaluate hydraulic capture and demonstrate containment. For some high-priority sites, phase-partitioning tracers can be used to quantify subsurface volume of nonaqueous phase liquid (NAPL) in support of targeted NAPL-zone remediation activities. This presentation contains several case studies and discussions of other potential practical applications of tracers in environmental hydrogeology and groundwater remediation.

Pre-Screening for Explosives Residues in Soil Prior to HPLC Analysis Utilizing Expray
Bjella, Kevin L., Cold Regions Research and Engineering Laboratory, Hanover, NH.
Report No: ERDC/CRREL TN-05-2, 19 pp, Feb 2005

Characterization of the presence and amount of energetic residues on military training ranges involves the sampling and analyzing of the surface and near-surface soils. The concentration of energetic residues in samples collected at firing points and impact locations can range from below instrumental detection limits in parts per billion (ppb) to percent levels. Reverse-phase high-performance liquid chromatography (RP-HPLC) is typically used for analysis of these energetic residues. Extract concentrations of 10 parts per million (ppm) TNT and 20 ppm RDX/HMX/NG are considered safe upper limits for RP-HPLC. Higher analyte concentrations may carry over to subsequent samples, elevating responses and yielding false positives. This requires reanalysis of the samples possibly affected, and may require that corrective measures be taken to address instrumental performance. To avoid interruptions to the analytical runs, a simple screening technique was developed using a commercially available colorimetric explosives detection kit. Pre-screening utilizing the Expray Explosives Detection Kit prior to analysis has proven to be useful for coarse determination of concentration values within a factor of 10. Dilution can then be carried out to bring the sample concentration down to an analytically acceptable level, and/or the placement within the analyzing sequence can be designed to minimize the effects of the carryover. This report describes the testing of the Expray Explosives Detection Kit for this screening process.
http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/TN05-2.pdf

Proceedings from the USEPA Seminars on Air Indoor Vapor Intrusion San Francisco, Dallas, & Atlanta Dec 2002, Jan & Feb, 2003
U.S. EPA Tech Transfer Online Publication, 2003.

The presentations from the three seminars on air indoor vapor intrusion have been made available in pdf files. The presentations provide background on the problem of vapor intrusion and discuss regulatory and health concerns, screening, sampling, and mitigation.
http://www.epa.gov/ttbnrmrl/presentations.htm

Proceedings: Workshop on Subsurface Vapor Intrusion to Indoor Air, December 11-12, 2003, Jupiter Beach, Florida
Electric Power Research Institute (EPRI), Palo Alto, CA. Report No: 1010916, Aug 2004

Subsurface vapor intrusion (SVI) has been the subject of increasing regulatory attention in response to cases of indoor air containing concentrations of volatile organic compounds at concentrations of potential concern for human health, attributable to upward migration from underlying soil or groundwater. This report summarizes the proceedings of a Workshop on Subsurface Vapor Intrusion to Indoor Air--held in Jupiter, Florida, December 11-12, 2003--with emphasis on areas such as SVI transport, migration, modeling, fingerprinting, mitigation, and other key issues. This workshop brought together representatives from various operating companies, as well as leading experts with experience and interest in the SVI field. The workshop focused on evolving areas such as technical assessment of subsurface vapor transport, vapor migration into buildings, and resolution of subsurface vapors from other contributing sources (consumer products, building materials, ambient outdoor air, etc.). Workshop participants also identified knowledge gaps to develop a roadmap for future work.

Quantification of Groundwater Contamination in an Urban Area Using Integral Pumping Tests
Bauer, S., M. Bayer-Raich, and T. Holder (Univ. of Tubingen); C. Kolesar and D. Muller (Federal Environment Agency Austria, Vienna); T. Ptak (Univ. of Tubingen).
Journal of Contaminant Hydrology, Vol 75 Nos 3-4, p 183-213, Dec 2004

The integral groundwater investigation method was used for the quantification of PCE and TCE mass flow rates at an industrialized urban area in Linz, Austria. The pumping wells were positioned along control planes perpendicular to the groundwater flow direction, operated for a specified time (days), and sampled for contaminants. The concentration time series of the contaminants measured during operation of the pumping wells were then used to determine contaminant mass flow rates, mean concentrations, and the plume shapes and positions at the control planes. The 3 control planes used in Linz were positioned downstream from the potential source zones, which are distributed over the site. Use of the integral investigation method made it possible to (1) identify active contaminant sources requiring additional investigation and remediation activities, (2) quantify the individual source strength in terms of mass flow rates at the control planes, (3) estimate the contaminant plume position relative to the control planes, and (4) identify large parts of the area that could be excluded from further investigation and cleanup activities.

Rapid Hydraulic Conductivity Tests Using Slug Test Accelerator Tool
Goldowitz, Joshua, Rochester Inst. of Technology, Rochester NY.
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

Hydraulic conductivity (K) is the most commonly measured hydraulic characteristic on contaminated sites because it is crucial for determining the velocity of contaminated groundwater. A new tool and technique is described which allows for an accurate K measurement in one-quarter the time of a state-of-the-practice slug test. Traditionally K is tested by introducing a solid cylinder (the slug) into a well and lowering it below water table. The well water is displaced upward, producing a difference in water level (ho) between the well and the aquifer. The residual difference in water level (h) is then monitored as the volume of displaced water seeps into the aquifer. This is known as a falling head test. The same results are obtained with a rising head test where water is removed from the well. In either case K is determined from the slope of h/ho vs. time. The new tool consists of two coaxial 5' tubes. The outer tube just fits within a 2" monitoring well and the inner tube is just large enough for the probe of an electric water level meter. The annulus between the tubes is sealed, and the inner tube has sufficient extensions to reach from the top of the well to below the water table. The well is "slugged" by inserting the bottom of the tool 1' into the water. This produces a 4' ho in the inner tube. The test is completed by monitoring h in the inner tube. The new tool and procedure accelerates the determination because it produces a large ho for a given volume of displaced water. Field tests show close agreement between K results using the new tool and traditional slug testing.

Rapid Monitoring of the Biodegradation of Phenol-Like Compounds by the Yeast Candida maltosa Using BOD Measurements
Fialova, A., E. Boschke (Inst. Food Technol. Bioprocess Eng., TU Dresden, Czech Republic), T. Bley.
International Biodeterioration and Biodegradation, Vol 54 No 1, p 69-76, 2004

This paper examines the use of an AQUALYTIC(R) Sensomat System for continuous measurement of biological oxygen demand (BOD). The device was found to be suitable for small-scale studies of the degradation of phenol-like compounds by the soil-borne yeast Candida maltosa. C. maltosa can use phenol and catechol as sole sources of carbon and energy and is unaffected by resorcinol. It can also co-metabolize p-cresol, but cannot utilize benzoate or salicylate. These results may have practical implications for the use of C. maltosa in soil bioremediation applications, such as bioventing. Enzyme tests were also performed to help interpret the data. Phenol hydroxylase activity reached maximum levels at the beginning of the exponential phase during cultivation on phenol. After the phenol had been completely utilised, the enzyme was slowly degraded.

Real-Time Analysis of Small Volume Samples with Micro Ion-Selective Electrodes
Timms, Wendy A. and M. Jim Hendry.
Ground Water Monitoring & Remediation, Vol 24 No 4, Fall 2004

Microelectrode and micro ion-selective electrode (ISE) technologies were applied to obtain real-time analysis of pH, Eh, and major ions in pore-water samples. The precision and accuracy of micro ISEs were significantly improved by standardizing the solution matrix, accounting for electrode drift and implementing an iterative calibration procedure with analyses of selected samples by conventional techniques. Though labor-intensive, this procedure enabled reliable, real-time analysis of chemically complex pore water effluent samples from a column test of low-permeability clay-rich till that produced effluent sample volumes of only 0.2 to 0.5 mL/d.

Real-Time Detection of Intentional Chemical Contamination in the Distribution System
Byer, David E. and Kenneth Carlson, Colorado State Univ., Fort Collins.
Report No: CI04-965, DTIC: ADA430305, 34 pp, Feb 2005

In an examination of the feasibility of on-line monitoring of drinking water distribution systems, four credible threat drinking water contaminants (aldicarb, sodium arsenate, sodium cyanide, and sodium fluoroacetate) were added to tap water and analyzed at different concentrations to determine their detectability. Bench-top analysis and on-line monitoring equipment was used to measure pH, chlorine residual, turbidity, and total organic carbon values before and after introduction of these contaminants. Results indicate that all four contaminants can be detected at relatively low concentrations. Three of the four contaminants were detected below a concentration that will cause significant health impact.
http://handle.dtic.mil/100.2/ADA430305

Recent Advances in Acquisition and Analysis of Seismic, GPR, and Electrical Resistivity Data for Hydrogeophysical Investigations
Baker, Gregory S., Univ. at Buffalo (SUNY), Buffalo, NY. Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 310, 2004

A paradigm shift is occurring in which geophysical data are no longer used strictly as supplemental qualitative information for groundwater models, but rather as a critical quantitative constraint for understanding these complex systems. This presentation identifies several recent advances of techniques in near-surface geophysics as applied to hydrologic problems, covering studies of fracture-related flow anisotropy using seismic refraction tomography, rapid azimuthal electrical resistivity analysis, and dense 3D GPR volume visualizations, as well as an innovative method for target discrimination (e.g., NAPL identification) using amplitude variation with offset analysis on GPR data.

Recent Studies Assessing Discrete-Interval Samplers and Direct-Push Monitoring Wells
Parker, L.V. (ERDC CRREL); M.E. Kram (NFESC); W. Major (NFESC). National Conference on Water-Quality Field Activities, Orlando, Florida, 19-22 November 2002. Abstracts, p 11, 2002

The results from two different studies are presented. One study, funded by the Army Environmental Center, examined the ability of five discrete-interval type samplers to recover representative concentrations of a variety of organic and metal analytes. The other study, funded by ESTCP, is a five-site, multi-year evaluation of the long-term use of direct-push monitoring wells. This effort is headed by the Naval Facilities Engineering Service Center (NFESC). The devices tested in the discrete-interval study were the Kabis, HydraSleeve, Discrete Interval, and USGS Passive Diffusion Bag samplers, and the Pneumo-Bailer. In the first phase of the study, the samplers were tested for their ability to recover known concentrations from a standpipe. Analytes of concern included volatile organics, explosives, pesticides, and metals. In the second phase of this study, these devices were tested for their ability to recover representative concentrations of TCE from a deep monitoring well. Concentrations from the devices were compared with concentrations of samples taken using low-flow sampling.

Recommended Practice for Inspecting Buried Lined Steel Tanks Using a Video Camera
Ken Wilcox Associates, Inc. 19 pp, Sep 1999

The inspection of an underground storage tank using a video camera can be carried out for the following purposes: to ensure the lining is still performing in accordance with original design specifications, to determine if a lined tank is structurally sound, and to determine the suitability of these lined tanks for upgrading by the application of cathodic protection.
http://www.kwaleak.com/protocols/Video_Inspection_Practice_Sept99.pdf

Recovery Determinations for Dioxin Analysis with the CALUX® Bioassay
Clark, G.C., A.C. Chu, J.D. Gordon, D. Brown, and Mick Chu (Xenobiotic Detection Systems Inc., Durham, NC); M. Nakamura and H. Murata (Hiyoshi Corporation, Shiga, Japan); M.S. Denison (Univ. of California, Davis). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

Bioassays do not differentiate between isotopically labeled and unlabeled analytes. Dioxin recovery determinations in bioassays can be accomplished with a surrogate sample spiked with a radiolabeled congener of dioxin. This paper reports that 1,2,3,4-TCDD, a biologically inactive congener of the dioxin family of chemicals, can be used as an internal spike to determine recoveries of dioxin-like chemicals. Samples were spiked with C-14 labeled 2,3,7,8-TCDD or 1,2,3,4-TCDD and submitted to extraction and clean up using Xenobiotic Detection Systems, Inc. patent pending XCARB sample clean up method (acid silica column in series with an XCARB column). The XCARB column is differentially eluted to yield a PCB and PCDD/F fraction. The 1,2,3,4-TCDD spiked samples were resuspended in toluene containing 4 PCB injection standards, and recoveries determined by gas chromatograph with electron capture detection or scintillation counter. Average recoveries determined by 1,2,3,4-TCDD with paired samples spiked with 14C- 2,3,7,8-TCDD indicated that the recoveries determined by the two methods were very similar, 88.5% and 87.2%, respectively. Recovery determinations were also verified by HRGC/HRMS. This procedure allows for quantitative determination of dioxin-like chemicals in various sample matrices.

Reference Handbook for Site-Specific Assessment of Subsurface Vapor Intrusion to Indoor Air
Electric Power Research Institute (EPRI), Palo Alto, CA. Report No 1008492, Mar 2005

Subsurface vapor intrusion is only one of several possible sources for volatile and semi-volatile chemicals in indoor air. This report provides guidance on the site-specific assessment of the significance of subsurface vapor intrusion into indoor air. Topics covered include theoretical considerations, sampling and analysis considerations, recommended strategies and procedures, interpretive tools, mitigation measures, and suggestions for future research. This document reflects a comprehensive understanding of the current scientific knowledge in this field.

Remote Data Collection Used for Mines
Acone, Scott (New England District); Dan Lawson and Kate White (Engineer Research and Development Center). The Corps Environment, Vol 6 No 1, p 6 & 10, Jan 2005

The U.S. Army Corps of Engineers New England District has been supporting EPA Region I by providing engineering assistance at the abandoned Elizabeth Mine and Ely Mine sites in Vermont. Both sites were placed on the NPL in 2001. Acid mine drainage containing elevated metals concentrations and high silt content results from surface water and groundwater interaction with waste materials at these

copper mining sites. Both the District and the Cold Regions Research and Engineering Laboratory (CRREL) have been working with EPA to operate and maintain monitoring programs and define the contamination at the sites. The Corps has employed various types of instrumentation to monitor surface and ground water hydrology, meteorology, and water chemistry, installing a combination of off-the-shelf and innovative, state-of-the-art instrumentation and equipment to support site characterization and near real-time monitoring. Power is not available at these remote sites, so each data collection platform is powered by 3 solar panels. At 5 remote areas of the Elizabeth Mine, acid mine discharge data and various water quality parameters are stored on Campbell data loggers and periodically transmitted via radios to a cell phone for transmission to a database for rapid graphical display on a password-protected web site. To characterize variations in drainage sources and metal loading to the local stream during spring runoff at Ely Mine, water quality meters are used to measure water temperature, conductivity and pH in the streams at 20-minute intervals. Depth of flow in the stream is measured with a pressure transducer in a weir every 5 minutes, and air temperature and rainfall are recorded at 5-minute intervals. This information is also stored on a Campbell data logger. To determine the metal content in the runoff, water samples are collected remotely using an automated ISCO suction sampler. The sampler is triggered by rainfall events to collect water samples every 15 minutes, allowing analysis of total metals loading during thunderstorms. This project provides an example of the successful application of relatively inexpensive methods of data collection and transmission under remote conditions, using mostly off-the-shelf, battery-operated devices and data loggers that are accurate and provide near real-time access to data.
http://hq.environmental.usace.army.mil/Corps_Environment/archives/vol6_no1.pdf

Remote Sensing and GIS Accuracy Assessment
Lunetta, Ross S. & John G. Lyon.
CRC Press, Boca Raton, FL. ISBN: 156670443X, 320 pp, 2004

The difficulties inherent in assessing the accuracy of large-area spatial data sets, their subsequent analysis by GIS, and their importance to landscape characterization make the development of methods for robust accuracy assessment a critical challenge. In December 2001, the U.S. EPA sponsored a symposium focused on evaluating the scientific elements relevant to performance of accuracy assessments for remote sensing derived data sets and GIS data analysis and integrated products. The result is this peer-reviewed text from an international group of scientists representing federal, state and local governments, academia, and non-governmental organizations. The papers provide an overview of the scientific elements relevant to accuracy assessments for remote sensing-derived data and GIS data analysis and integration products. Specific topics include sampling issues, reference data collection, edge and boundary effects, error matrix and fuzzy assessments, error budget analysis, and special issues related to change detection accuracy assessments.

Research on Advanced Environmental Monitoring System for Production Facilities: AEMS
Shimizu Corporation, 10 Feb 2000

The goal of this AEMS project is to create a comprehensive architecture for a total environmental monitoring system to protect the health of people and groundwater from leaks or spills of chemicals in and around the production facilities. The system will integrate sensor technologies and analytical methods for detecting chemicals, forecasting plume development, and estimating the source location.
http://www.ims.org/projects/project_info/aems.html

A Resource for MGP Site Characterization and Remediation: Expedited Site Characterization and Source Remediation at Former Manufactured Gas Plant Sites
U.S. EPA, Technology Innovation Office.
Report No: EPA 542-R-99-005, 221 pp, May 1999

The U.S. EPA, in conjunction with states, industry trade associations, and individual utilities, has compiled a summary of innovative strategies and technical approaches for expediting site characterization and source material remediation at former manufactured gas plant (MGP) sites. Unlike remediation sites of other industries, MGP sites are typically not found at locations where utilities operate today, are often located in residential communities that have developed around abandoned industrial locations, and are owned by entities unrelated to the modern utility. This document provides information on useful approaches and tools for characterization and remediation being applied at former MGP sites. The document outlines site management strategies and field tools for expediting site characterization at MGP sites; presents a summary of existing technologies for remediating MGP wastes in soils; provides sufficient information on the benefits, limitations, and costs of each technology, tool, or strategy for comparison and evaluation; and illustrates the implementation of these tools and strategies with case studies. Innovative strategies for managing former MGP sites include multi-site agreements, dynamic work planning, teaming approaches to expedite remedial action planning and execution, and methods for dealing with uncertainty at these sites. Technical innovations for site characterization include direct push and other field screening technologies used to complement traditional analytical approaches. A variety of approaches and technologies have been employed to provide cost-effective solutions to treating the wastes remaining at former MGP sites. The information presented in this document is applicable to the characterization and remediation of former MGP sites conducted under traditional remediation programs, as well as the large number of MGP sites likely to be addressed under voluntary cleanup programs.
http://costperformance.org/monitoring/pdf/02_mgp_resource.pdf

A Revaluation of Antiquated Partitioning Coefficients and their Affect on Soil Clean-up Levels
Sapanara, M.H. (GZA GeoEnvironmental, Inc., Norwood, MA); J.J. Clark and A.J. Ricciardelli (GeoEnvironmental, Inc., Norwood, MA); K. Walsh (GZA GeoEnvironmental, Inc., Norwood, MA).
The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster Presentation.

A recently developed soil sampling method (EPA Method 5035) dramatically improves the efficiency of soil analyses for VOCs, by as much as an order of magnitude. This in turn has affected the development of soil cleanup levels. At a Connecticut Superfund Site in 1994, soil cleanup levels were established via leach testing/partition modeling of samples collected using then-current methodology. SVE was implemented to clean up the site. A few years later, the data indicated that the cleanup objectives were being approached; however, soil samples collected using Method 5035 indicated significant residual concentrations, greater than concentrations detected prior to remediation. It was suspected that these increased concentrations were an artifact of the sampling methodologies employed. To assess the effect of using Method 5035 on the detected soil concentrations and required cleanup levels at the site, the investigators collected soil samples and analyzed them via a modified synthetic precipitation leaching procedure (SPLP) and Method 5035/8260. A soil-water partitioning coefficient (Kd) was then calculated for each set of samples. Using a multivariate statistical analysis and a 1-D steady-state flow/finite difference transport model, they were able to demonstrate that the leachable concentrations in soil were not significant relative to groundwater goals. These data were subsequently used to revise the site-specific goals for VOCs in soil by an order of magnitude.

A Review of Emerging Sensor Technologies for Facilitating Long-Term Ground Water Monitoring of Volatile Organic Compounds

Sutton, Douglas J. (GeoTrans, Inc.); Kathleen Yager (US EPA, Office of Superfund Remediation and Technology Innovation). Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization, 15-17 June 2004, Dallas, Texas.

An EPA report, "A Review of Emerging Sensor Technologies For Facilitating Long-Term Ground Water Monitoring of Volatile Organic Compounds," (EPA 542-R-03-007, 2003) summarizes the status of emerging sensor technologies that could be used for long-term monitoring of volatile organic compounds (VOCs). This presentation summarizes that report and its findings, focusing on sensor technologies for long-term groundwater monitoring generally associated with monitored natural attenuation or pump and treat. The following technology categories are considered: (1) technologies that provide in situ sampling and analysis of VOCs in groundwater, (2) commercialized technologies that automate both sampling and above-ground analysis of VOCs in groundwater, and (3) hand-held or otherwise field-portable instruments that can be used for the analysis of VOCs in groundwater at the well where the sample is obtained. Chemiresistors, quartz crystal microbalances, high resolution ion mobility spectrometry, fiberoptic sensors, metal oxide sensors, and surface acoustic wave sensors are among the technologies discussed. The report also describes factors or challenges that influence the applicability of these technologies, such as reliability, regulatory acceptance, consideration of site-specific conditions, and cost-effectiveness. To evaluate the cost-effectiveness of the technologies, the estimated costs of purchasing and using sensor-based probes at a hypothetical site are compared with the life-cycle costs of more traditional groundwater sampling and analysis techniques (i.e., three-well volume purging or low-flow sampling) at the same site. Recommendations are provided that may help improve the applicability of their technologies and move them from the laboratory to widespread use in the field.
http://207.86.51.66/siteopt/ataglance.htm

Sample Pretreatment Methods for the Determination of Mycotoxins and other Hazardous Substances (Dioxins) in Food and Feeding Materials using Gas Chromatography and Double Fragmentation Mass Spectrometry--MS/MS

Grochowalski, A., Cracow Univ. of Technology, Krakow, Poland.[2003?, www.dioksyny,pl]

This paper describes newly invented methods that have been successfully used in the determination of mycotoxins, dioxins, PAHs, pesticide residues and other toxic organics at ppt levels in many sample matrices. Methods are presented for semipermeable membrane (SPM) sample cleanup and preconcentration for the determination of toxic organic compounds in industrial, environmental, biological, and food-stuff matrices. This method is based on an isotope dilution procedure with the use of isotopically labeled internal and cleanup standards. Determination is performed using gas chromatography coupled with mass spectrometry equipped with double fragmentation mass spectrometric detector (GC-MS/MS system). Identification and confirmation is based on characteristic mass spectral data obtained from electron ionization primary ions and helium atom collision secondary ions (MS/MS mode).
http://www.dioksyny.pl/files/SPM_cleanup_food_preliminary.ang.pdf

Sampling Explosives in Ground Water Using the Redesigned HydraSleeve Sampler and USGS Nylon Diffusion Sampler
Parker, Louise and Denise MacMillan, U.S. Army Corps of Engineers, Engineer Research and Development Center, Cold Regions Research and Engineering Lab, Hanover, NH.
Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization, 15-17 June 2004, Dallas, Texas.

In recent years, there has been considerable interest in ground water sampling devices that allow one to profile the contamination within a well with depth. While these devices cannot be used for low-flow purging and sampling, they can be used for either no-purge or minimal-purge sampling, where it can be assumed that ground-water flow within the well screen is horizontal and laminar (i.e., almost exclusively in short-screened wells). Two devices designed for this type of sampling are the USGS Passive Diffusion Bag (PDB) sampler and the HydraSleeve sampler. Previous research has shown that the PDB sampler cannot be used for sampling explosives, and while the HydraSleeve sampler could be used to recover representative concentrations of some analytes, such as explosives, the up-and-down motion necessary for sampling can disturb the well and elevate turbidity. The effect the HydraSleeve device has on turbidity would prevent its use for sampling for charged species, such as metals and perchlorate, and highly hydrophobic organic compounds, such as PCBs and some pesticides. Other membranes and diffusion samplers are being examined to find one that could be used for sampling explosives. One device developed by D. Vroblesky of the USGS is a Nylon sampler. This device consists of a polypropylene jar, a 120u Nylon mesh that covers the open end of the jar, and an (open) polypropylene cap that holds the membrane in place. The HydraSleeve sampler has been substantially redesigned since its earlier evaluation. The newly designed device has a thin plastic (polyethylene) reed valve that has replaced the ball check valve. A weight can be added to the top of the device that allows the length of the (flexible) device to be compressed in the well. As a result, the sampler can be filled in a single pull, reducing concerns with turbidity substantially. This presentation reports findings from recent laboratory and field tests of these devices.
http://clu-in.org/siteopt/posters.htm

Semi-Permeable Membranes for Environmental Aqueous Sampling
Seaman, J., D. Hardison, D. S. Walling, and A. Kelsey-Wall (Univ. of Georgia/ Savannah River Ecology Lab, Aiken, SC); E. Hart (Westinghouse Savannah River Company, Aiken, SC). Fourth SETAC World Congress, 25th Annual Meeting in North America, 14-18 November 2004, Portland, Oregon.
Society of Environmental Toxicology and Chemistry, Pensacola, FL. Platform Presentation IP049, 2004

The use of selectively permeable membrane bags has proven effective for sampling various constituents in monitoring wells, including the use of polyethylene bags in the sampling of VOCs and other organics from discrete aquifer screen zones within wells. A major disadvantage of polyethylene membranes is the limited suite of compounds that can penetrate the material. Often, there is a need to evaluate additional constituents, including inorganics and other organics that are not readily diffusible through polyethylene surfaces. To assess the potential of other materials for groundwater sampling, a series of laboratory equilibration experiments was performed using nylon screen and dialysis membranes as diffusion samplers for various organic and inorganic compounds to determine the time required for equilibration under various conditions; however, incomplete equilibration was observed for the nylon screen materials at all pH levels, presumably due to the limited transfer area under stagnant flow conditions. Dialysis membrane results indicate a more complete equilibration for most metals under various conditions. In the most acidic solutions (pH 2 to 3), concentrations in membrane samplers were similar to the surrounding matrix solution within 12 to 18 hours. Similar results were found for most

metals at more environmentally realistic pHs (pH 4.5 to 6.5), excluding Cu, Cr, and Pb. This may reflect the formation of metal hydrolysis species at the higher pH that take longer to equilibrate. Near complete equilibration of organic carbon, chloride, and nitrate suggests that measurements of these constituents obtained from membrane samplers reflect concentrations within the environment. These data demonstrate that multiple particle size cutoffs and/or longer equilibration times may be required to allow for complete diffusion, depending on matrix composition.

Sensing Superfund Chemical with Recombinant Systems
Deo, Sapna K., Xhifen Xu, Dhritiman Ghosh, Anna Rothert, Jessika Feliciano, Xu Guan, Elisa D'Angelo, Leonidas G. Bachas, and Sylvia Daunert, Univ. of Kentucky, Lexington.
Report of the Superfund Basic Research Program 2004 Annual Meeting: Applying Molecular Technology Methods to Characterize and Reduce Risks to Humans and Ecosystems, 3-4 November 2004, Seattle, Washington.

There is a need for simple analytical techniques to monitor directly the levels of hazardous heavy metals, such as arsenic and antimony, and polychlorinated organics, such as PCBs and chlorocatechols. Researchers have designed and developed genetically engineered bacteria-based sensing systems for the detection of environmental pollutants by taking advantage of microorganisms that have developed resistance mechanisms in order to survive in contaminated environments. The resistance to arsenic and antimony is conferred on bacteria by the ars operon, which codes for proteins that help bacteria in extruding these toxicants out of the cell. Biosensing systems have been developed for arsenic/antimony by genetically designing bacteria in a way that couples the natural regulatory mechanisms of Escherichia coli with the expression of reporter genes. In such systems, the level of expression of the reporter protein can be related to the concentration of the target compound(s) present in the environment. The whole-cell biosensing systems developed for chlorocatechols and PCBs using reporter gene technology are discussed. These cell-based biosensing systems have not yet found field applications despite their simplicity to operate, ease of production, and low cost. The authors describe the development of bacterial biosensors with potential applications in field sensing and propose two strategies to adapt these whole-cell sensing systems for field applications. An inexpensive sensing strip and a centrifugal microfluidic platform in the shape of a compact disc are a simple way to detect environmental contamination without the need of expensive instrumentation and trained personnel. In contrast, the microfluidic platform offers high throughput and multiplexing capabilities. Both systems offer complete portability, which allows them to be used as field sensors.
http://www-apps.niehs.nih.gov/sbrp/2/annualconfreport/agenda.html

Shrinking the Biologic World: Nanobiotechnologies for Toxicology
Zieziulewicz, T.J. and D.W. Unfricht (New York State Dept. of Health, Albany, NY); N. Hadjout, M.A. Lynes, and D.A. Lawrence (Univ. of Connecticut, Storrs).
Toxicological Sciences, Vol 74, p 235-244, 2003

Devices used to assess biologic and toxicologic processes at the nanoscale will allow important new research pursuits. Nanofabricated tools are needed to detect, separate, analyze, and manipulate cells or biologic molecules of interest. The emergence of laser tweezers, surface plasmon resonance (SPR), laser capture microdissection (LCM), atomic force microscopy (AFM), and multi-photon microscopes have allowed for these assessments. This review highlights several devices that have been made possible by techniques originating in the microelectronics industry. These devices can be used for toxicologic

assessment of cellular structures and functions, such as cellular adhesion, signal transduction, motility, deformability, metabolism, and secretion.
http://toxsci.oupjournals.org/cgi/content/full/74/2/235

A Simple Accelerated Rock Weathering Method to Predict Acid Generation Kinetics
Kargbo, David M. & Jiren He, Temple Univ., Philadelphia, PA.
Environmental Geology, Vol 46, p 775-783, 2004

The new, simple, and less expensive accelerated weathering kinetic method discussed in this paper is proposed for use in lieu of the complex and expensive ASTM setup to determine the potential for a rock formation to generate acid mine drainage (AMD). The proposed method correlates strongly with the standard ABA method that has already been demonstrated to be correct 90% of the time in assessing overburden quality before mining and predicting post-mining drainage quality after mining. Unlike the ABA method, it has the advantage of assessing the kinetics of acid generation. Future additional testing of the method should include a side-by-side comparison with the ASTM method and determination of the repeatability and reproducibility of test-method results.
http://www.temple.edu/eer/weather.pdf

Site Characterization Using Non-Invasive Geophysical Techniques at a Former Carburetor Manufacturing Plant
Parish, Joseph M., Tetra Tech EM Inc.
Society of Exploration Geophysicists (SEG) Technical Program Expanded Abstracts, p 537-540, 2004

A geophysical investigation was performed at the Carter Carburetor Superfund site in St. Louis, MO, to locate drums containing metal shavings and polychlorinated biphenyl (PCB)-contaminated hydraulic oil allegedly buried under a half-acre paved section of the facility. The investigation was performed using a Geonics EM61 time-domain metal detection instrument and GSSI SIR 3000 ground-penetrating radar (GPR). The results of the survey showed strong anomalies suggesting a massive burial area at the southwestern portion of the site, as well as three underground storage tanks (USTs) and what appeared to be three trenches where USTs were once present. The presence of two other USTs found in another area of the site was confirmed using these methods. The geometric appearance of the metal detection anomalies and historical documentation supported the interpretation that the anomalies were caused by demolition debris from the former buildings and not by buried containers. Subsequent exploratory trenching confirmed this interpretation. Sampling of two of the USTs indicated the presence of PCBs and organic compounds. The geophysical investigation proved a cost-effective and efficient means of site characterization, eliminating the need for more extensive intrusive work and redirecting the focus toward UST investigations at the site.

Soil Screening Using the Membrane Interface Probe: Controlling False Positives and False Negatives
Dougherty, J.N., J. Mayo, S. Kellogg, D. Klerides, and W. Jaslanek, CDM Federal Programs Corporation, Edison, NJ. Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

The membrane interface probe (MIP) is a relatively new technology for screening soil and groundwater for volatile organic compounds (VOCs). Standard QA/QC methods have not been established to ensure that the MIP data provide a consistently reliable surrogate for the presence or absence of VOCs in soil or groundwater. This paper presents QA/QC methods developed by CDM in

consultation with the manufacturer to provide consistently reliable data and to address false negative or false positive results during MIP field work. In this way, the confirmatory soil or groundwater sampling program can be focused on areas of likely soil and groundwater contamination. The QA/QC program was developed by CDM in preparation for a MIP soil and groundwater screening program VOCs at an EPA Superfund Site in Long Island, NY. The QA/QC program consisted of two elements: tracking each MIP instrument and performance confirmation sampling. To track each instrument, a careful record was kept of where each MIP instrument was used and its history of response testing. Response testing was required on a daily basis, and an MIP instrument was considered 'new' if it was modified, repaired, or replaced. Performance confirmation sampling was completed by grouping the MIP locations into lots of 20 to 25 locations each. Within each lot, a duplicate MIP run was completed and various gas samples were collected. The duplicate MIP run was completed to demonstrate the reproducibility of MIP instrument response. Duplicate MIP locations were placed within a few feet of the original MIP location. Gas sampling was done to check if the MIP sensors were responding to VOCs. Gas samples included a lot blank, equipment blank, field blank, and a MIP gas sample. The MIP gas sample was collected using an absorbent trap placed in the stream of the carrier gas. The carrier gas circulates down to the MIP probe where it picks up VOCs, if present, and carries them up to a series of sensors. The MIP gas samples were analyzed (EPA Method TO-17) at a local laboratory within 24 hours so that the results could be used to determine if a false positive or false negative had occurred. A false negative was defined as a MIP reading negative for VOCs when VOCs were detected in the gas sample, and a false positive was defined as a MIP reading positive for VOCs when VOCs were not detected in the gas sample. If a false positive or a false negative was observed then corrective action was taken to determine the source of the problem and correct it.

Solid Phase Microextraction Headspace Sampling of Chemical Warfare Agent Contaminated Samples: Method Development for GC-MS Analysis

Jackson Lepage, C.R. & J.R. Hancock (Defence Research and Development Canada, Medicine Hat, AB); H.D.M. Wyatt (Regina Univ., SK, Canada).

Proceedings of the 27th Arctic and Marine Oilspill Program (AMOP) Technical Seminar, 8-10 June 2004, Edmonton, AB, Canada. Environment Canada, Emergencies Science and Technology Division, Environmental Technology Centre, Ottawa, ON, Canada. v. 1, p 525-535, 2004 [OSTI: DE20485455]

In Canada, analytical techniques used to identify the composition of the samples suspected to contain chemical warfare agents include gas chromatography-mass spectrometry (GC-MS), liquid chromatography-mass spectrometry (LC-MS), Fourier-transform infrared spectroscopy (FT-IR), and nuclear magnetic resonance spectroscopy. GC-MS and LC-MS generally require solvent extraction and reconcentration, thereby increasing sample handling. The authors examined analytical techniques that reduce or eliminate sample manipulation. In particular, this paper presents a screening method based on solid phase microextraction (SPME) headspace sampling and GC-MS analysis for chemical warfare agents, such as mustard, sarin, soman, and cyclohexyl methylphosphonofluoridate in contaminated soil samples. SPME is a method that uses small adsorbent polymer coated silica fibers to trap vaporous or liquid analytes for GC or LC analysis. Collection efficiency can be increased by adjusting sampling time and temperature. This method was tested on two real-world samples, one from excavated chemical munitions and the second from a caustic decontamination mixture.

Spatial Distribution Mapping of Trace Metals in Groundwater Using Remote Sensing and GIS: A Case Study From India

Padmaja, Vuppala, Asadi Siva Sankar, and M. Anji Reddy, Jawaharlal Nehru Technological Univ., Hyderabad, Andhra Pradesh, India.

24th Annual Meeting of the Society of Environmental Toxicology and Chemistry, 9-13 November 2003, Austin, Texas. SETAC, Abstract PT066, 2003

In India, degradation of groundwater quality due to high concentrations of heavy metals has led to a systematic monitoring of land use and its impact on ground water in Zone III under the Municipal Corporation of Hyderabad (MCH). Land use and its impacts on ground water quality with respect to heavy metals is being studied using remote sensing and GIS. IRS-IC PAN and IRS-ID LISS-III satellite images have been processed and merged using EASIPACE software to generate a land use / land cover map. A field survey was conducted in the study area for the collection of groundwater samples from uniformly distributed locations. The samples were analyzed for metals (e.g., As, Cd, Fe, B, Mn, Cr, Cu). using inductively coupled plasma mass spectrophotometer (ICPMS). The spatial and attribution databases thus created were integrated, and maps showing spatial distribution of heavy metals have been prepared using ARCVIEW GIS software. From these maps, high concentrations of iron exceeding the permissible limits for drinking water were observed in certain areas, possibly due to the discharge of untreated effluents from cigarette factories, tanneries, and pipe-manufacturing companies. The concentration of Cu, Cr, Ni, B and Mn were found to be within the permissible limits. The results obtained will produce recommendations and suggestions to improve the quality of water in Zone III.

Spatial Optimization of Long-Term Monitoring Well Networks at the Massachusetts Military Reservation (MMR)

Ward, David, Jacobs Engineering, Anchorage, AK.

Proceedings: Accelerating Site Closeout, Improving Performance, and Reducing Costs Through Optimization, June 15-17, 2004, Dallas, Texas.

In the process of spatial winnowing, each well is geostatistically evaluated for its contribution to the overall delineation of remaining contamination; uninformative wells are removed from the monitoring program unless they serve other purposes. Geostatistically based spatial winnowing is widely applicable to sites where characterization is complete and the focus has shifted to monitoring the already delineated plume. Second-generation statistically based spatial winnowing applied to monitoring well networks for the CS-10 and SD-5 plumes at MMR identified 92 wells that did not improve delineation of remaining groundwater contamination. 207 of 299 wells were retained in the long-term monitoring network, a reduction of 31%, without significantly affecting understanding of the plume geometry, internal mass distribution, and total plume mass. Other factors also affected well selection, including the need for sentry wells at key points outside the plume boundary and downgradient of the remedial system. This robust second-generation technique, reflecting only network geometry, relies on mapping the sum of kriging covariances and uses an extended kriging algorithm to deal with isolated wells. Operationally, kriging is based on the covariances of nearby samples, which are in turn a function only of distance and the geostatistical structure of the sample set. Regions with a relatively high sum of covariances contain spatially redundant monitoring wells, some of which are then winnowed from the network. Winnowing is validated by demonstrating that the remaining wells define essentially the same plume, with negligible differences in mass, volume, geometry, and maximum concentration. An extended kriging algorithm is essential to handle wells around the periphery of the monitoring network. Standard kriging requires that wells be separated by less than twice the range distance; isolated wells play no role in the interpolated plume shell regardless of their concentrations. Though manually interpolated control points can fill gaps

in a monitoring network, the sums of covariances from the resulting mixed data set reflect the choice of control points as much as the geometry of the monitoring network. Instead, the kriging algorithm can be extended to interpolate around solitary wells based solely on the geostatistical structure of the sample set, retaining the influence of plume-bounding peripheral wells while eliminating much of the need for control points.
http://clu-in.org/siteopt/posters.htm

Stable Isotope Probing Shows Flow of Pollutant Carbon Through a Soil Microbial Community
Madsen, E.L., C.M. DeRito, and G.Pumphrey, Cornell University.
Report of the Superfund Basic Research Program 2004 Annual Meeting: Applying Molecular Technology Methods to Characterize and Reduce Risks to Humans and Ecosystems, 3-4 November 2004, Seattle, Washington. Poster presentation 87.

A molecular technique, Stable Isotope Probing (SIP), is being used to identify biodegrading microbial populations by following the flow of carbon from a pollutant (C-13 phenol) into soil and the active populations in a soil microbial community. The overall approach sought to link field respiration to microbial populations with and without prior exposure to phenol. The field-based assay involved the release of C-13-labeled phenol and unlabeled phenol to soil plots and the subsequent analysis of labeled CO2 respiration by gas chromatography/mass spectrometry (GC/MS). Key treatments included 11 20-ml doses (either C-13 or unlabeled 10,000 ppm phenol) applied to 5.3 cm2 plots at 1-day intervals prior to a final C-13-phenol dose. Significant labeled CO2 production (>4 times background) was observed from the soil with no prior phenol exposure. Labeled CO2 release was boosted by a factor of 20 (to 2.15 mmoles) when multiple additions of unlabeled phenol had been previously applied to the soil. As expected, the greatest mass of labeled CO2 released was found in plots where all doses of phenol were C-13 labeled. Following DNA extraction from the soil plots, cesium chloride density gradient centrifugation was employed to separate 13C-labeled soil DNA from the 12C-DNA pool. 16S rRNA genes were amplifiable by PCR from the C-13/DNA fractions in only the C-13 treatments (not those that received unlabeled phenol). Sequencing of 16S rRNA clone libraries prepared from the C-13/DNA fraction showed distinctive microbial populations in treatments with prior exposure to C-12 and C-13 labeled phenol. Adapted populations differed from unadapted populations. The patterns also revealed the identities of primary- and secondary- degrading soil populations comprising food chains involved in system carbon flow.

Stable Isotopes of Hydrogen as an Environmental Indicator for Landfill Leachate
Humphrey, J.D., R.A. Statom, and G.D. Thyne, Colorado School of Mines, Golden.
Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004): Abstracts with Programs, Vol 36 No 5, p 395, 2004

When landfill liners leak, the unique stable hydrogen isotopic signature of landfill leachate can be used as a tracer for identifying impact on local groundwater. The chemical composition of landfill leachate is highly variable, making interpretation of monitoring well data and identification of leachate in groundwater difficult. Generation of methane gas during anaerobic decomposition of organic waste produces isotopically light methane, leaving the water enriched in the heavier hydrogen isotope. The methanogenesis process does not affect the oxygen isotopic composition. An evaluation of the isotopic composition of landfill leachate collected over multiple years from the Dyer Boulevard Landfill in Palm Beach County, FL, compared hydrogen and oxygen isotopes of local precipitation with leachate samples, which have a distinctive hydrogen isotope shift toward heavier values. The data show that hydrogen isotope enrichment is strongest during early landfill history, when rates of microbial respiration and

methane generation are the greatest. The maximum degree of enrichment is 20 per mil over meteoric water, and lessens with age of waste, suggesting that this technique would be most useful for detecting liner leaks early in the operational history.

Submersible Online Oxygen Removal System Coupled to an in Situ Voltammetric Probe for Trace Element Monitoring in Freshwater
Tercier-Waeber, M.-L. (University of Geneva, Sciences II, Geneva, Switzerland) and J. Buffle.
Environmental Science & Technology, Vol 34 No 18, p 4018-4024, 2000

An online oxygen removal system was built to allow in situ deoxygenation of freshwater before in situ voltammetric detection of trace elements using a submersible probe. The oxygen removal system is based on the permeation of oxygen through a silicone tubing surrounded by an enzymatic cross-linked O2 scavenging gel. The enzyme cross-linked gel has many advantages compared to the chemical O2 reducing solutions proposed in the literature for laboratory online deoxygenation, such as (1) ease of preparation and storage under normal room condition, (2) good long-term stability (maximum time tested 1 month), (3) no formation of interfering insoluble oxidized chemical compounds adsorbed on the external silicone tubing wall, and (4) easy in situ application. The authors describe the construction of the system, the systematic laboratory tests performed to optimize its performance, and examples of environmental applications. In situ monitoring and profiling of Cu(II), Pb(II), and Zn(II) in oxygenated lake water have been performed using this new online oxygen removal device coupled to a submersible voltammetric probe. The results indicate that the online oxygen removal system is robust and efficient for in situ, online deoxygenation and allows reliable subsequent voltammetric measurements of trace metals present at sub-nM level in oxygen-saturated freshwater.

Time-Series Monitoring in Fractured-Rock Aquifers
Johnson, Carole D., John W. Lane, Jr., and Frederick D. Day-Lewis, U.S. Geological Survey.
Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 295-307, 2004

Time-lapse monitoring of subsurface processes is an emerging and promising area of hydrogeophysics. The combined use of non-invasive or minimally invasive geophysical methods with hydraulic and geochemical sampling is a cost-effective approach for aquifer characterization, long-term aquifer monitoring, and remediation monitoring. Time-lapse geophysical surveys can indirectly measure time-varying hydrologic parameters such as fluid saturation or solute concentration. Monitoring of time-varying hydrologic processes provides insight into aquifer properties and structure and aquifer responses to natural or induced stresses, such as seasonal fluctuations or fluid injection experiments for active remediation. The U.S. Geological Survey is cooperating with EPA, DoD, the University of Connecticut, and Stanford University researchers to apply time-lapse geophysics for site characterization and remediation monitoring at various sites. Recent and ongoing examples of time-lapse monitoring in fractured-rock aquifers include 1) application of attenuation-difference, borehole-radar tomography used to monitor a series of sodium chloride tracer injection tests in fractured crystalline rock, 2) application of attenuation- and velocity-difference tomography and radar-reflection data to monitor steam injection in a fractured limestone aquifer, 3) design of an electrical resistivity tomography investigation to monitor the injection of resistive water into brackish water in a fractured limestone aquifer for aquifer storage and recovery, and 4) combined application of borehole-geophysical logging with long-term discrete-interval monitoring of hydraulic head and water-chemistry in a fractured crystalline-rock aquifer.
http://www.clu-in.org/products/siteprof/2004fracrockconf/cdr_pdfs/indexed/group1/295.pdf

Toxicity and Bioaccumulation Testing of Zinc from Weathered Substrates Using Plants and Worms
Best, E.P.H. (U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS); K.N. Geter (Analytical Services, Inc., Vicksburg, MS); H.E. Tatem (U.S. Army ERDC, Vicksburg, MS).
The 19th Annual International Conference on Contaminated Soils, Sediments and Water, 20-23 October 2003, University of Massachusetts at Amherst.
Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. CD-ROM, 2003

A study was conducted to evaluate the toxicity of metals from metal-contaminated dredged material to terrestrial plants and worms, bioaccumulation of metals from metal-contaminated dredged material in terrestrial plants and worms, and effects of substrate characteristics other than metal concentration alone on the biotic responses. Results showed that bermudagrass is a far more sensitive test organism than earthworms. Of the substrate characteristics tested other than zinc concentration, i.e. organic matter content, moisture level (only in plants), and pH, none significantly affected biomass production and tissue metal concentration in both organisms.

Trimethylbenzoic Acids as Metabolite Signatures in the Biogeochemical Evolution of an Aquifer Contaminated with Jet Fuel Hydrocarbons
Namocatcat, J.A., J. Fang, and M.J. Barcelona (Univ. of Michigan); A.T.O. Quibuyen (Univ. of the Philippines); T.A. Abrajano, Jr. (Rensselaer Polytechnic Inst.).
Journal of Contaminant Hydrology, Vol 67 Nos 1-4, p 177-194, Dec 2003

Evolution of trimethylbenzoic acids in the KC-135 aquifer at the former Wurtsmith Air Force Base, Oscoda, MI, is being examined to assess whether changes in the composition of trimethylbenzoic acids and the distribution and concentration profiles exhibited by 2,4,6- and 2,3,5-trimethylbenzoic acids temporally and between multilevel wells reflect processes indicated an actively evolving contaminant plume. The concentration levels of trimethylbenzoic acids were 3 to 10 orders higher than their tetramethylbenzene precursors, a condition attributed to slow metabolite turnover under sulfidogenic conditions. The observed degradation of tetramethylbenzenes into trimethylbenzoic acids obviates the use of these alkylbenzenes as non-labile tracers for other degradable aromatic hydrocarbons, but provides rare field evidence on the range of high molecular weight alkylbenzenes and isomeric assemblages amenable to anaerobic degradation in situ. The coupling of actual tetramethylbenzene loss with trimethylbenzoic acid production and the general decline in the concentrations of these compounds demonstrate the role of microbially mediated processes in the natural attenuation of hydrocarbons and may be a key indicator in the overall rate of hydrocarbon degradation and the biogeochemical evolution of the KC-135 aquifer.

Ultra-Sensitive Fully Automated Immunoassay for Detection of Propanil in Aqueous Samples: Steps of Progress Toward Sub-Nanogram per Liter Detection
Tschmelak, J., G. Proll, and G. Gauglitz, Eberhard-Karls-Univ. of Tuebingen, Tuebingen, Germany.
Analytical and Bioanalytical Chemistry, Vol 379 Nos 7-8, p 1004-1012, Aug 2004

Broad application and heavy use of the herbicide propanil have contributed to soil and water contamination. The authors describe progress toward sub-nanogram per liter detection of propanil with a fully automated immunoassay. In contrast with common analytical methods such as GC-MS or HPLC-MS, the biosensor requires no sample pre-treatment and pre-concentration. The basis of the sensitive assay is an antibody with a high affinity constant toward propanil. During the optimization process, different surface modifications (four different immobilized derivatives) were compared and the amount of antibody per sample was reduced. Optimization of the assay resulted in an LOD of 0.6 ng/L and an

LOQ of 4.5 ng/L with no sample pre-treatment or pre-concentration. These results for propanil with the RIANA instrument and its improved sensitivity for detection of a single pesticide at the low nanogram-per-liter range show that biosensors can compete with common analytical methods for water analysis.

Ultra-Sensitive Trace Analysis of Cyanide Water Pollutant in a PDMS Microfluidic Channel Using Surface-Enhanced Raman Spectroscopy
Yea, K.H., S. Lee, J.B. Kyong, J. Choo, E.K. Lee, S.W. Joo, and S. Lee.
Analyst, Vol 130 No 7, p 1009-1011, 2005

Rapid and highly sensitive trace analysis of cyanide-contaminated water in an alligator teeth-shaped PDMS microfluidic channel was investigated using surface-enhanced Raman spectroscopy. Compared with previously reported analytical methods, the detection sensitivity was enhanced by several orders of magnitude.

Ultrasensitive Voltammetric Detection of Trace Heavy Metal Ions Using Carbon Nanotube Nanoelectrode Array
Liu, Guodong, Yuehe Lin, Yi Tu, and Zhifeng Ren.
Analyst, Vol 130 No 7, p 1098-1101, 2005

The authors describe ultra-sensitive voltammetric detection of trace heavy metal ions using nanoelectrode arrays (NEAs) based on low-site density carbon nanotubes (CNTs). The NEAs were prepared by sealing the side-walls of CNTs with an epoxy passive layer that reduces the current leakage and eliminates the electrode capacitance, leading to a low background current and providing a high signal-to-noise ratio. The CNTs/NEAs coated with a bismuth film were used successfully for voltammetric detection of trace cadmium(II) and lead(II) at the sub-ppb level. A detection limit of 0.04 ug/L was obtained under optimum experimental conditions. The new carbon NEA sensing platform holds great promise for environmental monitoring of toxic metals.

Uptake of PAHs into Polydimethylsiloxane Disks from Water: an Alternative Passive Sampling Device
White, K. and D. Shea, North Carolina State University, Raleigh, NC.
24th Annual Meeting of the Society of Environmental Toxicology and Chemistry, 9-13 November 2003, Austin, Texas. SETAC, Abstract 461, 2003

Passive sampling devices are commonly used to monitor concentrations of organic contaminants in water. Scientists determined uptake and sampling rates of 49 polycyclic aromatic hydrocarbons (PAHs) into polydimethylsiloxane (PDMS) disks to investigate their potential as passive sampling devices. PDMS disks were sampled in triplicate over 25 days in a static renewal system. PAHs with a log Kow <5 achieved equilibrium within 25 days, with most compounds achieving equilibrium between 10 and 25 days. Uptake rates for these compounds ranged from 0.08 to 0.8-L/gd. Due to the relatively rapid uptake of low molecular weight PAHs, deployment times of less than 10 days would be necessary to maintain linear uptake. Within this limitation, PDMS disk appear to offer great potential for monitoring PAH exposure in the aquatic environment.

Uptake of Polycyclic Aromatic Hydrocarbons into an Iso-Octane Filled Variant of the Semipermeable Membrane Device
Luellen, D. (Virginia Inst. of Marine Science, Gloucester Point, VA); D. Shea (North Carolina State Univ., Raleigh, NC).
24th Annual Meeting of the Society of Environmental Toxicology and Chemistry, 9-13 November 2003, Austin, Texas. SETAC, Abstract 459, 2003

The neutral lipid triolein in the standard semipermeable membrane device (SMPD) was replaced with iso-octane to create an ISPMD. Laboratory calibration experiments were conducted with the ISPMD to determine the sampling rates of 47 polycyclic aromatic hydrocarbons (PAHs) and related heterocyclic compounds. PAH remained in the linear uptake phase for at least 14 days, at which time the loss of iso-octane from the ISPMD became significant (>10%). Sampling rates ranged from 0.36 to 3.47 L/d. Field verification of these sampling rates yielded agreement within about a factor of 2 for most PAH, with some larger discrepancies (8-fold) for the highest molecular weight PAH at a single site. The reported ISPMD sampling rates allow quantitative estimations of dissolved concentrations of 47 PAH and related heterocyclic compounds that are commonly used for PAH source identification and allocation and for risk assessments. The ISPMD allowed direct injection of the iso-octane into the gas chromatograph, greatly simplifying the analysis compared to the standard SPMD design.

Urease-Glutamic Dehydrogenase Biosensor for Screening Heavy Metals in Water and Soil Samples
Rodriguez, Belen Bello, John A. Bolbot, and Ibtisam E. Tothill, Cranfield Univ., Silsoe, Beds., UK.
Analytical and Bioanalytical Chemistry, Vol 380 No 2, p 284-292, Sep 2004

A screen-printed 3-electrode amperometric biosensor based on urease and the nicotinamide adenine dinucleotide hydrogen (NADH)-glutamic dehydrogenase system was developed and applied to the screening of heavy metals in environmental samples. The development of an amperometric sensor for the monitoring of urease activity was made feasible by coupling the urea breakdown reaction catalysed by urease to the reductive ammination of ketoglutarate catalysed by glutamic dehydrogenase (GLDH). The use of negatively charged nafion film created a more concentrated environment of cations in proximity to the enzyme, enhancing the urease inhibition when compared to gel entrapment. The calculated detection limits were 63.6 and 55.3 g/L for Hg(II) and Cu(II), respectively, and 4.3 mg/L for Cd(II). A significant urease inactivation was recorded in the presence of trace amounts of metals (g/L) when the enzyme was used free in solution. Though the obtained results were in agreement with the standard methods employed for sample analysis, the use of the amperometric assay (with free urease) proved more feasible for the screening of trace amounts of metals in polluted samples.

Use of Alkaline Extraction to Quantify Sulfate Concentration in Oxidized Mine Tailings
Yin, Guohong and Lionel J.J. Catalan, Lakehead Univ., Thunder Bay, ON, Canada.
Journal of Environmental Quality, Vol 32, p 2410-2413, 2003

An alkaline extraction method has been developed for the determination of total sulfate in mine tailings containing secondary sulfate minerals formed by the oxidation of primary sulfides. The proposed method is simple, yields an accurate yet rapid measurement of sulfate, and involves a safer laboratory operation than conventional methods that make use of strong HCl acid solutions. Moreover, this method allows the specific measurement of sulfate in the extract, whereas conventional methods are generally limited to the measurement of total S by inductively coupled plasma atomic emission spectrometry due to the interference of chloride with sulfate in ion chromatography.

The Use of a Passive, Integrative, In Situ Sampler to Assess the Influence of Seasonal and Episodic Events on the Distribution of Bioavailable Manganese (Mn) and Trace Metals in the Lower Willamette River, Portland Harbor Superfund Site, OR

Hillwalker, W.E., O. Krissanakriangkrai, R. Grove, and K.A. Anderson, Oregon Health and Science University SBRP. Report of the Superfund Basic Research Program 2004 Annual Meeting: Applying Molecular Technology Methods to Characterize and Reduce Risks to Humans and Ecosystems, 3-4 November 2004, Seattle, Washington. Poster presentation.

An 18 mile stretch of the lower Willamette River, OR, was investigated for the distribution of bioavailable trace metals from 2001 to 2004. The areas assessed are contaminated with metals, polychlorinated biphenyls (PCBs), dioxins/furans, pesticides, and polyaromatic hydrocarbons (PAHs). Alternative sampling methods, including in situ sampling devices and aquatic organism collection, were used to determine the influence of seasonal and episodic events on the distribution of bioavailable manganese (Mn), copper (Cu), chromium (Cr) and zinc (Zn) in the Portland Harbor and McCormick and Baxter Superfund sites. Diffusive gradients in thin film (DGT) is an in situ, time-integrated, passive sampling device containing a chelex resin with high selectivity for labile, divalent cations. DGT were deployed within the main river channel near urban, industrial, and Superfund land uses during a range of river conditions from 2001 to 2004. Two species of predatory fish were collected along the 18-mile stretch of the lower Willamette River in 2000, and crayfish were collected at the same locations as DGT deployment in 2003. Preliminary data indicate that bioavailable trace metal concentrations were influenced by episodic events, such as terrestrial run-off and dilution, seasonal variations in river flow and precipitation, as well as land use factors influencing metal source to the river. Trace metal bioaccumulation by organisms varied relative to organism- and site-specific factors.
http://www-apps.niehs.nih.gov/sbrp/2/annualconfreport/poster.html

Use of Enzyme-Linked Immunosorbent Assays for Analyzing PCB, PBDE and PAH Contamination in an Urban Great Lakes tributary and Quantification by Gas Chromatography-Mass Spectrometry.
Abdallah, F. and D. Aga (Buffalo State College, Buffalo, NY); S. Inamdar, C. Tsai, and S. Franceschini (Univ. at Buffalo, Buffalo, NY). 24th Annual Meeting of the Society of Environmental Toxicology and Chemistry, 9-13 November 2003, Austin, Texas. SETAC, Poster PT101, 2003

The Scajaquada Creek receives runoff from 29 square miles of urban and suburban communities around the City of Buffalo and drains into the Niagara River. High concentrations of nutrients, heavy metals, PCBs, and PAHs have been reported in the creek's water. Determining the level of contamination of sediments by hydrophobic compounds such as PBDEs, PCBs, PAHs, and common pesticides is costly and time-consuming, but knowledge of the spatial distribution of these contaminants is critical for identifying localized sources, implementing remedial actions, and assessing the suitability of the water as habitat for aquatic organisms. Investigators used class-selective enzyme-linked immunosorbent assays (ELISAs) that respond to several PCB congeners (Aroclor 1016, 1232, 1242, 1248, 1254, 1260, 1262, and 1268) and selected carcinogenic PAHs (Benzo(a)anthracene, Chrysene, Benzo(b)Fluoarenthene, Benzo(a)pyrene, Benzo(k)fluoranthene, among others). ELISA is an effective method of analysis that relies on specific interactions between antibodies and antigen (target analyte) to measure the concentration of the contaminant. The use of ELISA as a screening tool allows the collection of more samples for improved spatial resolution that is otherwise cost-prohibitive. Gas chromatography/mass spectrometry (GC/MS) an analytical method by which a sample is vaporized and separated into individual organic compounds was used to quantify the amount of each individual PAH component in the sediment samples. Both ELISA and GC/MS found high concentrations of PAHs and PCBs.

Use of Rebound Testing for Evaluation of Soil Vapor Extraction Performance at the Savannah River Site
Switzer, Christine, Timothy Slagle, Donald Hunter, and David S. Kosson.
Ground Water Monitoring & Remediation, Vol 24 No 4, Fall 2004

In 1999, a pilot soil vapor extraction (SVE) system was installed at a waste area within DOE's Savannah River Site (Aiken, SC) to remediate trichloroethene (TCE) contamination and to evaluate monitoring and operational strategies for SVE application in layered heterogeneous materials. The specific objectives of the results reported were to evaluate the use of rebound analysis of soil gas concentrations as the basis for operational strategies and to establish the endpoint criteria for active remedial action. Three soil gas TCE concentration rebound tests were conducted over a period of 18 months to assess system performance and progress. For each rebound test, the system was shut down and allowed to equilibrate for two to four weeks. Soil gas TCE concentrations were measured several times during this equilibration period. Comparison of these rebound test results has been used for evaluating SVE system performance. A transient 2-D diffusion model was used to convert soil gas TCE rebound concentrations to estimates from distance to source, and the model predictions correspond with observed dense nonaqueous phase liquid at the site. These rebound tests can provide enough information about contaminant distribution and SVE mass transfer limitations to select a reasonable and appropriate endpoint for active remedial operations.

Use of Small-Diameter Bladder Pumps in Direct-Push Ground Water Monitoring Wells at the CRREL Site
Parker, Louise V., John W. Govoni, and Martin H. Stutz, Engineer Research and Development Center, Hanover, NH, Cold Regions Research and Engineering Lab (CRREL).
Report No: ERDC/CRREL-TR-04-24, NTIS: ADA430469, 21 pp, Dec 2004

Several different small-diameter (1/2- and 3/4-inch) bladder pumps from different manufacturers were tested in 1/2- and 3/4-inch direct-push (DP) monitoring wells at the CRREL site in Hanover, NH. Obtaining a sample at this site has been challenging because the depth to ground water is over 100 feet and thus substantial lift is required to bring the water to the surface. Although the different brands of pumps fit into the small-diameter wells, all of them hung up in some of the wells when attempting to install them at the sampling depth; however, the investigators found that machining a few thousandths of an inch off the diameter of the pumps was all that was necessary to get them to the desired depth. Three brands of 3/4-inch bladder pumps were tested in the site's DP wells and delivered between 25 and 315 mL/min. Two brands of 1/2-inch bladder pumps were tested and delivered between 20 and 100 ML/min. Concentrations of TCE obtained using two different brands of a 3/4-inch diameter pump were compared and statistically significant differences were found. The same result was true when the two brands of 1/2-inch diameter pumps were compared, though the differences in this case were slight. It is possible that differences in the previous conditioning the pumps received in the wells (i.e., equilibration times for the materials with the well water) were responsible for much of these differences.
http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/TR04-24.pdf

Using Commercially Available Enzyme Bioassays to Rapidly Screen and Monitor Metal-Contaminated Sites

Choate, L.M. (USGS, Lakewood, CO); J.F. Ranville and E.P. Blumenstein (Colorado School of Mines, Golden). Geological Society of America 2004 Denver Annual Meeting (November 7-10, 2004), Abstracts with Programs, Vol 36 No 5, p 28, 2004

Former sites of mining activities often contain waste-rock dumps and tailings piles that affect the surrounding soil, sediment, water, and biota by the release, through weathering, of toxic metals (Cu, Zn, Cd, etc.). The degree of the environmental impact depends on both the leachability of the metals and their bioavailability, the former controlled by the solid phases with which the metals are associated and the latter by aqueous chemical speciation. Indicator organisms, such as Ceriodaphnia dubia, Daphnia Magna, other invertebrates, and fish, have traditionally been used to assess toxicity of chemicals in the aquatic environment. These bioassays are generally time-consuming, expensive, and require culturing of live organisms. Microbioassays are being established as less costly alternatives for screening purposes. Two commercially available microbioassays were selected for study: MetPLATE® and Toxichromotest®. These microbioassays are based on the selective inhibition of the activity of ß-galactosidase enzyme in a mutant Escherichia coli strain. Since the hydrolase enzyme is specific for heavy metals, the assays are described as being sensitive to heavy metal toxicity. The investigators combined a simple water field leach procedure with the enzyme bioassays to develop a rapid screening tool for asessing the toxicity potential of mine-waste rock piles. The metals were determined by ICP-AES analysis. Application of the enzyme bioassays to the leachate provided a measure of the bioavailable fraction. To evaluate the enzyme-based methods, they were compared to 48-hour Ceriodaphnia dubia tests in a mining-impacted area. Initial results suggest that MetPLATE® provides a sensitive screening tool for determining the environmental impact of mining activities.

Using Major Ions Data to Support the Demonstration of Hydraulic Containment in a Fractured Bedrock Aquifer

Sayko, S.P. and W.F. Daniels (Services Environmental, Inc.); R.J. Passmore (Glenn Springs Holdings, Inc.). Proceedings: 2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, 13-15 September 2004. p 100-114, 2004

Demonstration of hydraulic containment is typically accomplished by contouring groundwater level data from monitoring wells and interpreting groundwater flow directions from the potentiometric contours. In fractured bedrock aquifers, the interpretation of water levels is often confounded by the complex structure and sharp contrasts in hydraulic properties. The Hyde Park Landfill Site in Niagara Falls, NY, is located over a fractured dolomite aquifer. A bedrock hydraulic containment system was installed and began operation in 1993, but hydraulic containment could not be conclusively demonstrated with water level data. Installation of additional pumping wells, monitoring wells, and increased pumping had not resolved the difficulties in demonstrating containment. In 2001, it was recognized that a re-characterization of the site and revision of the site conceptual model was necessary to address the containment objective. A complete site reassessment was performed, including an extensive geophysical investigation, reevaluation of the site conceptual model, and the installation of 113 small-diameter, short-screen piezometers. As part of this effort, 70 of the new piezometers were sampled for major ions. The major ions results supported the site conceptual model and interpretation of water level data from the new piezometers, and strongly supported the interpretation of hydraulic containment. The combination of a supportable site conceptual model, water level data, and major ions data demonstrate that the hydraulic

containment objectives have been achieved. This paper presents the use of major ion data for support of the hydraulic performance requirements.
http://www.clu-in.org/products/siteprof/2004fracrockconf/cdr_pdfs/indexed/group1/100.pdf

Using Rank-Order Geostatistics for Spatial Interpolation of Highly Skewed Data in a Heavy-Metal Contaminated Site
Kai-Wei, Juang and Dar-Yuan Lee (National Taiwan Univ.); Timothy R. Ellsworth (Univ. of Illinois).
Journal of Environmental Quality, Vol 30 , p 894-903, 2001

Rank-order geostatistics with standardized rank transformation were used for the spatial interpolation of pollutants with a highly skewed distribution in contaminated soils. Commonly used nonlinear methods, such as logarithmic and normal-scored transformations, are not always suitable for this assessment. A real data set of soil Cd concentrations with great variation and high skewness in a contaminated site in Taiwan was used for illustration. The spatial dependence of ranks transformed from Cd concentrations was identified, and kriging estimation was readily performed in the standardized-rank space. The estimated standardized rank was back-transformed into the concentration space using the middle point model within a standardized-rank interval of the empirical distribution function. The spatial distribution of Cd concentrations was then obtained. The probability of Cd concentration being higher than a given cutoff value also can be estimated by using the estimated distribution of standardized ranks. The contour maps of Cd concentrations and the probabilities of Cd concentrations being higher than the cutoff value can be used for delineation of contaminated soils.

Visualizing Contaminants in Plants
Petkewich, Rachel.
Environmental Science & Technology, Science News - 30 June 2004

With a nondestructive analytical technique and imaging software, researchers in the United Kingdom have devised the first way to 'see' where contaminants reside in living plants. The researchers have shown that their approach can track the movements of an organic pollutant from the waxy cuticle into the aqueous cytoplasm of leaf cells. The location of the compound being tracked can be seen under a microscope. The images are acquired with two-photon excitation microscopy (TPEM), and reconstruction software is used to create 3-D pictures. By combining images collected at a single wavelength, the researchers watched how anthracene spread through much of a maize leaf over a four-day period. The kind of information provided by this study could dictate which plants are selected for phytoremediation applications. Not all contaminants can be tracked in all plants, however, because TPEM requires that the contaminant naturally fluoresces and at a different wavelength than the plant. So far, the technique is limited to certain chemicals. Additionally, most plants can take up a little of everything, and a sensitive, semiquantitative technique like TPEM will find them, which can complicate the data; however, where the technique can be applied, it gives very good information on localization of the target chemical at a subcellular level, information that would be extremely difficult to get with traditional techniques. The researchers are currently using the method to track pesticides and compound degradation on and within living leaves, as well as how roots and root hairs handle these chemicals. Preliminary results indicate that the pesticide movement is more rapid and diffuse than that of the anthracene. The information gained from the study of the behavior of the model compounds will provide greater understanding of how organic contaminants migrate within plants following uptake from soil in phytoremediation or crop contamination studies.

Which Groundwater Remediation Objective Is Better, A Realistic One Or A Simple One?
Ren, Xiaolin, Master's thesis, University of Illinois, 73 pp, 2003.

Numerous coupled optimization and simulation models have been developed to improve groundwater remediation designs. One of the first steps in developing an optimal groundwater remediation design problem is creating appropriate objective functions, which represent the primary goals of the design. This paper explores two issues that can arise in creating objective functions and interpreting multi-objective results: cost function complexity and visualization of high-order multi-objective problems (those with more than 2 objectives). This research seeks to identify what situations encountered in remediation design would make the development of a realistic objective function necessary. Once the cost function is defined, solution of high-order multi-objective problems can identify a complex nondominated surface of solutions that can be difficult to visualize. Several visualization approaches are explored for identifying tradeoffs among three objectives (total cost, risk, and total cleanup time) for a hypothetical case study. A new approach is presented that can clearly visualize all the optimal solutions and all the relationships among three objectives to improve decision-making. With this approach, the results show that if the required risk level is high, a short-term remediation is preferred, while for a low risk level, a long-term remediation is more cost-effective. Further cost function complexity is explored in both a hypothetical case study and a field-scale application at Umatilla Army Depot in Oregon. The results show that realistic cost functions tend to find better solutions than the simplified cost functions and also identify more optimal solutions on the Pareto frontier than the other functions. For both the hypothetical and the Umatilla case, the realistic cost functions achieved up to 14% improvement in total cost, though the degree of loss in accuracy varies substantially for the two case studies considered and for different parameter settings (e.g., cleanup length, risk level, or mass remaining) within each case study.
http://cee.uiuc.edu/emsa/documents/xren-2003-01.pdf

Why Optimize Long Term Groundwater Monitoring Design? A Multiobjective Case Study of Hill Air Force Base
Reed, P., B.S. Minsker, and A. Valocchi, Univ. of Illinois at Urbana-Champaign.
Bridging the Gap: Meeting the World's Water and Environmental Resources Challenges: Proceedings of the World Water and Environmental Resources Congress, Orlando, FL. American Society of Civil Engineers, Washington, DC. ISBN: 0-7844-0569-7, 2001

The authors present a case study that demonstrates the use of a Nondominated Sorted Genetic Algorithm (NSGA) for monitoring design at Hill Air Force Base. The method combines fate-and-transport simulation (though it also can be used with historical data alone), plume interpolation, and adaptive search to identify the tradeoff between monitoring costs and mass estimation error. The method efficiently provides decision makers a direct representation of the tradeoff between monitoring objectives, such as cost and error. The case study also identifies the most and least significant monitoring wells in a preexisting monitoring network.
http://cee.uiuc.edu/emsa/conference/preed-2001-01.pdf

X-Ray Fluorescence-Based Multi-Metal Continuous Emission Monitor: Development
Hay, K.J.; Bruce E. Johnsen; John A. Cooper, Construction Engineering Research Lab (Army) Champaign, IL.
Report No: ERDC/CERL-TR-05-3, NTIS: ADA430237, 60 pp, Jan 2005

Army demilitarization incinerators will need to comply with the Hazardous Waste Combustor National Emission Standards for Hazardous Air Pollutants that will regulate metals and metal compounds listed under the Clean Air Act Amendments. A large problem for these incinerator operations is limited knowledge of the types and quantities of emitted metals. Compliance may be determined only through trial burn emission tests because of this limitation. A continuous emission monitor (CEM) for multi-metals will provide the emission data, a tool to help meet compliance requirements, and the opportunity to adjust burn strategies for increased production. The XCEM multi-metal CEM was developed using x-ray fluorescence (XRF) as the analytical method and an automated sampling system that provides extractive batch sampling onto a filter tape. The system is operated with user-friendly WonderWare software that provides automation, calibration routines, and report generation. A prototype XCEM was tested in the laboratory with a spiked gas stream against U.S. EPA Reference Method 29 for four sample runs. The XCEM met the relative accuracy criteria for four of seven metals. A field-ready XCEM was built for demonstration at the 1236 Deactivation Furnace at Tooele Army Depot, UT.

A Yeast-Based Cytotoxicity and Genotoxicity Assay for Environmental Monitoring Using Novel Portable Instrumentation
Knight, A.W., P.O. Keenan, N.J. Goddard, P.R. Fielden, and R.M. Walmsley.
Journal of Environmental Monitoring, Vol 6 No 1, p 71-79, 2004

This paper describes an assay capable of simultaneously measuring both general toxicity and more subtle genotoxicity in aqueous environmental samples. The assay uses eukaryotic (yeast) cells, genetically modified to express a green fluorescent protein whenever DNA damage (as a result of exposure to genotoxic agents) is repaired. A measure of the reduction in cell proliferation is used to characterize general toxicity, producing EC50 and LOEC data. The assay protocol is designed for use in the field and dedicated, portable instrumentation has been developed to support it. Solutions of metal ions, solvents, and pesticides have been evaluated using the assay. The authors present preliminary data comparing the yeast assay's response to that of a standard Daphnia test in the analysis of the toxicity of 34 varied industrial waste effluents.