DTSC Remediation Symposium — Highlights

BY JENNIFER NYMAN, MALCOLM PIRNIE, INC.

The California Department of Toxic Substances Control (DTSC) hosted a free, public Remediation Technology Symposium from May 14 through May 16, 2008, in Sacramento and via webcast. The event was co-sponsored by United States Environmental Protection Agency (U.S. EPA) Region 9. It was presented in cooperation with the Groundwater Resources Association (GRA) of California and the Geology Department of California State University, Sacramento, and was attended in person by over 200 environmental professionals and via webcast to over 100 participants.

The symposium was the result of a unique collaborative effort of industry, academia and government. **Brian Lewis** of DTSC, a GRA Director, led the organization of the symposium, which was initiated by DTSC Director Maureen Gorsen. He was supported by DTSC Chief Engineer Watson Gin, and industry representatives Steve Figgins of Brown and Caldwell,

Michael Kavanaugh and Jennifer Nyman of Malcolm Pirnie, Inc., Murray Einarson of AMEC Geomatrix, and John Sankey of True Blue Technologies, Inc.

The first two days of symposium presentations were held at the California Environmental Protection Agency Headquarters Building in Sacramento. An impressive lineup of speakers from industry and academia presented overviews and recent updates for site characterization and remediation technologies and linked the use of those technologies to successful remedial design. The final day of the symposium, May 16, was held outdoors at California State University, Sacramento, and provided vendors an opportunity to demonstrate the latest equipment and technologies for drilling, site characterization and remediation.

DTSC and its co-sponsors and cooperators appreciate the participation of the following industry representatives who shared the latest in remediation technology during the symposium through their displays and discussions with attendees during symposium breaks and receptions: Thermal Remediation Services, CETCO Liquid Boot Company, Regenesis, EOS Remediation, Boart Longyear, Blaine Tech Services, Inc., RSI Drilling, AMEC Geomatrix, and Brown and Caldwell.

Information on the symposium, including slide presentations, videos of presentations, photos, speaker biographies and links to websites for participating vendors, is available at www.dtsc.ca.gov/HazardousWaste/Remediation.cfm.

Symposium Summary

Watson Gin, DTSC's Chief Engineer, opened the symposium the first day by describing the overwhelming interest in the event. He discussed the recent reorganization of cleanup programs within DTSC into a single Cleanup Program, which brings together all the resources needed for cleanup, incorporates the priorities of the former programs and provides opportunities for improvements and enhanced efficiencies. Mr. Gin then spoke about the transformation of remedial technologies over time, and emphasized the current availability of green technologies for remediation, such as *in situ* approaches, to be covered during this symposium and in a subsequent public DTSC symposium.

The first technical session of the symposium addressed characterization methods for successful remedial design. **Murray Einarson** of AMEC Geomatrix presented advances made in site characterization and monitoring over the past 30 years from high-resolution field research. Key advances in knowledge included the spatial and temporal variability in dissolved contaminants, the presence of non-aqueous phase liquids (NAPLs), limitations of hydrodynamic

Vironex displays the CPT/MIP technology during the field demonstration day.

mixing transverse to flow, consideration of aquifer contamination versus groundwater contamination and the importance of biochemical reactions. Mr. Einarson emphasized the need for high-resolution site characterization and the depiction of plumes using cross-sections transverse to flow (in transects). The Triad approach, a second-generation investigation/cleanup strategy developed under the leadership of U.S. EPA, was then discussed by **Brad Call** of the Army Corps of Engineers, Sacramento. Mr. Call is a member of the U.S EPA-led Triad Community of Practice. He explained the procedures and benefits of three major Triad components: systematic planning (including development and continual refinement of the conceptual site model), dynamic work strategies and real-time measurements.

The final two talks of the session focused on specific site characterization methods. **Eliot Cooper** of Vironex discussed the Membrane Interface Probe (MIP). He outlined its advantages of providing high-resolution, real-time data on both soil lithology and a variety of volatile organic compounds with depth, and then presented case studies in which MIP was used in conjunction with *in situ* remediation to optimize amendment delivery to the subsurface and obtain effective amendment/contaminant contact. **Randy St. Germain** of Dakota Technologies, Inc. presented a new generation of optical sensors for characterizing NAPL source zones. Optical screening tools now have the capability to detect most fuels and oils, including creosotes and tars, at concentrations above 10 to 100 parts per million.

Michael Kavanaugh of Malcolm Pirnie, Inc., transitioned between site characterization and remediation by discussing decision-making for closure of contaminated groundwater sites. Dr. Kavanaugh reviewed technical obstacles to restoration of contaminated groundwater, including the presence of NAPLs, physical heterogeneity, contaminants in inaccessible regions, sorption and difficulties characterizing the subsurface, and he discussed regulatory initiatives recognizing these technical limitations and alternative end-points to groundwater restoration. Dr. Kavanaugh then outlined and discussed the following strategies to accelerate closure: aggressive source depletion technologies, the Triad approach, molecular biological and other diagnostic tools to accelerate the transition to monitored natural attenuation (MNA), risk assessment to identify low-risk sites and the use of land-use controls. Matrices to assist in decision-making for remedy selection are publicly available in U.S. EPA and National Research Council (NRC) documents.

The final session of the day, on *in situ* aeration-based remedial approaches, was delivered by **Paul Johnson** of Arizona State University. Dr. Johnson reviewed the

principles of *in situ* soil vapor extraction, bioventing, air sparging, and oxygen delivery for aerobic biodegradation; the settings in which each should be used; factors affecting performance of each technology; and how to apply the technologies cost-effectively. His work on *in situ* air sparging concluded that air distribution is highly sensitive to subtle changes in soil structure, making predictions of air distributions and long-term performance of air sparging difficult.

The second day included an extended session on *in situ* remediation technologies and an expert panel discussion with questions from the audience. As the first speaker, **Doug Mackay** of the University of California, Davis provided an overview of natural and enhanced bioremediation of groundwater contamination from fuels. Dr. Mackay described why many benzene, toluene, ethylbenzene and xylene (BTEX) plumes have enough distance along their flowpaths to naturally degrade below levels of concern, and how vertical mixing can enhance the natural attenuation by contacting the fuel contaminants with electron acceptors required for microbial degradation. He also discussed the most effective ways to amend oxygen to aid in the degradation of gasoline oxygenates, which are very mobile in groundwater and often extend beyond the BTEX plumes. **Ryan Wymore** of CDM next presented recent progress in the bioremediation of chlorinated solvent dense NAPL (DNAPL) source areas. He reviewed experimental and field studies supporting potential advantages of bioremediation for partial depletion of DNAPL sources, such as destruction of contaminants *in situ* and enhanced mass transfer of chlorinated solvents from the NAPL phase to the aqueous phase. **Lisa Alvarez-Cohen** of the University of California, Berkeley, continued the topic of bioremediation with her talk on the application of molecular tools to optimize bioremediation. Dr. Cohen discussed the key role of *Dehalococcoides* organisms in the bioremediation of chlorinated solvents and the use of molecular tools to identify these organisms, confirm the function of dechlorination and characterize microbial communities. She concluded molecular tools can aid in determining when biostimulation will work, when bioaugmentation is necessary and how to optimize the growth of *Dehalococcoides* at chlorinated solvent sites.

After the discussion of the bioremediation of fuels and chlorinated solvents, **Evan Cox** of Geosyntec Consultants, Inc. addressed the remediation of perchlorate. He first reviewed treatment techniques for perchlorate in groundwater, including the *ex situ* techniques of ion exchange, bioreactors and granular activated carbon, and the *in situ* treatment techniques of metal-catalyzed reduction and bioremediation. He then presented a case study of successful treatment of a perchlorate plume with biobarriers. The second half of Mr. Cox's presentation addressed treatment techniques for perchlorate in soil, including *ex situ* composting and *in situ* bioremediation.

Brian Lewis, Program Chair and GRA Director, and DTSC Director Maureen Gorsen make closing remarks at the DTSC Remediation Symposium.

Wilson Clayton of Aquifer Solutions, Inc. spoke on the basics, theory, design and application of *in situ* chemical oxidation. He reviewed advantages and disadvantages of the approach and summarized the major oxidants used in groundwater remediation. Dr. Clayton emphasized the importance of effectively delivering and transporting the oxidant in the subsurface to react with the contaminant of interest. An iterative design process is required to obtain successful contact between the oxidant and contaminant.

The final speaker of the symposium was **Michael Basel** of Haley & Aldrich, Inc., who presented the evolution of thermal technologies for remediation, the details of three thermal technologies, and recent advances in thermal remediation. Thermal technologies treat a wide variety of contaminants under many conditions via *in situ* destruction, enhanced mass removal and/or acceleration of *in situ* reactions. Dr. Basel emphasized that thermal technologies are efficient and cost-effective if applied under the appropriate conditions; each type of thermal treatment works optimally under specific conditions, and each has its own challenges.

During the presentations, audience members were invited to submit questions, which were presented for discussion to an **expert panel** composed of Watson Gin, Ryan Wymore, Steve Figgins, Evan Cox, Doug Mackay and Randy St. Germain. Many questions regarded the limitations or applicability of specific remedial technologies. The panelists recognized limitations to most of the *in situ* technologies in fractured rock environments and technical challenges to achieving drinking water standards in NAPL source areas. They also concurred that inappropriate application of some technologies, such as air sparging, can mobilize contaminants.

Maureen Gorsen, DTSC Director, concluded the indoor presentations by acknowledging the superior contributions of the speakers, the work of the organizing committee and the attentiveness of the audience. She supported the symposium as an investment in DTSC's personnel and all those involved in site remediation.

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The third and last day of the symposium, held outdoors at California State University, Sacramento consisted of remediation technology field demonstrations by vendors. Technology demonstrations from seven vendors were 30-minute formal presentations with equipment demonstrations to groups of about 20 participants, with interactive question and answer sessions following the demonstrations. Participants rotated through the circuit of seven presentations. Shade canopies, chairs and refreshments helped mitigate the unseasonably hot weather. Field presentations were followed by a group lunch, allowing scientists and vendors to continue the lively information exchange.

Vendor presentations included EOS Remediation bioaugmentation and biostimulation products; Blaine Tech groundwater sampling technical services with demonstration of low-flow sampling using their custom-built sampling truck; Environmental Bio-Systems molecular oxygen diffusion systems for enhanced bioremediation; CETCO Liquid Boot soil vapor barrier system installation demonstration; Boart Longyear drilling and soil core recovery using a 300-series sonic drill rig; RSI Drilling compact sonic drill rig demonstration showcasing the latest generation of small-footprint sonic drill rigs; and Vironex remediation services including a direct-push cone penetrometer test (CPT)/Membrane Interface Probe (MIP) data acquisition demonstration and a detailed review of their custom-built chemical oxidation/biostimulation chemical mixing and injection service truck.

Dr. Jennifer Nyman is an environmental engineer in the Emeryville office of Malcolm Pirnie, Inc. specializing in the characterization and remediation of groundwater and sediment. She is an expert on the geochemistry and microbial transformations of metals in the subsurface.

Photographs are by Dr. John Karachewski of DTSC.