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EPA Ground Water Currents

Developments in innovative ground water treatment

UNIQUE FIELD LABORATORY TO RESEARCH PLANNED AQUIFER RELEASES

The Groundwater Remediation Field Laboratory (GRFL), located at Dover Air Force Base, Delaware is the first facility in the United States where researchers can conduct carefully planned contained releases of chlorinated solvents and fuel into a natural aquifer. It is the second such faciility in the world. GRFL is part of the National Environmental Technology Tests Sites Program (NETTS) which was established under and funded by the Strategic Environmental Research and Development Program (SERDP) to enable efficient and relevant demonstrations of innovative and emerging clean-up technologies. SERDP is a multi-agency program to respond to the environmental requirements of the military and those problems that they share with the Department of Energy and EPA.

The GRFL provides a test bed and infrastructure for evaluating the transport of dense non-aqueous phase liquids (DNAPL) contamination in ground water and soil and for the demonstration and verification of remediation and monitoring technologies. The GRFL allows for detailed evaluation of emerging technologies by conducting contained release experiments. These experiments allow researchers to conduct mass balance type studies in a controlled field setting. The results of these studies will provide information necessary to design and engineer improved treatment systems for contaminated soils and ground water. The State of Delaware Department of Natural Resoures and Environmental Control has issued a permit to GRFL under Title 7 Chapter 60 of the State Code.

The first experiment will look at the co-oxidative bioventing of a mixture of jet fuel and chlorinated solvents. This technology, if successful, will have wide application to the remediation of mixtures of organic compound in the vadose zone and may represent a cost effective remediation tool.

Here is the history of the construction of the GRFL. The site characterization effort involved a complex, integrated program of field and laboratory studies to analyze a broad range of hydrogeological and biogeochemical properties. The characterization effort was broken into two phases with multiple tasks. Tasks included: surface geophysics, cone penetrometer survey and soil borings, laboratory analyses of soil properties, pumping test, tracer test, unsaturated hydraulic conductivity, air conductivity and a 3-D ground water model.

Surface geophysical studies were performed on a 10 meter grid that was established at the site. Geophysical surveys included ground penetrating radar (GPR), high resolution seismic, surface resistivity and low frequency electromagnetics. These studies were completed by a team of researchers and consultants including Applied Research Associates, the University of Delaware and the Air Force Phillips Laboratory. All the surface geophysical data produced similar results on site geology. The site consists of a water table aquifer 11 to 14.5 meters thick underlain by an aquitard which ranges from 8 to 12 meters thick. The water table is approximately 8 meters below ground surface.

Soil samples were sent for analyses of physical, chemical, microbiological,

(continued on page 3)

This Month in Currents

SPECIAL INSERT
Do not miss the special insert in this issue of Currents.

ISSUES

The EPA Regional Ground Water Forum is a group of EPA professionals representing Regional Superfund and Resource Conservation and Recovery Act Offices committed to the identification and resolution of ground water issues impacting the remediation of Superfund and RCRA sites. The Forum has three GROUND WATER ISSUE publications of interest to the readers of GROUND WATER CURRENTS related to nonaqueous phase liquids (NAPLs) and low-flow sampling. All of these publications can be ordered by calling the Center for Environmental Information (CERI) at 513-569-7562 and referring to the Document Numbers (given below).

"Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling and Remediation" (Document No. EPA/540/S-95/503) provides a comprehensive literature review regarding the compatibility of NAPLs with a wide variety of materials used at hazardous waste sites. A condensed reference table of compatibility data for 207 chemicals and 28 commonly used well construction and sampling equipment materials is provided. Field experiences illustrating incompatibility problems of common wastes are also included. This will assist monitoring and recovery system design personnel with the decision making process concerning the most effective materials to be used in heavily contaminated subsurface environments.

"Light Nonaqueous Phase Liquids" (Document No. EPA/540/S-95/500) contains a discussion of LNAPL transport. It addresses LNAPL transport through porous media and transport parameters such as density, viscosity, interfacial tension, wettability, capillary pressure, saturation and residual saturation and relative permeability. LNAPL migration at the field scale is discussed, including Darcy's Law, field scale versus pore scale, migration through the vadose zone, accumulation at the water table, smearing due to fluctuating water table, migration in fractured media and migration through man-made pathways. The publication also addresses the fate of LNAPLs in the subsurface, site characterization, LNAPL characteristics, sampling and remediation. Extensive references are provided.

"Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" (Document No.EPA/540/S-95/504) is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA regional personnel and other environmental professionals engaged in ground water sampling. It addresses monitoring objectives and design considerations, definition of low-flow purging and sampling, low-flow (minimal drawdown) sampling protocols, low-permeability formations and fractured rock and contains a list of scientific/technical references.

NEW FOR THE BOOKSHELF

Two new documents from the State perspective have been published. Both deal with injectants. EPA has also published a manual on ground water and leachate systems. A brief description of each is given below.

SURFACTANT INJECTION FOR GROUNDWATER REMEDIATION: STATE REGULATORS' PERSPECTIVES AND EXPERIENCES (EPA Document No. EPA 542-R-95-011). This report is based on a series of interviews with State regulators involved in the review and approval of applications for demonstrations or applications of surfactant technologies for the remediation of ground water. The report focuses on identifying specific technical issues, non-technical problems, training and technical or policy needs that would contribute to improving the use of in situ surfactant enhancements. The goal of the study was to identify barriers and describe successes in gaining State regulatory approval, in order to promote understanding among various stakeholders vital to developing this important technology. The publication can be ordered from the National Technical Information Service (NTIS) (Order No. PB96164546), 5285 Port Royal Road, Springfield, VA 22161 (telephone number: 703-487-4650).

STATE POLICIES CONCERNING THE USE OF INJECTANTS FOR IN SITU GROUND WATER REMEDIATION (EPA Document No. EPA-542-R-96-001). This report is based on information about State policies and regulatory programs affecting demonstrations or use of injectants for the remediation of contaminated ground water. The report focuses on identifying specific State regulatory and policy barriers to the use of techniques that enhance in situ ground water treatment technologies

(continued on page 3)

REGULATORY CLOSURE AFTER INNOVATIVE TECHNOLOGY REMEDIATION

At the Lawrence Livermore National Laboratory (LLNL) in Livermore, California, environmental regulatory agencies have concurred that remediation of gasoline contaminated soil above the water table is complete. This is the first formal regulatory closure of a non-excavation cleanup activity at the Laboratory's Livermore site since cleanup began in 1988. A relatively inexpensive innovative technology known as Dynamic Underground Stripping was used to clean up 29,000 liters of gasoline that leaked into the ground from an underground gasoline storage tank a number of years ago. Researchers from LLNL and the University of California (UC) at Berkeley teamed up to demonstrate a unique and new combination of technologies that comprise Dynamic Underground Stripping. The process employs vapor extraction during underground steaming and electrical heating. The heat is applied by steam and electricity to vaporize trapped contaminants in the soil.

Once vaporized, the contaminants are removed by vacuum extraction. The processes are monitored and guided by underground imaging. Dynamic stripping removed most of the gasoline (29,000 gallons) in only nine months of active time and at a cost $11 million for treatment and the supporting research. It is estimated that the same cleanup would now cost $6 million over six months. This is in contrast to excavation biodegradation that would have taken a year and cost about $30 million. Pump and treat activities have been estimated to take 200 years at this site with cost ranging from $20 million to $60 million.

The U.S. EPA, the California Department of Toxic Substances Control and the Regional Water Quality Control Board-San Francisco Bay Region concluded that soil cleanup efforts above the water table at the site of the gasoline spill were no longer necessary and that the soil remediation efforts have met or exceeded "Applicable or Relevant and Appropriate Requirements" as stated in the Livermore Site Record of Decision agreed to by the regulatory agencies in 1992. Cleanup of contaminated ground water continues.

For more information, contact Gordon Yano at 510-423-3117.

(continued from page 1)

mineralogical properties by the Air Force Wright Lab, the University of Delaware and Virginia Polytechnical Institute and State University. Results of these studies show the water table aquifer to consist of a fining upward sequence overlain by a coarsening upward sequence of fine to medium sands with varying amounts of silt, clay and gravel. The soils are slightly to moderately acidic and have relatively low cation exchange capacities due to low clay contents and the predominance of kaolinite in the clay fraction. The microbiological study indicated that both the total population and activity of microorganisms decreases with depth. Samples from the aquitard were determined to be silty clays and clayey silts with significant amounts of montmorillonite clay.

Infrastructure at the site consists of a doubled walled sheet pile test cell, an on-site trailor mounted cone penetrometer system, and a GIS

(continued on page 4)

(continued from page 2)

through the use of injecting surfactants, co-solvents and nutrients. The goal of the study was to identify institutional barriers that may inhibit the use of injectants. The study briefly describes experience and policies of each state and provides a contact person who can provide additional information. The publication can be ordered from NTIS (Order No. PB96-164538) at the address and number above.

MANUAL: GROUNDWATER AND LEACHATE TREATMENT SYSTEMS (EPA Document No. EPA/625/R-94/005) This manual was developed for remedial design engineers and regulatory personnel who oversee the ex situ ground-water or leachate treatment efforts of the regulated community. The manual can be used as a treatment technology screening tool in conjunction with other references. More importantly, the manual briefly presents technical considerations (or concepts) for use when evaluating, designing or reviewing a system design for the treatment of contaminated ground water or leachate from land disposal operation. It is not intended for use as a detailed design manual for specific technologies. For Superfund applications, readers should follow the presumptive guidance for contaminated ground water that EPA's Superfund program has issued. The manual can be ordered from the Center for Environmental Research Information at 513-569-7562

(continued from page 3)

based data acquisition and control system (DACS).

A modular building was set up to provide on site office and laboratory capabilities for the permanent GRFL staff and visiting principle investigators.

The sheet pile test cell was constructed using the patented Waterloo Barrier Sealable Joint Sheet Pile. The test cell is approximately 5 by 10 meters and surrounded by a second 7 by 12 meter cell of the same construction. Although unique groutable joints require the box to be built above ground, it is keyed into underlying aquitard 12 meters below ground surface. Once construction is completed, the joints are flushed and grouted to ensure a complete seal. An average hydraulic conductivity for the test cell has been determined to be in t 10E-9 cm/sec range. After construction of the test cell i complete, the cell is cov red with a temporary st cture to prevent rain wate from infiltrating the cell. T is allows for better cont ol of environmental facto s affecting a remedi-ation process. The Air Force's n w trailer mounted cone p netrometer (CPT) unit is c apable of in talling wells and collecting soil samples within the confines of the test cells. The CPT system has the capability of conducting CPT tests for soil type; collecting soil, water and soil gas samples; and installing monitoring wells up to 2 inches in diameter.

The DACS will collect and maintain a data base of all experimental data and has the ability to perform some control functions for experiments in the field. The DACS may be remotely accessed to provide researchers not on site with real time data. The office laboratory contains an area for sample preparation and has an HP6890 GC with ECD and FID detectors for analyses of soil, water or soil gas.

The Dover NETTS site provides support to environmental technology demonstrations at various sites around Dover Air Force Base. Additionally, GRFL has participated in the Partnership for Peace program by hosting visiting scientists and engineers from North Atlantic Treaty Organization (NATO) members and Eastern European countries.

For more information, call GRFL's Principal Investigators Mark Noll at 302-677-4147 and/or Alison Thomas at 904-283-6303.

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To get on the permanent mailing list for Technology Innovation Office publications or to order additional copies of this or previous issues of Ground Water Currents, send a fax request to the National Center for Environmental Publications and Information (NCEPI) at 513-489-8695, or send a mail request to NCEPI, P.O. Box 42419, Cincinnati, OH 45242-2419. Please refer to the document number on the cover of the issue if available.
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(continued from page 3)

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After construction of the test cell is complete, the cell is covered with a temporary structure to prevent rain water from infiltrating the cell. This allows for better control of environmental factors affecting a remediation process.

The Air Force's new trailer mounted cone penetrometer (CPT) unit is capable of installing wells and collecting soil samples within the confines of the test cells. The CPT system has the capability of conducting CPT tests for soil type; collecting soil, water and soil gas samples; and installing monitoring wells up to 2 inches in diameter.

The DACS will collect and maintain a data base of all experimental data and has the ability to perform some control functions for experiments in the field. The DACS may be remotely accessed to provide researchers not on site with real time data. The office laboratory contains an area for sample preparation and has an HP6890 GC with ECD and FID detectors for analyses of soil, water or soil gas.

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