United States Environmental Protection Agency

Solid Waste Emergency Response (5102W)

EPA 542-N-94-006
August 1994

EPA

TECH TRENDS

The Applied Technologies Journal for Superfund Removals & Remedial Actions & RCRA Corrective Actions

Unique Multi-Vendor Bioremediation Demonstration Begins

VOC's
Bioremediation
Soil
Ground Water

By James B. Harrington,
New York State Department of Environmental Conservation

Three pilot-scale bioremediation studies are being conducted concurrently at the same site, the Sweden 3 - Chapman inactive hazardous waste site in the Town of Sweden, Monroe County, New York, as part of a Multi-Vendor Treatability Demonstration of Bioremediation Technologies (MVTD). Having three vendors working concurrently on the same site, each using a different biotechnology, is quite unique. The purpose of the project is to demonstrate the application of innovative technologies utilizing bioremediation for treatment of soils contaminated with volatile organic compounds (VOCs). The 12-month pilot-scale demonstration is being jointly sponsored by the New York State Department of Environmental Conservation (NYSDEC), the New York State Center for Hazardous Waste Management (NYS Center) and the U.S. Environmental Protection Agency's Superfund Innovative Technology Evaluation (SITE) Program.

The objectives of the MVTD demonstration are to: (1) demonstrate that use of naturally occurring microorganisms can be effective in remediating a hazardous waste site in New York State; (2) generate field data to allow the simultaneous comparison of different biological processes; (3) permit an evaluation of in-situ and ex-situ approaches; and (4) evaluate the performance of each biological approach in meeting the clean up goals established for the site.

The three vendors and the technology that each will demonstrate are: (1) SBP Technologies, Inc. and Environmental Laboratories, Inc. UVB (Vacuum-Vaporized Well) system; (2) the R.E. Wright Associates, Inc. In-Situ Field Bioremediation Treatment System; and (3) the ENSR Consulting and Engineering and Larson Engineers Ex-Situ Biovault. The first process consists of a specially adapted ground water well,

Multi-Vendor continued on page 3

VISITT Database Plus Immunochemistry Insert

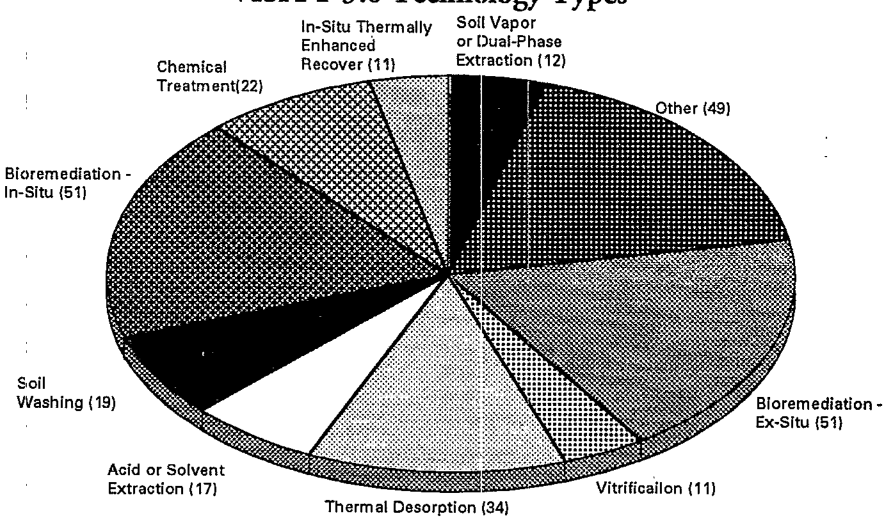
VISITT. EPA announces VISITT 3.0, the latest update of its Vendor Information System for Innovative Treatment Technologies database. In addition to adding 47 new vendors, VISITT 3.0 updates information for most of the 141 vendors in its predecessor, VISITT 2.0. Altogether, there are 171 companies offering 277 technologies in 31 categories, of which 201 are full-scale and commercially available. VISITT gives you information about equipment, performance costs and project experience. (See graph, this page, for summary of contents.)

VISITT 3.0 is available free of charge. To order, send your name, address and diskette size (5-1/4 or 3-1/2 inch) to EPA/NCEPI either by FAX (513-891-6685) or by mail (NCEPI, 11029 Kenwood Road, Building 5, Cincinnati, OH 45242-0419) and ask for Document No. EPA 542-N-94-003.

VISITT also can be downloaded on EPA's Cleanup Information Bulletin Board System (CLU-IN). To access CLU-IN by modem, call 301-589-8366; or, to contact the CLU-IN Help Desk call 301-589-8368.

IMMUNOCHEMISTRY. Don't miss the four page special insert in this issue. It contains valuable information on immunochemical analysis of environmental samples.

VISITT 3.0 Technology Types



Source: U.S. EPA, VISITT Database, June 1994

EX-SITU BIOREMEDIATION OF TNT, DINOSEB & OTHER PESTICIDES/ HERBICIDES

By Wendy Davis-Hoover, Risk Reduction Engineering Laboratory

Pesticides, Herbicides, TNT
Bioremediation
Soil/Liquid

The J. R. Simplot Ex-situ Anaerobic Bioremediation System is a technology designed to destroy nitroaromatic compounds without forming any toxic intermediates. The process can successfully operate with bioreactor temperatures as low as 18 degrees Centigrade, much below optimum. The EPA SITE (Superfund Innovative Technology Evaluation) Program has evaluated the Simplot system's destruction of the herbicide, dinoseb (2-sec-butyl-4,6 dinitrophenol), at Bowers Field, an airport in Ellensburg, Washington with a site contaminated by crop dusters. The SITE program has also evaluated the destruction of TNT (2,4,6-trinitrotoluene) at the Weldon Spring site in St. Louis, Missouri.

In the Bowers Field demonstration, the Simplot process reduced the levels of dinoseb by greater than 99.88%, to below detection limits, from an average pretreatment concentration of 28 milligrams per kilogram (mg/kg) of feed soil. No known toxic products were found in the analysis of the post-treatment samples. Other pesticides (nitroanaline, malathion, atrizine and parathion) were also reduced in the treated slurry.

In the Weldon Spring demonstration, TNT was reduced by greater than 95% to below 1 ppm for most soil samples, from an average pretreatment soil concentration of 1,500 ppm on a dry weight basis. No known toxic metabolites were seen; and, toxicity tests are ongoing.

Usually under aerobic conditions, degradation of nitroaromatic compounds form products that are toxic. However, the Simplot system treats contaminated soils (or liquids) using an anaerobic consortium of soil microorganisms. Anaerobic degradation of nitroaromatics takes place without the formation of these toxic products.

The J. R. Simplot technology mixes a carbon source with contaminated soil and then adds water and a phosphate buffer to create a buffered slurry. This prompts aerobic microorganisms to consume the carbon source and oxygen, thus lowering the redox potential of the slurry and creating anaerobic conditions. Anaerobic microorganisms then consume the targeted toxins present in the slurry.

The mechanics of the process begin with excavated soil being sent through a vibrating screen to remove large rocks and other debris. The rocks and debris are washed to remove surface contamination. For the dinoseb process, this rinse water is combined with make-up water and added to the bioreactor. (TNT is not very water soluble; thus, these rocks are treated in a different manner.)

For both dinoseb and TNT, soil which has been seived is added to the bioreactor with water to provide one liter of water for each kg of soil to be treated. A phosphate buffer is added to the system to control the pH to around 7 pH. Batches of soil and potato starch (2% by weight) are homogenized together and added to the bioreactor until the system is 75% full. According to laboratory studies, optimum conditions for dinoseb degradation are temperatures of 30 and 35 degrees Centigrade with a pH between 7 and 7.5. The optimum temperature range for TNT is also 30 and 35 degrees Centigrade with an optimum pH of 6 to 7.

The technology is suitable for soils and liquids contaminated with nitroaromatic compounds. However, the medium to be treated must be free of toxic metals or any other compounds that may be detrimental to the appropriate microorganisms.

An Innovative Technology Evaluation Report describing the complete dinoseb demonstration and other pertinent information will be available in the fall of 1994. An Innovative Technology Evaluation Report describing the TNT demonstration will be available in the winter of 1995.

For more information call Wendy Davis-Hoover at EPA's Risk Reduction Engineering Laboratory at 513-569-7206.

DATA MANAGEMENT SYSTEM INTEGRATES SOFTWARE FOR SUPERFUND SITES

By Richard G. Eilers, Risk Reduction Engineering Laboratory

Managers of Superfund sites and Resource Conservation and Recovery (RCRA) facilities now have a new tool to assist in the graphical characterization and data management at contaminated soil and ground water sites. The GIS\Key™ Environmental Data Management System is a software system that integrates proven software under a single shell. This integration allows database management activities that would otherwise be more difficult or costly to perform because it singly meets needs typically requiring multiple, independently run pieces of software. The SITE (Superfund Innovative Technology Evaluation) Program evaluated GIS\Key™ because of its applicability to all Superfund sites. The system can meet industry needs and satisfy hazardous waste site reporting requirements for soil and ground water contaminants; but, it cannot manage ecological assessment or air pollutant data.

The SITE evaluation assessed the software performance and accuracy of GIS\Key™ output. The GIS\Key™ procedures were reviewed to ensure the data integrity, to evaluate general usability and to compare GIS\Key™ features to user requirements.

Here are the strong points. GIS\Key™ facilitates the collection, reporting and analysis of site management data by producing a variety of site-specific tables, graphs and maps. The software can successfully generate four types of contour maps to assist in ground water mapping: (1) hydrogeologic maps; (2) chemical concentration isopleths; (3) geologic structure maps; and (4) geologic structure thickness isopach maps. With GIS\Key™, menu commands can yield several standard chemistry reports and construction and borehole summary tables. The system also can prepare well and borehole logs based on the information in the database. Among its capabilities are geologic cross sections, boring logs, potentiometric maps, isopleth maps, structure maps, summary tables,

Software continued on page 4

United States
Environmental Protection
Agency

Environmental Monitoring
Systems Laboratory
P.O. Box 93478
Las Vegas NV 89193-3478

January 1994

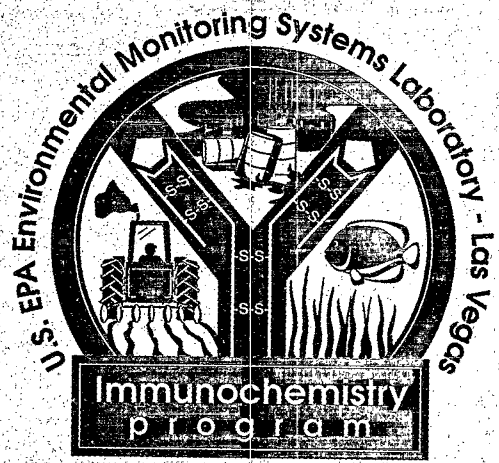
OFFICE OF RESEARCH AND DEVELOPMENT

TECHNOLOGY SUPPORT PROJECT

EPA

Immunochemical Analysis Of Environmental Samples

An EMSL-LV Innovative Technology



The Need

Field methods used for detecting compounds of environmental significance traditionally have been derived from standard laboratory methods. When laboratory methods are adapted to the field, they are often relatively slow, insensitive, expensive, and require bulky transportable equipment and skilled operators. There is a need for rapid, sensitive, low-cost, portable, and simple field methods for analysis of environmental samples. Immunochemistry offers those advantages. The only specialized equipment needed is a spectrophotometer, microtiter plates or test tubes, precision pipets, and immunologic reagents.

Commercial manufacturers sell kits for field screening, and new equipment and methods are being developed for rapid, accurate field analysis of a wide variety of analytes, such as heavy metals, dioxins, and PCBs, that are found at Superfund and RCRA sites. As a result the regulator and regulated communities view immunochemistry as a powerful technology for screening analysis of environmental contaminants.

Immunochemistry includes techniques such as immunoaffinity chromatography and immunoassay. Sample preparations based on immunoaffinity take advantage of the attraction between an antibody and a specific analyte. The procedure has great potential for cleanup of complex samples like soils and sludges. By rinsing a sample over an antibody-treated surface, chemists can isolate particular compounds that adhere to the antibody. The isolated compound is then eluted from the immobilized antibody and is ready for analysis by chromatography or immunoassay. One common immunoassay is the enzyme-linked immunosorbent assay (ELISA). In this technique, the selectivity of the antibody for the analyte and the resultant antibody-analyte complex is the basis for the specificity of immunoassays.

9311-0146EX93ODC
Recycled/Recyclable
Printed with Soy/Canola Ink on paper that contains at least 50% recycled fiber

The Use

The Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV) is pioneering an investigation into the usefulness of immunochemical techniques for monitoring the extent of contamination in environmental and biological matrices. EMSL-LV has developed and demonstrated several of these techniques and believes that they hold great promise for the quantitative analysis of target analytes for use in ground-water surveillance, *in situ* hazardous waste site monitoring, and assessment of human exposure. Current work involves the analysis of chemicals like PCBs, nitroaromatics, and certain pesticides that are difficult to analyze by other analytical methods. EMSL-LV has sponsored two national meetings that focused on regulatory issues and technological advances in environmental immunochemistry. These meetings brought together government, industry, and university scientists to discuss problems of mutual interest in the field.

A 1993 Technology Support Center project at a Superfund site in Region 5 demonstrated the usefulness of immunochemical methods for screening PCBs in soil and river sediment. This project was an example of cooperation between EPA, DOE, the state of Michigan, and various contractors. Two immunoassays and a chloride-ion specific electrode were used on site and the real-time analytical results were compared with standard GC results from EPA method 8081. Preliminary results show good agreement between the immunoassays and GC and even stronger correlation could be achieved with tighter quality control measures.

In addition, other EPA offices have applied immunochemistry for screening and analysis in their programs. The Office of Water has used immunoassays to screen indirect discharges of specific analytes for permitting under the Clean Water Act (304h). Sample analysis data may soon be used for comparison and compliance monitoring within selected industries, such as commercial laundries. The Office of Pesticides is looking at ways to shorten the pesticide registration process by using immunochemistry as a cost-effective technology.

Other government agencies and universities are studying immunochemical methods. The Food and Drug Administration (FDA) may use immunoassays to obtain data for the calculation of safe concentrations of residues. A recent university project used immunoassays to track contamination during the 1993 Midwestern flood. In applications as diverse as organic geochemistry and military operations, immunochemical methods have been used for volatile organic compound measurement. The U.S. Department of Agriculture (USDA) is integrating immunoassays into rapid test procedures for detection of residues in meat and poultry. Results from these tests will be used in regulatory and compliance programs for veterinary drugs, sanitation, and pest control. The National Institute for Occupational Safety and Health (NIOSH) has applied immunoassays to herbicide research, clinical analysis, biomarkers, and immune biomonitoring. They use the methods to detect morphine factor, alachlor, atrazine, cyanazine, metalachlor, and 2,4-D. State laboratories have analyzed soil samples and water from private wells using immunochemical test systems for triazine (atrazine) samples.

The results of EPA's Superfund Innovative Technology Evaluation

The Use (continued)

(SITE) studies indicate a strong correlation between field immunoassays, laboratory immunoassays, and gas chromatography-mass spectrometry.

Another field use of immunochemistry that is being explored at EMSL-LV, the personal exposure monitor (PEM), may revolutionize safety and exposure requirements for workers who deal with hazardous chemicals. Immunochemical dosimeter badges can be used to detect pentachlorophenol and nitroaromatics, and are being developed for parathion and chloropyrifos. These badges are lightweight, inexpensive, quick, and provide a real time indication of exposure.

The Limits

The use of immunochemical techniques is gaining acceptance in the environmental sciences. One need that is being addressed is that of specificity. Frequently, immunoassays are available for a class of compounds, like PCBs. Specific quantitation for each component has been difficult.

The development of PEMs, for example, must address the question of diffusion of chemicals through a semipermeable membrane, the optimum concentration of the antibody, detection limits of the PEM and quantitation by immunoassay, the efficiency of the antibody in capturing the analyte, and the capacity of the device.

Validation studies of reproducibility, matrix effects, field trials, false negatives/positives, and correlation with other tests will assist acceptance of immunochemical methods at Superfund and RCRA sites. The legal defensibility of immunochemical results is yet to be determined.

Advantages and limitations are summarized below.

Advantages	Limitations
• Field portable • User friendly • Quick and inexpensive • Potential for wide range of analytes • Useful for many matrices • Low detection limits	• Separate immunoassay needed for each analyte • More complex analysis required for quantitation of specific analytes • Long development time for new antibodies and methods

The Status

One new avenue of investigation is the use of antibody-coated, fiber-optic immunosensors. Another application is the integration of robotics capability for high sample throughput and the development of a tiered analytical approach, i.e., biological and environmental samples, biomarkers, target analytes, and degradation products. This system of analytical procedures will enable scientists to measure contamination at the source, follow the fate and transport of residual amounts, and assess

(continued on next page)

The Status (Continued)

human exposure. Multianalyte immunoassays that can identify several analytes are expected to expand the desirability of immunoassay technology for environmental use. Work in this area is already underway at EMSL-LV and elsewhere. Other applications of immunochemistry, such as multianalyte optical immunobiosensors and biorefractometry, are being developed.

Industry recently formed the Analytical Environmental Immunochemistry Consortium (AEIC), which is focussing on performance-based method guidelines, method validation, and formation of consensus on regulatory and technological issues. The National Technology Transfer Center (NTTC) offers a vehicle for collaborative studies. Cooperative Research and Development Agreements (CRADAs) between industry and the government can be used to promote technology development and licensing of immunochemical applications. The EMSL-LV has a Technology Transfer Office that is able to coordinate CRADAs for the development of immunochemical methods.

References

Immunochemical Methods for Environmental Analysis, J. M. Van Emon and Mumma, R. O., eds. ACS Symposium Series 442, Washington, DC, 1990, 229pp.

Immunochemistry Summit Meeting II, C. L. Gerlach and D. A. Fuccillo, reporters. September 1-2, 1993, Las Vegas, NV. Internal Report to EMSL-LV.

Immunochemical Methods for Environmental Analysis, J. M. Van Emon and V. Lopez-Avila, Anal. Chem., Vol. 64, No. 2, 1992.

For further information about the immunochemistry program at the EMSL-LV, contact:

Dr. Jeanette Van Emon
U.S. Environmental Protection Agency
Environmental Monitoring Systems Laboratory
P.O. Box 93478
Las Vegas, NV 89193-3478
(702) 798-2154

For information about using immunochemical methods at a Superfund or RCRA site through the EMSL-LV Technology Support Center, contact:

Mr. Ken Brown, Director
Technology Support Center
U.S. Environmental Protection Agency
Environmental Monitoring Systems Laboratory
P.O. Box 93478
Las Vegas, NV 89193-3478
(702) 798-2270

For information about the Technology Transfer Office at the EMSL-LV, contact:

Mr. Eric Koglin
U. S. Environmental Protection Agency
Environmental Monitoring Systems Laboratory
P.O. Box 93478
Las Vegas, NV 89193-3478
(702) 798-2432

COMMUNICATION • TRAINING • TECHNOLOGY SUPPORT
Technology Support Project

The Technology Support Center fact sheet series is developed by Clare L. Gerlach, Lockheed Environmental Systems & Technologies Company, Las Vegas

REQUEST FOR INFORMATION ON INNOVATIVE MIXED RADIOACTIVE AND HAZARDOUS WASTE TECHNOLOGIES

The U.S. Environmental Protection Agency (EPA) and the Departments of Energy (DOE), Interior and Defense, in conjunction with the Western Governors Association (WGA), are interested in information about innovative mixed radioactive and hazardous waste remediation technologies. The DOE is the lead Federal agency for the request for information. Below is a description of the specific information that is requested, followed by a description of the activities of the Federal government/WGA partnership.

DOE's Office of Environmental Management has been soliciting information from commercial companies and technology developers interested in demonstrating new and innovative technologies to accelerate the identification, treatment, remediation, storage or disposal of mixed radioactive and hazardous waste at Federal facilities in the western United States. The date set for interested parties to submit descriptions of specific cleanup technologies was September 30, 1994.

Submissions are to describe technologies which aid in the cleanup of high-level, transuranic or low-level mixed waste and facilitate the environmental restoration of contaminated soils, buried waste drums and/or ground water. The technology description, limited to five pages, addresses the following issues: (1) ability to alleviate risks to public health and safety and to the environment; (2) capacity for public acceptance; (3) potential permitting and regulatory barriers; (4) extent of private sector and multi-agency involvement; (5) potential for technology transfer or commercialization; (6) likelihood of successful demonstration, including an assessment of technical risks; (7) capacity for volume reduction of hazardous and radioactive components; (8) viability of final waste forms and treated secondary waste forms to gain public acceptance, be relatively stable and meet regulatory criteria; (9) magnitude of recycling and material recovery potential; and (10) ease of implementation to full scale initiative.

Information was to be submitted to Dr. George Coyle, Office of Technology Development, EM-50, U.S .Department of Energy, 1000 Independence Avenue, S.W., Room 5B-104, Washington, DC 20585 or faxed to 202-586-6773.

Based on the technology descriptions received by DOE, a formal Request for Proposal may be issued to focus on specific needs and site characteristics. DOE's formal notice of request for information, published in the FEDERAL REGISTER on June 2, 1994, is pursuant with the activities of the Federal Advisory Committee to Develop On-site Innovative Technologies (DOIT) Committee. The formation of the DOIT Committee, a fact-finding advisory group, is the result of the signing of a Memorandum of Understanding (MOU) among the Secretaries of the Departments of Defense, Energy and the Interior; the Administrator of EPA; and the Western Governors Association. The purpose of the MOU is to establish a more cooperative approach to the development of technical solutions to environmental restoration and waste management problems shared by states, commercial entities and the Federal Government. It is hoped that the regional approach will serve as a demonstration of principles and practices which may be adopted nationally.

In addition to identifying improved and innovative cleanup technologies, the DOIT Committee attempts to address all the issues needed for successful technology development and transfer, including: regulatory and institutional barriers; worker training and education; technical and financial needs and requirements; commercialization issues, procurement; and public and stakeholder participation.

Multi-Vendor continued from page 1

a negative pressure stripping reactor, an in-situ bioreactor and an above-ground vapor-phase bioreactor. This process focuses on removing volatile contaminants out of the soil above the water table as well as volatile contaminants in the ground water. The contaminants are then treated biologically. The second process utilizes bioventing technology where injection and extraction wells will allow the vendor to regulate oxygen and nutrient levels to stimulate the native bacteria in the soil into biodegrading the contaminants of concern. The third process is based upon the construction of two identical biovaults. Contaminated soils are placed in each biovault where nutrient, moisture and oxygen levels can be controlled. The first biovault is operated under aerobic conditions. The second biovault is operated back and forth between aerobic and anaerobic conditions.

These MVTD pilot-scale demonstrations will not interfere with on-going remediation at the site, where approximately 2,500 drums of hazardous waste and grossly contaminated soil have already been removed. The Record of Decision, signed in March 1994, specified excavation of contaminated soil with on-site treatment via Low Temperature Thermal Desorption; limited ground water remediation is also specified. If the MVTD project is successful, these technologies will be used to remediate the remaining contamination at the site.

The three vendors for the MVTD were chosen through a competitive process. Thirteen technical proposals were submitted in response to a formal Request for Proposal. After a review of those proposals, nine technology vendors were invited to submit bids. The three vendors selected began field work in July 1994.

The NYS Center coordinated the development of the protocol that was the centerpiece of the Requests for Proposals and will be on-site to document vendor progress and provide sample collection assistance. The SITE program will provide sample collection and analytical services, sampling protocol development and project reports. The NYSDEC developed the project and is leading it, providing management and funding for the treatment vendors and construction support services necessary to implement the study.

For more information, call Jim Harrington at NYSDEC at 518-485-8792.

hydrographs, chemical time series graphs, tables and other maps and line graphs that meet reporting requirements.

GIS\Key™ site maps typically start with digitized basemaps, including U.S. Geological Survey 7.5 minute quadrangle maps, to provide general topography and features such as streets, highways, schools and bodies of water. Site-specific features such as buildings and waste management units are then added. Project maps for Resource Conservation and Recovery Act (RCRA) hazardous waste facilities and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites are stored inside the regional basemaps and act as the visual starting points from which users can obtain specific chemical, geologic and hydrologic data for each map point. Environmental data for a project–chemical, geological and hydrological–are stored in the GIS\Key™ database. GIS\Key™ improves overall project data quality because it provides several validity and consistency checks. The chemistry module reviews chemical laboratory quality control data and parameters, checks site data against historical ranges and generates exception reports. Sample locations that provide values which fail QC objectives are visually indicated to the user and thus help to avoid the use of suspect data in maps and reports. The geology module includes lithology, user-defined formations and blow counts. The hydrology module includes derived aquifer parameters such as verticle and horizontal permeability. The database is linked to the other component of the geographical information system, GIS\Graphics. Data can be entered into the database either manually or electronically.

GIS\Key™ provides several editable reference lists, including a list of regulatory thresholds, test methods, chemical names, aliases and registry numbers. GIS\Key™ produces presentation quality graphics that are designed to be included directly into reports. The maps, sections and well logs require little or no editing. Third-party graphics' tools can be used to modify or enhance graphic output.

GIS\Key™ does not require specialized computer skills, but some specialized AutoCAD®, electronic data transfer and database management system skills are needed to make full use of it. The GIS\Key™ system is compatible with 386 and 486 microcomputers and runs on standard DOS and local area networks. The GIS\Key™ database menu provides commands for electronic database import and export; and, data subsets can be exported in a format compatible with EPA GRITS/STAT to conduct statistical routines that conform to RCRA guidelines.

For more information, call Richard Eilers at EPA's Risk Reduction Engineering Laboratory at 513-569-7809. An Innovative Technology Evaluation Report (Document No. EPA/540/R-94/505) and a Site Technology Capsule (Document No. EPA/540/SR-94/505) describing detailed results of the evaluation can be ordered by calling the Center for Research and Environmental Information (CERI) at 513-569-7562; please refer to the document numbers when ordering.

To order additional copies of this or previous issues of Tech Trends, or to be included on the permanent mailing list, send a fax request to the National Center for Environmental Publications and Information (NCEPI) at 513-891-6685, or send a mail request to NCEPI, 11029 Kenwood Road, Building 5, Cincinnati, OH 45242-0419. Please refer to the document number on the cover of the issue if available.

Tech Trends welcomes readers' comments and contributions. Address correspondence to: Managing Editor, Tech Trends (5102W) U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460

United States
Environmental Protection Agency
National Center for Environmental
Publications and Information
P.O. Box 42419
Cincinnati, OH 45242-0419

Offical Business
Penalty for Private Use $300

EPA 542-N-94-006