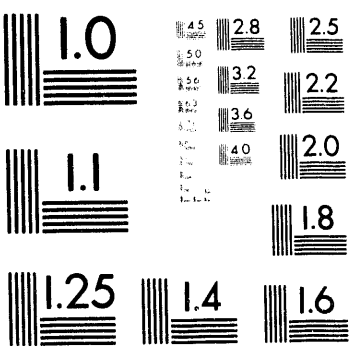
1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

1 of 2

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TECHNOLOGY PROJECTS FOR CHARACTERIZATION - MONITORING OF VOLATILE ORGANIC COMPOUNDS (VOCs)

Gregor A. Junk and Wm. J. Haas Jr.

Ames Laboratory*
Iowa State University
Ames, Iowa 50011-3020

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Office of Technology Development
VOC Arid Integrated Demonstration

Date Transmitted: July 1992

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MASTER

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ABSTRACT

One hundred thirty technology project titles related to the characterization of volatile organic compounds (VOCs) at an arid site are listed alphabetically by first contact person in a master compilation that includes phone numbers, addresses, keywords, and short descriptions. Separate tables are presented for 62 field-demonstrated, 36 laboratory-demonstrated, and 35 developing technology projects. The technology projects in each of these three categories are also prioritized in separate summary tables. Additional tables are presented for a number of other categorizations of the technology projects: In Situ; Fiberoptic; Mass Spectrometer; Optical Spectroscopy; Raman or SERS; Ion Mobility or Acoustic; Associated; and Commercial. Four lists of contact person names are provided so details concerning the projects that deal with sampling, and VOCs in gases, waters, and soils (sediments) can be obtained. Finally, seven wide-ranging conclusions based on observations and experiences during this work are presented.

TECHNOLOGY PROJECTS FOR CHARACTERIZATION - MONITORING OF VOLATILE ORGANIC COMPOUNDS (VOCs)

Gregor A. Junk and Wm. J. Haas Jr.

Ames Laboratory, Iowa State University, Ames, IA 50011

INTRODUCTION

Prologue

The U. S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management is responsible for environmental cleanup at numerous facility locations employed for nuclear weapons production and testing and for research and development activities in support of both military and peaceful uses of nuclear energy (U. S. DOE 1991). The DOE goal, to be accomplished by 2019, is to stop or prevent the migration of large existing quantities of radioactive and hazardous chemical materials at approximately 3700 waste storage and contaminated sites to the biosphere. The cost will likely exceed $100 billion; many of the needed technologies are currently less effective and less efficient than required, and some needed technologies do not exist.

The Office of Technology Development (OTD) has responsibility for providing the needed technologies. This office has focused most of its attention on providing solutions, or at least better solutions, for problems that exist at many DOE sites. It funds research and development, integration of required technology from all sources, and several Integrated Demonstrations (IDs). Each ID focuses on the demonstration and evaluation of the best available technologies to provide a "cradle-to-grave" solution for a specific problem. The VOC Arid Integrated Demonstration was established because the problem of soil and ground water contaminated by volatile organic compounds (VOCs) exists, not only at the Hanford site, located near Richland, WA, but at approximately fifty percent of DOE sites (U. S. DOE 1992).

In fiscal year 1991, nearly one-half of the approximately $2 billion budget of the entire Office of Environmental Restoration and Waste Management was consumed by characterization costs. The potential return on investment in IDs and in new and advanced characterization technologies is obviously large.

General Background

Most of the information in this document was taken from letter reports from Ames Laboratory to the coordinator of the VOC Arid Integrated Demonstration (ID). The work reported on was the generation of a list of technology projects applicable to the characterization of VOCs in the vadose zone and in the groundwater at the VOC Arid ID site. The projects were to be prioritized according to their perceived potential for successful contribution to achievement of the goals of the VOC Arid ID. The work was

to be completed in three months so the product could provide input to funding decisions at the ID.

Monitoring-Characterization. Technologies that are useful for characterization can also be employed for monitoring, e.g., for tracking the progress of a remediation process. Therefore, no distinction between characterization technology projects and monitoring technology projects was attempted in this work.

When characterization of the contamination at a site is deemed to be adequate for making informed action decisions, the measurement efforts can then focus on individual compounds such as carbon tetrachloride and chloroform at Hanford and trichloroethylene and perchloroethylene at Savannah River. The latter measurements can frequently be made using less expensive instruments, in situ sensors, and innovative approaches that attempt to bypass one or more of the following sequential steps of the traditional characterization process: 1) sampling; 2) extraction; 3) separation; 4) identification; and 5) quantification.

Ideal Goal of the VOC-Arid Characterization Task. Volatile organic compounds at either an arid or non-arid site will be present as follows: 1) in the vapor phase in the air above the site and in the soil gas; 2) dissolved in the water present in both the saturated and unsaturated zone; 3) adsorbed on natural soils, on solid co-contaminants, and on particulate matter in the water phase; 4) free liquid as a pure component or as part of a mixture with individual volumes ranging from microscopic to macro pockets of liquid; and 5) complexed with naturally occurring humic material in both the soils and waters. The ideal characterization effort would provide data on all these forms, and this information would be used in designing the remediation plan.

Practical Goal of the VOC-Arid Characterization Task. Complete characterization is too costly and time consuming. Hence, the practical characterization goal is usually the acquisition of only sufficient data to proceed efficiently with the selection and implementation of appropriate clean-up technologies. This report addresses technology projects that have the potential for achieving this practical goal.

RESULTS AND DISCUSSION

Characterization-Monitoring Technology Projects for Volatile Organic Compounds (VOCs)

One hundred thirty technology project titles related to the characterization-monitoring of VOCs at an arid site are listed alphabetically by first contact person in Table 1. Also included in Table 1 are the telephone numbers and addresses for the contact persons, keywords, and short project descriptions. In a few cases, we used a question mark to indicate some uncertainty concerning the proper use of a word.

The sequence followed for acquisition of information for the technology projects listed in Table 1 was as follows: 1) review of the Technical Task Plans listed in the DOE FY 1992 Research, Development, Demonstration, Test, and Evaluation Program Guidance; 2) requests for information on technology projects in introductory telephone calls and

letters to all DOE Technical Program Managers; 3) follow-up telephone calls to the Technical Program Managers; 4) contact with Argonne National Laboratory personnel to obtain information on technology projects that were funded through the Applied R&D Private Sector Activities Program; 5) direct communication with the Characterization Technical Support Group chairman; 6) literature search of Chemical Abstracts; 7) direct communication with the Monitoring Technical Support Group chairman; 8) telephone networking with knowledgeable investigators; and 9) telephone interviews with contact persons. Procedures 1, 4, 7, 8, and 9 were the most productive.

Table 1 is incomplete because of the difficulty of identifying all the applicable technology projects, especially those in universities and the private sector. For example, in the Argonne work mentioned above, 147 proposals were reviewed and 15 were funded. Information on the 132 unfunded proposals is not available. Additionally, it was obvious in the telephone interviews conducted for this work that many principal investigators or contact persons withheld project information because they considered it to be of a proprietary nature. Others cited concern about the cost of safety and regulatory requirements as a disincentive to their involvement in an Integrated Demonstration.

One of the contact persons for each technology project was interviewed at least once by telephone to obtain information about the project. A short description, 100 words or less, was requested for each technology project. Some descriptions provided by the contact persons were longer, but we included them without condensation; other lengthy descriptions were condensed when this was possible without loss of content. Some contact persons responded well to separate requests for mailing complete descriptions of the technology project and its successes and failures. The latter information is too lengthy to include in this report. It is on file at Ames Laboratory and is available from the authors on request.

The contact person listed first for each technology project in Table 1 is not the sole source of information about the project. The other contact persons listed for a project can also provide information. Appendix A lists alphabetically all the contact persons identified in Table 1.

Text continues after Table 1 on page 45.

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Table 1. Master Compilation of VOC Characterization - Monitoring Technology Projects

Title: Portable Gamma Ray Imaging of Bulk Soil
Contact Person:
Aitken, Alfred (NDI) **Phone:** 703-339-7555
Nuclear Diagnostics Inc.
P.O. Box 726
Springfield, VA 22150
Alternate Contacts:
Keywords: Associated, radiation, uncertain, soil, L-demo
Description:
This project has the objective of evaluating the feasibility of a soil assay system for elements using inelastic gamma ray imaging and spectroscopy (IGRIS) and capture gamma ray spectroscopy (CGRS). The project, if successful, will be applied to the remediation of soils contaminated with radionuclides, heavy metals, and other pollutants.

Title: Miniature Ion Trap Based GC-MS
Contact Person:
Andresen, Brian (LLNL) **Phone:** 510-422-0903, 510-423-1189
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Raber, Ellen (LLNL) 415-422-3985
Keywords: GC-MS, ion-trap, L-demo, gas, extracts, soil, water, CIHC
Description:
This ion trap based instrument is being developed with a goal of a rugged hand-held instrument to be used in field analyses.

Title: Portable Quad GC-MS
Contact Person:
Andresen, Brian (LLNL) **Phone:** 510-422-0903 or 510-423-1189
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Raber, Ellen (LLNL) 415-422-3985
Keywords: GC-MS, quad, gas, soil, water, extracts, F-demo
Description:
This inexpensive and rugged 60 pound instrument combines commercial and home-made components for rapid turn-around GC-MS analyses in the field.

Title: Fiberoptics Surface-Enhanced Raman Spectroscopy for Organic and Inorganic Contaminants
Contact Person:
Angel, Mike (LLNL) **Phone:** 510-423-0375

Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Keywords: SERS, fiberoptics, developing, water, gas, in situ, ClHC
Description:
This proposal is to look at surface-enhanced Raman spectroscopy and waveguide Raman for trace contaminant measurements. This compliments other Raman work because it promises much higher sensitivity.

Title: Scanning Line-of-Sight Remote Raman Spectroscopy for Intermediate Range Characterization of Mixed Waste
Contact Person:
Angel, Mike (LLNL) **Phone:** 510-423-0375
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Kulp, Tom (LLNL)
Keywords: Raman spectroscopy, developing, remote, mixed, ClHC, soil?
Description:
This work will develop a non-invasive Raman telescopic scanner for characterizing remote samples such as UST, or through hot-cell windows. This does not involve fiber optics but compliments that work by providing characterization of any line-of-sight substrate (e.g., through hot-cell windows, surface of a tank, etc.)

Title: Fiberoptics for $CHCl_3$ and CCl_4 at Arid Site
Contact Person:
Angel, Mike (LLNL) **Phone:** 510-423-0375
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Langry, Kevin (LLNL)
Keywords: Fiberoptics, ClHC, gas, in situ, water, L-demo
Description:
We are developing a CCl_4 sensor for the Arid-Site Demo.

Title: In Situ Detection of VOCs. Phase IV
Contact Person:
Angel, Mike (LLNL) **Phone:** 510-423-0375
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Langry, Kevin (LLNL)
Keywords: Fiberoptics, developing, in situ, gas, water
Description:
We are developing improved VOC sensors.

Title: Advanced Fiberoptics Sensors
Contact Person:
Angel, Mike (LLNL) **Phone:** 510-423-0375
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Keywords: Fiberoptics, developing, in situ, gas, water
Description:
This project involves basic studies of ways to improve upon fiberoptic based sensors.

Title: Reversible Fiberoptic Fluorescence Sensor Combined with Cone Penetrometer for Detection of BTEX
Contact Person:
Angel, Mike (LLNL) **Phone:** 510-423-0375
Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
Alternate Contacts:
Keywords: Fiberoptics, in situ, fluorescence, penetrometer, reversible, BTEX, water?, sensor, VOCs, gas, F-demo
Description:
No written information provided by contact person.

Title: UV and IR Spectrophotometry Optimized for Fiberoptics and VOCs in Gas and Water
Contact Person:
Arrendale, W. (UAH, JMBN, Inc.) **Phone:** 205-895-6473
JMBN, Inc.
1216 Stonehurst Dr.
Huntsville, AL 35801
Alternate Contacts:
Nielson, Bruce (Air Force) 904-283-2942
Keywords: UV, IR, fiberoptics, L-demo, reversible, gas, water, CIHC
Description:
UV-VIS-NIR spectrophotometers with optics optimized for single strand optical fiber cables are used. We have developed techniques for benzene, toluene, xylene, chlorinated hydrocarbons, iodinated hydrocarbons, and iodine species in dilute aqueous solutions. The technique has also been used in gas mixtures.

Title: In Situ Permeable Flow Sensor
Contact Person:
Ballard, Sandy (SNL) **Phone:** 505-844-6293
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Keywords: Associated, F-demo, hydrology, flow, in situ, water
Description:
The In Situ Permeable Flow Sensor is a new instrument that uses a thermal perturbation technique to measure the 3-dimensional groundwater flow velocity vector at a point in a permeable, saturated, unconsolidated, geologic material. The device is permanently buried at the point where the

measurement is to be made, avoiding all the pitfalls associated with flow measurements in boreholes. The technique does not require detailed knowledge of the permeability, avoiding the necessity of performing a pump test, which is a great advantage at hazardous waste sites where disposal of purge water can be a problem. Flows as low as a few meters per year can be accurately measured using this technology.

Title: Assessment of Subsurface VOCs Using Chemical Microsensor Arrays
Contact Person:
Batterman, Stuart (U. of Michigan) **Phone:** 313-763-2417
School of Public Health
109 Observatory Street
Ann Arbor, MI 48109
Alternate Contacts:
Keywords: SAW, acoustic, developing, in situ, gas
Description:
The results of the research will demonstrate that microsensor array instruments can provide rapid and reliable compound-specific concentrations of volatile organics in soil vapor. The low projected cost of manufacture (less than $1000 in production quantities), the capabilities of continuous, unattended operation, and the ability to transmit data from remote locations, SAW sensor-based monitors should be a cost-effective and desirable monitoring approach.

Title: Accelerator MS for Detecting ^{36}Cl Produced in Weapons Testing at INEL
Contact Person:
Beasley, Tom (DOE-EML) **Phone:** 212-620-3636
Environmental Measurements Laboratory
376 Hudson St.
New York, NY 10014-3621
Alternate Contacts:
Cecil, DeWayne L. (INEL) 208-526-2060
Keywords: MS, F-demo, modeling, ^{36}Cl, H_2O transport, water
Description:
Chlorine-36, produced in weapons testing during the early 1950's, is being used to determine vadose zone water infiltration rates at the INEL. Using accelerator mass spectrometry techniques, it is now possible to detect as few as 10 atoms of ^{36}Cl in 10^{15} atoms of stable chloride. Since chloride behaves conservatively in the subsurface, ^{36}Cl tracer technology is being used to extend the dynamic range (both areally and in time) of water tracing at the INEL which, until now, has been accomplished using tritium. Parameterization of hydraulic and transport models at the INEL using ^{36}Cl will be transferable to modeling efforts at other DOE facilities.

Title: In Situ Mapping of Radionuclides in Sub-Surface and Surface Soil
Contact Person:
Brodzinski, R.L. (PNL) **Phone:** 509-376-3529
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Perkin, R.W. (PNL) 509-376-0204
Robertson, D.E. (PNL) 509-376-5664
Keywords: Associated, F-demo, radiation, soil, in situ, penetrometer

Description:
The primary objective of this program is to develop and demonstrate technology for the measurement of uranium in subsurface and surface soils at the Fernald Integrated Demonstration Site. To accomplish the first part of this, we will employ directional gamma-ray spectrometry for measuring the natural uranium, as well as added uranium, as a function of depth in bore holes. The general concept for subsurface directional gamma-ray spectrometry was developed and demonstrated previously for measurements in contaminated soils at the Hanford site.

Title: Advanced Mixed Waste Assay System
Contact Person:
Brodzinski, R.L. (PNL) **Phone:** 509-376-3529
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Arthur, R.L. (PNL) 509-376-0405
Geelhood, B.D. (PNL) 509-376-0276
Keywords: Associated, F-demo, radiation, mixed, containers
Description:
An existing Pacific Northwest Laboratory (PNL) portable, waste-barrel assayer system will be upgraded. An improved system will be designed and constructed to accommodate barrels as large as 96 gallons and calibrated for barrels of several standard sizes. Software will be improved to allow artificial-intelligence decision-making routines to make more effective use of combined neutron and gamma-ray analyses. Collimated fast-neutron and sodium iodide gamma-ray detectors will be used to passively image the radioactive contents and/or actively image the matrix of waste barrels. Sample loading and changing will be automated to make waste barrel analysis less labor-intensive, hence, more cost effective.

Title: Optical Fiber-based Sensor for In Situ Determination of Chlorinated Hydrocarbons
Contact Person:
Burgess, Lloyd (U. of Washington) **Phone:** 206-543-0579
Center for Process Analytical Chemistry
MS BG-10
Seattle, WA 98195
Alternate Contacts:
Wangen, Lawrence (LANL) 206-543-3427
Henshaw, John (U. of Washington)
Keywords: Fiberoptics, optical, L-demo, reversible, gas, water, in situ
Description:
A renewable reagent, optical fiber-based chemical sensor utilizing the Fujiwara reaction and membrane sampling has been developed for the in situ determination of multiple species in mixtures of chlorinated hydrocarbons. Multiwavelength absorption spectra and temporal variation provide the selectivity for multivariate data analysis.

Title: Fiber Optic Micromirrors
Contact Person:
Butler, Mike (SNL) **Phone:** 505-844-6897
Sandia National Laboratories
Organization 1315, P.O. Box 5800
Albuquerque, NM 87185-5800
Alternate Contacts:

Keywords: Fiberoptics, optical, L-demo, in situ, ClHC, TCE, CCl_4
Description:
Simple but effective detection of volatile organics is obtained based on changes in the reflectivity of a micromirror formed by application of a thin polymer layer to the end of a fiber optic line. These sensors have the potential to be used to prepare inexpensive systems of multiple sensors at remote locations.

Title: Fiberoptic Raman Spectrograph for In Situ Environmental Monitoring
Contact Person:
Carrabba, Dr. Michael (EIC) **Phone:** 617-769-9450
EIC Labs Inc.
111 Downey Street
Norwood, MA 02062
Alternate Contacts:
Keywords: SERS, Raman, fiberoptics, L-demo, ClHC,screening, water, real-time, in situ
Description:
This project will develop a small (suitcase size) Surface Enhanced Raman Spectrometer (SERS) that can be used in field screening for a wide variety of organic and metallic pollutants in ground and surface waters. The system will identify trace contaminants in groundwater in real time.

Title: Laser-induced Fluorescence Over Fiber Optics
Contact Person:
Chudyk, Wayne (Tufts U.) **Phone:** 617-381-3211
Dept. of Civil Engineering
Tufts University
Medford, MS 02155
Alternate Contacts:
Keywords: Fiberoptics, fluorescence, F-demo, water, gas, in situ, BTEX
Description:
This technique has been field demonstrated for detection of BTEX compounds in the aqueous phase in ground water at low ppm values. Laboratory detection limits are in the ppb range, and laboratory demonstration of vapor phase measurements has also been successful.

Title: Centrifuge Technology for Vadose Zone Transport Measurements
Contact Person:
Conca, James (WSU Tri-Cities) **Phone:** 509-375-3268
Washington State University, Tri-Cities
100 Sprout Rd., Plant Mail H2-52
Richland, WA 99352
Alternate Contacts:
Wright, Judith (PNL)
Keywords: Associated, L-demo, transport, benchscale, predictive, modeling
Description:
The unsaturated flow apparatus reduces the time required to measure transport parameters (such as hydraulic conductivity, VOC permeability, diffusion coefficients and retardation factors/distribution coefficients) for VOCs and water from years to hours without changing the behavior of the system.

Title: Environmental Monitoring of Chlorinated Hydrocarbons Using Ion Mobility of Negative Ions
Contact Person:
Conrad, Frank J. (SNL) **Phone:** 505-844-4190
Sandia National Laboratories
Division 9548, P.O. Box 8500

Albuquerque, NM 87185-5800
Alternate Contacts:
Kenna, Bernard T. (SNL) 505-844-5343
Keywords: Ion-mobility, developing, F-demo?, gas, portable, water
Description:
Although our research has been focused on the application of IMS to detection of explosive compounds, we have had occasion to study the IMS detection of some organic materials, including specific chlorinated hydrocarbons, as interferents to detection of explosives. The IMS demonstrated good sensitivity for these compounds. Chlorinated hydrocarbons of environmental interest, e.g. trichloroethylene (TCE), trichloroacetone (TCA), carbon tetrachloride, and ethylene chloride, are electronegative. Therefore, the IMS should have good detection sensitivity for these compounds.

Title: Passive Groundwater Headspace Sampler
Contact Person:
Crockett, Alan (INEL) **Phone:** 208-526-1574
Idaho National Engineering Laboratory
Center for Environmental Monitoring/Assessment
Idaho Falls, ID 83415
Alternate Contacts:
Keywords: Sampling, F-demo, headspace, water, ClHC, in situ
Description:
Development of a composite wastewater sampler suitable for the collection of volatile organic compounds over a 24-hour period (Invention Disclosure Record submitted to DOE). Such a sampler will greatly improve the quality of data compared to the normal grab sample, or greatly reduce analytical costs compared to collection and analysis of multiple samples within the compositing period.

Title: Colloidal Borescope for Groundwater Flow Measurements
Contact Person:
Cronk, Tom (ORNL-Grand Junction) **Phone:** 303-248-6265
Oak Ridge National Laboratory
P.O. Box 2567
Grand Junction, CO 81502
Alternate Contacts:
Kearl, Pete (ORNL) 303-248-6211
Keywords: Associated, F-demo?, hydrology, flow, colloids, in situ, water
Description:
The colloidal borescope is a down-hole instrument designed to assess local groundwater flow velocity as well as colloidal transport potential. The technology is suitable for use in two inch and larger monitoring wells.

Title: In Situ Chemical Analysis Using Laser Ion-mobility Spectroscopy
Contact Person:
Danen, Wayne (LANL) **Phone:** 505-667-4686
Los Alamos National Laboratory
Los Alamos, NM 87545
Alternate Contacts:
Keywords: Ion-mobility, laser, developing, in situ, inactive
Description:
No written information provided by contact person.

Title: Instruments for In Situ Characterization of Tank Waste
Contact Person:
Delisle, G.V. (WHC) **Phone:** 509-376-1866
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352
Alternate Contacts:
Keywords: Associated, in situ, developing, integration, tanks, radiation, chemical, physical
Description:
The objective of this task is to develop, design, and demonstrate a fully integrated system capable of performing in situ or on-site characterization of underground storage tank (UST) wastes. Techniques for determining the physical, chemical, and radiological nature of UST wastes will be developed and deployed.

Title: FTIR For Volatile Organics in Soil Gas and Thermally Desorbed Organics
Contact Person:
Demirgian, Jack (ANL) **Phone:** 708-252-6807
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
Alternate Contacts:
Keywords: IR, heated-cell, L-demo, gas, soil, thermal, laser, penetrometer, CIHC
Description:
A soil sample is thermally desorbed into an evacuated long path infrared cell. Data collection takes approximately 1 minute and analytical results can be printed within another minute. The method has been successfully tested on five volatile organics and the detection levels are 20 - 40 ppm.

Title: Differential Absorption Lidar (DIAL) for Remote Sensing
Contact Person:
DiBenedetto, John [EG&G (RSL)] **Phone:** 805-681-2240
EG&G/RSL
Santa Barbara Operations
Goleta, CA 93117
Alternate Contacts:
Keywords: IR, white-cell, developing, CCl_4, gas, remote
Description:
Differential Absorption Lidar (DIAL) is a widely cited technique that uses light absorption rather than emission to detect gaseous targets such as organic solvent plumes. Fourier transform infrared spectroscopy is used by environmental scientists to monitor gas pollutants (EPA smog measurements). DIAL and FT infrared techniques have been proposed for monitoring trace solvent vaporization at solvent waste sites due to the high degree of specificity, sensitivity (ppb) and long integration path lengths (kilometers). DIAL techniques are part of the overall RDDT&E program at EG&G Santa Barbara Operations, however the development of hardware is not presently in this year's scope of work.

Title: Active Remote Sensing for Airborne Mapping of Toxic Materials
Contact Person:
DiBenedetto, John [EG&G (RSL)] **Phone:** 805-681-2240
EG&G/RSL
Santa Barbara Operations
Goleta CA, 93117

Alternate Contacts:
Lutz, Stephen (EG&G) 805-681-2244
Keywords: Laser, fluorescence, F-demo, remote, gas, soil, aircraft, survey
Description:
Laser induced fluorescence (LIF) is most often done using ultraviolet lasers, exciting both organic and inorganic compounds, then detecting the characteristic red shifted fluorescence in the near ultraviolet and visible. LIF, as generally applied, detects materials on the surface but could be applied to underwater optical emission in some cases. Plant stress evaluation, oil pollution monitoring and uranium ore detection will be investigated in FY92.

Title: Robotics - Contaminant Analysis Automation
Contact Person:
Dodson, Michail (PNL) **Phone:** 509-375-2039
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Bennett, David 509-375-2159
Keywords: Robotics, developing, soil, SVOCs, PCBs, EPA-methods
Description:
This project attempts to automate standard EPA methods with initial emphasis on PCBs. Applicability to VOCs is questionable.

Title: Aerial Measurement System Program for Radiation Surveillance
Contact Person:
Doyle, Jack [EG&G(RSL)] **Phone:** 702-295-8001
EG&G/EM, Inc.
MS RSL-10, P.O. Box 1912
Las Vegas, NV 89125
Alternate Contacts:
Proctor, Alan [EG&G/EM(RSL)] 702-295-8764
Keywords: Associated, F-demo, radiation, aerial, remote
Description:
Large arrays of gamma detectors flown on helicopter platforms provide detailed isotopic isopleth maps of both natural and man-made radionuclides. Changes in the natural environmental radiation levels of less than 5% can be detected. The RSL also operates a number of very sensitive in situ High Purity Germanium detectors that record data in the field on battery powered 8000 channel analyzers. The RSL remote sensing capabilities also include Wild RC-10 and -20 aerial mapping cameras and a Daedalus 1268 multispectral scanner which provide very sensitive detection of thermal signatures and both visible and invisible spectra. Data channels used match those of the Landsat Thematic Mapper and French Spot satellites.

Title: Non-Intrusive Sensing of Environmentally Important Objects and Species
Contact Person:
Duray, J.R. (Geotech) **Phone:** 303-248-6702
Geotech, Inc.
Grand Junction Projects Office
P.O. Box 2657
Grand Junction, CO 81502-2657
Alternate Contacts:
Snyder, D.D. (Geotech) 303-248-6697

MacLean, H.D. (Geotech) 303-248-6101
Keywords: Associated, developing, geology, containers
Description:
A three-part project for screening a site, locating containers, and measuring elements using a tensor magnetic gradiometer, broadband electromagnetics, and an integrated borehole geophysical system capable of NAA.

Title: Solid Phase Extraction in Combination with Spectroscopy for Monitoring Water Pollution
Contact Person:
Eastwood, Delyle (Lockheed) **Phone:** 702-734-3287
Lockheed Engineering & Scientific Co.
Las Vegas, NV 89119
Alternate Contacts:
Poziomek, Ed (UNLV) 702-739-3382
Keywords: Sampling, fluorescence, L-demo, water, BTEX, Empore
Description:
Tests have been conducted for anthracene extracted from water using commercial Empore solid phase extraction disks and fluorescence spectroscopy.

Title: Ion-mobility Spectrometry for VOCs in Soil, Gas, and Water
Contact Person:
Eiceman, Gary (NMSU) **Phone:** 505-646-2146, 410-671-3634 (Aberdeen Pvg. Gnds.)
Deptartment of Chemistry
New Mexico State University
Las Cruces, NM 88003-0003
Alternate Contacts:
Poziomek, Ed (UNLV) 702-739-3382
Keywords: Ion-mobility, F-demo, gas, water, portable, CIHC
Description:
Ion-mobility spectrometry (IMS) is an instrumental technology for detecting and characterizing organic compounds as gas phase ions in air at atmospheric pressure. Continuous monitoring of volatiles in water is being developed using a solvent-less membrane based approach in conjunction with ion mobility spectrometers. Results from laboratory studies show that molecules of various moieties including alcohols, aldehydes, ketones, amines, and chlorocarbons can be successfully extracted from water into a flow of gas and delivered to an ion mobility spectrometer.

Title: Miniature Ion-mobility Spectrometer for In Situ Measurements of VOCs
Contact Person:
Eiceman, Gary (NMSU) **Phone:** 505-646-2146, 410-671-3634 (Aberdeen Pvg. Gnds.)
Department of Chemistry
New Mexico State University
Las Cruces, NM 88003-0003
Alternate Contacts:
Poziomek, Ed (UNLV) 702-739-3382
Keywords: Ion-mobility, developing, gas, in situ
Description:
Ion-mobility spectrometry is a technique for the detection and characterization of organic compounds as vapors at ppb concentrations in air. An IMS operates at atmospheric pressure. This leads to certain practical advantages including size, power, weight, and simplicity. The UK and US military establishments funded IMS research and development efforts which resulted in compact IMS units that weigh 2 kg, use 4 watts, are wholly self-contained, and are mil-spec hardened for field use in chemical

defense applications. IMS is a prime candidate for technology transfer from the chemical defense arena to environment field screening and analysis applications.

***Title: Passive Soil Gas Survey - PETREX
Contact Person:
Einhorn, Irving N. (NERI) **Phone:** 203-677-9666
Northeast Research Institute, Inc.
Suite A-100, 309 Farmington Avenue
Farmington, CT 06032-1943
Alternate Contacts:
Keywords: GC, GC-ITMS, F-demo, gas, water, soil, VOCs, CIHC, sampler, commercial
Description:
The patented PETREX Technology is a passive soil gas survey method used during site assessments to provide a rapid reconnaissance screening of soil, groundwater, and surface water for volatile and semivolatile organic compounds (VOCs and SVOCs). PETREX Surveys can detect a wide range of compounds including petroleum products, chlorinated solvents, paint thinners, degreasers, dry cleaning fluids, pesticides, insecticides, and fire retardants, and are widely used to provide initial characterization of a site. The results of a PETREX Survey are used to guide well placement and soil boring programs. By screening sites before initiating expensive drilling programs, overall site assessment costs can be substantially reduced.

Title: Crosshole Seismic Tomography
Contact Person:
Elbring, Greg (SNL) **Phone:** 505-844-4904
Sandia National Laboratories
Division 6231, P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Keywords: Associated, F-demo, geology, seismic, 2D, 3D?, mapping
Description:
Crosswell compressional and shear-wave seismic surveys, where the seismic source and receiver are located within boreholes, are being used both for determining site geology by mapping subsurface velocities and for monitoring air-stripping remediation processes. Air-stripping processes are imaged by comparing seismic velocities before and during the air injection. Changes in subsurface saturation due to the injected air are reflected as changes in seismic velocity, thus allowing mapping of paths followed by the injected air.

Title: Vadose Zone Monitoring at a Mixed Waste Management Facility
Contact Person:
Emer, Dudley (REECO) **Phone:** 702-295-7808
Reynolds Electrical & Engineering Co.
P.O. Box 98521, MS-738
Las Vegas, NV 89193-8521
Alternate Contacts:
Keywords: GC-FID, F-demo, gas, passive, sampling

Description:

***** Information about this technology received after evaluation and prioritization on March 26, 1992.**

The organic compounds are adsorbed onto an activated carbon cartridge over a given time period. The adsorbed components are then thermally desorbed onto a GC column and the separated components are measured by FID.

Title: Electrochemical and Piezoelectric Sensors for Monitoring of Groundwater
Contact Person:
Farmer, Joseph (LLNL) **Phone:** 510-423-9777
Lawrence Livermore National Laboratory
Livermore, CA 94550
Alternate Contacts:
Glass, Bob (LLNL) 510-423-7140
Keywords: Electrochemical, acoustics, piezoelectric, water, developing
Description:
Lawrence Livermore National Laboratory is developing compact, user-friendly electrochemical sensors for monitoring toxic metals, anions, and pH in natural environments. A variety of chemical contaminants can be measured using a single multielement, microelectrode array. The microsensor arrays are being fabricated using microlithographic techniques. Application is being made in the areas of waste reduction in electroplating operations and environmental remediation.

Title: Optimization of In Situ Volatilization Systems
Contact Person:
Filley, Thom (Env. S/E) **Phone:** 708-790-4010
Environmental S/E
751 Roosevelt Road
Building 7, Suite 110
Glen Ellyn, IL 60137
Alternate Contacts:
Keywords: Associated, modeling, gas, transport, F-demo?
Description:
In order to better understand the ISV process and provide a tool for the design optimization and evaluate the effectiveness of these systems, a numerical simulator was developed. This multidimensional, multiphase transport simulator incorporates mass, partitioning between the soil, water, vapor, and oil phases.

Title: Portable Acoustic Wave Sensors
Contact Person:
Frye, Greg (SNL) **Phone:** 505-844-0787
Sandia National Laboratory
Division 1315, P.O. Box 5800
Albuquerque, NM 87185-5800
Alternate Contacts:
Keywords: Acoustics, L-demo, in situ, gas, piezoelectric
Description:
PAWS systems are being developed for real-time, on-line monitoring of exhaust and process streams as well as in situ detection of contaminant concentrations underground. These systems use a patented technique to provide rapid evaluation of the identity and concentration of volatile organics, including chlorinated hydrocarbons.

Title: Inexpensive Sensor for In Situ Detection of Free Liquids
Contact Person:
Gee, Glendon (PNL) **Phone:** 509-376-8424
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Cary, John (retired) 509-376-4412
Keywords: Optical, L-demo, liquids, non-selective, in situ, commercial?, water, soil, qualitative
Description:
Sensor developed at Department of Energy's Pacific Northwest Lab consists of an optical switch containing a solid-state infrared light emitting device joined to a porous disk made of ceramic, fritted glass, PTFE (Teflon), or various carbon-based materials. Material selected determines if water or organic liquid is absorbed into the pores. Light transmitted through the disk, which has been placed into the soil, is measured - it's proportionate to the amount of water or organic liquid absorbed into the pores. Amount of liquid in the disk can be related to the amount of liquid in the surrounding soil. Technology is available from Battelle, operator of Pacific Northwest Labs, for commercialization and manufacture.

Title: Minimally Invasive 3D Site Characterization Using Penetrometer, Synergistic Electromagnetic Mapping Technology (SEMT) and Seismic Units
Contact Person:
Gibbons, John (ARA) **Phone:** 505-883-3636
Applied Research Associates, Inc.
4300 San Mateo Blvd. N.E.
Albuquerque, NM 87110
Alternate Contacts:
Keywords: Associated, penetrometer, developing, seismic, resistivity, water, hydrogeology
Description:
Heavy duty cone penetrometer, shallow high resolution seismic and electrogeophysical systems integrated through 3D database and computer graphics system for real-time and short-time in-the-field site analysis. Soil and water sampling with on-board water chemical analysis and sample handling facility. Development sponsored by USDOE RDDT&E Program.

Title: Chlorinated Solvent Fiberoptics Sensors
Contact Person:
Grey, Alan (INEL) **Phone:** 208-526-1414
INEL, EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415-2208
Alternate Contacts:
Keywords: Fiberoptics, developing, RI, in situ, CIHC, reversible, gas, water
Description:
The objective of this task is find and/or develop a polymer with refractive index matching to the fiber core that preferentially absorbs chlorinated solvents. This will be done through a literature search and laboratory experimentation. From a selected list of polymers, optical fibers will be coated and their response to solutions of various chlorinated solvents determined. From this study, the best polymer will be selected. Other criteria the polymer must meet are that it must be hydrophobic, any absorption must be reversible, and it must be durable under field conditions.

Title: Real Time Monitor for Organics - $ITMS^2$
Contact Person:
Guerin, Mike (ORNL) **Phone:** 615-574-4862
Oak Ridge National Laboratory
Bldg. 4500-S, MS-6120
Oak Ridge, TN 37831
Alternate Contacts:
Wise, Marc (ORNL) 615-574-4867
Buchanan, Michelle (ORNL)
Keywords: MS2, ion-trap, L-demo, water, soil, vapor, extracts, archive
Description:
The known capability of simulating tandem MS-MS using an ion trap is being investigated for applicability to environmental and waste disposal studies.

Title: Mixed Wastes (EPA agreeable) and Field Analytical Technologies (capabilities and needs)
Contact Person:
Guerin, Mike (ORNL) **Phone:** 615-574-4862
Oak Ridge National Laboratory
Bldg. 4500-S, MS-1620
Oak Ridge, TN 37831
Alternate Contacts:
Griest, Wayne (ORNL) 615-574-4864
Keywords: GC, water, mixed, L-demo, CIHC
Description:
VOCs in radioactive mixed wastes have been determined by purging the volatile organics from a sample using an inert gas and collecting the purged chemicals on solid sorbent traps. The contents of the solid sorbent traps are subsequently analyzed by thermal desorption gas chromatography mass spectrometry.

Title: Real Time Monitor for Organics - ITMS
Contact Person:
Guerin, Mike (ORNL) **Phone:** 615-574-4862
Oak Ridge National Laboratory
Bldg 4500-S, MS-1620
Oak Ridge, TN 37831
Alternate Contacts:
Wise, Marc (ORNL) 615-574-4867
Buchanan, Michelle (ORNL)
Keywords: MS, ion-trap, F-demo?, water, soil, gas, extracts, archive,
Description:
Direct sampling ITMS involves the direct introduction of VOCs into an ITMS without prior collection or separation. VOCs in water or in soil (water slurries) are purged with helium into the ITMS and their evolution is continuously monitored. VOCs are detectable within fifteen seconds and sufficient data is acquired for quantitation in approximately three minutes. Detection limits for the EPA TCL VOCs in water range from approximately 1-5 ppb depending on the analyte. Laboratory and field-transportable versions of the instrumentation are available. Field instrumentation has been successfully demonstrated at the Savannah River Integrated Demonstration site. The archiving of samples on solid adsorbents while making measurements is a unique capability of this development that provides for future more detailed analyses if desired.

Title: Spectroelectrochemical Sensors
Contact Person:
Haas, John (ORNL) **Phone:** 615-574-5042
EIC Laboratories
P.O. Box 2008
Oak Ridge, TN 37831-6113
Alternate Contacts:
Keywords: SERS, electrochemical, fluorescence, in situ, gas, water, L-demo
Description:
In situ detection of solvents, such as CCl_4 and TCE in groundwater, using coupled laser fiber optics to detect electrode-induced chemical intermediates with Raman activity.

Title: Portable Derivative UV Absorbance Spectroscopy (DUVAS) for Aromatic Screening
Contact Person:
Haas, John (ORNL) **Phone:** 615-574-5042
EIC Laboratories
P.O. Box 2008
Oak Ridge, TN 37831-6113
Alternate Contacts:
Keywords: UV, L-demo, water, soil, extracts, aromatics, screening
Description:
Three versions of a portable DUVAS instrument have been developed for hazardous waste site characterization. The instruments are designed to make measurements of organic contaminants in liquid and vapor samples. They are useful at all stages of site cleanup from initial characterization to remediation and post-remediation monitoring. One version of the instrument provides rapid (1 minute/sample), cost-effective field screening of liquid samples (e.g., groundwater or soil extracts) for contaminants such as benzene, toluene, xylenes, polynuclear aromatics, and other aromatics. The device is especially useful during initial site characterization when many samples need to be checked and results are needed quickly.

Title: Portable Borehole Fiberscope with DUVAS (Derivative UV Absorbance Spectrometer)
Contact Person:
Haas, John (ORNL) **Phone:** 615-574-5042
EIC Laboratories
P.O. Box 2008
Oak Ridge, TN 37831-6113
Alternate Contacts:
Keywords: UV, fiberoptics, L-demo, in situ, water, aromatics
Description:
A second version of the instrument is equipped with a fiberoptic probe that provides in situ monitoring capability for liquid samples. The probe is especially useful for real-time groundwater monitoring during remediation and for rapidly detecting contaminants in waste process streams, storage drums, etc. Again, this version of DUVAS selectively detects aromatic contaminants such as solvents or gasoline and other fuels (all of which contain aromatics) at sub-ppm levels.

Title: Portable 3-Meter Path Cell Derivative UV Absorbance Spectroscopy (DUVAS)
Contact Person:
Haas, John (ORNL) **Phone:** 615-574-5042
EIC Laboratories
P.O. Box 2008
Oak Ridge, TN 37831-6113

Alternate Contacts:
Keywords: UV, L-demo, gas, CIHC
Description:
The third version of DUVAS has a long-path (3 meter) cell and is able to measure organics in the vapor phase. Chlorinated solvents such as carbon tetrachloride and trichloroethylene, as well as aliphatic and aromatic hydrocarbons, can be sensitively detected. The instrument is especially useful for on-line monitoring of volatile organics during remediation.

Title: ?In Situ? Characterization of Waste by Ion Trap Mass Spectrometry
Contact Person:
Hemberger, Phil (LANL) **Phone:** 505-665-5735
Chemical & Laser Sciences Division
Los Alamos National Laboratory
Los Alamos, NM 87545
Alternate Contacts:
Keywords: GC-MS, ion-trap, F-demo, air, water, soil, extracts
Description:
Near real-time field detection of volatile organic compounds in soil, air, and water is accomplished with a transportable gas chromatograph/ion trap mass spectrometer that we have developed. The instrument is menu-driven for operation by a relatively unskilled operator. It can be assembled for a parts cost of $75K. The instrument has been demonstrated at Rocky Flats and can provide immediate support for DOE IDs or remediation efforts.

Title: MS1-301 Series Organic Vapor Monitors: Portable GC Using Air as Carrier Gas and Solid State Detector.
Contact Person:
Jarvis, Lynn (MSI) **Phone:** 410-939-1089
Microsensor Systems, Inc.
120 S. Union Ave.
Havre de Grace, MD 21078
Alternate Contacts:
Wohltjen, Hank (MSI) 502-745-0099
Keywords: GC, gas, F-demo, VOCs, portable, commercial
Description:
The MSI-301 Organic Vapor Monitors combine a simple, rugged, temperature controlled GC, a low maintenance solid-state detector, and an on-board microcomputer to provide exceptional capability and ease of operation, and are distinguished by the use of scrubbed air as the carrier gas. These portable GC instruments are very versatile and can be optimized to monitor a wide range of organic vapors, such as benzene, BTEX, ethylene oxide, formaldehyde, and methanol, at concentrations from low ppb to the ppm range. They offer many other features including complete automatic, continuous operation and alarm, full remote control and eight hour data storage in on-board memory.

Title: Miniature Sampler Based on Sorption Tubes for Vapors in Bore Holes
Contact Person:
Jenkins, Roger (ORNL) **Phone:** 615-576-8594
Oak Ridge National Laboratory
Bldg. 4500-S, MS-1620
Oak Ridge, TN 37831
Alternate Contacts:
Keywords: Sampling, F-demo, gas, water, headspace

Description:
Solid sorbent traps have been developed for the collection of airborne VOCs. Trap configurations optimized for the field collection of VOCs from water and soil have been investigated. Multisorbent traps containing increasingly sorptive resins in series appear especially promising for VOC sampling.

Title: Optimization of Sampling Strategies for Contaminant Source Characterization
Contact Person:
Johnson, Robert (ANL) **Phone:** 708-252-7004
Argonne National Laboratory
Environmental Assessment/Information Science Division
9700 South Cass Avenue
Argonne, IL 60439-4832
Alternate Contacts:
Keywords: Sampling, developing, strategies, software, water
Description:
Argonne has developed software that, when used with an object-oriented database, allows for efficient and interactive sampling strategy selection for contaminant plume delineation. Combining Bayesian analysis with spatial statistics, this approach allows the relationship between sampling costs and the value of additional sampling to be explored.

Title: High Resolution Shear Wave Seismic Reflection Surveying for Hydrogeological Investigation
Contact Person:
Johnson, William J. (Rizzo) **Phone:** 412-856-9700
Rizzo and Associates
300 Oxford Drive
Monroeville, PA 15146
Alternate Contacts:
Keywords: Associated, F-demo?, geology, water
Description:
A new technology being developed by Paul C. Rizzo Associates under contract to Argonne National Laboratories is the High Resolution Shear Wave Seismic Reflection technique. Although still under development, an initial field experiment near Charleston, S.C., has demonstrated that confined and unconfined groundwater aquifers can be detected and mapped from the surface. The research has also shown that it is possible to triple the resolution obtained from conventional high resolution surveys by using shear waves.

***Title:** Quantitative Deep Soil Vapor Analyses
Contact Person:
Kagel, Carla (K Prime, Inc.) **Phone:** 510-222-4815
4197 Lakeside Dr., Suite 170
Richmond, CA 94806
Alternate Contacts:
Kagel, Richard A. (K Prime) 510-222-4815
Kladnik, George (K Prime) 510-222-4815
Keywords: GC, F-demo, gas, soil, water, VOCs, CIHC, sampler, commercial
Description:
K Prime has developed a technology for conducting quantitatively accurate soil vapor contamination surveys, including on-site laboratory and innovative deep probe technology. The technology has been

*** Information about this technology received after evaluation and prioritization on March 26, 1992.

demonstrated at numerous sites in the Western U.S. under various conditions of terrain and weather, and has successfully defined VOC contaminant plumes and identified known contaminant sources. Advantages of the technique over more conventional soil gas technologies include: inert, non-adsorbing probe; soil permeability data; depth profiling 2 to 100 feet; 10 to 20+ samples per day; results within 30 minutes of sampling; NIST-traceable gas-phase calibration; standard EPA QA/QC; and computer contour mapping on-site.

Title: Passive Samplers for Groundwater Site Characterization
Contact Person:
Kaplan, Edward (BNL) **Phone:** 516-282-2007
Brookhaven National Laboratory
Waste Management R&D Group
Bldg 703, 50 Rutherford Rd.
Upton, NY 11973-5000
Alternate Contacts:
Colombo, Peter (BNL) 516-282-3045
Keywords: Sampler, F-demo, water, CIHC, VOCs, inorganics
Description:
BNL has developed a new groundwater mechanical sampler capable of taking many one-liter samples simultaneously at several depths in the same well. This sampler has been tested in the laboratory, at BNL, and is now undergoing more extensive field trials at the Savannah River Integrated Demonstration Project. The information it provides is important during all stages of developing and monitoring remedial actions, but is particularly invaluable during the site characterization process, where a 3-D composite picture can be drawn of subsurface contaminant plumes and groundwater flow.

Title: Modified Membrane Sampler
Contact Person:
Kaplan, Edward (BNL) **Phone:** 516-282-2007
Brookhaven National Laboratory
Waste Management R&D Group
Bldg. 703, 50 Rutherford Dr.
Upton, NY 11973-5000
Alternate Contacts:
Keywords: Sampler, F-demo, water, membrane, flow
Description:
BNL has modified an existing sampler based on membrane technology, and has also used this device to provide simultaneous samples at several depths in the same well, and to determine the horizontal specific discharge at these locations. This sampler has been tested in the laboratory, at BNL, and is now undergoing more extensive field trials at the Savannah River Integrated Demonstration Project. The information it provides is important during all stages of developing and monitoring remedial actions, but is particularly invaluable during the site characterization process, where a 3-D composite picture can be drawn of subsurface contaminant plumes and groundwater flow.

Title: Surface Flux Sorbent Canister
Contact Person:
Karp, Kenneth (Geotech) **Phone:** 303-248-6564
Geotech, Inc.
P.O. Box 14000
Grand Junction, CO 81502
Alternate Contacts:
Keywords: Sampler, gas, VOCs, CIHC, charcoal, F-demo

Description:
Sorbent canisters are sealed to the surface of the soil for periods up to seven days before returning the sample to the laboratory for analyses of volatile organic compounds (VOCs). Average surface-flux values are calculated from the laboratory measurement of the mass of VOCs collected on the sorbent, collection efficiency, sampling area of the canister, and exposure time. A major advantage to this approach for screening and characterizing areas of potential contamination is that quantitative measurements can be conducted for most of the VOCs on EPA's priority pollutants list. Canisters are simple, rugged, and can be easily deployed and collected without disturbing the site. Temporal variations in the surface-flux can be averaged out to some degree using this method.

Title: Passive Subsurface Monitoring Device
Contact Person:
Karp, Kenneth (Geotech) **Phone:** 303-248-6564
Geotech, Inc.
P.O. Box 14000
Grand Junction, CO 81502
Alternate Contacts:
Keywords: Sampling, F-demo, CIHC, water, gas, membrane, passive
Description:
This in situ device is used to passively monitor volatile organic compounds (VOCs) in the vadose zone or groundwater. Installation can be at any desired depth in conventional or existing monitoring wells. For shallow applications, the device can be installed using a 1-inch diameter pipe. The device consists of a detector which fits inside a specially designed sampling chamber equipped with a diffusional barrier. VOCs diffuse across the barrier, into the chamber, and are collected by the detector. The detector can easily be retrieved and returned to the laboratory for analysis, or qualitative concentrations can be determined directly in the field.

Title: Surface Flux Accumulator Device
Contact Person:
Karp, Kenneth E. (Geotech) **Phone:** 303-248-6564
Geotech, Inc.
P.O. Box 14000
Grand Junction, CO 81502
Alternate Contacts:
Keywords: Sampler, gas, VOCs, CIHC, F-demo
Description:
This device is used to measure temporal surface-flux from volatile organic compounds by sealing the open end of a 3.1 L accumulator to the surface of the soil and monitoring the concentration build-up. The time rate of change in concentration inside the accumulator is related to the flux. Advantages to this measurement approach are that a large number of screening measurements to delineate areas of potential contamination can be performed in the field, relatively fast and inexpensively, without disturbing the site.

Title: Rapid Groundwater and Soil-Gas Sampling System
Contact Person:
Karp, Kenneth E. (Geotech) **Phone:** 303-248-6564
Geotech, Inc.
P.O. Box 14000
Grand Junction, CO 81502
Alternate Contacts:
Keywords: Sampler, gas, water, ram, VOCs, F-demo

Description:
This system consists of a hydraulically powered ram designed to quickly collect soil-gas or groundwater samples. High integrity samples for radiologic or organic laboratory measurements can easily be collected from 20 feet below ground level. The system is also configured to allow the collection of high integrity soil samples and is equipped with portable gas chromatographs for conventional field analysis. The GJPO has acquired two complete systems.

Title: SEAMIST Membrane System for Emplacement of Sensors
Contact Person:
Keller, Carl (SEA) **Phone:** 505-982-6698
Science Engineering Associates
1570 Pacheco, Suite D-1
Santa Fe, NM 87501
Alternate Contacts:
Keywords: Associated, F-demo, sampling, sensors, emplacement
Description:
SEAMIST (TM): This name applies to a system developed by Science and Engineering Associates (SEA) for the emplacement of instruments and the recovery of gas and liquid samples from drilled or punched holes in geologic media of all kinds. The system is based upon the ability of an impermeable tubular membrane (e.g., coated fabric) to be installed and retrieved from a hole via an inversion process like that of pulling a finger from a rubber glove or peeling a sock from one's foot. The membrane is emplaced from a reel inside a pressurized canister. The net effect is that a hole can be completely lined with an impermeable, pressurized liner at 20 ft./min. The liner supports the hole wall and can carry into position absorbent collectors, gas sampling tubing, logging tools and the like.

Title: Porous Silicon Sensors for Vapor Phase Organics
Contact Person:
Kelly, Mike (SNL) **Phone:** 505-844-4031
Sandia National Laboratories
Division 1824, P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Guilinger, Terry (SNL) 505-845-9043
Keywords: Acoustics, piezoelectric, CIHC, gas, in situ, developing
Description:
The high surface area and controlled pore size obtainable using electrochemical etching of silicon can be combined with surface modification techniques to prepare sensors for detecting volatile organics. The ability to integrate these sensors with silicon IC processing should enable the preparation of inexpensive yet smart sensors.

Title: Fiberoptics Based Sensor for BTEX
Contact Person:
Klainer, Stan (FiberChem) **Phone:** 702-361-9873
FiberChem Inc.
Las Vegas, NV 89154
Alternate Contacts:
Keywords: RI, fiberoptics, L-demo, BTEX, gas, water, in situ
Description:
This development appears to have interferences and other operational problems. No written description provided by contact person.

Title: Fiberoptics Based on Refractive Index Probe for TCE in Soil and Groundwater
Contact Person:
Klainer, Stan (FiberChem) **Phone:** 702-361-9873
FiberChem Inc.
Las Vegas, NV 89154
Alternate Contacts:
Keywords: RI, fiberoptics, CIHC, in situ, developing, water, soil
Description:
This development appears to have interferences and other operational problems. No written description provided by contact person.

Title: Long Path Length IR
Contact Person:
Koglin, Eric (EPA) **Phone:** 702-798-2432
Technology Support Center
P.O. Box 93478
Las Vegas, NV 89183
Alternate Contacts:
Keywords: IR, developing, optical, gas, VOCs, commercial
Description:
Commercially available equipment used for remote site surveys.

Title: Long Path Length UV (DOAS)
Contact Person:
Koglin, Eric (EPA) **Phone:** 702-298-2432
Technology Support Center
P.O. Box 93478
Las Vegas, NV 89193
Alternate Contacts:
Keywords: UV, optical, gas, commercial, F-demo
Description:
Commercially available equipment used for remote site surveys. The differential absorption spectrometer shows promise for air pollutant measurements but probably not CIHC.

Title: In Situ Detection of Chlorine and Nitrates in Bore-Holes using Neutron Activation
Contact Person:
Koizumi, Carl (WHC) **Phone:** 509-376-9534
P.O. Box 1970
MSIN G6-50
Richland, WA 99352
Alternate Contacts:
Keywords: NAA, F-demo, Cl, nitrate, in situ, non-selective
Description:
Neutron activation instrumentation can be integrated into the normal logging process for borehole investigations.

Title: Development of Analyte-Selective Membranes for Optical and Acoustic Detection Methods
Contact Person:
Langry, Kevin (LLNL) **Phone:** 510-403-0375
Lawrence Livermore National Laboratory

Environmental Sciences Division
Livermore, CA 94550
Alternate Contacts:
Keywords: Acoustic, fiberoptics, membranes, in situ, water, gas, developing
Description:
The project provides fundamental information to be used for the testing and selection of membranes to be used for in situ measurements.

Title: Site Characterization and Analysis Penetrometer System (SCAPS)
Contact Person:
Lee, Tom (Waterways Exp. Station) **Phone:** 601-634-2661
U.S. Army Corps of Engineers
Waterways Experimental Station, MS GG-F
Vicksburg, MS 39180
Alternate Contacts:
Cooper, Stafford (Waterways) 601-634-2477
Keywords: Associated, F-demo, in situ, drilling, fluorescence
Description:
The objective of the research and development activity has always been to produce equipment that can be used to screen sites for chemical or radiological contamination in a rapid and economical manner. SCAPS includes a suite of geophysical instruments for surveying the site for concealed obstacles and buried utility lines, a specifically-designed truck housing the hydraulic rams for pushing the penetrometer rod, and a data acquisition and analysis system that can display sensor data on-site in real time. Laboratory-based computers are used to produce three-dimensional plots from completed site investigations. The SCAPS penetrometer currently has sensors that measure soil strength, electrical resistivity, and fluorescence of the soil immediately adjacent to the penetrometer rod. The SCAPS unit can also take soil and water samples and put monitoring instrument implants in place.

Title: EPA Approved Methodology for TCLP and Organics in Mixed Wastes
Contact Person:
Lewis, Leroy (WINCO) **Phone:** 208-526-3295
Westinghouse Idaho Nuclear Co.
Box 4000
Idaho Falls, ID 83403
Alternate Contacts:
Keywords: GC, FID, ECD, F-demo, EPA-methods, CIHC, mixed-waste, mobile, water, soil, gas
Description:
The RCRA methods manual, SW-846, prescribes methods for the analysis of hazardous wastes. These same methods are expected to be used for the analysis of mixed hazardous wastes without regard for the fact that these wastes may have dangerous radiation fields associated with them. Because many of the DOE facilities have mixed hazardous wastes with dangerous radiation fields, there is a significant need for development of apparatus and techniques that permit the analysis of these samples in hot cells, using master-slave manipulators. The WINCO Analytical Chemistry Section has been developing equipment which can be operated remotely to determine the TCLP of heavy metals, the volatile organic compounds and the flash point on samples of high-level mixed waste. At the present time, a system for the determination of selected volatile organics is in routine use at the Remote Analytical Laboratory hot cell.

Title: Development of Fiberoptics for In Situ Sensors with Focus on Petroleum
Contact Person:
Lieberman, Stephen (NOSC) **Phone:** 619-553-2778

Navy Ocean System Center
Point Loma
San Diego, CA 92106
Alternate Contacts:
Keywords: Fiberoptics, developing, in situ, petroleum, gas
Description:
This effort is closely related to the Mike Angel investigations and the coupling to the cone penetrometer for measurement of petroleum products.

Title: Rapid Headspace Analysis of Soil and Water
Contact Person:
Looney, Brian (SRL) **Phone:** 803-725-5181
Savannah River Laboratory
Waste Management/Environmental Restoration
Aiken, SC 29808
Alternate Contacts:
Eddy, Carol (SRL) 803-725-2418
Keywords: GC, F-demo, CIHC, water, soil
Description:
A headspace analysis method was developed to facilitate the accurate and rapid delineation of the vertical and horizontal distribution of VOCs in the subsurface, and to reduce the sample handling, laboratory preparation, and analytical complexity. The headspace method consists of four steps: 1) subsample a core sample immediately after retrieval using a small tube/plunger system, 2) place the subsample into a 22.5 mL headspace vial, 3) add 5 mL of suspending solution and cap vial, and 4) analyze an aliquot of the headspace using a gas chromatograph. The method was developed and modified as a result of multiple investigations and has been applied to over 2000 samples from both saturated and unsaturated sediments. The headspace method minimizes losses of volatiles and generates results rapidly, enabling informed decision making during site characterization.

Title: TerraTrog for Soil Gas Sampling
Contact Person:
Lucero (ITRI) **Phone:** unknown
Alternate Contacts:
Keywords: Sampling, gas, water, USATHAMA, F-demo
Description:
This device developed for the Army has been evaluated by the monitoring TSG and found to be of questionable value.

Title: Borehole Aquifer and Soil Gas Depth-Discrete Sampling and Testing Device
Contact Person:
Luttrell, S. (PNL) **Phone:** 509-375-6023
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Keywords: Sampler, L-demo, water, gas
Description:
This device may be used to obtain depth-discrete groundwater and soil-gas samples, hydraulic conductivity estimates, and hydraulic head measurements during borehole drilling; individual samples or measurements are made by changing modular components of the device prior to deployment. The

device accesses the sample zone by pounding or pushing a probe below the disturbed zone of drilling in order to retrieve or obtain the desired sample or data.

Title: Automated Purge and Trap GC for Chlorinated Hydrocarbons
Contact Person:
Mackay, Doug (A+RT) **Phone:** 415-324-2809
Analytic & Remedial Technologies, Inc.
206 W. O'Connor St.
Menlo Park, CA 94025
Alternate Contacts:
Keywords: GC, F-demo, commercial, purge, trap, water, automated, ClHC
Description:
The A+RT volatile organics analytical system (AVOAS) consists of a manifold which permits automated sampling from multiple locations, an injector which extracts VOCs from aqueous samples by a proprietary process similar to purge and trap and injects them into a gas chromatograph, and software that provides system control, storage of data, and telecommunications. The AVOAS has been evaluated in the EPA SITE program and has been found to yield results comparable to, or in some cases, better than those obtained through manual sample collection and subsequent analysis by a certified lab.

Title: Portable On-Site IR Analyzer
Contact Person:
McClelland, John (Ames) **Phone:** 515-294-7948
Ames Laboratory, ISU
B27 Spedding Hall
Ames, IA 50011
Alternate Contacts:
Keywords: IR, L-demo, ClHC, commercial, modified, gas, water
Description:
A portable commercial photoacoustic IR spectrometer has been adapted to analyze up to five chlorinated hyrocarbons, including TCE, TCA and CCl_4 with quantitative outputs every two minutes. Sensitivities of sub-parts-per-million and a wide dynamic range are possible for sample points up to 300 feet from the instrument. Part-per-million level transport of CCl_4 and TCE through 300 feet of tubing have been demonstrated in laboratory experiments.

Title: Ultrasensitive Laser Analysis of Contaminants
Contact Person:
McDowell, R.S. (PNL) **Phone:** 509-375-6681
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Keywords: MS, developing, laser, soil, SVOCs
Description:
A team at Battelle Pacific Northwest Laboratory is developing laser ablation and ion-beam sputtering of samples followed by double-resonance time-of-flight laser ionization mass spectrometry as a routine, field-deployable ultrasensitive analytical method for VOCs, radionuclides, heavy metals, and inorganics in soils, groundwater, solid mixed wastes, and tank cores. Advantages will include the minimization of sample size, operator hazards, waste generation, disturbance to sampled areas, and cost; minimal pretreatment needed; faster analyses and greater throughput; high accuracy; and full speciation of complex mixtures.

Title: Full Implementation Cone Penetrometer
Contact Person:
McLelland, Greg (WHC) **Phone:** 509-376-2260
Westinghouse Hanford Company
P.O. Box 1970, MS N3-05
Richland, WA 99352
Alternate Contacts:
Keywords: Associated, in situ, fluorescence, F-demo
Description:
This is a coordinated effort related to adding different measurement technologies to the cone penetrometer. See Tom Lee (SCAPS).

Title: Drilling Technology Development at VOC-Arid Demonstration
Contact Person:
McLelland, Greg (WHC) **Phone:** 509-376-2260
P.O. Box 1970, MS N3-05
Westinghouse Hanford Company
Richland, WA 99352
Alternate Contacts:
Keywords: Associated, sonic, penetrometer, Ditch Witch, vertical, horizontal, monitoring, remediation, F-demo?
Description:
This is an integrated study of various drilling technologies and their applicability to various waste sites.

Title: Surface Characterization/Mapping of Tank Waste Using FTIR
Contact Person:
Mech, S.J. (WHC) **Phone:** 509-376-8858
Westinghouse Hanford Company
P.O. Box 1970, MS L7-05
Richland, WA 99352
Alternate Contacts:
Keywords: IR, F-demo, soil, water
Description:
No written description provided by contact person.

Title: Fiberoptic Sensor and Analysis for the Integration Demo for Clean-up of Soils and Groundwater in Non-Arid Sites
Contact Person:
Milanovich, Fred (LLNL) **Phone:** 510-422-6838
Lawrence Livermore National Laboratory
P.O. Box 808, L-524
Livermore, CA 94550
Alternate Contacts:
Keywords: Fiberoptics, spectroscopy, water, TCE, $HCCl_3$, regulatory, adsorption, reagent, licensed, F-demo
Description:
The Integrated Demonstration at the Savannah River Site (SRS) has been chosen as the initial location for field demonstration of LLNL fiber sensor technology. Sensors and instruments that are significantly into, or through, the development stage will be evaluated as to their applicability to the SRS. Initial target compounds will be volatile organic solvents and fuels. The LLNL TCE sensor has established

sensitivity at below drinking water standard and has been engineered for field testing. Consequently, it will be the focus of FY 92 and 93 activities at SRS. It is anticipated that a second generation TCE sensor will be ready for field testing by late FY 92. Three sensor placement modalities will be evaluated: 1) screened vadose zone well implant, 2) direct well-water implant and 3) penetrometer placement.

Title: In Situ Detection of Organics, Demo Support
Contact Person:
Milanovich, Fred (LLNL) **Phone:** 510-422-6838
Lawrence Livermore National Laboratory
P.O. Box 808, L-524
Livermore, CA 94550
Alternate Contacts:
Keywords: Fiberoptic,spectroscopy, gas, TCE, $HCCl_3$, regulatory, in situ, adsorption, reagent, licensed, F-demo
Description:
This project is in cooperation with Mike Angel and covers a wide range of activities related to the demonstration of fiber optic technologies. Fiber optic sensors (optrodes) will be evaluated and field-tested for in situ monitoring of contaminant species in ground water. A protocol for using in situ fiber-optic sensors for vadose and aqueous-phase measurements will be developed. This will require the development of field-portable fiber-optic instrumentation, development of test procedures for in situ measurements, and testing optrodes under real world conditions to determine their limitations. Successful sensors will be moved to site-directed applications or integrated demonstration projects. Coordinated with U.S. Army Corps of Engineers fiber optic sensor work.

Title: Quadrupole Molecular Beam Mass Spectrometer for VOCs in Air
Contact Person:
Milne, Tom (NREL) **Phone:** 303-231-1384, 303-231-4402
National Renewable Energy Lab
1617 Cole Blvd
Golden, CO 8040
Alternate Contacts:
Keywords: MS^3, quad, gas, intermediates, user-facility, L-demo
Description:
The Solar Energy Research Institute (now NREL) has employed free-jet, molecular-beam, mass spectrometric (MBMS) sampling for the last decade. The system is used for direct, real-time sampling of reactive system at ambient conditions. Such a system is a nearly universal detector for gaseous species. It is best suited for the detection and quantitation of reactive, condensible or non-chromatographable species in complex mixtures at pressures of 1-10 atmospheres. This system features a triple quad detector to aid the identification of ions by employing collisionally induced dissociation.

Title: Time of Flight-Quadrupole Transportable Molecular Beam MS^2 for VOCs in Air
Contact Person:
Milne, Tom (NREL) **Phone:** 303-231-1384 or 1440
National Renewable Energy Lab
1617 Cole Blvd
Golden, CO 80401
Alternate Contacts:
Keywords: MS^2, quad, TOF, gas, intermediates, user-facility, L-demo

Description:
Because of the many applications of the MBMS, and to increase the application versatility of such sampling, a second, transportable system (TMBMS) is nearing completion. This system fits on a mobile unit of about 3 1/2' by 6' and is designed to be interfaced with engineering scale systems in the laboratory or the field. The TMBMS features a time-of-flight mass spectrometer as well as a quadrupole. The former will permit fast transient behavior to be studied.

Title: Mobile Platform Laboratory for Gas Characterization
Contact Person:
Moulton, Mike (SNL) **Phone:** 505-845-8106
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87585
Alternate Contacts:
Keywords: FTIR, GC, GC-MS, IC, IM, meteorology, F-demo
Description:
This mobile laboratory has multiple capabilities and can make laboratory type measurements at the site.

Title: Fiberoptic Remote UV-absorption with Transduction Dyes for Halogenated Aromatics in Water and Air
Contact Person:
Myrick, Mike (U. So. Carolina) **Phone:** 803-777-6018
Dept. of Chemistry and Biochemistry
Columbia, SC 29208
Alternate Contacts:
Keywords: Fiberoptics, L-demo, optical, in situ, gas, water, reversible, aromatics
Description:
We are investigating a novel technique, now demonstrated in the laboratory, which can make long-range (e.g., >200 meters) UV absorbance measurements over fiber optics. The technique accounts for scatter inside the sample to a large extent and is self-referencing. Preliminary evidence suggests that the technique has a detection limit near that of traditional absorption methods. The ultimate form of a UV-absorbance device utilizing this approach would be very simple, consisting of a small enclosure with dichroic beamsplitter and two detectors and optical filters, perhaps multiplexed to numerous UV samplers and read by a standard PC-type computer.

Title: New Methods for Collecting Water and Soil Gas Samples
Contact Person:
Nichols, Ralph (SRL) **Phone:** 803-725-5228
Savannah River Laboratory
Aiken, SC 29808
Alternate Contacts:
Keywords: Sampling, water, gas, F-demo?
Description:
This project involves testing of a screened hollow stemmed auger to collect vapor and water samples for VOC analysis. The sampler can also be used to collect data for estimating hydraulic conductivity.

Title: Soil Gas Surveying
Contact Person:
Nyquist, Jon (ORNL) **Phone:** 615-574-4646
Oak Ridge National Laboratory
Oak Ridge, TN 37831

Alternate Contacts:
Keywords: Modeling, developing
Description:
No written information provided by contact person.

Title: Fiberoptic Based Optical Emission Sensor for Total Organic Chlorine (Halo Sniff)
Contact Person:
Olsen, Khris (PNL) **Phone:** 509-376-4114
Pacific Northwest Laboratory
P.O. Box 999, MS K6-81
Richland, WA 99352
Alternate Contacts:
Evans, John (PNL) 509-376-0934
Keywords: TOCl, extract, fiberoptics, F-demo, water, gas, soil
Description:
A sensor based on spectrochemical emission from a radio frequency (RF) induced helium plasma was designed and tested as a detector for volatile chlorinated compounds in the gas phase. The "Halo Sniff" sensor uses a critical orifice air inlet and an RF-excited sub-atmospheric pressure helium plasma to excite the air sample. The excitation source is coupled to the associated collection optics by a fiber-optic cable. Halo Sniff monitors the emission intensity of the 837.6 nm emission line of chlorine. It has a verified linear from 2 to 500 ppmv carbon tetrachloride with a correlation coefficient of .996 and excellent reproducibility. The detection limit for carbon tetrachloride in air was 2 ppmv. Detection limits for other chlorine containing compounds will be directly proportional to the mole fraction of chlorine in the molecule of interest. Other halogen containing compounds can also be monitored by simply changing the narrow band pass filter to the specific wavelength of interest.

Title: Laser Spark Spectroscopy
Contact Person:
Ottesen, David (SNL) **Phone:** 510-294-3687
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Keywords: Optical, laser, metals, L-demo, soils
Description:
This has no direct application to measurement of VOCs but can measure elements from solid samples which may be related to VOCs.

Title: Enhanced Fiber-Coupled Raman Spectrometer
Contact Person:
Perkins, John (Westinghouse) **Phone:** 412-256-2712
Westinghouse STC
1310 Beulah Road
Pittsburgh, PA 15235
Alternate Contacts:
Suhre, Dennis (Westinghouse) 412-256-1570
Wutzke, Steve (Westinghouse) 412-256-1570
Keywords: Acoustic, Raman, developing, CIHC
Description:
No written information provided by contact person.

Title: Quartz Crystal Microbalance (QCM) and Surface Acoustic Wave (SAW) Probes
Contact Person:
Poziomek, Ed (UNLV) **Phone:** 702-739-3382
Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas
Las Vegas, NV 89154-4009
Alternate Contacts:
Keywords: Acoustics, piezoelectric, L-demo, BTEX, gas, water
Description:
QCM and SAW probes are chemical microsensors which measure changes in mass when analytes adsorb onto or react with coatings covering the transducers. They utilize piezoelectric substrates as signal transducers. Chemical or biochemical coatings provide selectivity. The analyte sorbs onto or into the coating, reversibly or irreversibly, through molecular association effects and/or chemical reactions. These interactions are sensed by producing signals which relate to the concentration of the analytes. Both QCM and SAW microsensors are mass-to-frequency transducers. A typical SAW output would exhibit changes in device frequency over time. Advantages of SAW devices over QCM ones include higher sensitivity (due to higher operating frequencies), smaller size, greater ease of coating, and improved ruggedness. However, if solution applications are being sought, the QCM devices are more adaptable at the present time than are the SAW probes. Research currently being pursued includes adaptation of SAW technologies to specific environmental applications and drug interdiction. Of specific environmental interest are benzene, toluene, ethylbenzene, and toluene (BTEX). Use of SAW devices as biosensors is also being investigated. Cooperative efforts in this research are in place with Microsensor Systems Inc., Bowling Green, KY.

Title: Molecular Modeling of Sensor Chemistry and Biochemistry
Contact Person:
Poziomek, Ed (UNLV) **Phone:** 702-739-3382
Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas
Las Vegas, NV 89154-4009
Alternate Contacts:
Keywords: Modeling, developing, coatings, software, sensors
Description:
The Molecular Modeling, Analysis, and Display System (MMADS) software is available for various studies involving sensor chemistry and biochemistry. MMADS is a direct descendant of the TRIBBLE system. Additional routines have been adapted from the CHEMLAB system, the QUIPU system, and the Quantum Chemistry Program Exchange. MMADS provides a "chemist's workbook" - a user-friendly, integrated suite of programs for quantum, physical, and physical organic chemistry, as well as state-of-the-art molecular graphics routines. An example of the use of MMADS in sensor science research is through structure activity relationships to design recognition coatings for environmental analytes of interest. Molecular fit would increase the probability of chemical reactions or molecular association effects for recognition events in sensor devices. A research application would be to design molecules which mimic the physiological action of biological compounds with a goal of designing recognition coatings for specific hazardous compounds.

Title: Recognition Coatings and Evaluation
Contact Person:
Poziomek, Ed (UNLV) **Phone:** 702-739-3382
Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas
Las Vegas, NV 89154-4009

Alternate Contacts:
Keywords: Evaluation, developing, sensors, coatings, chemistry
Description:
The major problems and barriers in the development of chemical sensors do not deal with microminiaturization or microelectronics, but rather with chemistry. Not only are there few guidelines for practitioners for a particular application, but there is also little information base on the fundamental chemistry. Major barriers still remaining to be solved in recognition coating selection and evaluation include:

• Lack of an information base on chemical reactions and molecular association effects in vapor-solid and liquid-solid phases which can be drawn upon for development of sensor coatings.

• Lack of guidelines on choosing selective coatings for use in conjunction with chemical sensors.

• Lack of standard or reference methods for screening and evaluating candidate coatings in sensor applications. A variety of approaches are being followed to address these interesting challenges, especially for volatile organic chemicals (VOCs).

Title: Rapid In Situ Measurements of PAHs and other Polyaromatic Contaminants in Groundwater and Soils at U.S. DOE Facilities
Contact Person:
Poziomek, Ed (UNLV) **Phone:** 702-739-3382
Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas
Las Vegas, NV 89154-4009
Alternate Contacts:
DLugosz, Joseph J. (EPA) 702-798-2598
Keywords: Fiberoptics, fluorescence, gas, water, aromatics, in situ, developing
Description:
The objective of this work is to conduct in situ UV-vis luminescence (fluorescence and phosphorescence) of organic contaminants for rapid, real-time, on-site detection and measurement (monitoring) of ground water or soils at selected sites. Soils probably involve a microextraction which could also further increase the sensitivity for water samples. An advanced lightweight (11kg) portable field spectrofluorometer was delivered in February 1992 by Oak Ridge National Laboratory to EPA's Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV). EMSL-LV can now provide rapid, on-site field screening with this advanced instrument for real-time in situ monitoring for PAHs and similar polyaromatic contaminants.

Title: Ion-mobility Spectrometry for VOCs in the Atmosphere
Contact Person:
Proctor, Alan [EG&G(RSL)] **Phone:** 702-295-8764
EG&G Energy Measurements
P.O. Box 1912
Las Vegas, NV 89125
Alternate Contacts:
Keywords: Ion-Mobility, developing, F-demo?, gas, portable
Description:
Ion-mobility Spectrometry (IMS) is a highly sensitive, relatively selective, and semi-quantitative analytical technique which can readily be packaged into a portable system for field use. IMS determines the presence of trace quantities of many organic compounds (and some volatile inorganic chemicals) in air. Results are available in "real time" and interference between chemical signatures usually do not cause problems in analyzing mixtures. Small ion mobility spectrometers are available, and no vacuum systems or complex sample handling is needed. The IMS and supporting electronics are available in a package

whose volume is less than one cubic foot. We at RSL are adapting an IMS for field use in environmental characterization. We are building a sampling probe which samples contaminated atmospheres with minimal disturbance. In addition, we are developing software to make the instrument "user-friendly" for specific sensing applications.

Title: Electrical Resistance Tomography to Characterize Vadose Zone Processes and to Monitor Remediation for Arid Site Integrated Demonstration
Contact Person:
Ramirez, Abe (LLNL) **Phone:** 510-422-6909
Lawrence Livermore National Laboratory
Livermore, CA 94550
Alternate Contacts:
Daily, Bill (LLNL) 510-422-8623
Keywords: Associated, geology, F-demo
Description:
Application of ERT will provide a three-dimensional image of the distribution of injected gases below the water table and an image of the changes in moisture content caused by rainwater infiltration from the ground surface to the water table. This information can be used to infer the flow paths travelled by the injected gas as it displaces water in the saturated zone, and the rainwater infiltration paths as it moves through the vadose zone above the water table.

Title: Rapid Screening Reversible Sensor for Waste Site Detection and Monitoring of VOCs
Contact Person:
Reagen, William K. (INEL) **Phone:** 208-526-7793
INEL, EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415
Alternate Contacts:
Keywords: Colorimetric, fiberoptics, developing, in situ, reversible, gas, water
Description:
Early laboratory work has demonstrated a high probability for success in the development of a sensitive and reversible volatile organic compound (VOC) sensor for environmental screening and monitoring. The sensor will be stable to water and heat, provide instantaneous detection, and most importantly will be reusable in the field. It is of simple design but will provide rapid screening capabilities for pre-identified contaminants. The sensor will be configured to detect a broad range of VOCs, however, it will be calibrated for usage in field applications for the detection of carbon tetrachloride, trichloroethylene, or other selected analytes. Proprietary colorimetric inorganic reagents recently developed by 3M Corporation will be utilized in the development of the sensor. Successful engineering of 3M's vapochromic reagents with fiber optic technologies in the development of a first generation sensor prototype design has been demonstrated at the INEL. From this work, high probability is given for the rapid development of a low cost, reusable field sensor directly applicable to environmental monitoring.

Title: Selective Halogenated Hydrocarbon Sensor for Waste Site Detection and Monitoring
Contact Person:
Reagen, William K. (INEL) **Phone:** 208-526-7793
INEL, EG&G Idaho Inc.
P.O. Box 1625
Idaho Falls, ID 83415
Alternate Contacts:
Stone, Mark L. (INEL) 208-526-8664

Keywords: Fiberoptics, developing, in situ, colorimeter, reversible, gas, water
Description:
Membranes and selective reagents will be developed to provide specificity to the measurements of selected VOCs present in air and water. Cooperation with 3M in compound specific and reversible sensors will be pursued.

Title: Conventional Geophysical Approach to Small Area Site Characterization
Contact Person:
Reilly, Chris (ANL) **Phone:** 708-252-3879
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
Alternate Contacts:
Doskey, Paul (ANL) 708-252-7662
Burton, Jacqueline (ANL) 708-252-8795
Keywords: Seismic, ferromagnetic, F-demo, geology
Description:
No written description provided by contact person.

***Title: Field-Based Measurement of VOC Partitioning Coefficients
Contact Person:
Rice, Dave (LLNL) **Phone:** 510-423-5059
Lawrence Livermore National Laboratory
Livermore, CA 94550
Alternate Contacts:
Bishop, Dorothy (LLNL) 510-422-2267
Keywords: F-demo, water, soil, VOCs, ClHC
Description:
Field-based analytical techniques that measure spatially discrete areas of contaminant partitioning between soil and the interstitial water have been developed. The resulting field-based sorption constant (Kd) is critical in assessing contaminant plume migration, extent of site contamination, and in planning remediation strategies. Two devices were specially designed and constructed to accurately measure VOC concentrations from undisturbed sediment samples at specific depths. The bulk thermal desorption chamber (BTDC) is used to recover the total amount of VOCs in large, intact saturated aquifer samples, while the pore water extraction chamber (PWEC) is used to recover VOC concentrations in the pore water by centrifugation.

***Title: Measurement of Porewater Displacement during Mud Rotary Sampling for VOCs
Contact Person:
Rice, Dave (LLNL) **Phone:** 510-423-5059
Lawrence Livermore National Laboratory
Livermore, CA 94550
Alternate Contacts:
Jovanovich, Marina (LLNL) 510-422-2144
Keywords: F-demo, water, ClHC, soil
Description:
Analytical techniques to evaluate the amount of penetration of drilling fluid into sediment cores during a mud-rotary drilling and operations have been developed. To evaluate the extent of drilling fluid dilution

*** Information about this technology received after evaluation and prioritization on March 26, 1991.

of sediment fluids, a pore water extraction chamber (PWEC) was designed to hold an intact sediment core. The entire device is centrifuged and the interstitial water is collected in a small reservoir in the bottom. A sample for analysis is obtained using a syringe through a specially constructed valve.

***Title: Decision Support System for the Implementation of the Observational Approach to VOC Characterization
Contact Person:
Rice, Dave (LLNL) **Phone:** 510-423-5059
Lawrence Livermore National Laboratory
Livermore, CA 94550
Alternate Contacts:
Johnson, Virginia (LLNL) 510-423-2005
Keywords: F-demo, computer
Description:
A critical element in the observational approach to VOC characterization is the establishment of a decision support system that will allow the rapid interpretation of data such that informed decisions can be made at each succeeding step in the remedial process. Staff have applied a computer application developed by LLNL that allows the linking and integration of a variety of data management and data analysis and display applications to create a decision support system for the implementation of the observational approach to VOC characterization. This application, called the INTEGRATOR, was originally developed for the Department of Defense, Treaty Verification Program.

Title: SFE/Field Transportable Characterization of Co-Contaminants
Contact Person:
Riley, Robert (PNL) **Phone:** 509-376-1935
PO Box 999 MS KG-81
Richland, WA 99352
Alternate Contacts:
Keywords: SFE, IR, L-demo, TBP, DBP, DBBP, MBP, soil, extraction
Description:
This task focuses on the characterization of SVOCs which can modify the behavior of VOCs at a waste site. SFE is used to avoid the use of organic solvents and provide rapid and efficient removal of SVOCs from soil and sediment samples.

Title: Field Screening Technologies for Waste Site Characterization
Contact Person:
Riley, Robert (PNL) **Phone:** 509-376-1935
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Keywords: IR, L-demo, SFE, extraction, soil, F-demo?
Description:
Tools such as supercritical fluid extraction of solid samples and field deployable IR spectroscopy are investigated for field screening of organic constituents at a waste site.

***** Information about this technology received after evaluation and prioritization on March 26, 1992.**

Title: Fiberoptics with Dye Tracer to Obtain Vertical and Horizontal Hydraulic Conductivity
Contact Person:
Rossabi, Joe (SRL) **Phone:** 803-725-5220
Westinghouse Savannah River Co.
Bldg. 773-41A
Aiken, SC 29808
Alternate Contacts:
Keywords: Fiberoptics, associated, F-demo?
Description:
1. Using fiber optic absorption sensors in groundwater tracer tests (dye injections). Tests will be done on site. Sensors will be placed directly in aquifer at depths of up to 120 feet. Sensors will be used to obtain discrete vertical and horizontal hydraulic conductivity values. This will aid in effective remediation of the site. Results will be compared with simultaneous conductivity measurements obtained by multi-level bailer and traditional grab sampling methods.
2. Using flow through fiber optic absorption sensor to measure residence time distribution in bioreactor. Bioreactor will be used to treat aqueous phase TCE. Dye tracer test will be conducted.

Title: Fiber Optic Sensor for Chlorinated Hydrocarbons
Contact Person:
Saaski, Elric W. (Res. Int'l) **Phone:** 206-486-7831
Research International
18706 142nd Ave. N.E.
Woodinville, WA 98072
Alternate Contacts:
Keywords: Fiberoptics, in situ, ClHC, gas, L-demo
Description:
Research International is investigating miniature optical chemical sensor media responsive to chlorinated hydrocarbons. The transduction method is based on optical interferometer principles and may be thought of as an optical analog to an electrical surface acoustic wave device. The sensors being investigated function in both the vapor phase as well as in water and exhibit "ppm" sensitivity with a time constant under two minutes. All necessary opto-electronics are incorporated onto a custom card for insertion into an IBM-compatible personal computer. Use of a portable PC allows a completely field portable sensing system.

Title: Fiber Optic Chemical Sensor for Aromatic Hydrocarbons (BTEX)
Contact Person:
Saaski, Elric W. (Res. Int'l) **Phone:** 206-486-7831
Research International
18706 142nd Ave. N.E.
Woodinville, WA 98072
Alternate Contacts:
Keywords: Fiberoptics, in situ, L-demo, BTEX, gas
Description:
Research International has developed a miniature optical chemical sensor selective for aromatic hydrocarbons. The sensor is based on an optical interferometer and may be thought of as an optical analog to an electrical surface acoustic wave device. The sensor functions in both the vapor phase as well as in water and exhibits "ppm" sensitivity with a time constant ranging from seconds to minutes, depending on physical construction. All necessary opto-electronics are incorporated onto a custom card for insertion into an IBM-compatible personal computer. Use of a portable PC allows a completely field portable sensing system.

Title: Electromagnetic Induction
Contact Person:
Sandness, Gerald (PNL) **Phone:** 509-376-3808
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Keywords: Associated, geophysics, F-demo?
Description:
No written information provided by contact person.

Title: Ground Penetrating Radar
Contact Person:
Sandness, Gerald (PNL) **Phone:** 509-376-3808
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Keywords: Associated, geology, L-demo?
Description:
Main use appears to be in locating tanks buried near the surface. No written information provided by contact person.

Title: Multi-Parameter Sonde
Contact Person:
Schalla, Ron (PNL) **Phone:** 509-376-5064
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Evans, John (PNL) 509-376-0934
Keywords: Associated, F-demo, pH, temperature, conductivity, oxygen, water, commercial
Description:
This is a commercial unit sold by Martek, Inc., that measures a number of parameters such as pH, temperature, oxygen, and conductivity in water.

Title: Hydraulically Installed, Multi-Sampling Lysimeter
Contact Person:
Scroppo, Joseph (Bladon Int.) **Phone:** 708-803-2396 or 708-986-8040 ext.111
Bladon International Inc.
880 Tee Street
Des Plaines, IL 60016
Alternate Contacts:
Keywords: Sampling, L-demo, water, gas, in situ
Description:
A device capable of retrieving pore liquid and/or vapor samples from the unsaturated zone of the soil without pre-drilling a bore hole or monitoring well. Mechanically installed like the cone penetrometer, approximately ten sampling points can be configured into a single unit without commingling samples.

Title: GC-MS Mobile Laboratory for Gas Analysis
Contact Person:
Seidel, Cary (WHC) **Phone:** 509-372-0846
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352
Alternate Contacts:
Keywords: MS, GC, developing, VOCs, quad, gas, CIHC
Description:
The current work being done by Westingouse Hanford Company involves taking a GC/MS and installing it in one of our mobile laboratory trucks. This effort is being directed by Beverly Crawford. The concept is to install a GC/MS instrument in a mobile (truck) laboratory along with the required utilities and services to allow the instrument to be moved from one sampling site to another, while maintaining calibration to allow for analysis of gas samples in the field.

Title: Evaluation of Sampling Methods on VOC Measurements in Contaminated Soils
Contact Person:
Siegrist, R.L. (ORNL) **Phone:** 615-574-7286
Environmental Science Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831
Alternate Contacts:
Keywords: Sampling, L-demo, soils, CIHC, inadequacies, published, EST
Description:
Past research has shown a large negative bias in VOCs analyses due to sampling and sample handling procedures for soils. Continuing efforts involve studies of different compounds, soil conditions, and sampling environments to eliminate these biases.

Title: Fiberoptic Based Technologies for Site Characterization
Contact Person:
Sigel, George (Rutgers U.) **Phone:** 908-932-4729
Rutgers University
Fiberoptic Materials Research Program
P.O. Box 909
Piscataway, NJ 08855
Alternate Contacts:
Keywords: Fiberoptics, F-demo?, in situ, gas, water, VOCs, University
Description:
No written description provided by contact person. Phone conversations revealed this to be a large program with many graduate students working on fabrication of fibers and cooperative efforts with small companies.

Title: MDA Long Path Monitoring System
Contact Person:
Simpson, Orman (MDA) **Phone:** 404-242-0977
MDA Scientific, Inc.
3000 Northwoods Parkway
Norcross, GA 30071
Alternate Contacts:
McClenny, William (EPA) 919-541-3158
Koglin, Eric (EPA) 702-798-2432

Keywords: IR, gases, remote, sensors, commercial, F-demo
Description:
The MDA long path monitoring system is a field-deployable instrument that measures the absorption caused by infrared-active molecules. It does not require the acquisition of a sample, thereby insuring sample integrity. The instrument can make measurements in a few minutes, which allows the determination of temporal profiles for pollutant gas concentrations. The system transmits an infrared beam along a path to a retroreflector which returns it to the detector. The total path can be up to one kM in length. The system does not need calibration in the field.

Title: In Situ Samplers and In Situ Scan
Contact Person:
Smart, John (PNL) **Phone:** 509-367-8306
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
Alternate Contacts:
Schalla, Ron (PNL) 509-376-5064
Keywords: Sampling, F-demo, water, in situ
Description:
No written information provided by contact person.

Title: Selective Detection of Chlorinated Organic Contamination
Contact Person:
Stetter, Joe (TRI, Inc.) **Phone:** 708-357-0004
Transducer Research, Inc.
999 Chicago Ave.
Naperville, IL 60540
Alternate Contacts:
Keywords: Resistivity, L-demo, gas, water, ClHC, TOCl
Description:
A solid state gas sensor that changes resistance in the presence of compounds that contain the carbon-chlorine bond has been developed recently by Transducer Research, Inc. The sensor can be operated with a permeator so that it can detect chlorinated organic compounds in aqueous samples or above solid material. The sensor can detect from a few tenths of a ppm to several hundred ppmv and can be coupled to preconcentrators and diluters to extend the dynamic range. The entire sensor is only a few mm diameter and has the potential for local sensing or remote (downhole) use.

Title: Real-Time Sensors for VOCs Using Surface Modification
Contact Person:
Swanson, Basil (LANL) **Phone:** 505-667-5814
Los Alamos National Laboratory
INC-14, MS C-345
Los Alamos, NM 87545
Alternate Contacts:
Keywords: Fiberoptics, developing, reversible, water, air, in situ, sensors
Description:
Surface modification techniques where mono-layers and multi-layers of reagents are covalently bonded directly to a transducer surface are being employed to develop new chemical sensors that combine high molecular specificity, sensitivity, stability, and reversibility. Halogenated hydrocarbon sensors based on either mass or optical transduction are being developed for use in remote, downhole applications in both the vadose zone (mass transduction) and in ground water (optical transduction).

Reversible electrochemical sensors are also being developed for detection of a variety of complexing organic molecules in ground and surface water.

Title: Transportable GC-MS
Contact Person:
Thornberg, Steve (SNL) **Phone:** 505-844-8829
Sandia National Laboratories
Organization 1823, P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Keywords: MS, GC, quad, F-demo, portable, gas, water, soil, CIHC, regulatory, commercial
Description:
This is a field tested commercial unit obtained from Viking, Inc. Arid site demonstrations by SNL personnel have been highly successful.

Title: Minilab for In Situ Characterization Via Robotics with 8 Sensors
Contact Person:
Thornberg, Steve (SNL) **Phone:** 505-844-8829
Sandia National Laboratories
Organization 1823, P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Keywords: GC, TCD, developing, robotics, gamma, UST, mixed-waste, non-evasive, video
Description:
A miniaturized sensing package is being designed as a tool for a robotic arm which would be deployed through a small riser in a hazardous waste tank. While the robot arm scans the sensing package over the waste, a distributed computing system acquires sensor data, correlates the data with the position of the robot, and produces real-time sensor maps of the chemical and radiological contents of the tanks.

Title: Surface Enhanced Raman Spectroscopy for Environmental Samples
Contact Person:
Vo Dinh, Tuan (ORNL) **Phone:** 615-574-6249
Oak Ridge National Laboratory
Advanced Monitoring Development Group
Oak Ridge, TN 37831-6101
Alternate Contacts:
Yalcintas, Guvan (ORNL)
Keywords: Raman, SERS, developing, VOCs, SVOCs, phosphonates, water
Description:
No written information provided by contact person.

Title: Borehole Fiberscope
Contact Person:
Vo Dinh, Tuan (ORNL) **Phone:** 615-574-6249
Oak Ridge National Laboratory
Advanced Monitoring Development Group
Oak Ridge, TN 37831-6101
Alternate Contacts:
Keywords: UV, fiberoptics, F-demo?, in situ, BTEX, aromatics, water
Description:
No written information provided by contact person.

Title: Fiberoptic Organic Vapor Sensor
Contact Person:
Walt, David (Tufts U.) **Phone:** 617-381-3470
Tufts University
Department of Chemistry
Medford, MS 02155
Alternate Contacts:
Keywords: Fiberoptics, fluorescence, L-demo, gas, water, in situ
Description:
Fiber-optic sensors and supporting field-portable instrumentation have been developed that are capable of in situ, continuous measurements of volatile organic compounds in groundwater and soil samples. The sensors are based on the polymer absorption of organic vapor and result in fluorescence enhancement of an immobilized fluorophor.

Title: Horizontal Drilling and Sampling
Contact Person:
Wemple, Bob (SNL) **Phone:** 505-844-2230
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185
Alternate Contacts:
Keywords: Associated, drilling, sampling, F-demo?
Description:
This work represents a partnership between SNL and the Charles Machine Works, Inc. (Tm-Ditch Witch). Two part project includes: 1) building hybrid directional boring hardware from utilities installation, geothermal, and soil mechanics technologies, and 2) develop and demonstrate a hybrid capability for horizontal logging with penetrometers, specialty instruments and samplers.

Title: Multi-Level Simultaneous Sampler for Groundwater
Contact Person:
Widdowson, Mark (U. So. Carolina) **Phone:** 803-777-7521
University of South Carolina
Columbia, SC 29208
Alternate Contacts:
Keywords: Sampler, water, L-demo
Description:
Sample integrity for VOCs in groundwater is claimed. Probable extension to non-arid ID at SRS is being investigated. The system does NOT use a surface pump to collect the sample. No written information provided by contact person.

Title: Ferrocyanide Detection Using Laser Raman Scattering Spectroscopy
Contact Person:
Winkelman, W.D. (WHC) **Phone:** 509/376-3339
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352
Alternate Contacts:
Reich, Fred (WHC)
Keywords: Raman, developing, in situ, water

Description:
No direct applicability to VOCs. No written information provided by contact person.

***Title: Elemental Analyses in the Field Using XRF
Contact Person:
Wrigley, Jim (Advanced Analytical) **Phone:** 408-926-4057
1753 Cape Aston Court
San Jose, CA 95133
Alternate Contacts:
Keywords: XRF, F-demo, commercial, soils, water, metals
Description:
This is a field deployable technology for measuring metals in solution or in soils using proprietary sample preparation followed by XRF analysis.

*** Information about this technology received after evaluation and prioritization on March 26, 1992.

Primary Categorization and Prioritization of Technology Projects

Each of the identified technology projects for characterizing-monitoring VOCs was put into one of three categories: 1) Field-Demonstrated, 2) Laboratory-Demonstrated, or 3) Developing. Many times this classification judgment was easy; in some cases, it was not. For example, a technology project that had nearly complete failure in a field demonstration was still listed as field-demonstrated if the results showed conclusively what needed to be done and the necessary work had good prospects for near-term success. The difference between developing and laboratory-demonstrated technology projects was another gray area. Finally, technology projects evolve. The categorization in Table 1 is for a single point in time between December 1991 and April 1992.

The 62 field-demonstrated technology projects are listed in Table 2, the 36 laboratory-demonstrated in Table 3, and the 35 developing in Table 4. In each of these tables, and all other tables in this report, the technology projects are ordered alphabetically by first contact person name. Details about any listed technology project can therefore be located easily in the Table 1 master compilation.

The technology projects listed in Tables 2 through 4 were discussed, evaluated, and prioritized by a committee of six members on March 26, 1992. The committee was composed of two persons from the Monitoring Technical Support Group, one from the Characterization Technical Support Group, one from the Characterization, Monitoring, and Sensor Technology Integrated Program, and two from outside the DOE.

The committee began deliberations after a formal presentation of the status of the characterization effort at the VOC Arid ID site and the known characterization needs at this site. Those needs were the prime consideration used in the prioritization process, which also included consideration of such factors as technical quality, innovation, facilities, and principal investigator and staff competence.

The results of the consensus priority decisions are presented in Tables 5 through 7 for the field-demonstrated, laboratory-demonstrated, and developing technology projects. The classification of the projects into these three categories had been completed prior to the March 26 meeting. These prioritization tables were mailed to the committee members following the March 26 meeting and concurrence by all members was received by April 18, 1992.

The committee also provided the comments listed below for clarification of some possible questions about the tables (comments 1 through 5) and to highlight other matters of possible interest or concern regarding the characterization of the site (comments 6 and 7).

Comments

1. The projects listed in the Summary Tables are the best of those evaluated.

2. Few definitive objective criteria were available for the priority judgments.

3. The full project descriptions were not available for review; only the titles, short descriptions, and committee members' knowledge of the technologies and principal investigators were used in the evaluation and prioritization process.

4. Projects with the same priority number are ordered alphabetically.

5. Liquid-gas, liquid-solid, gas-solid, and liquid-liquid distributions and interactions of the volatile organic compounds are not addressed directly by any of the technology projects.

6. Applications of data fusion techniques for the primary contaminant, co-contaminants, and geologic information may have important usefulness for characterization and cleanup.

7. The advantages of field-deployable characterization techniques may not be fully realizable at sites contaminated with mixed waste.

Text continues after Table 7 on page 67.

Table 2. Field-Demonstrated Technology Projects for VOCs

Title: Portable Quad GC-MS
Contact Person(s):
Andresen, Brian (LLNL) Raber, Ellen (LLNL)

Title: Reversible Fiberoptic Fluorescence Sensor Combined with Cone Penetrometer for Detection of BTEX
Contact Person(s):
Angel, Mike (LLNL)

Title: In Situ Permeable Flow Sensor
Contact Person(s):
Ballard, Sandy (SNL)

Title: Accelerator MS for Detecting ^{36}Cl Produced in Weapons Testing at INEL
Contact Person(s):
Beasley, Tom (DOE-EML) Cecil, DeWayne L. (INEL)

Title: In Situ Mapping of Radionuclides in Sub-Surface and Surface Soil
Contact Person(s):
Brodzinski, R.L. (PNL) Perkin, R.W. (PNL) Robertson, D.E. (PNL)

Title: Advanced Mixed Waste Assay System
Contact Person(s):
Brodzinski, R.L. (PNL) Arthur, R.L. (PNL) Geelhood, B.D. (PNL)

Title: Laser-Induced Fluorescence Over Fiber Optics
Contact Person(s):
Chudyk, Wayne (Tufts U.)

Title: Environmental Monitoring of Chlorinated Hydrocarbons Using Ion Mobility of Negative Ions
Contact Person(s):
Conrad, Frank J. (SNL) Kenna, Bernard T. (SNL)

Title: Passive Groundwater Headspace Sampler
Contact Person(s):
Crockett, Alan (INEL)

Title: Colloidal Borescope for Groundwater Flow Measurements
Contact Person(s):
Cronk, Tom (ORNL-Grand Junction) Kearl, Pete (ORNL)

Title: Active Remote Sensing for Airborne Mapping of Toxic Materials
Contact Person(s):
DiBenedetto, John [EG&G (RSL)] Lutz, Stephen (EG&G)

Title: Aerial Measurement System Program for Radiation Surveillance
Contact Person(s):
Doyle, Jack [EG&G(RSL)] Proctor, Alan [EG&G/EM(RSL)]

Title: Ion Mobility Spectrometry for VOCs in Soil, Gas, and Water
Contact Person(s):
Eiceman, Gary (NMSU) Poziomek, Ed (UNLV)

Title: Passive Soil Gas Survey - PETREX
Contact Person(s):
Einhorn, Irving N. (NERI)

Title: Crosshole Seismic Tomography
Contact Person(s):
Elbring, Greg (SNL)

Title: Vadose Zone Monitoring at a Mixed Waste Management Facility
Contact Person(s):
Emer, Dudley (REECO)

Title: Optimization of In Situ Volatilization Systems
Contact Person(s):
Filley, Thom (Environmental S/E)

Title: Real Time Monitor for Organics - ITMS
Contact Person(s):
Guerin, Mike (ORNL) Wise, Marc (ORNL) Buchanan, Michelle (ORNL)

Title: ?In Situ? Characterization of Waste by Ion Trap Mass Spectrometry
Contact Person(s):
Hemberger, Phil (LANL)

Title: MS1-301 Series Organic Vapor Monitors: Portable GC Using Air as Carrier Gas and Solid State Detector.
Contact Person(s):
Jarvis, Lynn (Microsens. Sys., Inc.) Wohltjen, Hank (MSI)

Title: Miniature Sampler Based on Sorption Tubes for Vapors in Bore Holes
Contact Person(s):
Jenkins, Roger (ORNL)

Title: High Resolution Shear Wave Seismic Reflection Surveying for Hydrogeological Investigation
Contact Person(s):
Johnson, William J. (Rizzo)

Title: Quantitative Deep Soil Vapor Analyses
Contact Person(s):
Kagel, Carla (K Prime, Inc.) Kagel, Richard A. (K Prime, Inc.)
Kladnik, George (K Prime, Inc.)

Title: Passive Samplers for Groundwater Site Characterization
Contact Person(s):
Kaplan, Edward (BNL) Colombo, Peter (BNL)

Title: Modified Membrane Sampler
Contact Person(s):
Kaplan, Edward (BNL)

Title: Surface Flux Sorbent Canister
Contact Person(s):
Karp, Kenneth E. (Geotech, Inc.)

Title: Passive Subsurface Monitoring Device
Contact Person(s):
Karp, Kenneth E. (Geotech, Inc.)

Title: Surface Flux Accumulator Device
Contact Person(s):
Karp, Kenneth E. (Geotech, Inc.)

Title: Rapid Groundwater and Soil-Gas Sampling System
Contact Person(s):
Karp, Kenneth E. (Geotech, Inc.)

Title: SEAMIST Membrane System for Emplacement of Sensors
Contact Person(s):
Keller, Carl (SEA)

Title: Long Path Length UV (DOAS)
Contact Person(s):
Koglin, Eric (EPA)

Title: In Situ Detection of Chlorine and Nitrates in Bore-Holes using Neutron Activation
Contact Person(s):
Koizumi, Carl (WHC)

Title: Site Characterization and Analysis Penetrometer System (SCAPS)
Contact Person(s):
Lee, Tom (Waterways Exp. Station) Cooper, Stafford (Waterways)

Title: EPA Approved Methodology for TCLP and Organics in Mixed Wastes
Contact Person(s):
Lewis, Leroy (WINCO)

Title: Rapid Headspace Analysis of Soil and Water
Contact Person(s):
Looney, Brian (SRL) Eddy, Carol (SRL)

Title: TerraTrog for Soil Gas Sampling
Contact Person(s):
Lucero (ITRI)

Title: Automated Purge and Trap GC for Chlorinated Hydrocarbons
Contact Person(s):
Mackay, Doug (A+RT)

Title: Full Implementation Cone Penetrometer
Contact Person(s):
McLelland, Greg (WHC)

Title: Drilling Technology Development at VOC-Arid Demonstration
Contact Person(s):
McLelland, Greg (WHC)

Title: Surface Characterization/Mapping of Tank Waste Using FTIR
Contact Person(s):
Mech, S.J. (WHC)

Title: Fiberoptic Sensor and Analysis for the Integrated Demo for Clean-up of Soils and Groundwater in Non-Arid Sites
Contact Person(s):
Milanovich, Fred (LLNL)

Title: In Situ Detection of Organics, Demo Support
Contact Person(s):
Milanovich, Fred (LLNL)

Title: Mobile Platform Laboratory for Gas Characterization
Contact Person(s):
Moulton, Mike (SNL)

Title: New Methods for Collecting Water and Soil Gas Samples
Contact Person(s):
Nichols, Ralph (SRL)

Title: Fiberoptic Based Optical Emission Sensor for Total Organic Chlorine (Halo Sniff)
Contact Person(s):
Olsen, Khris (PNL) Evans, John (PNL)

Title: Ion-Mobility Spectrometry for VOCs in the Atmosphere
Contact Person(s):
Proctor, Alan [EG&G(RSL)]

Title: Electrical Resistance Tomography to Characterize Vadose Zone Processes and to Monitor Remediation for Arid Site Integrated Demonstration
Contact Person(s):
Ramirez, Abe (LLNL) Daily, Bill (LLNL)

Title: Conventional Geophysical Approach to Small Area Site Characterization
Contact Person(s):
Reilly, Chris (ANL) Doskey, Paul (ANL)
Burton, Jacqueline (ANL)

Title: Field-Based Measurement of VOC Partitioning Coefficients
Contact Person(s):
Rice, Dave (LLNL) Bishop, Dorothy (LLNL)

Title: Measurement of Porewater Displacement during Mud Rotary Sampling for VOCs
Contact Person(s):
Rice, Dave (LLNL) Jovanovich, Marina (LLNL)

Title: Decision Support System for the Implementation of the Observational Approach to VOC Characterization
Contact Person(s):
Rice, Dave (LLNL) Johnson, Virginia (LLNL)

Title: Field Screening Technologies for Waste Site Characterization
Contact Person(s):
Riley, Robert (PNL)

Title: Fiberoptics with Dye Tracer to Obtain Vertical and Horizontal Hydraulic Conductivity
Contact Person(s):
Rossabi, Joe (SRL)

Title: Electromagnetic Induction
Contact Person(s):
Sandness, Gerald (PNL)

Title: Multi-Parameter Sonde
Contact Person(s):
Schalla, Ron (PNL) Evans, John (PNL)

Title: Fiberoptic Based Technologies for Site Characterization
Contact Person(s):
Sigel, George (Rutgers U.)

Title: MDA Long Path Monitoring System
Contact Person(s):
Simpson, Orman (MDA) McClenny, William (EPA)
Koglin, Eric (EPA)

Title: In Situ Samplers and In Situ Scan
Contact Person(s):
Smart, John (PNL) Schalla, Ron (PNL)

Title: Transportable GC-MS
Contact Person(s):
Thornberg, Steve (SNL)

Title: Borehole Fiberscope
Contact Person(s):
Vo Dinh, Tuan (ORNL)

Title: Horizontal Drilling and Sampling
Contact Person(s):
Wemple, Bob (SNL)

Title: Elemental Analyses in the Field Using XRF
Contact Person(s):
Wrigley, Jim (Advanced Analytical)

Table 3. Laboratory-Demonstrated Technology Projects forVOCs

Title: Portable Gamma Ray Imaging of Bulk Soil
Contact Person(s):
Aitken, Alfred (NDI)

Title: Miniature Ion Trap Based GC-MS
Contact Person(s):
Andresen, Brian (LLNL) Raber, Ellen (LLNL)

Title: Fiberoptics for $CHCl_3$ and CCl_4 at Arid Site
Contact Person(s):
Angel, Mike (LLNL) Langry, Kevin (LLNL)

Title: UV and IR Spectrophotometry Optimized for Fiberoptics and VOCs in Gas and Water
Contact Person(s):
Arrendale, Dr. W. (UAH, JMBN, Inc.) Nielson, Bruce (Air Force)

Title: Optical Fiber-Based Sensor for In Situ Determination of Chlorinated Hydrocarbons
Contact Person(s):
Burgess, Lloyd (U. of Washington) Wangen, Lawrence (LANL)
Henshaw, John (U. of Washington)

Title: Fiber Optic Micromirrors
Contact Person(s):
Butler, Mike (SNL)

Title: Fiberoptic Raman Spectrograph for In Situ Environmental Monitoring
Contact Person(s):
Carrabba, Dr. Michael (EIC)

Title: Centrifuge Technology for Vadose Zone Transport Measurements
Contact Person(s):
Conca, James (WSU Tri-Cities) Wright, Judith (PNL)

Title: FTIR For Volatile Organics in Soil Gas and Thermally Desorbed Organics
Contact Person(s):
Demirgian, Jack (ANL)

Title: Solid Phase Extraction in Combination with Spectroscopy for Monitoring Water Pollution
Contact Person(s):
Eastwood, Delyle (Lockheed) Poziomek, Ed (UNLV)

Title: Portable Acoustic Wave Sensors
Contact Person(s):
Frye, Greg (SNL)

Title: Inexpensive Sensor for In Situ Detection of Free Liquids
Contact Person(s):
Gee, Glendon (PNL) Cary, John (retired)

Title: Real Time Monitor for Organics - $ITMS^2$
Contact Person(s):
Guerin, Mike (ORNL) Wise, Marc (ORNL) Buchanan, Michelle (ORNL)

Title: Mixed Wastes (EPA agreeable) and Field Analytical Technologies (capabilities and needs)
Contact Person(s):
Guerin, Mike (ORNL) Griest, Wayne (ORNL)

Title: Spectroelectrochemical Sensors
Contact Person(s):
Haas, John (ORNL)

Title: Portable Derivative UV Absorbance Spectroscopy (DUVAS) for Aromatic Screening
Contact Person(s):
Haas, John (ORNL)

Title: Portable Borehole Fiberscope with DUVAS (Derivative UV Absorbance Spectrometer)
Contact Person(s):
Haas, John (ORNL)

Title: Portable 3-Meter Path Cell Derivative UV Absorbance Spectroscopy (DUVAS)
Contact Person(s):
Haas, John (ORNL)

Title: Fiberoptics Based Sensor for BTEX
Contact Person(s):
Klainer, Stan (FiberChem)

Title: Borehole Aquifer and Soil Gas Depth-Discrete Sampling and Testing Device
Contact Person(s):
Luttrell, S. (PNL)

Title: Portable On-Site IR Analyzer
Contact Person(s):
McClelland, John (Ames)

Title: Quadrupole Molecular Beam Mass Spectrometer for VOCs in Air
Contact Person(s):
Milne, Tom (NREL)

Title: Time of Flight-Quadrupole Transportable Molecular Beam MS^2 for VOCs in Air
Contact Person(s):
Milne, Tom (NREL)

Title: Fiberoptic Remote UV-absorption with Transduction Dyes for Halogenated Aromatics in Water and Air
Contact Person(s):
Myrick, Mike (U. So. Carolina)

Title: Laser Spark Spectroscopy
Contact Person(s):
Ottesen, David (SNL)

Title: Quartz Crystal Microbalance (QCM) and Surface Acoustic Wave (SAW) Probes
Contact Person(s):
Poziomek, Ed (UNLV)

Title: SFE/Field Transportable Characterization of Co-Contaminants
Contact Person(s):
Riley, Robert (PNL)

Title: Field Screening Technologies for Waste Site Characterization
Contact Person(s):
Riley, Robert (PNL)

Title: Fiber Optic Sensor for Chlorinated Hydrocarbons
Contact Person(s):
Saaski, Elric W. (Research Int'l)

Title: Fiber Optic Chemical Sensor for Aromatic Hydrocarbons (BTEX)
Contact Person(s):
Saaski, Elric W. (Research Int'l)

Title: Ground Penetrating Radar
Contact Person(s):
Sandness, Gerald (PNL)

Title: Hydraulically Installed, Multi-Sampling Lysimeter
Contact Person(s):
Scroppo, Joseph (Bladon Int.)

Title: Evaluation of Sampling Methods on VOC Measurements in Contaminated Soils
Contact Person(s):
Siegrist, R.L. (ORNL)

Title: Selective Detection of Chlorinated Organic Contamination
Contact Person(s):
Stetter, Joe (TRI, Inc.)

Title: Fiberoptic Organic Vapor Sensor
Contact Person(s):
Walt, David (Tufts U.)

Title: Multi-Level Simultaneous Sampler for Groundwater
Contact Person(s):
Widdowson, Mark (U. So. Carolina)

Table 4. Developing Technologies for VOCs

Title: Fiberoptics Surface-Enhanced Raman Spectroscopy for Organic and Inorganic Contaminants
Contact Person(s):
Angel, Mike (LLNL)

Title: Scanning Line-of-Sight Remote Raman Spectroscopy for Intermediate Range Characterization of Mixed Waste
Contact Person(s):
Angel, Mike (LLNL) Kulp, Tom (LLNL)

Title: In Situ Detection of VOCs. Phase IV
Contact Person(s):
Angel, Mike (LLNL) Langry, Kevin (LLNL)

Title: Advanced Fiberoptics Sensors
Contact Person(s):
Angel, Mike (LLNL)

Title: Assessment of Subsurface VOCs Using Chemical Microsensor Arrays
Contact Person(s):
Batterman, Stuart (U. of Michigan)

Title: Environmental Monitoring of Chlorinated Hydrocarbons Using Ion Mobility of Negative Ions
Contact Person(s):
Conrad, Frank J. (SNL) Kenna, Bernard T. (SNL)

Title: In Situ Chemical Analysis Using Laser Ion Mobility Spectroscopy
Contact Person(s):
Danen, Wayne (LANL)

Title: Instruments for In Situ Characterization of Tank Waste
Contact Person(s):
Delisle, G.V. (WHC)

Title: Differential Absorption Lidar (DIAL) for Remote Sensing
Contact Person(s):
DiBenedetto, John [EG&G (RSL)]

Title: Robotics - Contaminant Analysis Automation
Contact Person(s):
Dodson, Michail (PNL) Bennett, David (PNL)

Title: Non-Intrusive Sensing of Environmentally Important Objects and Species
Contact Person(s):
Duray, J.R. (Geotech, Inc.) Snyder, D.D. (Geotech, Inc.)
MacLean, H.D. (Geotech, Inc.)

Title: Miniature Ion-Mobility Spectrometer for In Situ Measurements of VOCs
Contact Person(s):
Eiceman, Gary (NMSU) Poziomek, Ed (UNLV)

Title: Electrochemical and Piezoelectric Sensors for Monitoring of Groundwater
Contact Person(s):
Farmer, Joseph (LLNL) Glass, Bob (LLNL)

Title: Minimally Invasive 3D Site Characterization Using Penetrometer, Synergistic Electromagnetic Mapping Technology (SEMT) and Seismic Units
Contact Person(s):
Gibbons, John (ARA)

Title: Chlorinated Solvent Fiberoptics Sensors
Contact Person(s):
Grey, Alan (INEL)

Title: Optimization of Sampling Strategies for Contaminant Source Characterization
Contact Person(s):
Johnson, Robert (ANL)

Title: Porous Silicon Sensors for Vapor Phase Organics
Contact Person(s):
Kelly, Mike (SNL) Guilinger, Terry (SNL)

Title: Fiberoptics Based on Refractive Index Probe for TCE in Soil and Groundwater
Contact Person(s):
Klainer, Stan (FiberChem)

Title: Long Path Length IR
Contact Person(s):
Koglin, Eric (EPA)

Title: Development of Analyte-Selective Membranes for Optical and Acoustic Detection Methods
Contact Person(s):
Langry, Kevin (LLNL)

Title: Development of Fiberoptics for In Situ Sensors with Focus on Petroleum
Contact Person(s):
Lieberman, Stephen (NOSC)

Title: Ultrasensitive Laser Analysis of Contaminants
Contact Person(s):
McDowell, R.S. (PNL)

Title: Soil Gas Surveying
Contact Person(s):
Nyquist, Jon (ORNL)

Title: Enhanced Fiber-Coupled Raman Spectrometer
Contact Person(s):
Perkins, John (Westinghouse) Suhre, Dennis (Westinghouse)
Wutzke, Steve (Westinghouse)

Title: Molecular Modeling of Sensor Chemistry and Biochemistry
Contact Person(s):
Poziomek, Ed (UNLV)

Title: Recognition Coatings and Evaluation
Contact Person(s):
Poziomek, Ed (UNLV)

Title: Rapid In Situ Measurements of PAHs and other Polyaromatic Contaminants in Groundwater and Soils at U.S. DOE Facilities
Contact Person(s):
Poziomek, Ed (UNLV) DLugosz, Joseph J. (EPA)

Title: Ion Mobility Spectrometry for VOCs in the Atmosphere
Contact Person(s):
Proctor, Alan [EG&G(RSL)]

Title: Rapid Screening Reversible Sensor for Waste Site Detection and Monitoring of VOCs
Contact Person(s):
Reagen, William (INEL)

Title: Selective Halogenated Hydrocarbon Sensor for Waste Site Detection and Monitoring
Contact Person(s):
Reagen, William K. (INEL) Stone, Mark L. (INEL)

Title: GC-MS Mobile Laboratory for Gas Analysis
Contact Person(s):
Seidel, Cary (WHC)

Title: Real-Time Sensors for VOCs Using Surface Modification
Contact Person(s):
Swanson, Basil (LANL)

Title: Minilab for In Situ Characterization Via Robotics with 8 Sensors
Contact Person(s):
Thornberg, Steve (SNL)

Title: Surface Enhanced Raman Spectroscopy for Environmental Samples
Contact Person(s):
Vo Dinh, Tuan (ORNL) Yalcintas, Guvan (ORNL)

Title: Ferrocyanide Detection Using Laser Raman Scattering Spectroscopy
Contact Person(s):
Winkelman, W.D. (WHC) Reich, Fred (WHC)

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Table 5. Prioritization Summary

Field-Demonstrated Technology Projects

Priority	Project Title	Contact
1	Real Time Monitor for Organics - ITMS	Guerin
2	Miniature Sampler Based on Sorption Tubes for Vapors in Bore Holes	Jenkins
3	Ion Mobility Spectrometry for VOCs in Soil, Gas, and Water	Eiceman
3	SEAMIST Membrane System for Emplacement of Sensors	Keller
4	Colloidal Borescope for Groundwater Flow Measurements	Cronk
4	Crosshole Seismic Tomography	Elbring
4	Electromagnetic Induction	Sandness
4	Fiberoptic Based Optical Emission Sensor for Total Organic Chlorine (Halo Sniff)	Olsen
4	?In Situ? Characterization of Waste by Ion Trap Mass Spectrometry	Hemberger
4*	In-Situ Detection of Chlorine and Nitrates in Bore-Holes using Neutron Activation	Koizumi*
4	Rapid Headspace Analysis of Soil and Water	Looney
4	SCAPS	McLelland
4	Sonic Drill	McLelland

*Less expensive approaches for accomplishing this desirable logging are available.

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Table 6. Prioritization Summary

Laboratory-Demonstrated Technology Projects

Priority	Project Title	Contact
1	Centrifuge Technology for Vadose Zone Transport Measurements	Conca
2*	SFE/Field Transportable Characterization of Co-Contaminants	Riley*
3	Portable Acoustic Wave Sensors	Frye
4	Portable On-Site IR Analyzer	McClelland
5	Fiber Optic Sensor for Chlorinated Hydrocarbons	Saaski
6	Borehole Aquifer and Soil Gas Depth-Discrete Sampling and Testing Device	Luttrell
6	Development of Analyte-Selective Membranes for Optical and Acoustic Detection Methods	Langry
6	Hydraulically Installed, Multi-Sampling Lysimeter	Scroppo
6	Inexpensive Sensor for In-Situ Detection of Free Liquids	Gee
6	Miniature Ion Trap Based GC-MS	Andresen
6	Optical Fiber-Based Sensor for In-Situ Determination of Chlorinated Hydrocarbons	Burgess
6	Real Time Monitor for Organics - ITMS2	Guerin

*This is one of the very few projects that addresses the co-contaminant problem at the Hanford Arid ID site. A variety of well-documented techniques could address these semi-volatile and non-volatile co-contaminants and these techniques should be applied at the VOC site.

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Table 7. Prioritization Summary

Developing Technology Projects

Priority	Project Title	Contact
1	In-Situ Detection of VOCs. Phase IV	Angel
2*	Minimally Invasive 3D Site Characterization Using Penetrometer, Synergistic Electromagnetic Mapping Technology (SEMT) and Seismic Units	Gibbons*
3	Rapid Screening Reversible Sensor for Waste Site Detection and Monitoring of VOCs	Reagen
4	Fiberoptic Based Technologies for Site Characterization	Sigel
4	Miniature Ion Mobility Spectrometer for In-Situ Measurements of VOCs	Eiceman
5	Long Path Length IR	Koglin
5	Minilab for In-Situ Characterization Via Robotics with 8 Sensors	Thornberg
5	Non-Intrusive Sensing of Environmentally Important Objects and Species	Duray
5	Selective Halogenated Hydrocarbon Sensor for Waste Site Detection and Monitoring	Reagen

*This approach is desirable but the exclusive tie to the cone penetrometer is an unnecessary limitation. Other minimally invasive 3D approaches should also be investigated.

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Groupings of Technology Projects in Tables 8 Through 15

Some potentially useful groupings of the technology projects listed in Table 1 are as follows: Associated, In Situ, Fiberoptic, Mass Spectrometer, Raman or SERS, Ion Mobility or Acoustic, Commercial, and Optical Spectroscopy. Tables 8 through 15, corresponding to the above groups, were generated using the keywords from Table 1. The listing in each group is again alphabetical by the name of the first contact person for convenient location of technology details in Table 1. A short discussion of each table is given below.

Table 8. No hard rules were employed for including projects in this table of associated technology projects. Geophysical, drilling, radiation, and other technology projects were included for one or more of the following subjective and arbitrary reasons: 1) the technology development would be an aid in the characterization-monitoring effort by providing, for example, a new, less expensive drilling procedure; 2) the technology provides information required for the remediation process, for example, borehole logging information; 3) the technology is innovative; 4) the Technical Program Manager or contact person was persistent and cooperative in providing information.

Table 9. In situ technology projects have a high priority at the VOC Arid ID. For this reason, each of the technology projects that had a demonstrated capability of providing in situ information is listed. The long-term stability of many of the components of in situ devices has not yet been established, especially for VOC measurements in the water environment.

Table 10. The fiberoptic based technology projects are listed in Table 10. Their potential for in situ measurements is a major attraction. The long-term stability of many of these fiberoptic devices has not yet been established, especially for VOC measurements in water.

Table 11. The technology projects based on some form of mass spectrometry are listed in this table. In cases where the volatile contaminants are generally unknown, the GC-MS (gas chromatograph-mass spectrometer) systems, for example, can provide true characterization information. When the contaminants are known, systems such as the direct injection ion trap mass spectrometer can be used as sensitive and reliable near real-time monitors of VOC levels.

Table 12. The technology projects that use Raman or surface enhanced Raman spectroscopies are given in Table 12.

Table 13. Technology projects that use ion-mobility spectrometry or various acoustic methods are listed in Table 13.

Table 14. This incomplete compilation features private sector technology projects that have field-deployable potential. In most cases, however, that potential has not been rigorously demonstrated. In some instances, only minor modifications are necessary to make these commercial systems more useful in the field. Some of these modified systems could have high pay off, particularly where near term characterization-monitoring solutions are required.

Table 15. Some form of optical spectroscopy is employed in many technology projects. Only those for which optical spectroscopy appeared to be a critical element are included in Table 15.

Text continues after Table 15 on page 91.

Table 8. Associated Technology Projects for VOCs

Title: Portable Gamma Ray Imaging of Bulk Soil
Contact Person(s):
Aitken, Alfred (NDI)

Title: In Situ Permeable Flow Sensor
Contact Person(s):
Ballard, Sandy (SNL)

Title: In Situ Mapping of Radionuclides in Sub-Surface and Surface Soil
Contact Person(s):
Brodzinski, R.L. (PNL) Perkin, R.W. (PNL) Robertson, D.E. (PNL)

Title: Advanced Mixed Waste Assay System
Contact Person(s):
Brodzinski, R.L. (PNL) Arthur, R.L. (PNL) Geelhood, B.D. (PNL)

Title: Centrifuge Technology for Vadose Zone Transport Measurements
Contact Person(s):
Conca, James (WSU Tri-Cities) Wright, Judith (PNL)

Title: Colloidal Borescope for Groundwater Flow Measurements
Contact Person(s):
Cronk, Tom (ORNL-Grand Junction) Kearl, Pete (ORNL)

Title: Instruments for In Situ Characterization of Tank Waste
Contact Person(s):
Delisle, G.V. (WHC)

Title: Aerial Measurement System Program for Radiation Surveillance
Contact Person(s):
Doyle, Jack [EG&G(RSL)] Proctor, Alan [EG&G/EM(RSL)]

Title: Non-Intrusive Sensing of Environmentally Important Objects and Species
Contact Person(s):
Duray, J.R. (Geotech, Inc.) Snyder, D.D. (Geotech, Inc.)
MacLean, H.D. (Geotech, Inc.)

Title: Crosshole Seismic Tomography
Contact Person(s):
Elbring, Greg (SNL)

Title: Optimization of In Situ Volatilization Systems
Contact Person(s):
Filley, Thom (Environmental S/E)

Title: Minimally Invasive 3D Site Characterization Using Penetrometer, Synergistic Electromagnetic Mapping Technology (SEMT) and Seismic Units
Contact Person(s):
Gibbons, John (ARA)

Title: High Resolution Shear Wave Seismic Reflection Surveying for Hydrogeological Investigation
Contact Person(s):
Johnson, William J. (Rizzo)

Title: SEAMIST Membrane System for Emplacement of Sensors
Contact Person(s):
Keller, Carl (SEA)

Title: Site Characterization and Analysis Penetrometer System (SCAPS)
Contact Person(s):
Lee, Tom (Waterways Exp. Station) Cooper, Stafford (Waterways)

Title: Full Implementation Cone Penetrometer
Contact Person(s):
McLelland, Greg (WHC)

Title: Drilling Technology Development at VOC-Arid Demonstration
Contact Person(s):
McLelland, Greg (WHC)

Title: Electrical Resistance Tomography to Characterize Vadose Zone Processes and to Monitor Remediation for Arid Site Integrated Demonstration
Contact Person(s):
Ramirez, Abe (LLNL) Daily, Bill (LLNL)

Title: Fiberoptics with Dye Tracer to Obtain Vertical and Horizontal Hydraulic Conductivity
Contact Person(s):
Rossabi, Joe (SRL)

Title: Electromagnetic Induction
Contact Person(s):
Sandness, Gerald (PNL)

Title: Ground Penetrating Radar
Contact Person(s):
Sandness, Gerald (PNL)

Title: Multi-Parameter Sonde
Contact Person(s):
Schalla, Ron (PNL) Evans, John (PNL)

Title: Horizontal Drilling and Sampling
Contact Person(s):
Wemple, Bob (SNL)

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Table 9. In Situ Technology Projects for VOCs

Title: Fiberoptics Surface-Enhanced Raman Spectroscopy for Organic and Inorganic Contaminants
Contact Person(s):
Angel, Mike (LLNL)

Title: Fiberoptics for $CHCl_3$ and CCl_4 at Arid Site
Contact Person(s):
Angel, Mike (LLNL) Langry, Kevin (LLNL)

Title: In Situ Detection of VOCs. Phase IV
Contact Person(s):
Angel, Mike (LLNL) Langry, Kevin (LLNL)

Title: Advanced Fiberoptics Sensors
Contact Person(s):
Angel, Mike (LLNL)

Title: Reversible Fiberoptic Fluorescence Sensor Combined with Cone Penetrometer for Detection of BTEX
Contact Person(s):
Angel, Mike (LLNL)

Title: In Situ Permeable Flow Sensor
Contact Person(s):
Ballard, Sandy (SNL)

Title: Assessment of Subsurface VOCs Using Chemical Microsensor Arrays
Contact Person(s):
Batterman, Stuart (U. of Michigan)

Title: In Situ Mapping of Radionuclides in Sub-Surface and Surface Soil
Contact Person(s):
Brodzinski, R.L. (PNL) Perkin, R.W. (PNL)
Robertson, D.E. (PNL)

Title: Optical Fiber-Based Sensor for In Situ Determination of Chlorinated Hydrocarbons
Contact Person(s):
Burgess, Lloyd (U. of Washington) Wangen, Lawrence (LANL)
Henshaw, John (U. of Washington)

Title: Fiber Optic Micromirrors
Contact Person(s):
Butler, Mike (SNL)

Title: Fiberoptic Raman Spectrograph for In Situ Environmental Monitoring
Contact Person(s):
Carrabba, Dr. Michael (EIC)

Title: Laser-Induced Fluorescence Over Fiber Optics
Contact Person(s):
Chudyk, Wayne (Tufts U.)

Title: Passive Groundwater Headspace Sampler
Contact Person(s):
Crockett, Alan (INEL)

Title: Colloidal Borescope for Groundwater Flow Measurements
Contact Person(s):
Cronk, Tom (ORNL-Grand Junction) Kearl, Pete (ORNL)

Title: In Situ Chemical Analysis Using Laser Ion-Mobility Spectroscopy
Contact Person(s):
Danen, Wayne (LANL)

Title: Instruments for In Situ Characterization of Tank Waste
Contact Person(s):
Delisle, G.V. (WHC)

Title: Miniature Ion-Mobility Spectrometer for In Situ Measurements of VOCs
Contact Person(s):
Eiceman, Gary (NMSU) Poziomek, Ed (UNLV)

Title: Portable Acoustic Wave Sensors
Contact Person(s):
Frye, Greg (SNL)

Title: Inexpensive Sensor for In Situ Detection of Free Liquids
Contact Person(s):
Gee, Glendon (PNL) Cary, John (retired)

Title: Chlorinated Solvent Fiberoptics Sensors
Contact Person(s):
Grey, Alan (INEL)

Title: Spectroelectrochemical Sensors
Contact Person(s):
Haas, John (ORNL)

Title: Portable Borehole Fiberscope with DUVAS (Derivative UV Absorbance Spectrometer)
Contact Person(s):
Haas, John (ORNL)

Title: Porous Silicon Sensors for Vapor Phase Organics
Contact Person(s):
Kelly, Mike (SNL) Guilinger, Terry (SNL)

Title: Fiberoptics Based Sensor for BTEX
Contact Person(s):
Klainer, Stan (FiberChem)

Title: Fiberoptics Based on Refractive Index Probe for TCE in Soil and Groundwater
Contact Person(s):
Klainer, Stan (FiberChem)

Title: In Situ Detection of Chlorine and Nitrates in Bore-Holes using Neutron Activation
Contact Person(s):
Koizumi, Carl (WHC)

Title: Development of Analyte-Selective Membranes for Optical and Acoustic Detection Methods
Contact Person(s):
Langry, Kevin (LLNL)

Title: Site Characterization and Analysis Penetrometer System (SCAPS)
Contact Person(s):
Lee, Tom (Waterways Exp. Station) Cooper, Stafford (Waterways)

Title: Development of Fiberoptics for In Situ Sensors with Focus on Petroleum
Contact Person(s):
Lieberman, Stephen (NOSC)

Title: Full Implementation Cone Penetrometer
Contact Person(s):
McLelland, Greg (WHC)

Title: In Situ Detection of Organics, Demo Support
Contact Person(s):
Milanovich, Fred (LLNL)

Title: Fiberoptic Remote UV-absorption with Transduction Dyes for Halogenated Aromatics in Water and Air
Contact Person(s):
Myrick, Mike (U. So. Carolina)

Title: Rapid In Situ Measurements of PAHs and other Polyaromatic Contaminants in Groundwater and Soils at U.S. DOE Facilities
Contact Person(s):
Poziomek, Ed (UNLV) DLugosz, Joseph J. (EPA)

Title: Rapid Screening Reversible Sensor for Waste Site Detection and Monitoring of VOCs
Contact Person(s):
Reagen, William K. (INEL)

Title: Selective Halogenated Hydrocarbon Sensor for Waste Site Detection and Monitoring
Contact Person(s):
Reagen, William K. (INEL) Stone, Mark L. (INEL)

Title: Fiber Optic Sensor for Chlorinated Hydrocarbons
Contact Person(s):
Saaski, Elric W. (Research Int'l)

Title: Fiber Optic Chemical Sensor for Aromatic Hydrocarbons (BTEX)
Contact Person(s):
Saaski, Elric W. (Research Int'l)

Title: Hydraulically Installed, Multi-Sampling Lysimeter
Contact Person(s):
Scroppo, Joseph (Bladon Int.)

Title: Fiberoptic Based Technologies for Site Characterization
Contact Person(s):
Sigel, George (Rutgers U.)

Title: In Situ Samplers and In Situ Scan
Contact Person(s):
Smart, John (PNL) Schalla, Ron (PNL)

Title: Real-Time Sensors for VOCs Using Surface Modification
Contact Person(s):
Swanson, Basil (LANL)

Title: Borehole Fiberscope
Contact Person(s):
Vo Dinh, Tuan (ORNL)

Title: Fiberoptic Organic Vapor Sensor
Contact Person(s):
Walt, David (Tufts U.)

Title: Ferrocyanide Detection Using Laser Raman Scattering Spectroscopy
Contact Person(s):
Winkelman, W.D. (WHC) Reich, Fred (WHC)

Table 10. Fiberoptic Technology Projects for VOCs

Title: Fiberoptics Surface-Enhanced Raman Spectroscopy for Organic and Inorganic Contaminants
Contact Person(s):
Angel, Mike (LLNL)

Title: Fiberoptics for $CHCl_3$ and CCl_4 at Arid Site
Contact Person(s):
Angel, Mike (LLNL) Langry, Kevin (LLNL)

Title: In Situ Detection of VOCs. Phase IV
Contact Person(s):
Angel, Mike (LLNL) Langry, Kevin (LLNL)

Title: Advanced Fiberoptics Sensors
Contact Person(s):
Angel, Mike (LLNL)

Title: Reversible Fiberoptic Fluorescence Sensor Combined with Cone Penetrometer for Detection of BTEX
Contact Person(s):
Angel, Mike (LLNL)

Title: UV and IR Spectrophotometry Optimized for Fiberoptics and VOCs in Gas and Water
Contact Person(s):
Arrendale, Dr. W. (UAH, JMBN, Inc.) Nielson, Bruce (Air Force)

Title: Optical Fiber-based Sensor for In Situ Determination of Chlorinated Hydrocarbons
Contact Person(s):
Burgess, Lloyd (U. of Washington) Wangen, Lawrence (LANL)
Henshaw, John (U. of Washington)

Title: Fiber Optic Micromirrors
Contact Person(s):
Butler, Mike (SNL)

Title: Fiberoptic Raman Spectrograph for In Situ Environmental Monitoring
Contact Person(s):
Carrabba, Dr. Michael (EIC)

Title: Laser-Induced Fluorescence Over Fiber Optics
Contact Person(s):
Chudyk, Wayne (Tufts U.)

Title: Chlorinated Solvent Fiberoptics Sensors
Contact Person(s):
Grey, Alan (INEL)

Title: Portable Borehole Fiberscope with DUVAS (Derivative UV Absorbance Spectrometer)
Contact Person(s):
Haas, John (ORNL)

Title: Fiberoptics Based Sensor for BTEX
Contact Person(s):
Klainer, Stan (FiberChem)

Title: Fiberoptics Based on Refractive Index Probe for TCE in Soil and Groundwater
Contact Person(s):
Klainer, Stan (FiberChem)

Title: Development of Analyte-Selective Membranes for Optical and Acoustic Detection Methods
Contact Person(s):
Langry, Kevin (LLNL)

Title: Development of Fiberoptics for In Situ Sensors with Focus on Petroleum
Contact Person(s):
Lieberman, Stephen (NOSC)

Title: Fiberoptic Sensor and Analysis for the Integration Demo for Clean-up of Soils and Groundwater in Non-Arid Sites
Contact Person(s):
Milanovich, Fred (LLNL)

Title: In Situ Detection of Organics, Demo Support
Contact Person(s):
Milanovich, Fred (LLNL)

Title: Fiberoptic Remote UV-absorption with Transduction Dyes for Halogenated Aromatics in Water and Air
Contact Person(s):
Myrick, Mike (U. So. Carolina)

Title: Fiberoptic Based Optical Emission Sensor for Total Organic Chlorine (Halo Sniff)
Contact Person(s):
Olsen, Khris (PNL) Evans, John (PNL)

Title: Rapid In Situ Measurements of PAHs and other Polyaromatic Contaminants in Groundwater and Soils at U.S. DOE Facilities
Contact Person(s):
Poziomek, Ed (UNLV) DLugosz, Joseph J. (EPA)

Title: Rapid Screening Reversible Sensor for Waste Site Detection and Monitoring of VOCs
Contact Person(s):
Reagen, William K. (INEL)

Title: Selective Halogenated Hydrocarbon Sensor for Waste Site Detection and Monitoring
Contact Person(s):
Reagen, William K. (INEL) Stone, Mark L. (INEL)

Title: Fiberoptics with Dye Tracer to Obtain Vertical and Horizontal Hydraulic Conductivity
Contact Person(s):
Rossabi, Joe (SRL)

Title: Fiber Optic Sensor for Chlorinated Hydrocarbons
Contact Person(s):
Saaski, Elric W. (Research Int'l)

Title: Fiber Optic Chemical Sensor for Aromatic Hydrocarbons (BTEX)
Contact Person(s):
Saaski, Elric W. (Research Int'l)

Title: Fiberoptic Based Technologies for Site Characterization
Contact Person(s):
Sigel, George (Rutgers U.)

Title: Real-Time Sensors for VOCs Using Surface Modification
Contact Person(s):
Swanson, Basil (LANL)

Title: Borehole Fiberscope
Contact Person(s):
Vo Dinh, Tuan (ORNL)

Title: Fiberoptic Organic Vapor Sensor
Contact Person(s):
Walt, David (Tufts U.)

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Table 11. Mass Spectrometer Technology Projects for VOCs

Title: Miniature Ion Trap Based GC-MS
Contact Person(s):
Andresen, Brian (LLNL) Raber, Ellen (LLNL)

Title: Portable Quad GC-MS
Contact Person(s):
Andresen, Brian (LLNL) Raber, Ellen (LLNL)

Title: Accelerator MS for Detecting ^{36}Cl Produced in Weapons Testing at INEL
Contact Person(s):
Beasley, Tom (DOE-EML) Cecil, DeWayne L. (INEL)

Title: Passive Soil Gas Survey - PETREX
Contact Person(s):
Einhorn, Irving N. (NERI)

Title: Real Time Monitor for Organics - $ITMS^2$
Contact Person(s):
Guerin, Mike (ORNL) Wise, Marc (ORNL) Buchanan, Michelle (ORNL)

Title: Real Time Monitor for Organics - ITMS
Contact Person(s):
Guerin, Mike (ORNL) Wise, Marc (ORNL) Buchanan, Michelle (ORNL)

Title: ?In Situ? Characterization of Waste by Ion Trap Mass Spectrometry
Contact Person(s):
Hemberger, Phil (LANL)

Title: Ultrasensitive Laser Analysis of Contaminants
Contact Person(s):
McDowell, R.S. (PNL)

Title: Quadrupole Molecular Beam Mass Spectrometer for VOCs in Air
Contact Person(s):
Milne, Tom (NREL)

Title: Time of Flight-Quadrupole Transportable Molecular Beam MS^2 for VOCs in Air
Contact Person(s):
Milne, Tom (NREL)

Title: Mobile Platform Laboratory for Gas Characterization
Contact Person(s):
Moulton, Mike (SNL)

Title: GC-MS Mobile Laboratory for Gas Analysis
Contact Person(s):
Seidel, Cary (WHC)

Title: Transportable GC-MS
Contact Person(s):
Thornberg, Steve (SNL)

Table 12. Raman or SERS Technology Projects for VOCs

Title: Fiberoptics Surface-Enhanced Raman Spectroscopy for Organic and Inorganic Contaminants
Contact Person(s):
Angel, Mike (LLNL)

Title: Scanning Line-of-Sight Remote Raman Spectroscopy for Intermediate Range Characterization of Mixed Waste
Contact Person(s):
Angel, Mike (LLNL) Kulp, Tom (LLNL)

Title: Fiberoptic Raman Spectrograph for In Situ Environmental Monitoring
Contact Person(s):
Carrabba, Dr. Michael (EIC)

Title: Spectroelectrochemical Sensors
Contact Person(s):
Haas, John (ORNL)

Title: Enhanced Fiber-Coupled Raman Spectrometer
Contact Person(s):
Perkins, John (Westinghouse) Suhre, Dennis (Westinghouse)
Wutzke, Steve (Westinghouse)

Title: Surface Enhanced Raman Spectroscopy for Environmental Samples
Contact Person(s):
Vo Dinh, Tuan (ORNL) Yalcintas, Guvan (ORNL)

Title: Ferrocyanide Detection Using Laser Raman Scattering Spectroscopy
Contact Person(s):
Winkelman, W.D. (WHC) Reich, Fred (WHC)

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Table 13. Ion-Mobility or Acoustic Technology Projects for VOCs

Title: Assessment of Subsurface VOCs Using Chemical Microsensor Arrays
Contact Person(s):
Batterman, Stuart (U. of Michigan)

Title: Environmental Monitoring of Chlorinated Hydrocarbons Using Ion Mobility of Negative Ions
Contact Person(s):
Conrad, Frank J. (SNL) Kenna, Bernard T. (SNL)

Title: In Situ Chemical Analysis Using Laser Ion-Mobility Spectroscopy
Contact Person(s):
Danen, Wayne (LANL)

Title: Ion-Mobility Spectrometry for VOCs in Soil, Gas, and Water
Contact Person(s):
Eiceman, Gary (NMSU) Poziomek, Ed (UNLV)

Title: Miniature Ion-Mobility Spectrometer for In Situ Measurements of VOCs
Contact Person(s):
Eiceman, Gary (NMSU) Poziomek, Ed (UNLV)

Title: Electrochemical and Piezoelectric Sensors for Monitoring of Groundwater
Contact Person(s):
Farmer, Joseph (LLNL) Glass, Bob (LLNL)

Title: Portable Acoustic Wave Sensors
Contact Person(s):
Frye, Greg (SNL)

Title: Porous Silicon Sensors for Vapor Phase Organics
Contact Person(s):
Kelly, Mike (SNL) Guilinger, Terry (SNL)

Title: Development of Analyte-Selective Membranes for Optical and Acoustic Detection Methods
Contact Person(s):
Langry, Kevin (LLNL)

Title: Enhanced Fiber-Coupled Raman Spectrometer
Contact Person(s):
Perkins, John (Westinghouse) Suhre, Dennis (Westinghouse)
Wutzke, Steve (Westinghouse)

Title: Quartz Crystal Microbalance (QCM) and Surface Acoustic Wave (SAW) Probes
Contact Person(s):
Poziomek, Ed (UNLV)

Title: Ion-Mobility Spectrometry for VOCs in the Atmosphere
Contact Person(s):
Proctor, Alan [EG&G(RSL)]

Table 14. Commercial Technology Projects for VOCs

Title: Passive Soil Gas Survey - PETREX
Contact Person(s):
Einhorn, Irving N. (NERI)

Title: Inexpensive Sensor for In Situ Detection of Free Liquids
Contact Person(s):
Gee, Glendon (PNL)
Cary, John (retired)

Title: MS1-301 Series Organic Vapor Monitors: Portable GC Using Air as Carrier Gas and Solid State Detector.
Contact Person(s):
Jarvis, Lynn (MSI)
Wohltjen, Hank (MSI)

Title: Quantitative Deep Soil Vapor Analyses
Contact Person(s):
Kagel, Carla (K Prime, Inc.)
Kagel, Richard A. (K Prime, Inc.)
Kladnik, George (K Prime, Inc.)

Title: Long Path Length IR
Contact Person(s):
Koglin, Eric (EPA)

Title: Long Path Length UV (DOAS)
Contact Person(s):
Koglin, Eric (EPA)

Title: Automated Purge and Trap GC for Chlorinated Hydrocarbons
Contact Person(s):
Mackay, Doug (A+RT)

Title: Portable On-Site IR Analyzer
Contact Person(s):
McClelland, John (Ames)

Title: Multi-Parameter Sonde
Contact Person(s):
Schalla, Ron (PNL)
Evans, John (PNL)

Title: MDA Long Path Monitoring System
Contact Person(s):
Simpson, Orman (MDA)
McClenny, William (EPA)
Koglin, Eric (EPA)

Title: Transportable GC-MS
Contact Person(s):
Thornberg, Steve (SNL)

Title: Elemental Analyses in the Field Using XRF
Contact Person(s):
Wrigley, Jim (Advanced Analytical)

Table 15. Optical Spectroscopy Technology Projects for VOCs

Title: Optical Fiber-based Sensor for In Situ Determination of Chlorinated Hydrocarbons
Contact Person(s):
Burgess, Lloyd (U. of Washington)
Wangen, Lawrence (LANL)
Henshaw, John (U. of Washington)

Title: Fiber Optic Micromirrors
Contact Person(s):
Butler, Mike (SNL)

Title: Inexpensive Sensor for In Situ Detection of Free Liquids
Contact Person(s):
Gee, Glendon (PNL)
Cary, John (retired)

Title: Long Path Length IR
Contact Person(s):
Koglin, Eric (EPA)

Title: Long Path Length UV (DOAS)
Contact Person(s):
Koglin, Eric (EPA)

Title: Fiberoptic Remote UV-absorption with Transduction Dyes for Halogenated Aromatics in Water and Air
Contact Person(s):
Myrick, Mike (U. So. Carolina)

Title: Laser Spark Spectroscopy
Contact Person(s):
Ottesen, David (SNL)

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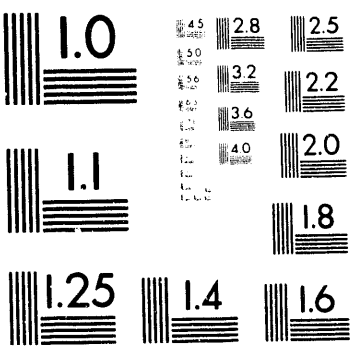
1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

2 of 2

Sampling Technology Projects

The collection of a valid sample is frequently only a small part of a characterization-monitoring technology project. This is even true for most of the 22 projects that have been identified here as specifically addressing sampling. These projects can be located in Table 1 by the following first contact person names: Crockett; Eastwood; Einhorn; Emer; Jenkins; Johnson; Kagel; Kaplan (2); Karp (4); Keller; Lucero; Luttrel; Nichols; Scroppo; Siegrist; Smart; and Wemple.

Technology Projects for VOCs in Gas, Water, and Soil (Sediment) Samples

The characterization of many arid sites requires the determination of volatile organic compounds (VOCs) present in the least complex gaseous matrix, the more complex water samples, and the most complex soil (sediment) matrix.

The 62 technology projects that deal with VOCs in the gaseous matrix can be located in Table 1 by the following first contact person names: Andresen (2); Angel (5); Arrendale; Batterman; Burgess; Chudyk; Conrad; Demirgian; DiBenedetto (2); Eiceman (2); Einhorn; Emer, Filley; Frye; Grey; Guerin; Haas (2); Jarvis; Jenkins; Kladnik; Karp (4); Kelly; Klainer; Koglin (2); Langry; Lewis; Lieberman; Lucero; Luttrell; McClelland; Milanovich; Milne (2); Myrick; Nichols; Olsen; Poziomek (2); Proctor; Reagen (2); Saaski (2); Scroppo; Seidel; Sigel; Simpson; Stetter; Thornberg; and Walt.

The 71 technology projects that address VOCs in the water matrix can be located in Table 1 by the following first contact person names: Andresen (2); Angel (5); Arrendale; Ballard; Beasley; Burgess; Carrabba; Chudyk; Conrad; Crockett; Cronk; Eastwood; Eiceman; Einhorn; Farmer; Gee; Gibbons; Grey; Guerin (3); Haas (3); Hemberger; Jenkins; Johnson (Robert); Johnson (William); Kladnik; Kaplan (2); Karp (2); Klainer (2); Langry; Lewis; Looney; Lucero; Luttrell; Mackay; McClelland; Mech; Milanovich; Myrick; Nichols; Olsen; Poziomek (2); Reagen (2); Rice (2); Schalla; Scroppo; Sigel; Smart; Stetter; Swanson; Thornberg; Vo Dinh (2); Walt; Widdowson; Winkelman; and Wrigley.

The fewest technology projects, only 29, address the complicated soil (sediment) matrix. These projects can be located in Table 1 by the following first contact person names: Aitken; Andresen (2); Angel; Brodzinski; Demirgian; DiBenedetto; Dodson; Einhorn; Gee; Guerin (2); Haas; Hemberger; Kladnik; Klainer; Lewis; Looney; McDowell; Mech; Olsen; Ottesen; Rice (2); Riley (2); Siegrist; Thornberg; and Wrigley.

CONCLUSIONS

Observations and experiences accumulated during the course of collecting, categorizing, and evaluating the information contained in this report were used to draw several conclusions. These are discussed briefly under the headings below.

Usefulness of the Table 1 Compilation of Technology Projects

This compilation of technology projects, although incomplete, has been useful for the intended purpose of prioritizing projects for the characterization-monitoring of volatile

organic compounds at the VOC Arid ID site. The compilation also provides useful information about technology projects that might well be applicable to needs at other Department of Energy sites.

The continued usefulness of such a list clearly requires a periodic update effort so new and missed information can be included.

Vadose Zone Characterization

The contamination of ground water is the primary concern at most waste sites; invariably, the source of this contamination is located in the vadose zone. The normal heterogeneity and complexity of this zone complicate the characterization. However, only 29 technology projects address soil, whereas 133 deal with the less complex gas and water matrices.

Apparently, most investigators have chosen to attack the more tractable gas and water problems.

Classical Analytical Chemistry

Many characterization problems needing immediate attention can be addressed cost effectively with field-deployed equipment and a classical approach. For volatile organic compounds, this is a sequential process of sample collection, extraction, separation, identification, and quantification. In some instances, one or more of these steps can be eliminated to further reduce costs, but all classical approaches require the collection of a valid sample. Sample collection is vitally important because an error made there cannot be rectified by subsequent application of more sophisticated instrumentation or expert interpretation. In spite of the importance of sampling, modern analytical chemistry has typically given it low research priority. Of the 130 technology projects in Table 1, only 22 address sampling, and many of those do so in a cursory way.

More effort needs to be devoted to the development and application of methods for obtaining valid samples and to the field application of the classical analytical approach for VOCs. These increased efforts should proceed in parallel with the currently funded in situ measurement efforts that avoid sampling.

Direct Measurement of Carbon Tetrachloride as a DNAPL

Carbon tetrachloride may be present as a dense non-aqueous phase liquid (DNAPL) in both the vadose zone and the saturated zone at the VOC Arid ID site. The DNAPL may be present as a pure liquid, a solution, or an emulsion. None of the technology projects listed in this report have clear applicability for the direct measurement of CCl_4 as a DNAPL. Several projects could be adapted to locate and quantify pockets of DNAPL in the vadose zone, but the number of needed sampling probes would make the cost of such work prohibitive. Likewise, no known technology project addresses the less complex but still extremely difficult problem of locating and quantifying pockets of CCl_4 as a DNAPL in the saturated zone.

Given the great difficulty of direct determination of CCl_4 as a DNAPL, indirect measurements that provide evidence of the presence of CCl_4 in the DNAPL form should be actively pursued.

Semi-Volatile and Non-Volatile Organic Compounds

Volatile organic compounds are of current primary concern at the VOC Arid ID and at other DOE sites. Before long, semi-volatile organic compounds (SVOCs), and later on, some non-volatile organic compounds (NVOCs) will receive more attention, either because they are hazardous materials themselves or because they can affect the migration, transformation, volatility, solubility, and in situ bio-remediation of VOCs. Phosphates, phosphonates, and lard oil, known co-contaminants at the VOC Arid ID site, are already beginning to receive some attention. At least two projects are currently underway at the site. (See Riley in Table 1.)

Many well-developed characterization technologies already exist for SVOCs. Individual technology projects that address SVOC characterization-monitoring problems should be identified and evaluated now. Later, the much less developed technologies for NVOCs might also be compiled and evaluated. Also, it would be wise to archive some water and soil samples, and extracts therefrom, for examination when the best technologies are identified or become available. Only one project identified here considers the value of archiving. (See Guerin ITMS in Table 1.) However, that project only addresses archiving for VOCs.

Biosensor Technology Projects

No characterization technology projects employing biosensors appear in Table 1. The extreme simplicity of the analytical procedures and the very low cost per analysis suggest that increased research and development on biosensors for VOCs would have a large potential return on investment.

Essential Involvement of Technology Providers

For success, the technology provider (the principal investigator and staff or the private sector equivalent) must communicate and cooperate with all other persons and organizations that comprise the ID. This will help ensure that the right new or adapted technology projects become part of the ID, i.e., those that best address the needs. It will also help overcome the ordinary difficulties of working at a strange site and perhaps even those special impediments to progress that exist at DOE sites.

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U. S. Department of Energy, 1992. *Chemical Contaminants on DOE Lands and Selection of Contaminant Mixtures for Subsurface Science Research.* DOE/ER-0547T, U. S. Department of Energy, Washington, DC.

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Alphabetical Listing of all Contact Persons in Table 1 as of April 1992*

Aitken, Alfred (NDI)
Andresson, Brian (LLNL)
Angel, Mike (LLNL)
Arrendale, Dr. W. (UAH, JMBN, Inc.)
Arthur, R.L. (PNL)
Ballard, Sandy (SNL)
Batterman, Stuart (U. of Michigan)
Beasley, Tom (DOE-EML)
Bennett, David (PNL)
Brodzinski, R.L. (PNL)
Buchanan, Michelle (ORNL)
Burgess, Lloyd (U. of Washington)
Butler, Mike (SNL)
Carrabba, Dr. Michael (EIC)
Cary, John (retired)
Cecil, DeWayne L. (INEL)
Chudyk, Wayne (Tufts U.)
Colombo, Peter (BNL)
Conca, James (WSU Tri-Cities)
Conrad, Frank J. (SNL)
Cooper, Stafford (Waterways)
Crockett, Alan (INEL)
Cronk, Tom (ORNL-Grand Junction)
Daily, Bill (LLNL)
Danen, Wayne (LANL)
Delisle, G.V. (WHC)
Demirgian, Jack (ANL)
DiBenedetto, John [EG&G (RSL)]
DLugosz, Joseph J. (EPA)
Dodson, Michail (PNL)
Doyle, Jack (RSL)
Duray, J.R. (Geotech)
Eastwood, Delyle (Lockheed)
Eddy, Carol (SRL)
Eiceman, Gary (NMSU)
Elbring, Greg (SNL)
Emer, Dudley (REECO)
Evans, John (PNL)
Farmer, Joseph (LLNL)
Filley, Thom (Env. S/E)
Frye, Greg (SNL)
Gee, Glendon (PNL)
Gealhood, B.D. (PNL)
Gibbons, John (ARA)
Glass, Bob (LLNL)
Grey, Alan (INEL)
Griest, Wayne (ORNL)
Guerin, Mike (ORNL)
Guilinger, Terry (SNL)
Haas, John (ORNL)
Hemberger, Phil (LANL)
Henshaw, John (U. of Wash.)
Jarvis, Lynn (MSI)
Jenkins, Roger (ORNL)
Johnson, Robert (ANL)
Johnson, William J. (Rizzo)
Kaplan, Edward (BNL)
Karp, Kenneth (Geotech)
Kearl, Pete (ORNL)
Keller, Carl (SEA)
Kelly, Mike (SNL)
Kenna, Bernard T. (SNL)
Klainer, Stan (FiberChem)
Koglin, Eric (EPA)
Koizumi, Carl (WHC)
Kulp, Tom (LLNL)
Langry, Kevin (LLNL)
Lee, Tom (Waterways Exp. Station)
Lewis, Leroy (INEL)
Lieberman, Stephen (NOSC)
Looney, Brian (SRL)
Lucero (ITRI)
Luttrell, S. (PNL)
Lutz, Stephen (EG&G)
Mackay, Doug (A+RT)
MacLean, H. D. (Geotech)
McClelland, John (Ames)
McClenny, William (EPA)
McDowell, R.S. (PNL)
McLelland, Greg (WHC)
Mech, S.J. (WHC)
Milanovich, Fred (LLNL)
Milne, Tom (NREL)
Moulton, Mike (SNL)
Myrick, Mike (U.So.Carolina)
Nichols, Ralph (SRL)
Nielson, Bruce (Air Force)
Nyquist, Jon (ORNL)
Olsen, Khris (PNL)
Ottesen, David (SNL)
Perkin, R.W. (PNL)
Perkins, John (Westinghouse)

* Abbreviated location given in parenthesis after each name.

Poziomek, Ed (UNLV)
Proctor, Alan (EG&G)
Raber, Ellen (LLNL)
Ramirez, Abe (LLNL)
Reagen, William K. (INEL)
Reich, Fred (WHC)
Reilly, Chris (ANL)
Rice, Dave (LLNL)
Riley, Robert (PNL)
Robertson, D.E. (PNL)
Rossabi, Joe (SRL)
Saaski, Elric W. (Research Int'l)
Sandness, Gerald (PNL)
Schalla, Ron (PNL)
Scroppo, Joseph (Bladon Int.)
Seidel, Cary (WHC)
Siegrist, R.L. (ORNL)
Sigel, George (Rutgers U.)
Simpson, Orman (MDA)
Smart, John (PNL)
Snyder, D.D. (Geotech)
Stetter, Joe (TRI, Inc.)
Stone, Mark L. (INEL)
Suhre, Dennis (Westinghouse)
Swanson, Basil (LANL)
Thornberg, Steve (SNL)
Vo Dinh, Tuan (ORNL)
Walt, David (Tufts U.)
Wangen, Lawrence (LANL)
Wemple, Bob (SNL)
Widdowson, Mark (U.So.Carolina)
Winkelman, W.D. (WHC)
Wise, Marc (ORNL)
Wohltjen, Hank (MSI)
Wright, Judith (PNL)
Yalcintas, Guvan (ORNL)

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Ames Laboratory
Office of Information
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P.O. Box 62
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William J. Haas, Jr.
Ames Laboratory
7 Spedding Hall
Iowa State University
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