

DEMONSTRATING AND DEPLOYING PRIVATE SECTOR TECHNOLOGIES AT DOE SITES – ISSUES TO BE OVERCOME

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ABSTRACT

The Department of Energy (DOE), Office of Environmental Management (EM) continues to pursue cost-effective, environmental cleanup of the weapons complex sites with a concomitant emphasis on deployment of innovative technologies as a means to this end. The EM Office of Science and Technology (OST) pursues a strategy that entails identification of technologies that have potential applications throughout the DOE complex: at multiple DOE sites and at multiple facilities on those sites. It further encourages a competitive procurement process for the various applications entailed in the remediation of a given facility. These strategies require a competitive private-sector supplier base to help meet EM needs. OST supports technology development and deployment through investments in partnerships with private industry to enhance the acceptance of their technology products within the DOE market.

Since 1992, OST and the National Energy Technology Laboratory (NETL) have supported the research and development of technology products and services offered by the private sector. During this time, NETL has managed over 140 research and development projects involving industrial and university partners. These projects involve research in a broad range of EM-related topics, including deactivation and decommissioning, characterization, monitoring, sensors, waste separation, groundwater remediation, robotics, and mixed waste treatment. Successful partnerships between DOE and Industry have resulted in viable options for EM's cleanup needs, and require continued marketing efforts to ensure that these technology solutions are used at multiple DOE sites and facilities.

An integral part of this technology development program is the demonstration and subsequent deployment at appropriate DOE sites of the technologies being developed. These technologies have been proposed in response to NETL solicitations that were issued based on the needs of DOE sites. Private-sector companies, however, those without long histories of involvement with the DOE weapons complex, have difficulty in getting the attention of EM decision makers at the sites. It is a continuous challenge for these companies to penetrate the DOE market. OST, in conjunction with NETL and other supporting organizations, has worked to facilitate these industry/site working relationships. Prior to demonstration and deployment, therefore, there are a number of key steps to be taken, including the careful identification of the most appropriate site; a commitment on the part of the site to host the demonstration; preparation of a detailed demonstration plan prior to the demonstration, clear delineation of duties and responsibilities, consideration of safety and regulatory issues, and so forth. Adherence to these conditions has proven immanently successful in a number of instances, three of which are described herein. The lesson is, it's worth the effort.

INTRODUCTION

The mission of the Department of Energy's (DOE's) Environmental Management (EM) Program is to clean up the environmental legacy of U.S. nuclear weapons production, with the goal of completing cleanup activities at most DOE sites within a decade. EM challenges sites to deploy innovative and more efficient technical approaches and technological solutions. Accordingly, EM's Office of Science and Technology (OST) research and development activities are designed to provide technological solutions that reduce costs and accelerate schedules associated with cleanup activities, reduce health and safety risks, and enable intractable problems to be solved.

Partnerships with private industry will reap significant benefits to the DOE's cleanup efforts, provided that the DOE sites maintain an open market to the private sector. Significant benefits will be realized by cost savings through widespread use of technologies and services provided by private sector companies in response to competitive procurements issued by the DOE sites. Strategies that entail competitive procurements based on end-state performance specifications, technology deployment, privatization, outsourcing and mortgage reduction require a competitive supplier base to meet EM needs. NETL provides an effective mechanism that industry can use to fill the information gaps needed to confidently bid on cleanup projects at the DOE sites.

SUCCESSFUL GOVERNMENT- INDUSTRY PARTNERSHIPS

In order to ensure that private industry, other Federal agencies, and universities are major participants in developing and deploying new and emerging technologies, OST provides a strong and stable financial commitment for building public and private-sector partnerships. NETL partners with private-sector entities such as colleges, universities, not-for-profit institutions, and industry in developing, demonstrating, and implementing improved technologies that specifically address the needs of multiple DOE sites and facilities. The approach is via government contracting mechanisms, primarily competitively procured contracts and financial assistance agreements.

A key to effective Government-Industry partnerships is the establishment of shared goals and objectives that meet the expectations of all parties entering the agreement. Industry has many incentives to expedite R&D work, including financial expediency, market entry, and internal corporate goals. The federal government, on the other hand, generally acts on mandates of policy from the executive and legislative branches, and is driven by goals and objectives of established programs. It is difficult to establish new programs and effect true partnerships because of the multitude and diversity of individuals and organizations involved in decision-making processes. For example, it is often necessary to elicit the support of DOE headquarters, a DOE field office, a site contractor, and various regulators and stakeholder groups in order to move forward with a single innovative solution to a cleanup problem. To rally the support of several DOE sites to the same cause requires a tremendous effort.

DOE has the major responsibility for establishing effective partnerships with private industry for innovative technology development and eventual deployment within the DOE complex. One

means through which partnerships can be developed in an R&D environment is a competitive procurement process that affords the private sector the opportunity to offer their approaches to solving problems that DOE identifies. In the procurement process the government must define the technology need, which establishes the technical requirements and desired outcome of the research. In addition, DOE needs to assess independently their desired cost targets and aid in establishing the acceptable bounds of technical and financial risks. The better DOE can define and articulate what their requirements are, the more likely they will attain the desired results at the best price.

The industry partners have the obvious responsibility for performing work in accordance with the cost, schedule, and performance requirements of their contract with the government. The NETL-managed contracts are implemented in Phases (or options) that allow either side to withdraw at designated decision points, thus minimizing the government's liabilities and providing opportunities to redirect work based on changing end-user requirements. In most instances, for the industry partner, the contract is the means to the end of having the technology product or service used within the DOE complex (market access), and just as important, having the potential for much broader commercial applications. With the assistance of DOE representatives, specifically the OST teams (as well as site personnel and support contractors), the industry partner is responsible for marketing technology solutions within the DOE community.

Execution of successful industry partnerships requires working closely with the private-sector developer, DOE technical managers, DOE Headquarters program personnel, and site personnel (which may include regulators and public stakeholders) to ensure that end-user requirements are met. The end user is the site contractor responsible for the cleanup job or a second-tier contractor that has the capability to respond to competitive solicitations for jobs at DOE sites. NETL's emphasis has always been to have the technology developer working closely with the end user(s) early in the development process to effect multi-site deployment of technologies. Without NETL's facilitation, it is difficult for private-sector companies to fully understand site-specific requirements, unless they have experience in working in the environment concerned. Private companies also have difficulty in getting the attention of decision makers at the sites, even if they have documented cost and performance data. In addition, the complexity of site organizations, inadequate communications, preferences of site personnel, potential conflicts of interest, budget and schedule issues, and many other factors can contribute to ineffective working relationships. NETL, in conjunction with OST, works diligently to facilitate these site working relationships.

Having successfully accomplished its technological objectives, a further challenge to many of NETL's industry partners is actual penetration of the DOE market. The diversity of sites, unclear and evolving site-specific requirements, the numerous decision-makers that must be marketed, difficulty in establishing correct contacts, and many other factors contribute to this challenge. Through diligence on the part of the company and the DOE, these challenges can be overcome, leading to successful partnerships that provide benefits to all involved parties.

A key element in the process of obtaining market penetration for private-sector participants in the OST program is the full-scale demonstration incorporated in the participant's research and

development contract. An effective demonstration, therefore, is a major goal of NETL's project management process. Key elements of this process include:

- Careful identification of the most appropriate site – accurate and realistic requirements with respect to the technology needed, the application in which it will be required, and the time-frame in which it will be required.
- Careful design of a comprehensive demonstration – not only full-scale, but also comprehensive with respect to both duration and scope.
- A commitment on the part of the site to host the demonstration – establishing early and effective working relationships between site and contractor personnel.
- Preparation and approval of a detailed demonstration plan well in advance of startup: clear delineation of duties and responsibilities, provision for compliance with safety and regulatory requirements, fall-back procedures, and other site specific requirements.

Three successful partnerships discussed below deal with significantly different technologies; all have a long, but not unusual, developmental history backed by business organizations that are dedicated to the success of the technology for multiple DOE applications. These organizations have taken full advantage of field-scale demonstrations and full-scale deployments of increasing size and scope to validate their technologies and gain a foothold in the DOE market. Although these organizations have had success, each would admit that market penetration is a continuous challenge that requires continuous marketing and sound business strategies to overcome. These technologies and the corresponding companies are:

- Well Injection Depth Extraction (WIDE) Soil Flushing
North Carolina State University/Informatics Corporation
- Pipe Explorer Surveying System
Science & Engineering Associates, Inc.
- A Wireline Cone Penetrometer System for Multiple Tool Usage
Applied Research Associates

The intent of these discussions is not to delineate the technical merit of the work conducted on behalf of DOE, but rather to discuss efforts that have been made to consummate DOE/Industry partnerships and the benefits of having gone to the trouble to do so.

Well Injection Depth Extraction (WIDE) Soil Flushing

Contamination in low-permeability, high-clay-fraction soils poses a significant technical challenge to *in situ* remediation efforts. Conventional technologies such as pump and treat groundwater remediation, and vapor extraction using conventional well fields, are typically ineffective when applied to sites with low permeability soils. The WIDE project was selected by NETL for its significant technological improvements over the conventional technologies and for its wide applicability throughout the DOE complex.

Technology Description:

Well Injection Depth Extraction (WIDE) is an innovative in situ remediation technology applicable to the remediation of fine-grained soils with hydraulic conductivities as low as 10^{-8} cm/s. The technology utilizes closely-spaced Prefabricated Vertical Wells (PVWs), that can be installed rapidly, to extract groundwater and/or soil vapor using an applied vacuum. The PVWs also can be used for injection of liquids in a soil-flushing scheme. Prefabricated Vertical Wells have been used in the geotechnical industry since the mid 1950's for dewatering fine-grained soil. The WIDE system has been successfully demonstrated for the removal of dissolved-phase contaminants, dense nonaqueous phase liquids (DNAPLs), and light nonaqueous phase liquids (LNAPLs) from the subsurface.

The WIDE system utilizes PVWs in lieu of conventional wells to extract groundwater and inject liquid flushing agents. PVWs, shown in Figure 1, are constructed of a geosynthetic composite system consisting of an inner core and an outer filter jacket. The PVWs are used for both extraction of groundwater/gases and injection of flushing solutions. Installed at relatively close spacings (<3 ft), the PVWs shorten groundwater drainage paths and accelerate soil flushing processes.

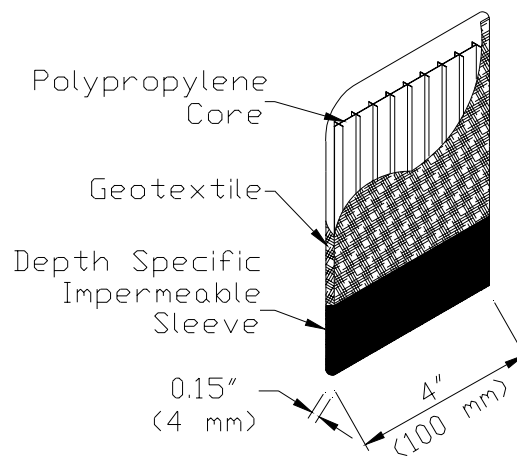


Fig. 1: WIDE System

The PVWs are designed for depth-specific extraction of contaminated plumes with or without concurrent liquid injection. The WIDE technology has been designed to target the source points of a plume, thereby controlling and minimizing the volumes of liquids being extracted. The PVWs are installed by a patented process of the Nilex Corporation which uses a direct push technology capable of an installation of 9 ft/s into firm clay soils. The PVWs are piped together at the surface, then a vacuum is applied to extract the groundwater and volatilize contaminants. Appropriate surface treatment trains are utilized to treat extracted groundwater and vapor.

The WIDE system was developed through DOE-funded research at North Carolina State University (NCSSU) and West Virginia University (WVU), in cooperation with the Nilex Corporation. The technology is being commercialized by the Informatics Corporation, Richland, WA.

Status:

The WIDE system was first demonstrated at DOE's Ashtabula Environmental Management Project (AEMP), which is located at a former uranium metals processing facility. This comprehensive demonstration was designed to address a wide array of contaminants residing in soils exhibiting low hydraulic conductivity. In addition, the demonstration needed to cover a significant area, address different modes of operation, and extend over a meaningful period of time. A demonstration meeting these criteria and proving to be successful would make the WIDE system an excellent candidate for applications throughout the DOE complex. Accordingly, the AEMP was selected to host the demonstration. The site's groundwater and soils are contaminated with trichloroethylene (TCE), uranium (U), and technetium-99 (⁹⁹Tc). The subsurface remediation is technically challenging due to the glacial till soil exhibiting low hydraulic conductivity (10^{-6} cm/s) and having a high clay fraction. A former evaporation pond at the site is credited as the source of the TCE and U contamination. The pond measured approximately 30 ft in length and 20 ft in width. The WIDE demonstration pad, therefore, was designed at 70 ft by 70 ft and was centered over the former pond. In addition to addressing three different contaminants, the demonstration was designed to operate in three modes: extraction-only, injection-only, and injection/extraction, and the demonstration period covered a full year. During demonstration, groundwater and air extraction rates were measured. Groundwater elevations and contaminant concentrations were monitored at the groundwater monitoring wells. Contaminant removal rates were calculated based on TCE and U concentrations of grab samples collected from extracted soil gas and groundwater.

Demonstration of the WIDE system in the glacial till soil showed that this innovative system did remove subsurface TCE and U contamination by extracting groundwater and soil gas from the low-permeability, high clay fraction soil. The WIDE technology has demonstrated its effectiveness and success in reducing the source of the contamination by achieving large contaminant concentration reductions within relatively short operational times. The WIDE system also proved capable of injecting liquids into the subsurface to enhance the soil flushing process. The WIDE system effectively reduced the source of the contamination in relatively short operational times. At one of the monitoring wells in the demonstration, the TCE concentration was reduced from an initial concentration of 400,000 $\mu\text{g/l}$ to 160,000 $\mu\text{g/l}$ (60% reduction) in 31 hours of operation.

Based on the performance data generated from the AEMP demonstration, the WIDE system was deployed at the former Lockbourne Air Force Base located at Rickenbacker Port Authority in Columbus, OH, overseen by the US Army Corps of Engineers. The system was successfully applied for the extraction of free-phase JP-4 petroleum hydrocarbons from soils with hydraulic conductivities ranging from 10^{-7} to 10^{-8} cm/s. This deployment is considered to be a major success. A detailed cost performance report is currently being prepared.

In late 2001, deployment of the WIDE system was initiated at the Battelle Columbus Laboratories Decommissioning Project (BCLDP) West Jefferson North Facility. The project is utilizing both water and a co-solvent to remove Cesium-137 from the site soil through a closed loop soil flushing system. A further full deployment is planned (currently in contract negotiations) at the Portsmouth [Ohio] Gaseous Diffusion Plant.

Pipe Explorer Surveying System

The baseline technology for conducting radiological surveys of pipes is passing a hand-held radiological sampling instrument over the exterior surface of the pipe. For a complete survey, personnel must gain access to the entire exterior surface over its full length. This is not always possible depending on the location of the pipe. Access to above ground piping may be restricted and access to buried pipe requires costly excavation. The baseline approach is difficult, time consuming, potentially hazardous, and not readily capable of detecting threshold surface contamination. The Pipe Explorer™ project was selected by NETL for its significant technological improvements over conventional technologies (discussed below) and for its wide applicability throughout the DOE complex. Virtually every facility on every site has an application for the Pipe Explorer™ technology.

Technology Description:

Using a technique applied to borehole instrumentation emplacements (SEAMIST™), the Pipe Explorer™ system integrates standard radiation detectors with a unique inverting membrane deployment method. The deployment method utilizes a long, tubular membrane to tow instruments through the pipes. The membrane is initially rolled up on a reel inside of a pressure-tight canister. The membrane exits the canister at the bottom and is wrapped back on the base-pipe and clamped. As pressurized air is introduced into the canister, the membrane inverts and distends out of the base-pipe. The membrane continues to invert until its end is completely distended. A tether attached to the end of the membrane is then reeled up to retrieve the system, in reverse fashion. A Pipe Explorer™ deployment setup is shown in Figure 2.



Fig. 2: Pipe Explorer Deployment Setup

To inspect the inside of pipes for radionuclide contamination, a gamma and/or beta radiation detector is mounted at the point where the tether is attached to the membrane. As the detector traverses the pipe, pulled by the advancing membrane, electrical pulses proportional to radioactivity on the surface are transmitted through a cable back to the canister and subsequently to a data acquisition system. Pulses are either simply counted for a gross contamination scan, or analyzed with a multi-channel pulse-height analyzer to determine their energy and, hence, the specific radioisotope.

The primary nuclear detectors that are used with the deployment system are sodium iodide and cesium iodide scintillation detectors coupled to photomultiplier tubes for gamma measurements. For beta measurements, an organic scintillator coupled to a photomultiplier tube was used. Since alpha particles cannot penetrate the membrane, a scintillating material is embedded into the membrane for specific alpha surveys. The scintillation is then detected by a photodiode located inside the membrane, which keeps the photodiode shielded from outside contamination. These detectors are configured in compact packages small enough to be transported around bends and obstructions in piping systems.

The detectors have been integrated with the inverting membrane deployment method so that the system can be used to inspect pipes with inside diameters two inches and greater. The system can be used in piping runs up to 500-ft long with and without multiple elbows and obstructions. The system control and data acquisition are remotely operable.

Status:

The development of the Pipe Explorer™ system began in October 1993. While demonstrations began in 1995, the system has evolved to expand detection capabilities and applicability to a broader range of site needs. Two complete deployment systems have been developed that incorporate four types of beta/gamma detectors, alpha detectors, video cameras, and pipe locators. The Pipe Explorer™ has been demonstrated and deployed at multiple DOE and nonDOE sites. Science & Engineering Associates, Inc. (SEA) is now actively marketing Pipe Explorer™ services to DOE and commercial nuclear facilities.

The Pipe Explorer™ system has been used for alpha, beta, gamma, and video surveys of over 6,000 feet of piping, involving a variety of radioactive isotopes. Two fully automated and two manually operated Pipe Explorer™ deployment systems have been used to conduct these surveys. The surveys have included pipes with up to eight elbows and with vertical runs in excess of nine meters (M). Detectors have been successfully deployed past rocks, oil, and other debris that have obstructed up to 50 percent of the pipe's cross-sectional area. The Pipe Explorer™ deployment systems are capable of conducting surveys in pipes with diameters ranging from 0.05 M (2 inches) to 1.22 M (48 inches), and survey lengths that vary from 30 M up to 300 M.

The demonstration program incorporated with NETL's development contract included by design a broad spectrum of these capabilities. It started with a feasibility demonstration at the Idaho National Environmental Engineering Laboratory (INEEL) Chemical Processing Plant in 1995. A

gamma detector was used to survey scrap piping ranging from 0.05 M (2 inches) to 0.10 M (4 inches) in diameter. In addition, a mock drainline system consisting of 3" steel piping was surveyed to detect Cs 137 sources placed in the piping.

The INEEL demonstration was followed within the year by a much more comprehensive demonstration at Argonne National Laboratory's (ANL's) CP-5 reactor site. This demonstration had three major components: 1) detection of Cs-137 and Sr/Y-90 in 4, 12, and 18-inch diameter pipes; 2) detection of Am-241 in 4-inch pipe; and 3) alpha surveys in concrete-embedded fuel rod storage tubes. This demonstration was one of several demonstrations sponsored by NETL as part of the ANL CP-5 Reactor Large-Scale Decontamination and Decommissioning Project (LSDDP). Upon completion of the LSDDP, ANL hosted a CP-5 Open House to facilitate contacts between the DOE user community and the demonstrating contractors. SEA made several serious contacts at this event that eventually led to commercial deployments of the Pipe Explorer™ technology. One success leads to another. To date, Pipe Explorer™ has 12 deployments, at a variety of DOE and non-DOE sites, to its credit.

The Pipe Explorer™ system has been a major success. The estimated cost savings to the government from the very first use of the Pipe Explorer™ system exceeded the total project cost of developing the technology. These savings result from cost avoidance in that the pipes concerned were certified to be contaminant-free and they could be left in the ground. While cost savings in other instances (where contaminants do exist) are not attributable, the certainty that contaminants do exist, and knowing what they are and what their concentrations are – priceless!

A Wireline Cone Penetrometer System for Multiple Tool Usage

Since the late 1980's, many new sensors and "tools" have been developed for cone penetrometer technology (CPT), greatly expanding its capabilities for environmental characterization. Such tools include various chemical, radiological, and geophysical sensors; soil, soil-vapor, and groundwater samplers; and down hole video. Using conventional CPT, the entire rod-string (the series of rod sections that make up the CPT rod) must be extracted from the hole to change the sensor or "tool" being used at the tip. Collecting soil samples with conventional CPT also requires the entire rod-string to be retracted for each sample collected. This slow process of removing and redeploying the entire rod-string is inefficient and expensive. An efficient method was needed to exchange CPT tools without removing the entire rod string from the ground.

Technology Description:

Applied Research Associates, Inc. (ARA) has developed an innovative cone penetrometer technology (CTP) system, the Wireline CPT system, that allows sensors and tools to be exchanged in a rapid manner without retracting the rod string. The Wireline CPT system consists of an innovative locking/retrieval system and an assortment of characterization tools that can be retrieved and interchanged from any depth. The name Wireline is derived from the wire cable that is attached to each tool for the purpose of retrieval. The Wireline CPT system utilizes slightly larger rods than conventional CPT, allowing passage of tools through the hollow center of the rod.

The Wireline CPT system consists of three main components:

- Specialized, high strength, fast coupling rod string;
- Tool locking and retrieval mechanism; and
- Individual characterization tools.

A rendering of the Wireline CPT system and selected tools is shown in Figure 3.

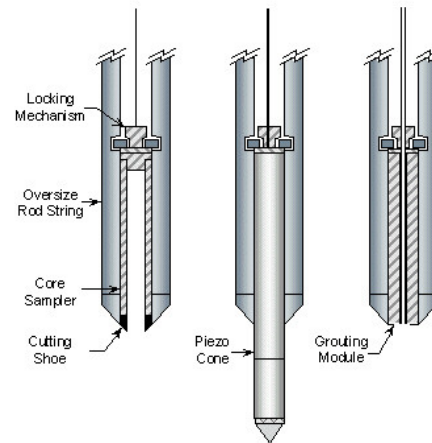


Fig. 3: Wireline CPT System

Status:

The development of the Wireline CPT system began in July 1998 and included the development of three characterization tools. The first tool is a standard small-diameter (1.125 inch) piezocone for determining soil type, stratigraphy, and soil strength characteristics. The second tool is a retrievable soil sampler that collects and retrieves core samples 1 inch in diameter by 12, 18, or 24 inches long. The third tool is an attachment to permit grouting of the penetration hole during retraction. In addition to the three characterization tools developed during this project, ARA also has developed a Wireline soil gas sampler, and a “dummy tip” for quickly advancing to the desired sampling depth without risking damage to a more expensive tool. A ribbon DNAPL sampler also was successfully utilized with the Wireline CPT system at SRS. The full potential of the Wireline CPT system will be realized as a full assortment of CPT tools is adapted to it.

The Wireline CPT system is widely considered a significant breakthrough in CPT and is commercially available through ARA. Projected savings of as much as 80% of standard CPT costs have been documented. The Wireline CPT was successfully demonstrated at both the Savannah River Site (SRS) and at the Hanford Site, and has since been fully deployed multiple times at other areas of SRS and at Hanford.

The Savannah River Site (SRS) and Hanford Site were targeted as demonstration sites for the technology early in the development and demonstration planning processes. Letters of support for the demonstrations were received from both SRS and Hanford. These letters reflect the excellent coordination and communications effort undertaken by ARA. In accordance with

comprehensive demonstration plans, the Wireline CPT was demonstrated at SRS in May 1999 at the M-Basin, and in April 2000 at the Chemical, Metals and Pesticides (CMP) Pits. At the SRS M-Basin, the reliability of the locking and release mechanism was tested, the validity of the piezocone measurements was assessed, operational procedures and system survivability were assessed, and the refusal depth and production rate of the system were benchmarked against conventional CPT. At the SRS CMP Pits, piezocone characterization in combination with 1) soil gas sampling, and 2) ribbon DNAPL sampling were assessed, as well as continuous soil sampling. A demonstration also was conducted at the Hanford Site in July and August 2000. The soil sampler was tested extensively at Hanford's Sisson and Lu Site of 200 East, in direct comparison with conventional CPT. The Wireline system also was tested in conjunction with the ARA Sonic CPT at Hanford. The Wireline system performed exceptionally well at both sites. These successful demonstrations led to the deployment of the technology multiple times at other areas at SRS and Hanford. The cost savings realized from these deployments far exceeds the government's development costs. Westinghouse Savannah River Company and Bechtel BWXT Idaho have purchased Wireline CPT systems for ongoing characterization work at these sites.

ARA was recently awarded a new project with EM's Science and Technology program to develop an Enhanced Access Penetration System for difficult geological settings. This project involves integrating ODEX-type drilling and laser drilling with the Wireline CPT to allow penetration of difficult geologic layers, such as Hanford's cemented Caliche layer. This layer was not penetrable by conventional CPT or by the Wireline CPT system with the sonic CPT attachment.

CONCLUSIONS

It is a continuous challenge for private companies, especially universities and small businesses, to understand and penetrate the DOE market with truly innovative technology-based solutions to environmental cleanup problems. In many cases, these efforts are more challenging and resource intensive than the technology development efforts they support. But, as evidenced from the preceding discussions, it can be extremely beneficial to DOE for private companies to pursue opportunities that have applications at multiple DOE sites and facilities, as well as commercial applications external to DOE. In order to encourage private-sector participation, DOE has the responsibilities to accurately define R&D requirements for site problems and to facilitate working relationships between private companies and the appropriate end users. The successes of the projects discussed above clearly demonstrate the importance of working closely with the sites to develop comprehensive demonstration plans; plans that will govern successful demonstrations that, in turn, will provide the data necessary to lead site decision makers, throughout the DOE complex, to fully deploy the technology. Private companies have demonstrated that they can offer cost-effective solutions, and that they are willing to align their businesses with DOE's requirements, but they need DOE's assistance in getting the attention of site decision makers. OST and NETL continue to assist private companies, because successful Government-Industry partnerships have proven to be an important component in accomplishing the mission of the EM cleanup program.