THE MIXED WASTE LANDFILL INTEGRATED DEMONSTRATION

Thomas D. Burford, Cecelia V. Williams and J. David Betsill
Environmental Restoration Technologies Department, 6621
Sandia National Laboratories

ABSTRACT

The US Department of Energy's Office of Technology Development (OTD) is developing, demonstrating and transferring needed technologies to Environmental Restoration, Waste Operations, and Defense Programs. As part of this initiative, OTD is supporting a network of Integrated Demonstrations (IDs). These IDs "integrate" the "demonstration" of new innovative technologies proposed by federal laboratories and partnered with universities and industry. Each ID is focused upon a different environmental need aimed at resolving specific problems representative of generic DOE environmental issues. The Mixed Waste Landfill Integrated Demonstration (MWLID) is hosted at Sandia National Laboratories in Albuquerque, New Mexico.

INTRODUCTION

The Mixed Waste Landfill Integrated Demonstration focuses on landfills in arid environments that contain heavy metals in complex mixtures with organic, inorganic, and radioactive mixed wastes. Its mission is to assess, demonstrate, and transfer technologies and systems that lead to faster, better, cheaper, and safer "in-situ" characterization, monitoring, remediation and containment of these landfills. Most important, the demonstrated technologies will be evaluated against the baseline of conventional technologies. These comparisons will include the cost, efficiency, risk, and feasibility of using these innovative technologies at other sites. Key goals of the MWLID are the commercialization of these technologies to the private sector and the routine use of these technologies by Environmental Restoration groups throughout the DOE complex. The success of the MWLID will be measured by the implementation of the technologies and systems to clean up contaminated waste sites at DOE facilities and similarly contaminated landfills nationwide.

The MWLID will demonstrate technologies at several landfills. Sandia National Laboratories' Chemical Waste Landfill received chemical hazardous waste from the Laboratories from 1962 to 1985, and the Mixed Waste Landfill received hazardous waste and radioactive wastes (mixed wastes) over a twenty-nine-year period (1959-1988) from various Sandia nuclear research programs. Additionally, the Technical Area II Classified Waste Landfill contains VOCs, inorganic, and mixed waste, has recently been to added as a demonstration site. These landfills are now closed. The Kirtland Air Force Hazardous and Solid Waste Amendments (HSWA) site, operated from 1960 to 1973 by the Air Force Weapons Laboratory, received waste from radiobiological experiments. These landfills have been selected as demonstrations sites because they are representative of many sites throughout the southwest and other arid climates. Additional sites may be used depending on technology selection and site "representativeness". Technologies successfully demonstrated at Sandia also can be used at similar sites in arid climates.

Originally these sites were selected for the landfills because of Albuquerque's arid climate and thick layer of alluvial deposits that overlay the groundwater by as much as 500' below the landfills. At the time, the thick layer of alluvial deposits (dry soils, gravel, and clays) was assumed to be a natural barrier between the landfills and groundwater. Today we know that additional precautions may be necessary to ensure safe disposal. For example, the Chemical Waste Landfill did not have a liner system to impede contaminant migration nor instrumentation to monitor its migration under the landfill. Now, all landfills must be designed with such advanced technology. In addition, contamination that recently has been detected below the Chemical and Mixed Waste landfills must be characterized, remediated, and monitored.

CHARACTERIZATION AND MONITORING

Characterization must answer the question: What is happening beneath the waste site? Detailed information must be known about the contamination including the source, types, mobility, and amounts as well as the spatial distribution of each contaminant. Quantitative information about the geologic and hydrologic properties of the site also must be determined so environmental scientists can accurately predict how contaminants behave underground. How will pollutants travel? Will the contamination migrate to the groundwater? If so, how long will it take? These key questions and many more must be answered before clean-up methods can be selected.

Scientists have described site characterization as looking at the sky through a straw and, with no other information, predicting the weather. Until recently, the analogy was often correct. Site characterization often involves drilling numerous holes in the ground, obtaining samples from the soils, and sending the samples to a laboratory for analysis. From such scant information, environmental professionals try to predict the nature and extent of subsurface contamination. This characterization process is expensive and inefficient. Also, traditional drilling techniques can induce contaminant migration and expose workers to significant health risks from handling the contaminated by-products.

One of the MWLID's primary goals is applying innovative technologies and characterization procedures to minimize disturbance at landfills while maximizing information gathered. Many state-of-the-art technologies are being demonstrated. For source characterization, non-intrusive technologies that do not require holes to be drilled or samples to be taken include electromagnetic measurements and magnetometry. We are demonstrating the magnetometer towed array jointly developed by the US Naval Research Laboratory, Geo-Centers Inc., and Sandia National Laboratories. The MWLID in consort with Argonne National Laboratory and ConSolve, Inc. is employing SitePlanner™ and Plume™., a computerized sampling tool using geostatistics which optimizes historical and field data, to aid in the formulation of a sampling strategy. This minimizes the number of holes required, provides optimal sampling locations and suggests appropriate sensor technologies. New methods of directional drilling (drilling at an angle), and horizontal boring are being demonstrated to minimize the problem of drilling-induced contaminant migration and contaminated drilling by-products. In addition, worker safety is enhanced because the drilling equipment can often be located at the periphery of a landfill. Two industry partners for these drilling projects are Charles Machine Works and Water Development Corporation. New Mexico State University and Pacific Northwest Laboratory are partners in demonstrating a rapid field screening method (stripping voltammetry) for the detection of heavy metals in soil samples retrieved through drilling. This method simultaneously can analyze for numerous metals at parts-per-billion (ppb) levels within several hours of collection.

Sensors which operate downhole to detect contamination or measure soil properties reduce the number of soil samples which have to be obtained and sent off a site for analysis. The SEAMIST™ membrane liner, developed by Science Engineering Associates, is a promising technology that, for many applications, can replace the rigid casing found in most boreholes. The borehole liner can be used for sample collection, in situ measurements, and transporting sensors downhole without allowing contact between the instruments and the contaminated soils.

Many of the characterization technologies being evaluated are also compatible with long-term monitoring activities. Several of the MWLID technologies will fulfill this dual role. Technologies that measure near-surface transport properties of fluids and gases in the vadose zone can provide valuable and necessary input to mandatory site-wide risk assessments. A Landfill Characterization and Monitoring System (LCMS) is being developed that, in addition to stressing integrated characterization activities, also emphasizes monitoring of the shallow unsaturated (vadose) zone.

Multiple technologies are required to fully characterize and monitor a site. Therefore, the MWLID will utilize a systems approach that incorporates compatible and complementary technologies for site investigation. It is the intent of the LCMS to integrate these technologies and provide as many of the necessary pieces as possible to the characterization and monitoring puzzle.

REMEDIATION AND CONTAINMENT

Site characterization provides the information necessary for the MWLID to tackle the technology development for remediation of mixed waste landfills using in-situ technologies that will minimize the risk from the landfill without excavating the waste materials and contaminated soils. This innovative remediation mission is based on the premises that 1) moving the landfill to another location only transfers the risk and 2) the national capacity for permitted mixed-waste landfills is limited. This further encourages remediation and management of mixed-waste landfills at their current location.

Few in-situ technologies are available to remediate contamination located in the unsaturated zone between the landfill and the groundwater. This "vadose zone" is an important area because it provides a barrier between the landfill and groundwater. While the vadose zone can effectively isolate and contain some contaminants, other contaminants may move quickly through this zone. When the unsaturated zone becomes contaminated with fast-moving pollutants, such as volatile organics, scientists are concerned that pollutants may reach groundwater before intervention can take place. The MWLID focuses on safe, efficient, and effective new methods to remediate fast-moving contamination in the unsaturated zone.

The remediation technologies can provide the basis for an advanced clean-up strategy.

Extraction

The MWLID is demonstrating innovative extraction technologies. One such system, Thermal Enhanced Vapor Extraction System (TEVES), Fig. 1, will demonstrate vacuum technology combined with soil heating methods and offgas treatment to remediate volatile organic wastes that often are found at mixed waste landfills. Another extraction technology being developed is Electrokinetics, Fig. 2, a method where subsurface chromium contamination is moved through the soils by the forces of a small electric field. Removal of the most rapidly moving constituents will then allow for long term remediation of the site.

Transformation

Some soil contaminants, such as chromium, can exist in more than one redox state, with one state being more mobile than the other. Technologies are being evaluated to find ways

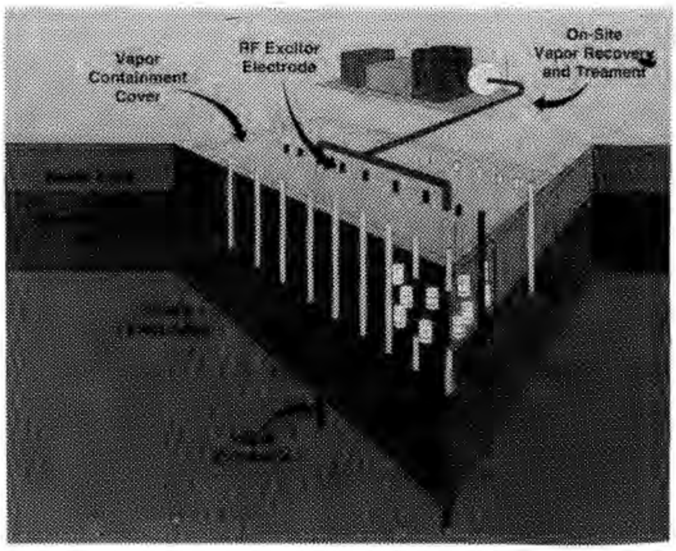

Fig. 1. Thermal Enhanced Vapor Extraction System (TEVES).

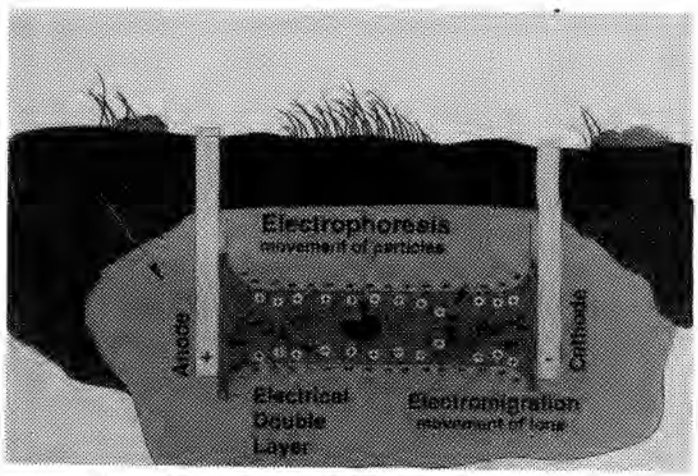

Fig. 2. Electrokinetic (EK) extraction system.

to transform more mobile chromium to a less mobile state by an in situ chemical reduction process.

Once the immediate threat of fast-moving contaminants is under control, the remaining landfill contents must be remediated or contained to minimize the long-term migration of slow-moving contaminants. Containment technologies involve: 1) the placement of surface covers to minimize precipitation infiltration into the landfill and leaching wastes into the surrounding soil; and 2) the placement of subsurface barriers to contain slow-moving soil contaminants. The MWLID is evaluating the materials and emplacement methods for subsurface barriers; but, more importantly, is evaluating methods to verify that subsurface barriers are meeting containment performance criteria. Current verification techniques include geophysical, hydrological, and observational methods.

Surface Covers

Above-ground technologies, termed covers or caps, are required for the closure of all landfills in order to reduce the amount of precipitation which leaches the waste out the landfill. Alternative cover designs which offer cost and technical advantages in arid and semi-arid regions are being demonstrated jointly by Sandia National Laboratories and Los Alamos National Laboratory.

A dry barrier, Fig. 3, which utilizes air flow through course gravel layers in order to remove moisture from the cover system is being evaluated for cover and subsurface applications. The MWLID is working with the University of New Mexico and D. B. Stephens on dry barrier designs and applications. A computer-based decision tool for environmental restoration professionals for designing optimal cover designs is under development.

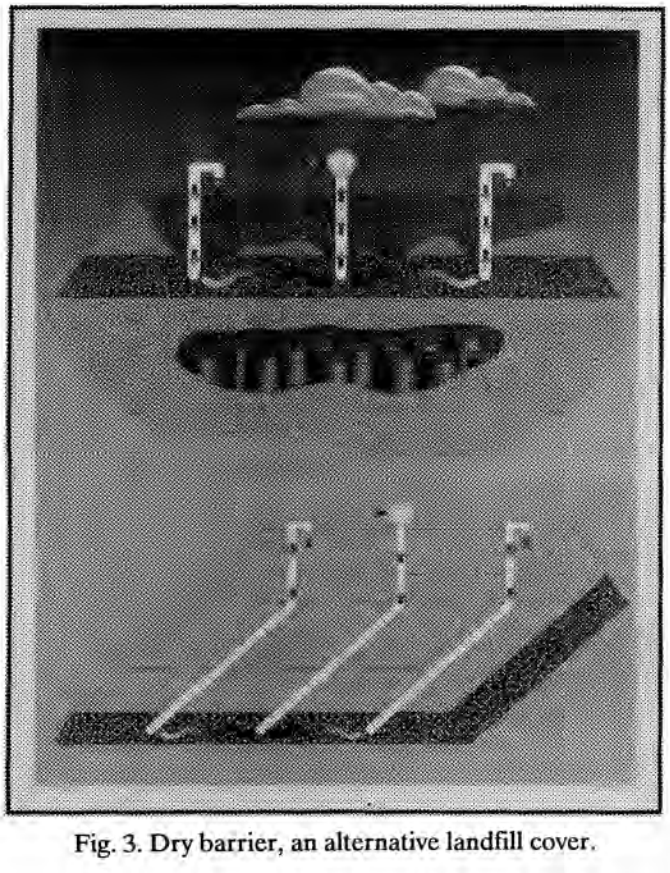

Fig. 3. Dry barrier, an alternative landfill cover.

Subsurface Barriers

The ID is evaluating the feasibility of emplacement of subsurface containment structures. Using directionally drilled holes to gain access under a landfill, materials such as grouts can be emplaced to limit leachate movement from the site and also provide a contained area to assist remediation and/or transformation techniques. Optimal materials for these structures are being selected. Other containment alternatives, such as permeable barriers which permit water flow but retain contaminants, are being evaluated.

TECHNOLOGY INTEGRATION

Technology Integration is an integral part of the MWLID mission. The focus of the technology integration effort is to facilitate the involvement of outside participants in the ID activities, to hasten the adoption of successfully demonstrated technologies throughout the DOE complex, and to expedite the transfer of the technologies to other Federal agencies and to the private sector.

Outside participants in the MWLID include technology developers, such as industrial and universities partners; other government agencies, and interested public groups. The ID integrates mature technologies from universities, industry, research institutions, and national laboratories for demonstration. Successfully demonstrated technologies are transferred out of the ID for use and commercialization. For example, an ID-funded migration barrier landfill cover is being jointly developed by Colorado State University and Los Alamos National Laboratories. SEAMIST™, a borehole liner and sampling system, is an example of an ID/industry-developed technology that has been successfully demonstrated and has been transferred for use at other federal, state, and private facilities. The SEAMIST™ patent have been sold to Eastman Cherrington Environmental, who will commercialize the technology nationally and internationally. Illinois Institute of Technology Research Institute (IITRI) is the research partner on the TEVES project. The TEVES project combines the use of soil heating methods developed by IITRI with vacuum extraction methods developed industry and an off-gas treatment system designed with the support of the VOCs in Non-Arid Soils Integrated Demonstration, Savannah River.

The ID is working with federal, state, municipal, and tribal governmental agencies to expedite the regulatory approval and the use of these technologies. For example, the New Mexico Environment Department is recommending the use of a MWLID-developed landfill cover at northern New Mexico landfill sites. We also are working with the USDA and New Mexico state regulators to implement the use of a ID/USDA-developed decision support software for the optimization of site-specific landfill cover designs.

The MWLID is aggressively developing partnerships with state, municipalities, tribal groups, and private industry to broaden the knowledge and use of its achievements. The ID is working with the New Mexico Environmental Alliance to apply innovative technical solutions to industrial environmental problems. Partnerships are developing with the New Mexico Association of Counties, the New Mexico Municipal League, New Mexico Hazardous Waste Management Society, the All Indian Pueblo Council, and citizens groups. We hope to assess municipal and tribal landfill problems with the aim of demonstrating innovative solutions for landfill restoration in the near future.

The MWLID is an active participant in the DOE-sponsored Waste Management Education and Research Consortium (WERC), a research partnership among the New Mexico universities, national laboratories and the Navajo Community College. We also actively support the Partnership for Environmental Technology Education (PETE), Youth Opportunity Training (YOT), Work-Study Training, and Summer Employment for Minatory Youth (SEMY). The ID provides internships and graduate research opportunities for students and educators to challenge them to become involved with innovative solutions to environmental problems.

The success of the MWLID will be measured by the use of successfully demonstrated technologies for the cleanup of the DOE complex and by technology transfer to private industry. Therefore, the innovative technologies must obtain public industry, and regulatory approval. A fundamental step toward that goal is to establish credible, two-way relationships and methods of communication between the MWLID and their stakeholders early in the process of development, demonstration, testing, and evaluation. The MWLID is a charter member of the DOE/SNL Community Relations Team (CoRe). CoRe seeks to develop a climate of trust and partnership with the public to identify, discuss, and resolve environmental, safety, health, cultural, social, and economic issues. This will provide essential public, industry, and regulatory interfaces necessary to the success of the MWLID.

MWLID DEMONSTRATION SCHEDULE

Prior to May 1992, field demonstrations of characterization technologies were performed at an uncontaminated site near the Chemical Waste Landfill. In mid-1992 through summer 1993, both non-intrusive and intrusive characterization techniques were demonstrated at the Chemical Waste Landfill. Subsurface and dry barrier demonstration were started in summer 1993 and will continue into 1995. Future plans include demonstrations of innovative drilling, characterization and long-term monitoring, and remediation techniques. Demonstrations were also scheduled in summer 1993 at the Kirtland Air Force HSWA site and will continue in 1994.

The first phase of the TEVES project occurred in April 1992 when two holes were drilled and vapor extraction wells were installed at the Chemical Waste Landfill. Obtaining the engineering design and environmental permits necessary to implement this field demonstration will take until early 1994. Field demonstration of the vapor extraction system will occur during 1994.