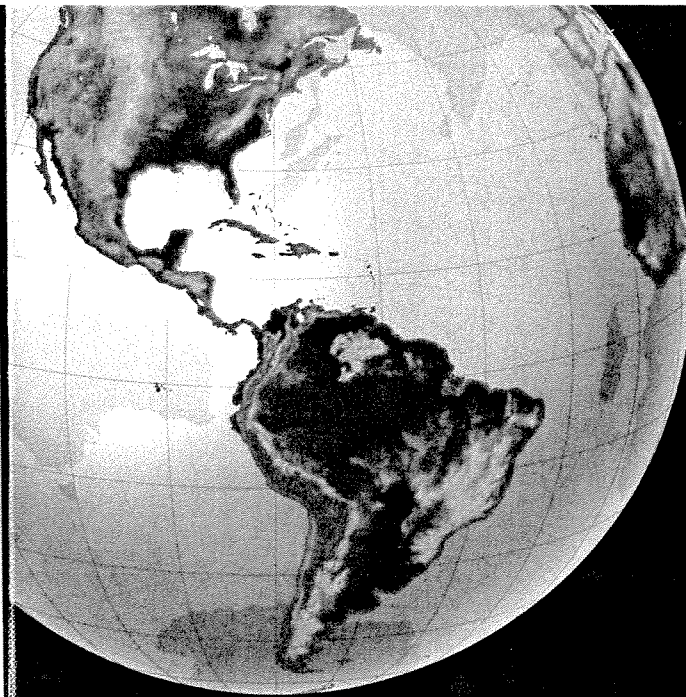




Environment, Energy, and Resources Law

The Year in Review 2004

The National

Energy-Environment

Law & Policy Institute

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SITE REMEDIATION¹ 2004 Annual Report

OVERVIEW OF NEW TECHNOLOGIES AND NEW CONTAMINANTS

I. EMERGING REMEDIATION TECHNOLOGIES

Remediation technologies are evolving, with previously radical approaches now considered almost routine. New technologies hold out the hope for less expensive and more timely site remediations.

A. *Microturbines*

The decomposition of solid waste in landfills produces landfill gas (LFG), a mixture consisting mostly of methane and carbon dioxide.² In response to Clean Air Act emission regulations, and concerns regarding the migration of explosive LFG many landfills have installed LFG collection equipment. While some large landfills pipe LFG to energy recovery systems, this is rarely cost-effective at smaller landfills that produce low amounts of LFG. Historically, the LFG at such sites was burned using flares, with no heat or energy recovery.

Commercial microturbines were introduced into the LFG market in 2001,³ offering the economical conversion of LFG into electricity, at capacities up to about 300 kilowatts (kW). These systems are much smaller than prior systems, with lower capital and long-term maintenance costs, and lower air emissions. There are currently about 20 microturbine systems installed at landfills in the United States.⁴ Changes in the energy market, combined with more stringent air emissions standards, will make the use of microturbines economically feasible at more landfills. H.R. 4520,⁵ enacted on October 22, 2004, provides an additional incentive by modifying section 45 of the Internal Revenue Code⁶ to provide tax incentives for LFG-fueled systems placed in service by January 1, 2006.

B. *Metals Stabilization*

Metals such as arsenic, lead, cadmium, chromium, and mercury are common soil contaminants historically excavated to prevent leaching into groundwater. Excavation and disposal costs are high at sites where soil requires handling as a hazardous waste.

Recent stabilization technologies take advantage of phosphate and sulfide chemistry to convert the metals to stable complexes and precipitates, such as pyrites, more efficiently and less expensively than previously available technologies, resulting in less soil mass. Leaching tests demonstrate that in many instances soils are no longer considered hazardous waste after stabilization and some of the initial bioavailability tests

¹ This report was prepared by Jeff Marshall of SCS Engineers (emerging technologies) Bruce Thompson of de maximus, inc. (1,4 dioxane) and Michael Girioni of Roux Associates (MTBE). Edited by Karen Mignone, Pepe & Hazard LLP.

² Mike McLaughlin and Joe Miller, *The Challenge of Redeveloping Landfills Can Be Overcome*, BROWNFIELD NEWS, October 2004, at 52.

³ JEFFREY L. PIERCE AND BENNY BENSON, SCS ENERGY, THREE SUCCESSFUL LANDFILL GAS FIRED MICROTURBINE PROJECTS: CASE STUDIES (2002).

⁴ Personal Communication between Jeff Marshall, PE, SCS Engineers and Jeff Pierce, PE, SCS Energy, Dec. 8, 2004.

⁵ American Jobs Creation Act of 2004, Pub. L. No. 108-357, 118 Stat. 1418 (2004).

⁶ 26 U.S.C. § 45 (2000).

are also promising. The selection of the appropriate additives and mix ratios is based upon soil chemistry and contaminant concentrations, and may require laboratory scale testing.

C. *Nanoscale Zerovalent Iron*

Zerovalent iron (ZVI) has been used to promote in-situ, abiotic oxidation of groundwater contaminants since the late 1990s. Target contaminants have included chlorinated solvents, petroleum fuels, PCBs, dioxins, explosives, select chlorinated pesticides, and some heavy metals. The typical in-situ treatment system has incorporated the funnel-and-gate approach, using subsurface barriers such as sheet piles to direct the groundwater flow through a permeable reactive zone containing ZVI, or the construction of a slurry wall containing ZVI. While successes have been reported, the costs associated with the installation and maintenance of the subsurface system components have discouraged many potential applications.

The results of recent laboratory and pilot scale studies indicate that improvements to the conventional ZVI approach may offer significant cost reductions, and may allow the application of ZVI at a broader range of sites. The use of the much smaller nanoscale iron particles, in lieu of iron powders or shavings, provides a much higher total surface area per unit volume to promote the oxidation reactions. The nanoscale iron particles can also be mixed into a slurry, and injected into the subsurface, eliminating the costs associated with installing subsurface equipment. Recent advances in the production processes have reduced the purchase price for iron particles by about 90%, compared with prices in the late 1990s.

Laboratory studies using palladium plated nanoscale ZVI resulted in the complete dechlorination of PCB Aroclor 1254.⁷

D. *Phytoremediation*

Phytoremediation, the use of vegetation to promote the degradation and/or extraction of contaminants from soil and water, "has been employed for over 300 years," and has been studied extensively over the last few years.⁸ A recent publication reports the results of an EPA-sponsored survey of recent field-scale phytoremediation projects. The survey database includes information that can be used to evaluate the application of phytoremediation, including types of contaminants, soil properties, geologic and hydrogeologic conditions, plant types, amendments, regulatory considerations, O&M, and performance monitoring.⁹

⁷ See generally *ESTCP Evaluates Bimetallic Nanoscale Particles in Treating CVOs*, TECH. NEWS & TRENDS (EPA, Washington, D.C.), March 2004, at 3, available at <http://www.epa.gov/tio/download/newsletters/tnandt0304.pdf>; ALEX MIKSZEWSKI, EPA, EMERGING TECHNOLOGIES FOR THE IN SITU REMEDIATION OF PCB-CONTAMINATED SOILS AND SEDIMENTS: BIOREMEDIATION AND NANOSCALE ZERO-VALENT IRON (2004), available at http://www.cluin.org/download/studentpapers/bio_of_pcb_paper.pdf; *Nanoscale Iron Could Help Cleanse the Environment*, Spacedaily, at <http://www.spacedaily.com/news/nanotech-03zp.html> (Sept. 9, 2003).

⁸ CYNTHIA GREEN & ANA HOFFNAGLE, EPA, PHYTOREMEDIATION FIELD STUDIES DATABASE FOR CHLORINATED SOLVENTS, PESTICIDES, EXPLOSIVES, AND METALS 2 (2004), at <http://clu-in.org/download/studentpapers/hoffnagle-phytoremediation.pdf> (last visited Feb. 16, 2005).

⁹ *Id.*

Phytoremediation is seldom used as the sole remediation technology. It is most suited for use as a component of a treatment train, at sites where contaminant concentrations are only slightly above remediation endpoints, and at sites where remediation endpoints do not need to be achieved quickly.¹⁰

E. *Update on Monitored Natural Attenuation*

Monitored natural attenuation (MNA) was originally touted as a replacement for active groundwater remediation approaches at many sites. While MNA has many applications, it may not be quite as easy or inexpensive as originally anticipated as it requires monitoring, often including biological and chemical indicator parameters. Natural attenuation proceeds much faster at some sites than at other sites having very similar hydrogeological and chemical conditions. Fluctuating contaminant concentrations, potentially resulting from unidentified residual source areas, hinder progress evaluations. Nonetheless, monitored natural attenuation continues to be applied at many sites, often in conjunction with institutional controls (e.g., groundwater use deed restrictions) and engineering controls (e.g., asphalt caps) to minimize or eliminate the risks associated with human exposure to groundwater contaminants.¹¹

II. 1,4-DIOXANE – AN EMERGING CONTAMINANT OF CONCERN¹²

A. *Introduction*

Chemically, the compound 1,4-dioxane is a cyclic aliphatic ether, classified by the Environmental Protection Agency (EPA) as a Class B2 (probable) human carcinogen.¹³ It is used as a solvent stabilizer, and as a solvent in paints, varnishes, lacquers, cosmetics and toiletries.¹⁴ It is also formed as a byproduct during production of compounds like surfactants (detergents and shampoos), and certain pharmaceuticals.¹⁵ 1,4-dioxane rapidly photo-degrades in air, but is highly resistant to biodegradation in soil and ground water.¹⁶ It is miscible in water, and sorbs poorly to soil organic carbon.¹⁷ These properties both lead to the potential for significant migration in ground water¹⁸ and can make it difficult to remove 1,4-dioxane from contaminated water using conventional treatment technologies.¹⁹ 1,4-dioxane has received a great deal of state and federal regulatory attention, and has the potential to serve as a basis to “re-open” previously closed groundwater investigations.

¹⁰ *Id.* at 3.

¹¹ This discussion is based on SCS experience at dozens of sites with dissolved phased organic contamination in groundwater.

¹² ORANGE COUNTY WATER DIST., FACT SHEET 1,4-DIOXANE---EMERGING CONTAMINANT OF CONCERN, at http://www.ocwd.com/_assets/_pdfs/1,4-Dioxane_Fact_Sheet.pdf (last visited Feb. 16, 2005).

¹³ EPA, INTEGRATED RISK INFORMATION SYSTEM, 1,4-DIOXANE (CASRN 123-91-1), at <http://www.epa.gov/iris/subst/0326.htm> (last visited Feb. 16, 2005) [hereinafter IRIS].

¹⁴ THOMAS K.G. MOHR, SANTA CLARA VALLEY WATER DIST., SOLVENT STABILIZERS, WHITE PAPER, PREPUBLICATION COPY 8 (June 14, 2001), at http://www.valleywater.org/Water/Water_Quality/Protecting_your_water/_Lustop/_Publications_and_Documents/_PDFs_Etc/SolventStabilizers.pdf.

¹⁵ *Id.*

¹⁶ *Id.* at 24.

¹⁷ *Id.* at 12.

¹⁸ *Id.* at 16.

¹⁹ *Id.* at 35.