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Abbreviations and acronyms used throughout articles include:

EPA Environmental Protection Agency
UST Underground Storage Tank
ppm parts per million
ppb parts per billion

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Soil in a day’s work

Our third annual Buyer’s Guide is a state by state listing of firms that provide remediation products and services. My theory is that geography is an important factor when choosing a remediation services firm. After all, remediating a contaminated soil site is not like going to the dentist or the auto mechanic, where you take the problem in with you to the service provider. In most cases, soil remediation requires a “house call.” So that is why the guide is organized by states—to help you choose a nearby firm, if possible.

I usually like to discuss the state of soil remediation business in this space in the Buyer’s Guide issue, quoting market projections and growth trends. But this year, I have not seen any reports provocative enough to quote, so I am only going to discuss the market from my own personal vantage point. And I am pleased to tell you, from where I sit, the dirt biz is jumpin’! The measurement tool I use is the telephone. Lately, people are slower to return my calls, and when they do, they are kind of breathless, and open the conversation by explaining to me how busy they are and how deep their desks are stacked with work orders.

Back in 1991, people generally answered their phones on the first ring—a bad sign in my book. In 1992, quite a few people had their phones disconnected—a very bad sign. But as we pass the halfway mark in 1994, the market burst is underway. People have the regulations figured out, and have decided what to do with their sites. Cleanups are underway, sites are being closed, fixed, upgraded, bought and sold. The financiers have calmed down, the state funds are bumping along, the regulators are more familiar with the new technologies—and the new technologies are making cleanups easier and more efficient. A good example is the Lasagna Process, featured on page 100. This approach, combining technologies and creating treatment lenses in the subsurface is very exciting, and delicious with garlic bread.

New in this issue is a feature called “AcadeMix,” by Alfred Conklin, Jr., Ph.D., in which the good doctor will explain what the soil scientists know that the rest of us need to know. In his first article, page 88, I learned things about soil I did not know before, and I bet you will too.

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Rethinking TPH
Work group studies standards with emphasis on human health

By Wade Wiesman

Over 100 leaders from government, industry and academia have formed a Total Petroleum Hydrocarbon Criteria Working Group to provide health-based cleanup alternatives at petroleum contaminated sites. The working group draws from experts within state regulatory agencies, academia, U.S. Department of Defense, Department of Energy, EPA, Agency for Toxic Substances and Disease Registry, Department of National Health and Welfare Canada, the petroleum, power and transportation industries, private consultants and consulting firms.

This technical and organizational diversity allows the group to "draw upon the knowledge and practical experience of its members to address common concerns and areas of advancement for the Total Petroleum Hydrocarbon (TPH) standard used for the evaluation and remediation of many petroleum contaminated sites."

The group intends to provide a technical forum for information exchange; define, evaluate and propose analytical methodologies related to environmental remediation and treatment of petroleum contaminated sites including environmental fate parameters; and evaluate the use of TPH and alternative approaches in the risk assessment process—with emphasis on human health.

One of the major efforts of the group is a technical evaluation of rational alternatives to TPH as related to the characterization and remediation of petroleum contaminated sites. This report will focus on positive and negative aspects of each alternative method, as well as an analysis of the site specificity of each approach. The group does not intend to delineate which method is the best, rather it intends to provide state regulatory agencies with the best fit as a technically sound, health-based approach to a specific, characterized site.

There are two reasons to use a basis other than TPH to assess contaminated sites. First, the chemical composition of TPH as a class of chemicals is poorly and inconsistently defined. Second, TPH-based cleanup standards have as their foundation the detection limit of analytical equipment, and there is no rational scientific basis, such as human health protection, for the standard.

In addition to the technical review of alternative approaches, the group will prepare a report that consolidates chemical constituent data on petroleum products, both pure product and weathered. It will include summary statistics which acknowledge a range of values for physicochemical characteristics and constituency. The group will look at analytical approaches to evaluating petroleum hydrocarbon contaminated soils and document strengths and weaknesses of each approach. The report will be presented at a special session at the Ninth Annual Conference on Hydrocarbon Contaminated Soils to be held October 17-20, 1994 at the University of Massachusetts, Amherst. A state focused workshop is also planned for the conference with emphasis on successful implementation of alternative approaches. The conference will be advertised in upcoming issues of Soils magazine.

To date, the EPA has not proposed standards for soil remediation based on either TPH or surrogate compounds. For example, the EPA Underground Storage Tank program has decided not to develop federal guidelines for the cleanup of soils contaminated with fuels. The decision to implement specific guidelines has been left to the discretion of individual states. The EPA's Office of Solid Waste and Superfund Office has assembled a work group to develop a set of soil screening levels for 30 contaminants, including the BTEX (benzene, toluene, ethylbenzene and xylenes) compounds, to be used during investigation of sites on the National Priorities List. If a contaminant level

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at a site exceeds the screening level, further investigation and characterization of the site would be indicated.

States using criteria other than TPH are intended to be protective of groundwater quality while protecting human health. The overwhelming trend in establishing soil cleanup concentrations is to use quantitative, compound-specific, scientifically defensible methodologies. Quantitative human health risk assessment is playing an increasingly important role in the derivation of compound specific cleanup levels. Hawaii, Illinois, Michigan, New Jersey and New York, for example, do not regulate TPH. Massachusetts and Oregon are examples of states that use TPH only as screening levels, or to provide rough estimates of the degree of contamination. The group recognizes each state's importance in the standards setting process for petroleum contamination, and is partnering with several states in the evaluation process. A study was conducted for the U.S. Air Force, Armstrong Laboratory at Brooks Air Force Base in Texas through EA® Engineering Science and Technology, Inc., to examine potential substitutes for TPH at jet fuel contaminated Air Force installations. The objective of the study was to examine the scientific basis for potential use of compounds other than TPH to establish cleanup standards. The four BTEX compounds were chosen as potential surrogates to TPH for jet fuels. These compounds were selected as potential surrogates since they are associated with jet fuel spills, their environmental fate and transport is predictable, their toxicology is relatively well-characterized, and there is regulatory precedence to establish site-specific cleanups based on one or more components of BTEX. Of the BTEX compounds, benzene is the most significant from a human toxicity standpoint since its human carcinogenic endpoint has been studied extensively for multiple exposure routes. Definitive carcinogenic toxicity benchmark values have also been established for benzene carcinogenicity and the existence of recognized toxicity information makes benzene the substitute of choice for TPH to evaluate potential human health impact to jet fuels. In addition, benzene has a low molecular weight and is water soluble and therefore mobile, making it high risk to groundwater. The study includes an overview of state requirements and the basis and background of the TPH standards used by some states.

The group is chaired by Captain Wade Weisman of the Air Force. Other officers include William Kucharski, Louisiana Department of Environmental Quality, vice chair; Robert Wilkenfeld, Chevron Research, treasurer; Beth Plotkin, Friedman and Bruya, secretary.

The group's goal is to develop useful tools for the states and responsible parties to use to evaluate and remediate petroleum contaminated sites.

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June July 1994 Soils 7
Add steam, subtract cost

Steam injection speeds remediation

by Douglas Dieter

Steam injection and vacuum extraction (SIVE) enhances in situ remediation by injecting steam into the subsurface and forcing its flow to an extraction location. As it travels through the subsurface, it strips contaminants and causes underground temperatures to rise. This elevated temperature causes in situ fluid contaminant mass transfer and phase change rates to increase. Liquid viscosities are reduced and the desorption of contaminants from soil and aquifers is accelerated. The moisture and warmth provided by the underground steam injection also accelerates biodegradation of residual organic contaminants. Therefore, contaminants are pumped out or degraded at dramatically increased rates as compared to conventional isothermal vapor and liquid pump-and-treat systems.

At a 1.2 hectare hazardous waste treatment, storage and disposal facility in San Jose, Calif., soils were subjected to 20 years of drum and tank spills, as well as underground tank and conduit leakage. Since the working surface area initially had no surface covering of asphalt or concrete, and the underground tanks had no secondary containment or monitoring devices, the wastes seeped into the soil, and eventually into the shallow groundwater, located at about 6 meters depth. Thus, the soils and groundwater were contaminated with 25 detected Volatile Organic Compounds (VOCs), including chlorinated solvents, acetone, trichloroethylene, xylenes, methyl ethyl ketone, toluene and ethylbenzene.

Site investigation revealed a very low permeability clay layer consistently located about 6 meters below the general

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Douglas Dieter is principal of SIVE Services, Alamo, Calif.
working area at the site, which provides a virtual seal against the downward migration of water and contaminants. On the surface of this clay layer is a thin layer (0 to one meter) of low quality groundwater. The data suggested that about 95 percent of the soil contamination was concentrated within a .4 hectare working area, in the south-central part of the site, which had recently been paved over with concrete.

Investigators estimated that some 13,500 kilograms of the solvents were present in the 22,800 cubic meters of contaminated soils under the concrete pad area.

The first step in the cleanup was to dig three groundwater recovery trenches to surround the groundwater contamination plume and prevent further migration down the water gradient of the site. Groundwater in contact with and above the impermeable clay layer at the site drained into the trenches which were outfitted with pumps to remove the polluted water. A fixed-film, batch-type biotreatment plant was set up to treat the groundwater, then pump it to the cooling water circulation system of the facility, which included a small evaporative cooling tower from which water could be released periodically into the city sewer system by following a monitoring method prescribed by permit.

 solvents from the soils. But, like pump-and-treat, conventional soil vapor extraction isothermal processing would take a long time. The mass transfer rates of VOCs from their underground locations into the flow streams of the water and air being pumped out of the ground can be very low, especially when the VOCs are trapped, either by capillary forces, or in stagnant dead-end pore passageways, and low permeability zones that are bypassed by the mainstream flow.

So, the investigation turned to consider the feasibility of applying steam enhancement to reduce the amount of time necessary to decontaminate the site. The company was interested in speeding up the pace of the cleanup, not only to reduce costs, but also because they wanted to develop the site. Even though steam injection was experimental, there was little or no risk to the site with respect to contaminant extraction performance. If the injection of steam

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Steam, from page 9

proved to be ineffective, it could simply be discontinued, with relatively little effect on the operation of the pumping systems. Steam generation and condensing equipment was necessary to regenerate the activated carbon adsorption system being used with the vapor pumping system, so there was relatively little additional expense for larger equipment with the additional steam capacity necessary to operate both the injection system and the recovery system at the same time. The feasibility investigation results indicated that with the use of steam, VOC concentrations in the tested samples were reduced by at least two orders of magnitude.

As a pilot test, six steam injection wells were installed at the site, each 600 millimeters in diameter and 5 meters deep. They were spaced at 1.5 meter intervals around a centralized, 6.6 meter deep vacuum recovery well. They

Figure two

were spaced so closely because the wells were installed simply as a test to check the ability of steam to be injected and flow horizontally through the soil without interrupting normal industrial activity at the site. The steam generation, condensing and wastewater treatment facilities already in place on the site were used for the test wells. Monitoring instruments verified that via steam and air flow, about 315 kilograms of VOCs were extracted in a six day test. On this basis, a full scale system was installed, with nine vacuum extraction wells and 16 steam injection wells, as in figure one, page 9, to target the contamination under the concrete pad. The wells were laid out in a five-spot pattern, whereby four injection wells surrounded each of the eight extraction wells. After drilling the 330 millimeter extractions wells, and the 230 millimeter steam injection wells, wire-wrapped steel casings were lowered into place. Pea gravel was poured into the space between the open interval and the casing, and sealed with

Continues on page 12 →
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bentonite pellets. Concrete was poured in from the surface to seal the wells and secure the casings.

The extractions wells were open to the full thickness of the soil, from the surface to about .6 meter below the clay layer, providing for contaminant extraction from the entire unsaturated soil layer as well as liquid drainage from the surface of the clay layer. The concrete pad, along with some additional concrete and polyethylene cover, supplied an impermeable surface barrier to eliminate short-circuiting of air flow in the extractions, and prevent steam escape to the surface. The steam injection wells were open from 3 to 4.5 meters of depth to allow for condensate drainage, as well as to allow for steam injection above atmospheric pressure.

The steam generation and solvent recovery equipment was mounted on a 14 meter flamed trailer. The equipment included a 150 horsepower steam boiler, a cooling tower, two 675 kilogram activated carbon filters, a 60 cubic meter per minute blower, 25 horsepower air compressor, and a 12 square meter shell and tube steam condenser.

Based on the number and sizes of the wells, the permeability of the soil—about 10 Darcys, as determined from the pilot test—and the design wellhead pressures, the flow rates to be expected were calculated using Darcy's Law. Steam flow was expected to be about 90 kilograms per hour, a total for all injection wells of 1,440 kilograms per hour. Using the calculated flow rate for steam, it would take about 1,000 hours to heat the 22,800 cubic meters of soil to steam temperature.

Each injection and recovery well had a differential-pressure type flowmeter installed in-line for air and steam flow rate metering, and ports were used for temperature and pressure measurements. Using factory-supplied calibration curves for the meters, and correcting for temperature and pressure, the instantaneous flow of steam into, and air/vapor mixture out of, each well was calculated. Injection and extraction pressures were set and maintained with regulating valves.
Total steam flow was monitored with a boiler feedwater meter to verify the sum of the individual steam flow meter readings. The factory-supplied blower flow calibration curve was used as a check on the sum of the individual air flow meter readings.

The process waste liquids were monitored using totalizing flowmeters in the first drip leg (V1) as shown in figure two, page 10, the second drip leg (V2), and the recovery tank (V3) exit lines. Liquids generated by the activated carbon steam regeneration cycle (Vr), were calculated by multiplying the number of regeneration cycles by the amount of liquid produced per cycle. Thus, the amounts of liquids produced by entrainment in the vapor flow, the amounts by the submersible pumps, and the amounts by condensing vapors at the surface could be determined. The amount of non-aqueous phase liquid was monitored by observing the percentage in the separation tank.

The main vacuum line was fitted with a septum port to allow for noncondensable vapor sampling. The condensate drip leg was fitted with a tap for liquid sampling. Liquid samples were also taken from the separation tank after removing liquids associated with the carbon regeneration cycle. Extraction wells were fitted with septum ports for sampling of vapors, and were fitted with taps for liquid

Continues on page 14 →

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Operating costs of SIVE vs. Iso-pumping at SSI

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Figure four
Steam, from page 13

sampling in order to determine VOC rates from the individual wells.

A gas chromatograph using flame-ionization detection was used on site, and samples were injected into it for VOC analysis immediately after retrieval. Figure three, page 12, shows the total mass of VOCs extracted at the site as a function of vacuum operation time. The total mass includes VOCs extracted via liquids—pumped, entrained and condensed vapors—as well as via the noncondensible vapors. In 10,000 hours of operation, 31,500 kilograms of VOCs were extracted from the site, more than twice the original estimate.

The amount of steam injected is also shown in figure three. Steam was injected in three intervals of the operational time. The first injection period, from 592 to 711 hours, was just to check the steam equipment and delivery system. Elevated extraction well temperatures were first noted at about the 2,100 hour mark while injecting during the second steaming period, which began at 1,891 hours and discontinued at 2,175 hours.

Extraction well temperatures were elevated during the third steaming period also, which took place from 3,390 to 4,647 hours. Extraction fluid temperatures as high as 60°C were noted at some wells during the last steaming stage. Total steam injected at the site during the 10,000 hours of operation was about 1,260,000 kilograms.

About 760,000 liters of liquids were extracted by the system. If the amount of liquid that would have been extracted in the 10,000 hours with no steam injection of about 133,000 liters is deducted from the total liquids extracted, 50 percent of the condensed equivalent of the injected steam was recovered.

It is estimated that conventional vapor extraction, without steam injection, would have taken at least 19,000 hours to recover the 31,500 kilograms of VOCs. The only significant additional expense for SIVE installation is the labor and material costs for installation of the steam injection wells, which was about 35 percent of the total installation cost at this site. Figure four, page 13, compares operating expenses for conventional vapor extraction with a steam injection system using 100 as the arbitrary number for the labor rate. As shown, the amount of labor required for operational supervision, maintenance and repairs is about the same for both systems on an hourly basis. Energy rate requirements for operating the SIVE system are about 50 percent higher than for iso-pumping alone because of the extra fuel required for the injected steam. The rate of wastewater production was about 5.5 times higher during steam injection so the total operating cost rate of SIVE was about two times the rate of operating the pumping system alone. So, even though installation and operating costs are higher for SIVE, overall costs are less due to reduced operating time.
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STEP into the LABORATORY

How labs test samples for bioremediation feasibility

By Sally Crane

Since bioremediation processes take place on microscopic levels, any bioremediation project involves a large number of laboratory tests and results to assess feasibility, and design the treatment scheme. Here’s a rundown of some of the kinds of tests, their purpose, and what the results mean.

In general, there are three steps in a study to determine the feasibility of bioremediation for a specific site—establish viability, identify the players, and determine their abilities.

The first step, to establish viability, is accomplished with a Total Heterotrophic Plate Count (TPC).

Sally Crane is director of client services for Microbe Inotech Labs Inc., St. Louis, Mo.

Within 20 minutes of the arrival of the soil or water sample from the site, a precise amount of the sample (1 gram of soil or 1 milliliter of water) is measured and placed in 9 milliliters of sterile water. From this, four or five serial dilutions are taken to get the bacterial populations down to a countable number. One tenth of a milliliter of each dilution is spread on a Petri plate of TriptYcase Soy Agar. The plates are incubated at 30°C for 24 hours. After 24 hours, the bacteria on the plate have reproduced to form colonies, which can be seen with the naked eye. The colonies are counted, and the results recorded in scientific notation. The plates are returned to the incubator for another 24 hours, and counted again. It is at this 48 hour point that the colonies have differentiated, and each has a distinct morphology in terms of color, size, shape and texture. The number of distinct colony types or strains can be recorded at this point. The results of the TPC are reported as a number of Colony Forming Units (CFUs) per gram or milliliter. This number is the
average of the number of colonies read on each plate of the dilution series, and refers to the number of carbon-using (heterotrophic) bacteria present in the gram of soil or milliliter of water. One CFU is equal to one bacterium in the original sample, and is an indicator of how lively, or viable the site is, and how much work will need to be done to bring the site to optimal conditions.

As stated above, the TPC tells the number of different strains of bacteria in the sample, the diversity of the population. A strain is a unique member of a species of bacteria. Strains within a species have different abilities. For example, 80 percent of Pseudomonas fluorescens bacteria are recognized as degraders of hydrocarbons. If the sample contains a fairly diverse, indigenous population, it probably contains some strains that are already successful at using the target contaminant. While each strain in a species has unique characteristics, it will have the same requirements for nutrients, air, temperature and water as all the other members of that species. This leads to the importance of indentifying the strains in the indigenous population.

The two most precise methods to identify environmental bacteria are Gas Chromatography Fatty Acid Methyl Ester (GC-FAME) and the Biolog™ Microplate System. It is possible to test for specific, common bacteria, such as coliforms, by plating a sample on a growth medium that selects for that organism. It is almost impossible to identify all bacteria with biochemical, morphological or toxigenic parameters, since there are 3,000 bacteria named and recognized by taxonomic oversight committees, and another 9,000 named, but not recognized. The GC-FAME database (version 3.8) can identify to genus and species level over 2,400 officially recognized bacteria. The Biolog™ (version 3.5) system can identify over 1,200 species of bacteria. The two technologies provide an automatic cross check for identification.

The GC-FAME system at Microbe Intech Laboratories, Inc., St. Louis, Mo., is composed of a sophisticated chromatographic system with an integrated computer system. At its most basic, the GC-FAME system identifies to genus and species, bacteria by the fatty acid composition profile of the organism. All organisms have a unique fatty acid profile. This profile of a bacterium from a site sample is compared to that of the reference strains in the system’s database library. In order to read the fatty acids of a particular bacterium, each isolated strain must go through a five-step chemical process to remove the fatty acids from the cells and suspend them in a hexane base. This suspension is injected into a long, hair thin tube in the gas chromatograph. The larger the fatty acids’ carbon chain, the longer it takes to get through the

Continues on page 62

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tube. At the end of the tube, a flame detects the fatty acids and records how long each took to get through the tube, and its concentration. Each time a fatty acid is detected, a peak is recorded on a chromatogram. By comparing the fatty acid retention times and concentrations to the database, the system identifies the bacteria.

The identification is reported as a name, with a Similarity and Distance coefficient. In order to create the database library, thousands of species of bacteria had to be tested. In fact, each species was tested hundreds of times to determine the set of characteristics unique to each species. The species characteristics that are in the database are an average of the characteristics of hundreds of tested bacteria of the same species. So, the Similarity and Distance coefficient of a particular organism refers to the similarity and distance from the hypothetical mean organism in the database. The hypothetical database organism has a similarity coefficient of one, and a distance coefficient of zero. So, the closer a strain’s coefficients are to one and zero, the more closely it matches the mean organism in the database. A good match is one with a similarity coefficient greater than .5, and a distance coefficient of less than 7.

The Biolog™ system identifies bacteria by characterizing it according to the carbon sources it can metabolize. The test uses a 96 well microtiter plate that contains 95 different carbon food sources, and a tetrazolium dye that turns purple when the bacterial strain consumes the carbon source. The plate is inoculated with an isolated bacterial strain suspended in sterile saline. It is incubated for 24 hours at 30°C. During this time, the bacterial strain tries to consume the different carbon sources in each well. The strain will be able to use some and not others. If the strain can use the carbon source in a well, the well turns purple. This creates a pattern of purple and clear dots as in the photo on page 60. Since the location of the individual carbon sources is fixed and standardized, the pattern of purple dots is unique to the bacterial species.

At the end of the 24 hours, the optical densities of the wells are read by an automated microplate reader which compares the dot pattern of the sample strain to the database of patterns of hypothetical organisms. As with the GC-FAME, the identification is reported by name with a similarity and distance coefficient.

The microtiter plate technology can also be used as a rapid test for individual strain’s ability to use a specified hydrocarbon. Unlike the microtiter plates that have 95 fixed carbon sources and one strain, the End-Point Assay microtiter plate is customized to contain only the target carbon sources added for a particular site, and a maximum of eight individual bacterial strains. Each test is designed with negative control, positive control, and unknown wells. After the plate is inoculated, it is incubated for 24 hours at 30°C, and read with an automated micro plate reader. Like the identification tests, the wells turn purple when the bacterial strain consumes the carbon source—in this case, a hydrocarbon contaminant. The automated reader determines the intensity of the color changes in each well. The darker the dye color, the more the carbon source was used by the bacterial strain.

Comparing the success of the strain’s growth to the positive and negative controls is an indication of how well the strain can degrade a contaminant under ideal conditions.

This information, along with the identity of the bacteria strain, is sufficient to begin to tailor specific enhancement methods for the site—particularly which nutrients are needed by the best degrader.

These tests not only allow for efficient planning and setup of a bioremediation site, they can also be used to monitor progress once the project is underway. Total Plate Count tests at regular intervals monitor the populations at the site as they change over time. At the completion of the project it may be advisable to again identify the bacteria at the site to assure regulatory agencies that no pathogenic species have moved in as
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Write in 084

84 June July 1994 Soils
Directory of government agencies

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617-565-3420

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26 Federal Plaza
New York, NY 10278
212-264-2657

Region 3
841 Chestnut St.
Philadelphia, PA 19107
215-597-9800

Region 4
345 Courtland St., N.E.
Atlanta, GA 30365
404-347-4727

Region 5
220 S. Dearborn
Chicago, IL 60604
312-353-2000

Region 6
1455 Ross Ave., 12th Floor, Ste. 1200
Dallas, TX 75270
214-655-6444

Region 7
726 Minnesota Ave.
Kansas City, KS 66101
913-551-7000

Region 8
1 Denver Pl., 999 18th St., Ste. 1300
Denver, CO 80202
303-293-1603

Region 9
75 Hawthorne St.
San Francisco, CA 94105
415-744-1305

Region 10
1200 6th Ave.
Seattle, WA 98101
206-553-4973

OTHER FEDERAL AGENCIES

Department of Agriculture
Agricultural Research Services
Facilities Division
Safety, Health and Environmental Mgt.
6303 Ivy Ln.

Greerbelt, MD 20770
301-344-0218

Department of Commerce
Office of Management Support
Environmental Safety and Compliance Room: 6020

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Write in 104

June July 1994 Soils 85
STATE AGENCIES

Phone numbers given are contact points for underground storage tank regulations:

Alabama Department of Environmental Management
205-270-5613

Alaska Department of Environmental Conservation
907-465-5200

Arizona Department of Environmental Quality
602-207-4228

Arkansas Department of Pollution Control and Ecology
501-562-6533

California State Water Resources, Central Board
916-227-4337

Colorado Department of Health
303-692-3330

Connecticut Department of Environmental Protection
203-566-5599

Delaware Department of Natural Resources and Environmental Control
302-323-4588

Florida Department of Environmental Protection
904-488-0190

Georgia Department of Natural Resources
404-362-2687

Hawaii Department of Health, Underground Storage Tank Division
808-586-4225

Idaho Division of Environmental Quality
208-334-5860

Illinois Environmental Protection Agency
217-782-6761

Indiana Department of Environmental Management
317-232-8603

Iowa Department of Natural Resources
515-281-8957

Kansas Department of Health & Environment
913-296-1684

Kentucky Division of Waste Management
502-564-6716

Louisiana Department of Environmental Quality
504-765-0741

Maine Department of Environmental Protection
207-289-2651

Maryland Department of the Environment
410-631-3442

Massachusetts Department of Environmental Protection
617-935-2160

Michigan Department of Natural Resources, Environmental Response Division
517-373-8168

Minnesota Pollution Control
612-297-8594

Mississippi Department of Environmental Quality
601-939-8460

Missouri Department of Natural Resources
816-795-8655

Montana Department of Health and Environmental Sciences
406-444-5970

Nebraska Department of Environmental Quality
402-471-4230

Nevada Department of Conservation and Natural Resources
702-687-5872
New Hampshire Department of Environmental Services
603-271-3503

New Jersey Department of Environmental Protection
609-984-3156

New Mexico Environmental Department
505-827-0079

New York Department of Environmental Conservation
518-457-9412

North Carolina Department of Environmental Management
919-733-1320

North Dakota Department of Health
701-221-5166

Ohio Department of Commerce
614-752-7941

Oklahoma Corporation Commission,
Underground Storage Tank Program
405-521-3107

Oregon Department of Environmental Quality
503-229-6764

Pennsylvania Department of Environmental Resources
717-772-5835

Rhode Island Department of Environmental Management
401-277-2234

South Carolina Department of Health & Environmental Control
803-734-5331

South Dakota Department of Environmental and Natural Resources
605-773-3296

Tennessee Department of Environment and Conservation
615-741-4081

Texas Natural Resource Commission
512-908-2247

Utah Department of Environmental Quality
801-536-4100

Vermont Agency of Environmental Conservation
802-241-3888

Virginia Water Central Board
804-527-5188

Washington Department of Ecology
206-459-6000

West Virginia Department of Natural Resources
304-558-6371

Wisconsin Department of Natural Resources
608-267-7560

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June July 1994 Soils 87
What is soil?

Soil scientist reveals fascinating facts about complex element

By Alfred Conklin, Jr., Ph.D.

Soil is one of the most complex components of the ecosystem. This makes it the hardest to describe, analyze, control and change. Why is it so complex? For that matter, what is soil?

An engineer friend of mine defines soil as anything he can move with a bulldozer. Contrast this with the soil scientist definition of soil as a natural body which results from the action of soil forming factors on the loose material covering the earth’s surface. Soil forming factors are time, parent material, topography, climate and vegetation. For the engineer, then, the soil would include some rather large rocks. But for the soil scientist, it would be restricted to sand, silt and clay. The soil scientist considers rocks and gravel as a part of soil, but these materials are not good for growing plants, and so are not as important as sand, silt and clay.

From an environmental standpoint, silt and clay are physically and chemically more reactive and are therefore more important than rocks, gravel and sand.

When defining soil, there are also the concepts of the regolith, solum and the vadose zone to consider. The regolith is defined as the loose material over the bedrock.

The solum is the volume of the soil which contains the genetic horizons. The vadose zone is the unsaturated portion of the regolith—the loose material above the bedrock and above the groundwater table.

The soil forming factors lead to the development of horizons in the soil, which are significantly different from layers deposited by wind, water or ice. There are three basic soil horizons. The A horizon, which is on the surface, is dark in color and high in organic matter content. This is the one we try not to spill contaminants on, and try to save for farming.

The B horizon is higher in clay content, and reddish in color. This horizon often restricts water movement through the soil. And the C horizon is the deeper material which has not yet been acted upon by the soil forming factors.

The A and B horizons are very different from the material from which the soil is forming. The organic matter, clay minerals and physical characteristics have been changed so that they no longer have the characteristics of the parent material or of ground rock. Figure one illustrates the arrangement of soil particles. Sand silt and clay particles are cemented together to form a unit, called a soil ped. The physical characteristics, particularly air and water movement, of soil are greatly affected by the stability of these units. A soil with strong, well-formed peds has higher air and
“Soil in the natural state resists physical, chemical and biological change. Once a soil is contaminated and thus changed, restoring it is very hard to do.”

Water movement through it than would otherwise be expected. In most cases, good ped structure will make cleanup of contaminated soils easier.

Chemistry and biology in soil are significantly different and more complex than chemistry and biology in the laboratory. The soil is made up of solids, liquids and gases. The solids are living, organic and inorganic—and changing all the time. Even the inorganic component, called the matrix, changes. New clays form, rock dissolves, and so on. The liquid, called the soil solution, consists of gases and organic and inorganic compounds, ions, and elements dissolved in water. Soil has yet another characteristic which is very important when considering pollution. It is highly buffered. Chemists have a precise definition for this term. Here, we only need to know that buffering in soil means that it resists change. Soil in the natural state resists physical, chemical and biological change. The addition of 100 metric tons of sand to 2 hectares of soil has little effect on its texture. Two metric tons of lime added to soil has a small effect on its pH. Add microorganisms to soil, and they disappear very rapidly. It is also important to remember that the reverse is also true. Once a soil is contaminated and thus changed, restoring it to the way it was is very hard to do. The longer soil has been contaminated, the harder it is to decontaminate.

The gaseous phase, called soil air, consists of oxygen, nitrogen, carbon dioxide, water vapor and argon. The soil air would appear to be similar to atmospheric air. And it is, except that its oxygen content is lower, and the carbon dioxide and water vapor content higher than the atmosphere. In addition, it is common to find small amounts of methane and nitroge oxides in soil air. So, even the gaseous phase of soil is not simple.

Although it contains oxygen, both oxidized and reduced compounds and environments are found in even small samples of unsaturated soil. Because of this, all soil contains both aerobic and anaerobic microorganisms. The variety of microorganisms in soil seems to be limitless. Aerobic, anaerobic, phototropic and lithotropic microorganisms abound. Bacilli, cocci, fungi, algae and microscopic animals, as well as larger plants and animals are always present in this most complex element under our feet.

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Enviroscan hits the road

Enviroscan Corp., Rothschild, Wis., expands its field sampling and field screening services with a new mobile laboratory system. It contains a Geoprobe hydraulic probe driving unit to collect subsurface samples. The unit penetrates asphalt, concrete and frozen earth. It is also equipped with the Geoprobe large bore sampler to collect discrete soil samples. The lab contains a temperature programmable gas chromatograph to screen soil and groundwater by the manual static headspace method. Write in 620 for more information.

Monitor measures up to five vapors

The new microprocessor controlled Multipoint Area Monitoring System, from Environmental Monitor Systems Inc., Houston, Texas, can measure up to five gases and vapors at up to 24 remote locations, says the company. It monitors and records air quality from sub ppm to percent concentration levels at contaminated sites. Write in 619 for more information.

Process recycles contaminated soil

Seaview Thermal Systems, Blue Bell, Pa., says their HT-6 Thermal Distillation process recycles hydrocarbon contaminated soils and purifies them for reuse as a mixed blend of oil, distilled water and residential-grade soil. The first commercial application of the technology is underway at a contaminated gas plant site in Paterson, N.J., to recycle more than 90,000 metric tons of soil in the next two years. Write in 623 for more information.

Airlock gate takes the heat

Thermal process airlock gate valves from Plattco Corp., Plattsburgh, N.Y., provide a non-wearing airlock seal for incineration, thermal desorption and air pollution applications at temperatures up to 870°C, says the company. Non-wearing seal prevents blowback, and is a solution to rotary feeders misapplied as airlocks for feed and discharge control. Write in 622 for more information.

New plastics help containment

Gundle Plastics, Houston, Texas, offers prefabricated systems for primary and secondary containment. Prefabricated pipe sections, manholes, sumps and bootless pipes can be customized to fit virtually any application. Custom size sheet panels of any Gundle lining material can be made to order up to 60 meters square. Write in 621 for more information.

Give a GC a brain

SRI Instruments, Torrance, Calif., says their PeakSimple II Serial Data System for HPLC and GC will control a GC, acquire, integrate and analyze up to four channels of data. The system connects to the serial port of any IBM compatible PC, and eliminates the need for a computer equipped with expansion slots. Write in 624 for more information.
New sampler is built to last

The new Terraprobe sampling system from Geoguard Inc., Medina, N.Y., samples soil, gas and groundwater to depths of 91 meters with only one or two operators. The probes are nickel plated with case hardened alloy steel shafts to withstand repeated use, says the company. Write in 625 for more information.

Say cheese

Photovac Inc., Markham, Ontario, introduces the intrinsically safe version SnapShot hand held photoionization gas chromatograph to measure toxic gases and vapors. Interchangeable modules allow for detection of individual or multiple target chemicals and contain the proper column, isothermal oven, methodology, software and libraries, says the company. The unit can be left unattended and data can be downloaded directly to a printer or computer. Write in 626 for more information.

Monitor exhaust gases

The new dual gas analyzer from Columbus Instruments, Columbus, Ohio, is designed to monitor exhaust gases from fermenters and bioreactors. It measures oxygen by a temperature and pressure-stabilized fuel cell, and carbon dioxide with infrared spectroscopy. The sensor can operate in a narrow range of gas concentrations around a set point with resolution of .001 percent, says the company. Write in 627 for more information.

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June July 1994 Soils 91
What’s new

- The 44th annual convention of the Petroleum Equipment Institute will be held October 12-14 at the Atlanta World Congress Center, Atlanta, Ga. The convention features the world’s largest exhibition of equipment used in petroleum marketing operations. The 576 booths will include underground and aboveground storage tanks, dispensing equipment, leak detection equipment and more. For more information, call PEI at 918-494-9696.

- Donley Technology, Garrisonville, Va., announces a 50-page report on distributors of environmental health and safety electronic code books. Electronic code books store regulatory information on diskettes, CD-ROM or online systems. The report costs $89, and may be ordered by calling Donley at 703-659-1954.

- Petroleum Environmental Services Inc., San Antonio, Texas, announces it has taken over marketing for PES 31®, the biotreatment product for hydrocarbon products, and PES 51®, an all-natural petroleum hydrocarbon cleaner used last summer for additional cleanup on the Exxon Valdez spill in Alaska. For more information call PES at 512-680-2950.

- A model report, designed for use with the ASTM Standard E 1527-93, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, has been published by ASFE: Professional Firms Practicing in the Geosciences. It is available for $37.50 or on disk in WordPerfect 5.1 for $40. To order, call ASFE at 301-565-2733.

- Dan Kaplan, president of Hertz Equipment Rental Corp., Park Ridge, N.J. has written a book, Service Success: Lessons from a Leader on How to Turn Around a Service Business, which focuses on performance measurement, productivity and customer satisfaction for service-oriented firms. The book costs $24.95, is in stores, or may be purchased by calling 1-800-CALL WILEY.

- EnviroProducts Inc., Lassung, Mich., is named Michigan’s exclusive distributor for Longyear’s line of Brainard Kilman well supplies. The line features TriLoc®, CircumSlot™ and Flush Threaded PVC. For more information contact Enviro Products at 517-887-1222.

- Geo-Con Inc., Monroeville, Pa., will help construct a deep barrier wall around the MCTCO Superfund Site in LaMarque, Texas to separate the contaminated groundwater plume from surrounding groundwater. The wall will be 1.6 kilometers long and 15 meters deep. For more information, call Geo-Con at 412-856-7700.

- Clean Soil Inc., West Columbia, S.C. announces it will work with BEC/Allwaste of Birmingham, Ala., to remediate hazardous waste sites with the Clean Soil unit. For more information, call Clean Soil at 803-699-0413.

Detector finds line leaks

Red Jacket Petroleum Equipment, Mission, Kan., introduces mechanical leak detectors to enable tank owners to perform the fastest EPA required, three-gallon-per-hour test for underground line leaks. Model FX2 operates with the pump running, eliminating costly shutdown for annual leak detector testing. Snap-Tap connectors allow testing without spilling product. The series is third-party approved for up to 212 meters of 76 millimeter pipe.

Write in 629 for more information

Pugmill shreds, screens, mixes

Portec Construction Equipment, Yankton, S.D., says their Kolberg Series 55 portable pugmill plant combines features of a shredder, screening plant and pugmill mixer all on a single highway portable chassis. The 7 cubic meter grizzly hopper has a variable speed belt feeder, a mill type shredder and 8 meter long product delivery conveyor with hydraulic powerfold for travel. Units are available with both liquid and dry additive injection systems.

Write in 628 for more information
Here's a lot to learn
Courses and training programs

- **Environmental Education Enterprises, 800-792-0005**
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  Concepts, Models and Case Studies in Contaminant Hydrogeology, $1,250, June 27-July 1, Las Vegas, Nev.
  Aeration Technologies for Soil and Groundwater Remediation, $750, June 29-July 1, Las Vegas, Nev.
  Design of Groundwater Contaminant Capture Systems, $1,450, July 11-14, Chicago, Ill.
  Environmental Site Assessments and Audits, $700, July 20-22, Nashville, Tenn.
  Treating Groundwater Contaminants, $700, July 20-22, Nashville, Tenn.
  Practical Karst Hydrogeology and Groundwater Modeling, $850, Aug. 2-5, Cave City, Ky.
  Geochemical Processes in Groundwater Movement, $850, Aug. 16-19, Albuquerque, N.M.

- **Georgia Tech Research Institute, 404-894-7430**
  Environmental Audits and Site Assessment, $795, Aug. 15-19 and Oct. 31-Nov. 4
  Management of Underground Storage Tank Systems, $795, Oct. 10-14
  Georgia Institute of Technology, Atlanta, Ga.

- **Texas Engineering Extension Service, 409-845-3418**
  Phase I Environmental Site Assessment, $595, July 18-21 in San Antonio, Oct. 17-21 in Bryan
  Environmental Site Assessment Update, $195, July 26 in Austin, Sept. 13 in San Antonio
  Environmental Sampling Investigation/Phase II ESA, $695, Aug. 1-4 in Bryan
  Remediation Technologies/Phase III ESA, $595, Sept. 20-22 in Bryan

- **University of Wisconsin-Madison, 800-462-0876**
  Managing Uncertainty and Decision Making for Site Remediation, $795, July 18-20, Seattle, Wash.
  Liquid Storage Tank Technology, $895, July 25-28, Madison, Wis.
  Cathodic Protection Design, $995, July 11-15, Madison

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Independence, MO 64053

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Write in 001

June July 1994 Soils 93
Analyzer measures up to lab test
Hydrocarbon analyzer provides real time information

FIC Environmental Inc., Las Vegas, Nev., conducted a series of field tests at an inactive underground storage tank site in Las Vegas to demonstrate that their Petrosense™ Portable Hydrocarbon Analyzer can accurately measure dissolved hydrocarbons in situ, and provide real-time information.

The measurements taken by the analyzer were compared to a gas chromatographic analysis performed by an independent commercial laboratory in accordance with EPA standard methods and procedures. Converse Environmental Consultants Southwest, a Las Vegas firm, participated in the initial comparative sampling phase of the field test as an independent third party. Well purging, sample collection and transportation of samples the lab on the first day of the testing were all handled by Converse staff. All subsequent samples were handled by FCI personnel.

The analyzer was calibrated with a certified p-xylene standard solution from Radian Corp. All measurements of dissolved hydrocarbons are expressed in terms of p-xylene equivalency. The relative responses for other aromatic hydrocarbons are shown in figure one.

In situ measurement of pre-purged water from well three with the analyzer showed 112.3 ppm total hydrocarbons, based on p-xylene equivalency, at a well depth of approximately 4.25 meters. After purging the well, at three well volumes of about 25 liters using a standard bailer, a 3.8 liter sample was removed for analysis by EPA Method 8015M. The bailer was lowered into well three a total of 15 times to collect the 3.8 liter sample. The 15th bailer sample was also used to fill four, 40 ml vials for analysis by EPA Method 624, BTEX and purge and trap TPH.

The analyzer was used to measure the hydrocarbon level in five different bailer samples. Figure two shows that the TPH concentrations measured in situ were different each time, and clearly showed a decreasing trend in the process of collecting the 3.8 liter sample. Figure two also shows results from Nevada Environmental Laboratory, and the close correlation with the analyzer measurements. For example, an averaged reading of 44.3 ppm by the analyzer corresponds to 48 ppm reported by EPA Method 8015M, while the 38.1 ppm measurement corresponds to 44 ppm TPH measured by EPA Method 624 purge and trap.

The next phase of the testing was to measure the recovery rate of the level of hydrocarbon concentration after purging of well three. The PetroSease™ hydrocarbon probe was placed inside a bailer and lowered into well three where in situ measurements were taken and samples collected for TPH analysis at Nevada Environmental Laboratory by EPA Method 624. Figure three summarizes the results. The analyzer measured dissolved hydrocarbons in terms of p-xylene equivalency with a high correlation to EPA lab methods, and provided real-time information about the changing dynamics of the well.

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Write in 458
Keep regulators in the loop
Ongoing communication expedites cleanup

A site owner in a hurry—usually when the race is on, its time against money. In this case, the combination of a proven technology with an experienced consultant with key regulatory agency contacts, helped everyone emerge a winner.
A real estate owner needed to refinance his strip mall in order to proceed with a multi-million dollar deal. But, in a property transfer bank audit to assess the refinancing, investigators discovered silty and clayey soils beneath a dry cleaning

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By James Reed, R.G., R.E.A.

James Reed, R.G., R.E.A. is project manager for Vapor Extraction Technology, Inc., San Clemente, Calif.

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Preliminary conference programs and registration materials will be available in September of 1994. Limited exhibition space is available.

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store in the mall were contaminated with up to 6,700 mg/kg perchloroethylene, as deep as 10.6 meters. Obviously, the bank halted progress on the refinancing until they received confirmation from regulatory agencies that the site was clean and closed.

The real estate developer asked Vapor Extraction Technologies, Inc., San Clemente, Calif., to remediate the site within three months. VET immediately mobilized to the site with a pre-permitted vapor extraction system and performed a feasibility test. The test showed favorable vapor permeability, radii of influence and contaminant vapor concentrations that matched adsorbed-phase contaminants. Both the state and county regulatory agencies were informed of site conditions and the cleanup plan.

While the regulators were considering the plan, VET staff requested and received verbal authorization to begin installation of the system. Wells were literally added to the operating system as they were installed. Infill wells were installed approximately each month during the extraction to sample soil and monitor the cleanup and assess the extent of the plume. With the general cooperation of the proprietor of the dry cleaning store, various sections of the operating cleaner floor were cleared for indoor drilling.

Each month, simplified and condensed plume maps, cross-sections and vapor extraction operating charts were sent by fax to the regulators so they could help in the decision-making process, and be current with the cleanup progress.

Vapor extraction continued for approximately nine weeks. Final verification borings, and the collection and analysis of 87 samples indicated that the soil was remediated to nondetectable levels of perchloroethylene—less than .005 mg/kg.

VET presented a final report to the regulators in a short question-and-answer meeting. Because the regulators had updates throughout the cleanup, they were able to write immediate closure letters. Before the ink could dry on the closure letters, the real estate owner whisked them to the bank, which promptly funded the refinancing deal.

In the end, several hundred kilograms of perchloroethylene were recovered with minimal site disruption. The total assessment and cleanup cost was less than $90,000. The key lesson: involve regulators early and keep them posted.

Write in 615 for more information

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For more information on the revolutionary dual-detector TVA 1000, phone toll-free: 1-800-521-0451. The Foxboro Company, Foxboro, MA 02035.
It's called, "the lasagna process." It's creative and innovative—and very promising. It's a recipe for remediation deep in the subsurface in difficult, impermeable soils.

The Lasagna Project began in January 1993, when Monsanto proposed to the EPA’s Remediation Technology Development Forum that a joint effort be initiated to advance a novel method to clean up clays and silty soils with very low water permeability.

When a spill occurs, if the soil near the surface is relatively permeable, such as soils with high sand content, the liquid percolates down into the soil depths until it is either adsorbed or trapped in the soil or reaches the water table. If the liquid is denser than water and is relatively insoluble in water, it will continue its downward flow until it becomes adsorbed or reaches an impermeable layer of clay or heavy silty material. The dense liquid pools on the surface of the clay layer to form a Dense Non-Aqueous Phase Liquid (DNAPL).

Frequently, the DNAPL finds cracks and fissures in the clay layers and continues its downward flow, slowly working its way into the clay pores and adsorbing on the surface of the clay.

Unfortunately, deep contamination in relatively impermeable clay layers may not be easily treatable by air or steam stripping, sparging, bioremediation, soil flushing or other such methods. Pump and treat methods may treat the groundwater, but residual contamination in the clayey layers slowly leaches out and recontaminates the water.

The Lasagna process merges several well known technologies into a treatment system to provide in situ treatment of contaminated clayey soils at any depth. The Monsanto approach involves three basic components. First is a method to force contaminants out of the microscopic pores in the clayey and silty regions of the soil so they cannot continue to leach into groundwater. The second component is the introduction of in situ sorption or degradation zones in the soil so that the contaminants do not have to be brought to the surface for treatment after they were forced out of the clay. The third component is to treat contaminants within the newly created treatment zones by introducing appropriate materials—such as sorbents, catalytic agents, microbes, oxidants or buffers.

To force the contaminants out of the pores, the system uses electrokinetic technology. Clay soils generally contain very small particles, tightly packed together. The pores between the particles are very small, and the pressure gradient required to force water through the pores is extremely high, since the pressure required increases exponentially as the pore size decreases. That is why clay makes an excellent lining for holding ponds. If the clay liner contains no breaks, water can sit on in for long periods of time without leaking through. Conversely, once clay has become saturated with water, it is very difficult to dry it out, since water diffuses through it so slowly. Electroosmosis relies on the fact that clay particles tend to be negatively charged in soil.

Water present in the small pores between the clay particles generally contains some charged ions, and the positive ions in the water are attracted to the negative surface of the clay. This forms a layer of positive ions on the surface of the water droplets. If a direct current electric field is applied to the soil, this layer of positive ions begins to migrate toward the cathode and drag the rest of the water droplet with it. The result is that water begins to move through the clay toward the cathode. And, in contrast to the use of pressure to force water out of the clay, movement of water by electroosmosis is virtually independent of the pore size between the clay particles. This phenomena was recognized by the German scientist Casagrande in the 1930s, and has been successfully used by civil engineers to dewater earthen dams and roadbeds. Application involves inserting electrodes into the soil on either side of the soil to be decontaminated, then applying direct current voltage of about 1 volt per centimeter. The water slowly moves toward the cathode at a rate of
about 25 mm per day. If the soil is relatively non-conductive, the current flow is quite low. For example, the cost for electricity to dewater a metric ton of clay would be about $3.00 with present electricity costs. Workers at MIT, Louisiana State University and elsewhere have been developing technology to use electroosmosis to pump contaminated water through dense soils and remove it at the cathode for surface treatment. (See “Clean up with kilowatts,” Soils, October 1993, page 38.) The goal of the Lasagna project is to avoid the problems of surface treatment by introducing treatment zones into the subsurface.

The reasoning is that if contaminants can be moved by electroosmosis into treatment zones, they won’t have to be moved all the way to the cathode and then brought to the surface for treatment.

Hydraulic fracturing (See “Crack the case wide open,” Soils, May 1994, page 28.) has long been used in the oil and gas industries to create porous zones in deep formations to enhance the extraction of oil and gas. Water slurry is injected into the area to be fractured. In over-consolidated soils, the pressure of the water being injected causes a horizontal, pancake-shaped fracture to form. The water slurry being injected contains sand, which remains in the pancake after the pressure is stopped and the soil tries to recompact. Such zones can be stacked one above the

Continues on page 102 ➔
other, and if the slurry is appropriately formulated, they become horizontal treatment zones. The EPA has been working on using such hydrofracture zones for in situ remediation of soils by injecting materials into the fracture zones to encourage bioremediation. (See, “Oxygen pellets spike bioremediation,” Soils, May 1994, page 14.)

To be effective, the hydrofracturing process requires good diffusion through the soil to either allow the contaminants to reach the treatment zones, or to allow the treatment materials to diffuse into the soil to reach the contaminants. This is particularly difficult in clayey soils. However, if the top and bottom pancakes in the stack are formulated with a conductive material such as graphite, they can become the electrodes for the electroosmosis process. In this way, contaminants can be pumped into treatment zones, and either be converted to environmentally benign materials, or adsorbed onto a substrate to prevent further leaching. Since the contaminants never have to reach the cathode, the voltage gradient can be periodically reversed. All that is needed is to have the contaminants pass into a treatment zone. Reversal of the voltage allows for multiple passes of the contaminant through a zone, should it not be degraded or adsorbed on the first pass. Periodic voltage reversal also helps eliminate the problems associated with operating direct current voltage in one direction over long periods of time.

In cases where the contamination is near the surface, the treatment zones and electrodes can be installed in a vertical array, using sheet piling technology. In this approach, the electrodes are sheaths of metal, driven into the ground with the same methods used in the construction industry. Treatment zones could be created with trenching technology, or other methods. Electrodes can also be made of piping, installed either horizontally or vertically. Horizontal drilling is an attractive option for contamination under buildings, roadways and other surface obstructions. (See, “Horizontal well breaks records, backs and hearts,” Soils, January-February 1994, page 22; and “Drilling on your side,” Soils, May 1994, page 22.)

The third component of the Lasagna process concerns the treatment materials themselves. The best treatment materials convert hazardous contaminants into environmentally benign materials, such as carbon dioxide and salt. Numerous laboratories have been working on formulations to enhance biodegradation. The University of Waterloo in Canada is working on the use of catalysts, such as iron, to dechlorinate chlorinated compounds in situ. If no acceptable destruction system can be devised for the particular contaminants at a site, then an adsorbent, such as activated carbon can be used. The adsorbent could either be recovered at some point, or might be left in the subsurface, if the adsorbed complex could be shown to pose no danger to the environment.

The current primary collaborators on the project include Monsanto, General Electric, DuPont, the EPA and the Department of Energy. Each of the companies is providing resources and technology to the project, and the DOE will provide funding to carry out field tests of the process at the DOE plant in Paducah, Ky. The EPA will provide $600,000 of funding to support its own efforts related to the Lasagna project and other initiatives of the Remediation Technology Development Forum (RTDF), a public and private partnership. The EPA’s efforts will be part of a Cooperative Research and Development Agreement signed in January by Carol Browner, EPA administrator, Philip Brodsky, Ph.D., director of corporate research and environmental technology for Monsanto; Richard Romanelli, director of safety and environmental management services for DuPont; and Samuel Schulhof, director of corporate environmental research for General Electric. Also integrally involved in the project is Mary Peterson of Battelle’s Pacific Northwest Labs, a key collaborator on behalf of the DOE.

Others, such as the Hazardous Substance Research Center at the University of Michigan, and the University of Cincinnati are also involved. Clean Sites serves as facilitator to coordinate and document the meetings of the collaborators.

The development of the process is being hailed for the cooperative spirit between government and the private sector, specifically EPA’s Environmental Technology Initiative (ETI), which facilitates research and cooperation among government, industry, academia and environmental groups. “The lasagna process is a perfect example of how we will work together with the private sector through ETI to bring new ideas to long standing environmental problems,” says Carol Browner, EPA administrator.

Write in 616 for more information
Announcement

Ninth Annual Conference on Contaminated Soils
Analysis, Fate, Environmental & Public Health Effects and Remediation
University of Massachusetts at Amherst
October 17–20, 1994

The annual Contaminated Soils Conference at the University of Massachusetts at Amherst has become the preeminent technical national conference in this important environmental area. The conference attracts 450-600 attendees annually which includes a wide variety of representation from state and federal agencies; military; industries including railroad, petroleum, transportation, utilities; the environmental engineering and consulting community; and academia.

Expediting Cleanups, this conference’s theme, will be supported by the development of a strong and diverse technical program in concert with a variety of educational opportunities available to attendees. The exhibition section brings real-world application to the technical theory and case studies which will be presented in the platform and poster sessions. Focused workshops will provide attendees with the type of practical application information which will impact their job performance immediately.

Breakfast discussion forums will be offered by a number of companies to encourage discussion and debate on timely technical and regulatory topics. A book and videotape viewing room will allow attendees to review information that has been, perhaps, beyond their reach previously. Employment opportunities in the field will be identified at the employment posting board.

For those attendees formally working towards professional degrees or wanting academic recognition, the conference will allow them to receive graduate credits through the University of Massachusetts. The conference promises to be an exciting opportunity for all those concerned with the challenge of developing creative cost-effective assessments and solutions that can withstand the demands of regulatory requirements.

SESSIONS

- Analysis/Environmental Fate
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- Diesel Fuel Contamination (sponsored by the Association of American Railroads)
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- Federal Technical

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- Innovative Technologies
- Polynuclear Aromatic Hydrocarbons (PAH) (sponsored by Gas Research Institute)
- Remediation
- State Issues
- Toxicity Testing (sponsored by the Gas Research Institute)

WORKSHOPS

- Analysis of Total Petroleum Hydrocarbons in Contaminated Soil
- Application of Horizontal Drilling to Contaminated Sites
- Environmental Fate of Hydrocarbons in Soils and Groundwater
- Fundamentals and Application of In Situ Bioremediation to Diesel Contaminated Soil
- Immunoassay Analysis of Contaminated Soils

- Modeling and Visualization of Hydrocarbon Fate and Transport
- Site Characterization
- Soil Washing as a Viable Remedial Technology
- State Workshop - TPH as a Rational Cleanup Standard
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